FARM AND SCHOOL PROBLEMS

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FOR

HIGH SCHOOLS AND NORMALS

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ILLUSTRATED

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PREFACE.

The introduction of Agriculture in the public schools of many states in recent years has aroused a considerable discussion relative to the purpose, scope, materials, and methods in teaching this important branch of education.

The great interest that has been taken by school children in the State and National contests in raising crops, has demonstrated that the practical side of agriculture has appealed to them with even greater force than the study of mere fundamentals.

The great demand of the rural teacher is to know what to do to make the rural school interesting and attractive and at the same time to make it an efficient factor that will help rural life to keep pace with the demands of the age.

There is also need of a more general knowledge of the magnitude, productive power, possibilities and opportunities of agriculture in the United States.

More of the spirit of cooperation between home and school will give to education a new field of material for the development of methods of instruction.

A study of agriculture in all of the states of the Union will give broader views of life and help to lift agriculture to greater heights in the field of universal interest.

The teaching of language, reading, history, physiology and hygiene, geography and arithmetic may be made to have more of the color of local environments of the rural school and thus infuse new life into old subjects.

The day of practical and technical vocational education is upon us. In the U. S. according to reports, 93% of our school children do not get any high school instruction. If they are to receive anything of practical value to assist them in solving life's problems in the production of one of the greatest of life's necessities — the things we eat — it must be done before they leave school.

Two of the greatest problems of the present time are the problems of agriculture and the rural school.

The demand is growing for definite concrete knowledge. The reading circle, the class room, the extension school, the normal training school and the agricultural high school are ready for the use of the material included in this book.

The aim of this book is to help solve the farm and school problem—in serving some of the following purposes:

1. It contains the important facts of agriculture as proven and demonstrated by the leading Agricultural Experiment Stations of the United States and foreign countries as well as the U. S. Government.

2. It contains a scientific discussion of those essential facts which are deemed absolutely practical in agriculture.

3. It is an economical study of the factors of greatest influence affecting the various operations of the farm.

4. It contains more than a thousand arithmetical problems stated for solution, requiring a more extensive and varied knowledge of mathematics than almost any other science.

5. It shows that agriculture is a mathematical problem dealing with drainage, roads, fences, mixing fertilizers, liming the soil, cost of equipment, labor, farm records and farm bookkeeping, market quotations, profit and loss in feeding, feeding balanced rations, nutritive ratios, milk records, seeding problems, crop yields per acre, farm statistics and farm management, etc.

6. It contains more than a thousand exercises, experiments and questions, leading to research work in the sciences of arithmetic, chemistry, physics, geology, botany, zoology and astronomy, as applied to experiments, observations, investigations, demonstrations, philosophy, facts, tables and rules, pertaining to practical agriculture.

For convenience, the tables for reference are placed in the text near the subject to which they are immediatetly related.

The summary in each chapter brings to the student the important points that predominate in the subject under consideration.

The cuts and illustrations are planned to serve as both scientific and artistic aids.

The score cards are at the end of the chapter treating of the objects to be judged.

The problems and questions referring to government reports are intended to lead to the formation of habits of research and the use of the bulletins and other publications.

One of the important features of this book is the list of library references at the end of each chapter.

Only such books and bulletins or publications are included as are directly related to the chapter discussed.

The list of publications is made of practical utility and value by giving the title of the book, author, grades to which adapted in the school, publisher, and in most instances, the list price.

This book will serve as a guide in preparing courses of study, selecting libraries, teaching agriculture, and in directing the actual operations of the farm.

The logical order of arrangement has been followed — soils, plants, animals, and farm management.

New subjects have been introduced and old subjects are treated in a new way.

Drainage, liming the soil, alfalfa, corn, dairying, feeds and feeding, adorning the farmstead and school grounds, the weather bureau, gardens, plants, production and consumption have received special attention. Farm Records and Accounts have received the attention to which they are justly entitled in the light of recent experience and progress in agriculture.

It is hoped that an acquaintance with the facts contained in this volume may be of inestimable value to every pupil, teacher and agriculturist.

May 25, 1915. H. L. GOLL.

INTRODUCTION.

I believe that the country which God made is more beautiful than the city which man made; that life out of doors and in touch with the earth is the natural life of man. I believe that work is work wherever I find it, but that work with Nature is more inspiring than work with the most intricate machinery. I believe that the dignity of labor depends not on what you do, but on how you do it; that opportunity comes to a boy on the farm as often as to a boy in the city, that life is larger and freer and happier on the farm than in the town, that my success depends not upon my location, but upon myself—not upon my dreams, but upon what I actually do, not upon luck, but upon pluck. I believe in working when you work, and in playing when you play, and in giving and demanding a square deal in every act of life.—*Edwin Osgood Grover.*

The truth is that even the simplest facts of chemistry and biology; facts which confront us every day of our lives, whatever our calling or vocation; facts upon the correct interpretation of which life itself may turn and does turn in countless thousands of cases every day, are still considered unworthy of attention in too large a proportion of our schools, as compared with the solution of mathematical puzzles and the raking over of linguistic rubbish heaps. Few farmers who have reached the middle period of life had the slightest encouragement in common school or high school to investigate their relationship to natural phenomena, and even the very few who found their way to college fared little better. The consequence is that the natural facts which are indefinitely simpler and more easy of comprehension than the extraction of square root in arithmetic or the solution of quadratic equations in algebra, and the correct understanding of which would be worth a thousand times more to the average individual than the ability to read at sight all the languages that have ever been spoken and forgotten, are yet sealed mysteries to the great majority of even the better educated portion of mankind.—*Chas. E. Thorne.*

Agriculture is Both a Science and an Art.

"Agriculture is the foundation of commerce."—*Gibbon.*

Agriculture is the science that teaches the most perfect and most profitable means of producing plants and animals. It is the art that transforms substances of little use and little value into products of greater utility and greater value.

In a factory we may see art transforming wool into woven fabrics; or we may see pig iron transformed into the finest watch springs or cambric needles. Just so agriculture has become a fine art. Agriculture takes fertilizers, manure, air, water, and the forces of light and heat and through the laboratories and workshops of nature, it transforms them into grain, flowers, fruits and other products.

These products are utilized by man directly, or indirectly after the change that is wrought by domestic animals, whereby we get leather, meat and wool; or by those special industries that produce flour, sugar, oil, butter, and similar necessaries of life.

Agricultural production does not depend solely upon the will of man, who directs its operations; it varies also according to certain atmospheric conditions dependent upon the region and upon the season; but science to a certain extent is sometimes made to control the forces of nature.

Agriculture is, therefore, a complex industry, requiring great knowledege when well understood, for like the climate with which its operations are directed, it is subject to extreme irregularities and peculiarities.

The agriculturist must understand the laws of cause and effect; he must investigate the results of practical experiments. Without observation, and improvement agriculture will fail. Intelligence mixed with labor, and labor mixed with love of the art will bring the greatest reward.

Scope of the Subject.

From the study of astronomy we learn something of the origin of the earth, of the earth's movements and of their relations to the causes of the seasons and their influences on plant and animal life.

The astronomical facts of greatest importance to agricultural science, are: the sun's heat; the revolution of the earth around the sun; the obliquity of the earth's axis to the plane of the ecliptic; and the rotation of the earth upon its axis.

The study of natural philosophy makes us acquainted with the laws of light and heat; of attraction and gravitation; of the nature of water, air and electricity and of various principles that are indispensable to the thorough knowledge of the natural phenomena pertaining to agriculture.

In geology we read a history of the formation of the earth's crust, with its rock formations; its fossils; i. e. shells, corals, leaves, and other remains of plant and animal life, that once existed on the globe.

Through chemistry we learn the composition of materials in soils, plants and animals and of the transformations which they undergo. And biology makes us acquainted with the principles of life as demonstrated in heredity, training, environment, evolution and progress.

Thus in the intelligent study of soils, in its relations to the elements of agriculture, the scientist must know something about the sciences: astronomy, geology, chemistry, physics, botany, zoology and biology.

It may properly be said that agriculture affords us one of the broadest fields for the development of the intellectual powers, for the study of agriculture is concerned chiefly in the three great divisions of nature — the mineral, the vegetable and the animal kingdoms.

How to Get Agricultural Information.

The United States is expending approximately forty millions of dollars annually for agricultural education. Wherever agriculture has been added to the course of study in the public schools it has therefore become necessary for teachers to become acquainted with the work that is being done by the following institutions:

1. The United States Department of Agriculture, Washington, D. C.
2. The State Experiment Stations.
3. The State College of Agriculture.
4. The State Board of Agriculture.
5. The State Department of Public Instruction.

It should be the aim of these different departments to co-operate in the promotion of agricultural instruction.

The teacher, the pupil and the farmer should know:

1. What is needed.
2. Where to get it.
3. How to get it.

The teacher should constantly have for one of his highest aims, the building up of a well regulated public school library.

The school should be on the mailing list of all the agricultural institutions that are authorized by the government to distribute free information.

All material received in the form of books, pamphlets and bulletins should be classified and systematically arranged so that they will be handy for reference.

The first important step to be taken is to write to different departments and ask for a circular giving the list of available publications.

Your congressman will assist you in getting important public documents, and other free material which the National Government may have for distribution.

Write to the United States Department of Agriculture, Washington, D. C., and ask for the following:

1. Circular 19. Publications of the Department of Agriculture Classified for the Use of Teachers.

Read carefully the "Introduction" in Circular 19 and you will understand how to secure the desired publication.

Other Lists of Department of Agriculture Publications.

These will be sent free upon application to the Secretary of Agriculture:

Publications of the Bureau of Chemistry. (Cir. 7, Division of Publications.)

Publications of the Bureau of Biological Survey. (Cir. 8, Division of Publications.)

Publications, Office of the Secretary, Office of the Solicitor, and the Division of Publications. (Circular 9, Division of Publications).

Publications of the Office of Public Roads. (Cir. 10, Division of Publications.)

Publications of the Forest Service. (Circular 11, Division of Publications.)

Publications of the Bureau of Statistics. (Circular 12, Division of Publications.)
Publications of the Bureau of Plant Industry. (Circular 13, Division of Publications.)
Publications of the Bureau of Soils. (Circular 14, Division of Publications.)
Publications of the Bureau of Animal Industry. (Circular 15, Division of Publications.)
Publications of the Bureau of Entomology. (Circular 16, Division of Publications.)
Publications of the Office of Experiment Stations. (Circular 17, Division of Publications.)
Publications of the Library. (Circular 18, Division of Publications.)
Bulletin List. (Document 723, Division of Publications.)
Monthly List of (Department) Publications. See page 2.
List of Station Publications received by the Office of Experiment Stations.

For a list of publications which the government prints and sells at cost, write to,

Superintendent of Documents, Government Printing Office,
Washington, D. C.

For a list of lectures illustrated with lantern slides, write to,
U. S. Dept. of Agriculture,
Office of Experiment Stations.

Locations of Agricultural Colleges and Experiment Stations of the United States.

Alabama	Auburn	Kentucky	Lexington
Alaska	Sitka	Louisiana	Baton Rouge
Arizona	Tucson	Maine	Orono
Arkansas	Fayetteville	Maryland	College Park
California	Berkeley	Massachusetts	Amherst
Colorado	Fort Collins	Michigan	East Lansing
Connecticut	Storrs	Minnesota	St. Paul
Delaware	Newark	Mississippi	Agricultural College
Florida	Gainesville	Missouri	Columbia
Georgia	Athens	Montana	Bozeman
Idaho	Moscow	Nebraska	Lincoln
Illinois	Urbana	Nevada	Reno
Indiana	La Fayette	New Hampshire	Durham
Iowa	Ames	New Jersey	New Brunswick
Kansas	Manhattan	New Mexico	State College

New York	Ithaca
North Carolina	Raleigh
N. Dakota	Agricultural College
*Ohio	Columbus, Wooster
Oklahoma	Stillwater
Oregon	Corvallis
Pennsylvania	State College
Rhode Island	Kingston
South Carolina	Clemson College
South Dakota	Brookings
Tennessee	Knoxville
Texas	College Station
Utah	Logan
Vermont	Burlington
Virginia	Blacksburg
Washington	Pullman
West Virginia	Morgantown
Wisconsin	Madison
Wyoming	Laramie

* Ohio has the Agricultural College at Columbus and the Experiment Station at Wooster.

Official Agricultural Score Cards.

One of the most important factors that has assisted in the improvement of domesticated animals and plants is the score card.

For a complete directory of national organizations having to do with agriculture and related subjects, including the names and addresses of their secretaries, and organizations for the promotion of the several breeds of livestock, poultry, etc., and a list of official score cards for various agricultural products, write to Doubleday, Page & Co., for The Garden and Farm Almanac for this year. (Price at News Stands 25c).

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Special credit is due J. Donald Goll for many valuable drawings used in this book.

TABLE OF CONTENTS.

PART I.

SOILS.

CHAPTER I.

Soils.

To understand the origin and formation of soil, we must first study the rocks from which our soils were originally formed. Rocks are composed chiefly of minerals belonging to four groups: silica and silicates, carbon and carbonates.

Silica is the most important material found in the earth's foundation. It is composed of silicon and oxygen. Chemistry tells us that Oxygen is the most abundant and widely distributed of all the elements. Oxygen constitutes about one-half of the weight of silica in its various forms — sand, flint, chalk, limestone, marble and clay.

Although oxygen is found in such great abundance in the atmosphere, water and soils, and is indispensable to life, yet, it does not concern our study of agriculture so much as those elements that are often found wanting in our soils. Silicon is found in all plants and may serve some purpose, but it is not known to be indispensable to plant life, so we will not consider it further in the study of plants.

The study of rocks in their relation to agriculture only needs to concern us to the extent of the following points:

1. They hold in groups combinations of elements.
2. Certain of these elements are essential to plant growth.
3. The groups of minerals in certain rocks determine the process of disintegration.
4. The character of the resulting soils are determined by the association of minerals composing the rock.

Silica, feldspar and mica are the constituents of granite. Granite, like most rocks containing silica, has disintegrated slowly under the action of atmospheric agents.

Feldspar consists of silica, alumina, along with lime, potash or soda and these elements dilate and contract unequally. Hence disintegration is rapid. It is hastened by penetration of water into the smallest fissures; the water congeals and by expansion enlarge[s] the fissures or bursts the rocks into fragments.

So by studying the composition of rocks we can determin[e] which are most easily disintegrated and by a study of soils w[e] can determine from what kind of rocks they have come. Thi[s] study of rocks and their composition has been of great importanc[e] to agriculture. Lime, phosphorus and potassium, three of th[e] elements most important to agriculture are taken chiefly from rocks.

According to geologists there have been many forces at

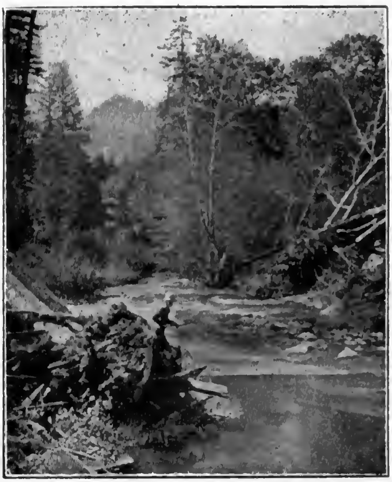

FIG. 1. How the Soils were formed.

FIG. 2. Formations. Soils, Lakes and Mountains.

work that have in many ways been responsible for the variatio[n] that now exists in our soils, and that have resulted in many of th[e] diversifications of agriculture.

In the formation of the earth's crust many of the element[s] necessary to plant and animal life were combined in the formatio[n] of various rocks. The mountains were the first parts of th[e] earth's crust to appear above the waters of a shallow ocean This has been accounted for through the theory of the contrac tion of a cooling globe that was in the beginning a fused or molten mass.

After the globe had sufficiently cooled, the moisture in the air began to condense and thus shallow oceans were formed and the atmosphere contained an enormous amount of watery vapor and carbon-dioxide for the maintenance of a luxurious vegetation on the borders of the oceans.

First there probably appeared rudimentary plants such as mosses. They derived their nourishment from the air and moisture, and became fixed to the rocks and by maintaining humidity facilitated and hastened the process of disintegration.

FIG. 3. The course of civilization.

FIG. 4. Man's work—An orchard in bloom.

When these plants that grew on rocks began to decay they left their debris with organic matter in the fissures of the rocks for the nourishment of more perfect forms of plant life. Thus we see the first steps toward vegetable life of the highest order. Trees were finally seen growing in the fissures of rocks becoming still more powerful agents in the transformation of rocks into soils.

There was a prodigious vegetation which absorbed an enormous amount of carbonic-acid gas; the vegetation was not decomposed in some places, and it was conserved under the water and the oxygen became fixed, instead of being restored to the atmosphere, and this is the carbon that we are burning today in the form of oil, gas and coal.

When the rains could not enter or permeate the hard primitive rocks the waters glided over the surface and increased the volume of torrents and carried the debris of plants, soils and rocks through the valleys to the borders of the oceans. These are known as transported soils.

As the earth grew older new forces came to assist in the process of transformation of rocks to soils. The fragments of rocks disengaged by heat, frost, plants and animals, were attacked by the action of water and its solutions (carbon-dioxide and oxygen) and were decomposed and transformed into gravel, sand, silt and clay.

To understand clearly the science of agriculture it is necessary to become familiar with the meaning of the following terms:

1. Land is the solid portion of the surface of the globe.
2. Earth is the loose material covering most of the land.
3. Soil is the earthly material capable of supporting plant life.
4. Humus is partly decayed vegetable matter in the soil.

*The inorganic constituents of the soil are but modified particles of rock. They vary in size and are usually classified according to size from the largest to the smallest as: rocks, boulders, pebbles, coarse gravel, fine gravel, coarse sand, medium sand, fine sand, very fine sand, silt, clay.

Clay soils may have particles less than 1-25000 of an inch in diameter.

Loam is clay and sand mixed with rich decayed vegetable matter.

Peat is a soil composed almost purely of vegetable matter, that is but slightly decomposed.

Muck is soil composed of a large part of well decayed vegetable matter.

A study of the origin of soils shows that they have been formed in various ways, and are known by different names:

Sedentary or *residual* soils are those that remain directly over the rocks from which they have been formed.

Transported soils are those that have been carried by the wind, water or glaciers.

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* Bulletin 24 of the U. S. Bureau of Soils gives a system of grouping and classification of soils according to size of particles.

Eolian soils are those that have been accumulated by the wind.

Alluvial soils are those that have been carried and deposited by water.

Drift soils are those that have been brought to their present location by the action of glaciers, as the drift clay in the northern part of the United States which is the result of the movement of the continental glaciers as they crept southward in prehistoric times.

These different kinds of soils and the rocks from whence they came and the rocks that lie immediately below are stored with the essential elements of soil fertility.

The soil, and the rocks, from which it is formed have been likened to a great storage battery. But fortunately for man this great mineral wealth is not immediately available for use. This plant food was stored up ages ago in such a manner that it is only given up in small quantities, only as each succeeding annual growth of vegetation has needed it, and even this is not always available without the application of some of the discoveries that are due to agricultural science.

Feldspar, a constituent of granite, contains nearly 14 per cent. potassium, or three times as much as wood ashes, but there is no known method as yet that has made it a source of great help to agriculture.

Phosphorus is distributed universally through the soil usually in combinations with iron or lime, but it has to receive some form of treatment to liberate it for use in agriculture.

Muck or peat found in swamp land is rich in nitrogen, but it is the result of vegetation that grew under such conditions that it resists decay, and the nitrogen is held in firm combination such as potassium in feldspar, or phosphorus in the rocks of Tennessee and other states in the south and west.

Therefore a soil may be rich in quantity of, and yet poor in the availability of plant food.

Soil Analysis.

"Chemical analysis is not a sufficient guide to the fertilization of the soil."—*Dr. Thorne.*

Certain soils have been found to contain 1,100 pounds of phosphorus per acre in the upper foot of earth. This is enough phosphorus to supply the requirements of this element needed to produce 4,680 bushels of wheat.

In this same soil there were 56,000 pounds of potassium, enough to supply the potassium found in 60,000 bushels of wheat.

In the same soil there was enough nitrogen to supply a crop of 4,000 bushels of wheat.

Yet the production of wheat without scientific treatment on this land is but 12 bushels per acre.

Thus the great problem of science is to determine the method of obtaining the necessary amount of plant foods that are known to exist among the rich stores of mineral wealth at our feet.

And furthermore one of the great problems of agricultural education is to dispel the illusions of those who have been planting and harvesting in the "sign of the moon" and to get the coming agriculturalist to get his inspirations from the sunlight of intelligence.

One of the most abundant of the elements in nature is nitrogen. Air is about 80% nitrogen. It is estimated that there are about 35,000 tons of this gas over every acre of land. It is only found below the surface of the land in the remains of plants, animals and soil air. It is not available for plant use, until it has been prepared through chemical changes in the soil; hence it is one of the most expensive of plant foods.

Maintaining Soil Fertility.

"A rational system of agriculture cannot be founded without the application of scientific principles."—*Liebig.*

Soil Fertility.

There are four things that must be considered in converting thin soils into productive lands.

1. Drainage, if needed by the land.
2. A sweet soil.
3. Vegetable matter or humus in the soil.
4. Available plant food in proper proportions.

In the solution of all problems relating to fertility and production we have some important laws or rules that have been established by scientific agriculture:

1. A soil is fertile when it contains all available plant foods necessary for the nutrition and growth of plants.
2. Crops remove a part of the soil's fertility.
3. Fertility is renewed by natural and artificial agencies.
4. Fertility of soil remains unchanged if all elements contained in the crop are returned to the soil.
5. The law of the minimum established by Leibig, is that a plant will develop and grow only in proportion to the essential element most feebly represented.
6. When we sell grain, hay, live stock, milk and fruit, we are removing certain constituents that must be replaced by some natural or artificial methods.
7. Various kinds of crops differ as to the amount of sunlight, heat, moisture, and plant foods that are necessary for a maximum crop.

PROBLEM.

1. If weather conditions are favorable for the growth of a crop of 100 bushels of corn per acre, and there is only phosphoric acid enough available to produce 70 bushels, and only enough nitrogen available to produce 40 bushels; what will be the yield per acre?

Natural Fertilizers.

The following table gives the fertilizer constituents in 1,000 pounds of feed stuffs, and is taken from Henry's "Feeds and Feeding":

Name of Feed.	*Nitrogen in Pounds.*	*Phosphoric Acid in Pounds.*	*Potash in Pounds.*
Corn	18.2	7.0	4.0
Corn and cob meal	14.1	5.7	4.7
Oats (grain)	20.6	8.2	6.2
Wheat (grain)	23.6	7.9	5.0
Wheat bran	26.7	28.9	16.1
Wheat middlings	26.3	9.5	6.3
Cotton seed	31.3	12.7	11.7
Cotton-seed meal	67.9	28.8	8.7
Linseed meal (new process)	57.8	18.8	13.9
Corn silage	2.8	1.1	3.7
Corn stover	10.4	2.9	14.0

Name of Feed.	*Nitrogen in Pounds.*	*Phosphoric Acid in. Pounds.*	*Potash in Pounds.*
Timothy hay	12.6	5.8	9.0
Red clover hay	20.7	3.8	22.0
Crimson clover hay	20.5	4.0	13.1
Alfalfa hay	21.9	5.1	16.8
Soy bean hay	17.5	4.0	13.2
Mixed grass hay	14.1	2.7	15.5
Kentucky blue grass hay	11.9	4.0	15.5

To find the value of the fertility or fertilizer value removed from an acre, find the production per acre; find the amount of nitrogen, phosphoric acid, and potash removed by referring to the above table and compute the value at the usual price of nitrogen at 15 c. per pound, phosphoric acid 5 c. and potash 4 c.

PROBLEMS.

1. In one year we exported 700 million pounds of linseed meal, and nearly 1,000 million pounds of cotton-seed meal; what was the fertilizer value of these two exports for one year, basing calculations on above table?

2. It has been estimated that there are 5 billion tons of high grade phosphate rocks in the United States. If on an average, a ton of phosphate rock contains 14 per cent phosphoric acid, valued at 5 cents a pound, what is the value of these 5 billion tons as a natural asset to the agricultural wealth of the United States?

3. What is the fertilizer value of one bushel of wheat? Of a bushel of corn?

4. What was the fertilizer value of the wheat exported from the United States, in 1912, if the amount was 30,000,000 bushels?

5. What was the fertilizer value of the 40,000,000 bushels of corn exported in 1912?

6. When a farmer sells a ton of timothy hay, what does he loose in its fertilizer value?

7. Find the difference between the fertilizer value of a ton of red clover hay and a ton of alfalfa hay.

8. Which will remove the most of each of the three fertilizers, nitrogen, phosphoric acid and potash from an acre of ground; 40 bushels of corn or 60 bushels of oats? Find difference in value of fertility removed.

9. Compare the value of fertility removed by 150 bushels of potatoes with that removed by 20 bushels of soy beans.

10. What is the difference in the fertilizer value of 100 pounds of corn stover and 100 pounds of oats straw?

11. Estimating the value of fertilizer constituents removed by each crop; which would yield the greater profit per acre at current prices, 30 bushels of wheat, 60 bushels of corn, or 8,000 pounds of alfalfa?

12. If the nitrogen in the air were available for plant growth and could be easily procured, what would 35,000 tons of this gas be worth at 15 cents per pound?

NOTE — Of course the difficulty in procuring nitrogen ready for plant use is responsible for the high price of nitrogen on the market. The price is subject to the law of supply and demand.

Manures.

The following facts and figures have been the results of experiments and demonstrations by The Ohio Agricultural Experiment Station:*

1. From steers fed on cement floors there were recovered about 8,500 pounds of manure per 1,000 pounds live weight in 6 months; and from those fed on dirt floors about 7,400 pounds of manure per 1,000 pounds of live weight in the same period.
2. Of the plant food in feed given fattening steers on cement floors, 75 per cent of the nitrogen, 78 per cent of the phosphorus, and 88 per cent of the potash were recovered in the manure. Of the plant food fed on dirt floors, there were 62 per cent of the nitrogen, 79 per cent of the phosphorus, and 78 per cent of the potassium recovered in the manure.
3. A large part of the nitrogen and potassium was contained in the liquid excrement and was lost which reduced the value of the manure.
4. Manure exposed to the weather in 1,000 pound piles from January to April, lost about one-third of its fertilizing value.
5. Open barnyard manure is worth about one-half as much as a fertilizer as fresh stall manure under ordinary farm conditions.
6. From $679 worth of feed and bedding used in fattening lambs, $257 worth of plant food was recovered in the manure.
7. In an experiment with cattle it was found that dairy cattle produced more manure than fattening steers.
8. It costs about $1.13 per square yard to put in cement floors in stalls, or about $4.25 to floor a stall 5 by 7 feet.
9. In the field experiments it was shown that a ton of manure produced by fattening steers, has returned a 13-year average

* Write for Bulletin 246, Ohio Experiment Station, Wooster, O.

increase to the value of $4.50, or enough to pay for cementing a stall each year.

10. Certain factors effect the value of farm manures. Species of animal, age, character of food, use of animal, bedding, all enter into the problem of determining the value of manure.
11. No two tables prepared by the best authorities give the same results in determining the value of manure for the reason that conditions, locality, climate, difference in composition of foods, breed of stock, and many other factors may cause a wide variation between the results of two experiments carried on in different places.
12. A careful study of a few of these tables will serve to show that we can make an estimate that will enable us to know very approximately what we are doing.

In estimating the difference between the profits of selling corn or hogs, hay or cattle, at the market price of each, there is no mathematical calculation that will show the correct solution that does not include the item of fertility in feeds and manures.

The following table gives results procured by Roberts:

Table I.

MANURE PER 1,000 POUNDS OF LIVE WEIGHT.

	Excrement per Year.	Manure with Bedding per Year.	Nitrogen per Year.	Phosphoric Acid per Year.	Potash per Year.	Value per Year.
	Tons.	Tons.	Pounds.	Pounds.	Pounds.	
Horse	8.9	12.1	153	81	150	$42.15
Cow	13.5	14.6	137	92	140	39.00
Sheep	6.2	9.6	175	88	133	46.05
Calf	12.4	14.8	150	105	102	40.35
Pig	15.3	18.2	331	153	130	80.60
Fowls	4.3	4.3	293	119	72	68.15

In the above table nitrogen is figured at 20 cents and the other constituents at 5 cents per pound.

Table 2.

AVERAGE COMPOSITION OF FRESH MANURES (WOLF).

	Water, Per Cent.	Nitrogen, Per Cent.	Phosphoric Acid, Per Cent.	Potash, Per Cent.	Value, per Ton.
Horse	70.0	0.58	0.28	0.53	$2.55
Cow	77.0	0.44	0.16	0.40	1.89
Sheep	64.0	0.83	0.23	0.67	3.39
Pig	73.0	0.45	0.19	0.60	2.14

This valuation is based on 15 cents for nitrogen and 5 cents for phosphoric acid and potash.

Table 3.

AVERAGE COMPOSITION OF MANURES (WITHOUT LITTER) CORNELL EX. STATION.

	Water, Per Cent.	Nitrogen, Per Cent.	Phosphoric Acid, Per Cent.	Potash, Per Cent.	Value, per Ton.
Horse	48.70	0.49	0.26	0.48	$2.21
Cow	75.25	0.43	0.29	1.44	2.02
Sheep	59.52	0.77	......	0.59	3.30
Pig	74.13	0.84	0.39	0.32	3.29

The valuation in table 3 is based on nitrogen at 15 cents per pound, phosphoric acid at 6 cents and potash at 4.5 cents per pound.

A comparison of the foregoing tables showing the value and composition from various experiment stations will show a variation, but they go to prove the accuracy of scientific investigation, for in each case there are differences in composition that are governed by species, type, age of animal, condition and character of food.

For instance, Roberts has calculated that the value of the manure produced in one year by a 150-pound pig fed on a highly nitrogenous food to be $3.34, and that of a pig of similar weight fed on a carbonaceous ration to be $1.84 for the same period.

The composition and value of mixed fresh manures according to Roberts is as follows:

Water, 75.9; Nitrogen, 0.45; Phosphoric Acid, 0.21; Potash, 0.52 per cent.

The value of this mixed manure at 15 cents per pound for nitrogen, 5 cents for phosphoric acid and potash is $2.08 per ton.

From the foregoing tables it may be estimated that live stock with the exception of poultry, sheep and hogs, will under ordinary conditions produce certain results from which we are able to reach the following conclusions:

1. 1,000 pounds of live stock on the average farm will produce about 12 tons of manure per year.
2. The value of this manure if well cared for, is worth at least $30 per year.
3. The total value of a manure is dependent upon the quality and qauntity of feed and bedding used.
4. To determine the value of manure, the farmer must calculate what the nitrogen, phosphoric acid, and potash in the manure would cost if purchased as commercial fertilizers.
5. In general it is safe to estimate that 75 per cent of the fertility in the feed is in the manure.
7. The fertilizer value as given in these tables depends upon the immediate use or the chemical treatment of these manures to prevent fermentation or leaching.

PROBLEMS.

1. It has been estimated at the price that plant food in manure would cost in fertilizers, that we are producing annually in the United States, manures worth as fertilizers $2,353,000,000. If 60 per cent of our manure is wasted what is the loss to the farmers of the United States?

2. If 40 per cent of all losses such as leaching and liquids could be prevented, what would be the gain in value of fertilizers annually?

3. If on an average we can save 90 per cent of the fertility in feed given to fattening cattle, how much can we save in value of fertilizers in feeding 8 ton of alfalfa? 100 bushels of corn? 2 ton of timothy hay? 50 bushels of oats? (See table page 7).

4. If a horse weighing 1,000 pounds consumes 2 pounds of cottonseed meal, 6 pounds of shelled corn, 6 pounds of wheat bran, and 13

pounds of timothy hay per day, when he is doing hard work; calculate the cost of such a feed for one year; determine the value of fertilizer requirements contained in the manure and find difference between cost of feed and value of manure.

Experiments.

1. Horse manure was lightly packed in a box and left exposed to the weather from March 30 to September 30, with the following results: Analyzed and weighed

	April 25.	*September 30.*
Gross weight	4,000	1,730
Nitrogen	19.6	7.79
Phosphoric acid	14.80	7.79
Potash	36.00	8.65

What was the per cent of loss in gross weight and in each of the elements given?

2. At the same time and in the same way, cow manure was treated with 300 pounds of gypsum, with the following results:

Gross weight	10,000 lbs.	5,125 lbs.
Nitrogen	47 lbs.	28 lbs.
Phosphoric acid	32 lbs.	26 lbs.
Potash	48 lbs.	44 lbs.

What was the per cent loss? To what do you attribute the difference in loss between problems 1 and 2?

Field Studies and Soil Experimentation By the School.

Each school should be supplied with reports or bulletins from the state in which the school is located, giving the results of the station's work in soil fertility and fertilizer experiments.

1. Make a collection to illustrate the different kinds and sizes of particles into which rocks have been ground or broken up by the forces of nature, such as stones, gravel, coarse sand, medium sand, fine sand, very fine sand, silt, and clay.
2. Have a collection of the three leading types of farm soils made up of the different soil constituents. The three leading types are sandy soils, clay soils and loam soils.
3. Examine soil particles under a strong microscope, magnifying at least 500 diameters. Make observations as to color, size, smoothness, shape, stickiness. Spread out a small portion of the dry soil on a glass plate and examine carefully with a magnifier. What minerals can you recognize? What percentage seems to be sand? Clay? Humus?

4. Make an experiment by placing some soil of each variety in a test tube, filled with water; shake well and allow the particles to settle. Note results. Which kind of particles settle most rapidly?

Fertilizer Experiments By the School.

1. Study composition of soil humus or organic matter. Use soil auger to determine color and formation of soils at different depths. Examine the three distinct layers — the surface soil, the subsurface soil and the subsoil. Examine the differences as shown on the side of a deep ditch.
2. Look along rock exposures or foundations of buildings for evidences of crumbling rock. What causes this decay? What term is given to the product of this decomposition?
3. Examine the bank or sides of any freshly made excavation or cut. How does the color of the material in the upper part of the cut differ from that in the lower? Look for roots of trees and other forms of vegetation. What work are they doing? How do they aid in making soil?
4. Examine the material just below the leaves in the woods or the sod or plant refuse in the field. What is the color? Describe the texture? What is its origin?
5. Take samples of the soil from the upper slopes of a fairly steep hill and from its base. Compare the two as to color, texture and composition. Which would be considered the richer soil? What has caused the difference?
6. Examine the soil of an old cultivated field and compare it with the soil of a fence row or uncultivated field or new ground that has never been plowed and note the difference. Why this difference?

Questions.

1. What is the relation of geology to agriculture?
2. What is soil?
3. Discuss four ways by which soils are formed?
4. How do plants and animals help to form soils?
5. What are loamy soils? Sandy soils? Clay soils?
6. What is a limestone soil? An alkali soil?
7. How may subsoil differ from surface soil?
8. When is a soil fertile and how may it become depleted of fertility?
9. When is a soil poor? Barren? Arid? Arable?
10. What is *available plant food?*
11. Can a soil be rich in plant food elements and at the same time be poor in available plant food? Why?

12. Why are some soils adapted to one kind of crop and not to another?

13. Where are the soils of greatest value in your vicinity? What makes them so?

14. Specify the crops considered best adapted to the different soils of your locality.

15. Discuss the loss of fertility in the sale of eggs, milk and meat, as compared with the loss of fertility in selling clover, alfalfa and corn.

16. Which is the better method of conserving the natural resources of the farm; to sell grain and hay or to sell eggs, meat and milk products?

17. An analysis of various soils in the United States showed on an average the presence of 3,000 pounds of nitrogen, 4,000 pounds of phosphoric acid, and 16,000 pounds of potash, in the upper foot of earth per acre, what would be the effect on agriculture if these elements were immediately available for plant food?

Books For Reference.

1. First Principles of Soil Fertility—Vivian, 7-10—Orange Judd Co., $1.00.
2. The Soil—King, 8-12—Macmillan Co., $1.50.
3. Principles of Soil Management—Lyon & Fippin, 8-12—Macmillan Co., $1.75.
4. Soils—Hilgard, 8-12—Macmillan Co., $4.00.
5. Soil and Crops of the Farm — Morrow & Hunt, 8-12 — Webb Pub. Co., $1.00.
6. Soil Fertility and Permanent Agriculture—Hopkins, 8-12—Ginn and Co., $2.25.
7. The Soil—Hall, 8-12—E. P. Dutton & Co.
8. Soils—Burkett, 8-12—Orange Judd Co.
9. Soils—Fletcher, 8-12—Doubleday, Page and Co.
10. Soils and Fertilizers—Snyder, 8-12—Macmillan Co.
11. Fertilizers and Crops—Van Slyke, 8-12.
12. Talks on Manures—Harris, 8-12.
13. The Farm that Won't Wear Out—Hopkins, 7-10.

Bulletins by the U. S. Department of Agriculture.

FARMERS' BULLETINS.

Number.

257. Soil Fertility.

406. Soil Conservation.

421. Control of Blowing Soils.

RUREAU OF SOILS.

Number.

22. The Chemistry of the Soil.
28. Studies on the properties of a Sterile Soil.
35. Alkali Soils of the United States.
34. Reclamation of Alkali Soils.
2. Soil Moisture.
10. Mechanics of Soil Moisture.

50. Moisture Content and Physical Condition of Soils.
51. Absorption of Vapors and Gases by Soils.
52. Absorption by Soils.
53. The Isolation of Harmful Organic Substances from Soils.
54. The Mineral Composition of Soil Particles.
55. Soils of the United States, Based upon the Work of the Bureau of Soils to January, 1908. Part I, Results of Recent Soil Investigations. Part II, Classifications of the Soils of the United States.
58. The Composition of Commercial Fertilizers.
59. Heat Transference in Soils.
62. Fertilizers for Cotton Soils.
67. Fertilizers on Soils Used for Oats, Hay, and Miscellaneous Crops.
68. The Movement of Soil Material by the Wind.
70. Some Effects of a Harmful Organic Soil Constituent.
72. Barium in Soils.
74. Chemical Nature of Soil Organic Matter.
75. Lawn Soils.
76. A Review of the Phosphate Fields of Florida.
77. Organic Compound and Fertilizer Action.
82. The Effect of Soluble Salts on the Physical Properties of Soils.

Write to the U. S. Department of Agriculture and ask for Dr. Wiley's "Methods of Analysis", Bulletin No. 107 (Revised). (272 pages). This important work not only gives methods for analysis of soils and fertilizers, but gives methods for analysis of plants, foods and feeding stuff, liquors, drugs and various products. It should be in every well equipped agricultural laboratory.

CHAPTER II.

Drainage.

MODIFYING THE SOIL.

Soil can be modified in some of the following ways:

1. Drainage.
2. Plowing and cultivation.
3. Humus in the soil.
4. Application of chemical fertilizers.
5. Cropping.
6. Rotation of crops.
7. Inoculation.

Drainage is one of the great world problems.

The drainage investigations conducted by the United States Government furnishes information that ought to play an important part in the development and conservation of our natural resources.

There are in the United States about 79,000,000 acres of land exclusive of tidal marshes that can not be profitably cultivated on account of too much moisture. There are over 60 million acres of swamp lands in the United States east of the 100th meridian.

It has been estimated by experts that the following number of acres can be drained with profit as follows:

52 million acres that are continually wet.
7 million acres of wet grazing land.
14 million acres that periodically overflow.
5 million acres that are periodically swampy.

PROBLEMS.

1. Assuming that 50 million acres of this land is practically worthless, and that drainage would make this land worth $100 per acre, what would be the net profit measured by land values if the cost of drainage were on an average $25 per acre?

2. It has been estimated that the increase of annual income from

the drainage of these extensive areas would amount to $278,000,000. This would represent an income of 6 per cent on how much capital or wealth?

Drainage is one of the first and most important of farm problems.

When water stands on the ground or near the surface for a certain length of time it interferes with the operations of the farm and with the growth of crops in some of the following ways:

1. It prevents or retards tillage, planting, cultivation and harvesting.
2. It renders soils soggy, compact and causes acidity.
3. It prevents the proper condition of temperature, moisture and ventilation.
4. It does not remove the more soluble salts formed by the decay of rock and organic matter and gives rise to alkali lands.
5. It causes stagnation of soil water; prevents aeration; excludes oxygen.

Wet soils remain cold because of the following reasons:

In undrained lands which contain more than 20 per cent moisture (which is about the average amount of moisture for growing crops) the surplus water must be removed to a very great extent by evaporation.

In the evaporation of one pound of water, as much heat is required as would raise the temperature of 21 square feet of surface soil, one foot deep, one and one-fourth degrees. The waste of sunshine in evaporation of moisture in a soil containing over 20 per cent moisture is very great.

Very few of the cultivated crops will grow where the soil temperature is below 45° F. The maximum results are reached at about 70°, which is about the proper temperature to germinate corn.

Necessity of Soil Ventilation.

Oxygen is as necessary in the soil for its different forms of life as it is in the air that we breathe.

Oxygen performs various uses in the soil, as,

(a) Removing undesirable gases, caused by germination and growth.
(b) It is essential to germination.

(c) It is essential to the life of the organisms that transform the nitrogen of organic matter into nitric acid.

(d) It prevents the action of denitrifying organisms. (Those that destroy nitrogen).

Effects of Too Much Water.

When there is too much water in the soil it excludes the air, prevents the nitrogen fixing bacteria from taking the free nitrogen of the air in the soil and combining it with oxygen and hydrogen to form nitric acid.

Thus the successful growth of alfalfa, clover and other legumes is impossible where bacteria cannot live.

Effects of Too Much Drainage.

Too much soil air in a rich soil will result in such strong development of nitrates, that humus and other organic nitrogen are quickly changed into soluble forms and leach away before they can be utilized by the growing crops.

Coarse sandy soils are often impoverished through too much ventilation and leaching.

Water-Drainage and Plant Growth.

The roots of corn, oats, clover and alfalfa will penetrate to a great depth if not restricted by water standing in the soil.

If water stands near the surface of the soil, the area for root development will be very small and the growth of the plant above ground will correspond to the development of its system of roots.

A wet puddled soil excludes air and resists root penetration.

A well drained soil will, in dry weather produce a better crop than the same soil will produce when it is undrained.

High, rolling or hilly land needs drainage for many of the same reasons that low lands are often drained.

The following illustration shows that water falling on cultivated land of good tilth does not enter the tile or ditches until the water in the soil rises to the level of the drains.

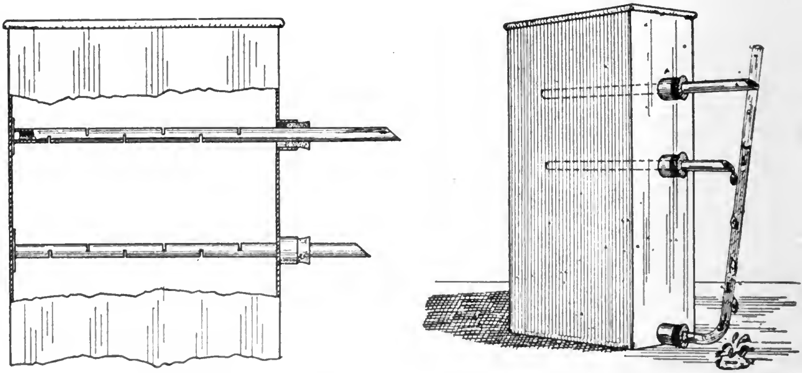

Fig. 1. Drainage apparatus used to show the action of tile in a drained soil. The drawing at the right shows the apparatus in use. The height of the water table is indicated by the level of the liquid in the glass tube. The figure to the left is a cross-section showing the slitted tubes in place. This shows that when the water table rises after a rainfall the deeper drain will be the first to carry water from the field.

When rain falls upon the soil, its tendency is to sink vertically downward until it reaches the *water table,* which is the point at which the pores in the rock or soil are completely filled with water.

Ground-water does not often have a horizontal surface. It usually rises or falls as the surface of the ground above it.

Beneficial Effects of Draïnage.

The benefits derived from drainage are many and important in their effects, among which may be mentioned some of the following:

1. It improves the physical condition of the soil.
2. It increases aeration and improves sanitary conditions.
3. It raises the average temperature, and lands warm up earlier in the spring.
4. It improves granulation, increases available moisture capacity.
5. It firms the soil and reduces heaving and erosion.
6. It removes injurious salts from alkali soils and makes sour lands sweet.
7. It enlarges the root zone and increases the available food supply.
8. It promotes the growth of desirable organisms.
9. It makes early plowing possible, and helps cultivation in killing weeds.

10. It facilitates the germination of seeds and insures a better stand of crops.
11. It makes work easier, decreases the cost of production and increases the income from the farm.
12. Drainage is one of the most important factors in the development of our agricultural resources and is therefore of far reaching influence in its bearings on civilization.

Methods of Drainage.

Land may have natural or artificial drainage.

A river system represents a natural method of drainage.

Water is often drained and carried through sand, gravel or porous rocks to lakes or streams.

The artificial method of removing water from the soil may be accomplished in two general ways:

(1) Drainage through open ditches and tile drains, to facilitate percolation.
(2) Surface culture, to hasten evaporation.

The rapid drainage of water through tile and ditches into streams and their tributaries often adds to the rapid rise and destructive effect of water in flood districts.

The Open Ditch.

The open ditch system of drainage has many objectionable features, such as the following:

1. Ditches become filled up.
2. There is great expense in cleaning.
3. Fields often have to be cut up into small and irregular tracts.
4. Open ditches hinder the use of improved machinery.
5. They make cultivation and other work more expensive.
6. There is also the loss in areas occupied by ditches.
7. Standing water in open ditches is unsanitary.
8. They are almost constantly in need of repair.
9. They are dangerous to laborers and live stock.

Advantages of Tile Drainage.

1. A good system of tile drainage will last a life time.
2. There is but little expense in maintaining a tile drain that has been properly constructed.
3. The increased production of crops will in a few years more than pay for the cost of tile drainage.

Facts About Tile.

Tile are made of clay or cement.

Clay tile are made of clay suitable for making good brick.

Tile range in size from 2 to 36 inches in diameter.

They range in length from 12 to 30 inches.

A round tile is stronger and will hold up more weight than hexagonal or octagonal tile.

Round tile are more easily handled, hauled and shipped.

Soft-burned tile if not below the frost line in the ground will crumble.

Hard-burned or vitrified tile are not injured by freezing unless water stands in the tile.

Thick tile make the best joints because they are not so apt to slip out of place as thin tile.

The United States Government reports recommend that tile should weigh at least as follows per foot:

Four inch tile....................................Six pounds.
Five inch tile....................................Eight pounds.
Six inch tile....................................Eleven pounds.

Experience has proven that no tile smaller than 3 inches should be laid, and 3 inch should never be used except where there is ample fall and where the lateral drains are laid close together. The smaller the tile the more easily and the more apt they are to become displaced, and the flow of water to be retarded by the disconnection.

(For facts relating to cement tile, read Farmers' Bulletin, No. 524, U. S. Dept. of Agriculture.)

It is better to use too large tile than too small.

Rules for Laying Tile.

In all instances the size of tile to be used will depend upon some of the following conditions:

1. The fall or grade from the beginning of the ditch to the outlet.
2. The type and nature of the soil as to percolation of water.
3. The average amount of rainfall annually.

4. Amount of water brought in by springs and adjacent territory.
5. The nature of the crops to be produced.
6. The depth of the ditch.

The deeper the drain, the wider the area that will be drained. In open soils drains should be deeper and farther apart than in close stiff soils.

Tile are put in from 2 to 4 feet deep according to the variations in the character of the soil.

Successful alfalfa growing depends upon deep tiling.

The deeper the drains the more water will be carried, when the drains are close enough to each other to keep the water table at about a uniform depth.

If a soil has had its non-capillary pores emptied to a depth of 3 feet, and another soil has had its pores emptied to a depth of 2 feet, the capacity of the deeper drain for storing a heavy rainfall is far greater than that of the shallow drain.

How the Water Enters the Tile.

When glazed tile are used, water can only enter by way of the joints, but where porous tile are used water enters the drain both by way of the joints and through the walls.

Experiments have demonstrated that water will pass through the walls of cement tile much more rapidly than through clay tile.

When water flows through tile for a considerable distance the friction of the water against the walls of the tile, greatly retards the flow of water.

When the flow of water is retarded by friction, joints, and curves, provision for greater flow must be made by using larger tile.

* On account of the friction on the walls of small tile, the amount of water carried when tile are running full, will increase faster than the squares of their inside diameters—as the tile are increased in size.

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* The area of the opening in an 8 inch tile is four times as great as that of a 4 inch tile, but the friction in the 4 inch tile is greater in proportion to the amount of water carried than in the 8 in. tile.

The areas of cross sections of tile increase in size as the squares of their diameters. If their diameters are 3, 6, 7, 12, their areas will be in the ratio of 9, 36, 49, 144, etc.

PROBLEM.

If the opening at the end of a tile 4 inches in diameter, is 12.56 + sq. in., what is the area of the opening at one end of a 10 inch tile?

Solution: $4^2 : 10^2 :: 12.56+ : (\ ?\ )$

$4^2 = 16.$

$10^2 = 100.$

$100 \div 16 = 6\frac{1}{4}.$

$6\frac{1}{4} \times 12.56+ = 78.59.$

78.59 + sq. in. is the area of the opening of a 10 inch tile.

PROBLEM.

1. How many times greater is the capacity of a 12 in. tile for carrying water, than that of a 6 in. tile?

2. What size tile will be required to carry four times as much water as a 5 inch tile?

The greater the fall, the greater the capacity to carry water. Doubling the grade increases the carrying capacity approximately one-third.

PROBLEM.

1. A 6 inch tile drain which has two inch fall per 100 ft. will drain a certain piece of land; what sized tile, in a drain with a fall of 4 in. per 100 ft. will be required to remove the same amount of water in the same length of time?

It has been recommended in the Government Reports, that in the dark silt loams of Illinois and Iowa, where the rainfall approximates 36 inches per year, the following rule holds good in actual practice:

For A Main Ditch.

An 8 inch tile with a fall of 2 inches to the 100 feet will drain 40 acres.

A 7 inch tile with a fall of 2 inches to the 100 feet will drain 30 acres.

A 6 inch tile with a fall of 2 inches to the 100 feet will drain 19 acres.

A 5 inch tile with a fall of 2 inches to the 100 feet will drain 10 acres.

A 4 inch tile with a fall of 2 inches to the 100 feet will drain 6 acres.

On the level soils of the South Atlantic and Gulf States where there is a heavier rainfall, the same tile as recommended above will drain about 75 per cent as much land as in Illinois and Iowa.

The less the fall the less will be the capacity of the tile to remove the water, and therefore the larger must be the tile used.

Systems of Drainage.

The distance apart at which tile drains should be placed will depend upon the character of the soil and the depth at which they are to be placed.

A depth of less than three feet is too shallow for the growth of many of our farm crops, and the distance between tile drains will vary from 40 feet in very heavy clays to 100 feet in loose open soils.

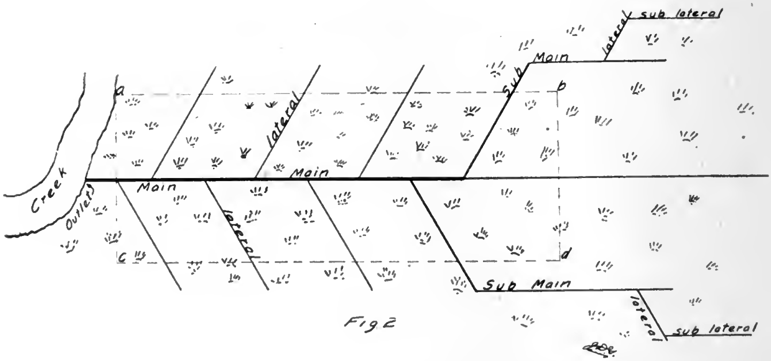
The following plans seem to be generally in use:

In heavy clay soils the distance apart for drains is 30 to 50 ft.
In ordinary loams the distance apart for drains is 40 to 60 ft.
In muck soils the distance apart for drains is 60 to 80 ft.
In sand or loam with clay subsoil near the surface the distance should be about on the average, 50 feet.

On the following page figure (2) represents a common arrangement and is shown here to make the student acquainted with the different terms and features of the work:

The rectangle a b c d represents an area that is double drained.

NOTE TO TEACHERS — Have pupils in the class in agriculture draw a diagram of the drainage of the home farm or some farm adjacent to the school house. Have them draw plans for a complete system of tiling, giving size of tile required, also depth and fall required.

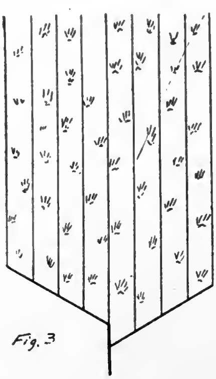


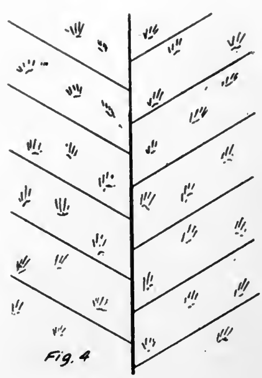
The following table gives the approximate number of feet of tile which will be required per acre, when laid in parallel lines:

20 feet apart	2,205 feet
30 feet apart	1,470 feet
40 feet apart	1,102 feet
50 feet apart	880 feet
100 feet apart	440 feet

This does not include the intercepting drain which may be necessary in some cases to complete the system.

The following cuts will illustrate the different systems of laying tile:





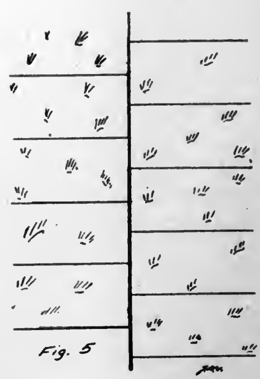


FIG. 3. One system of laying tile. FIG. 4. A common system of laying tile.

FIG. 5. In which the laterals are laid at right angles to the main.

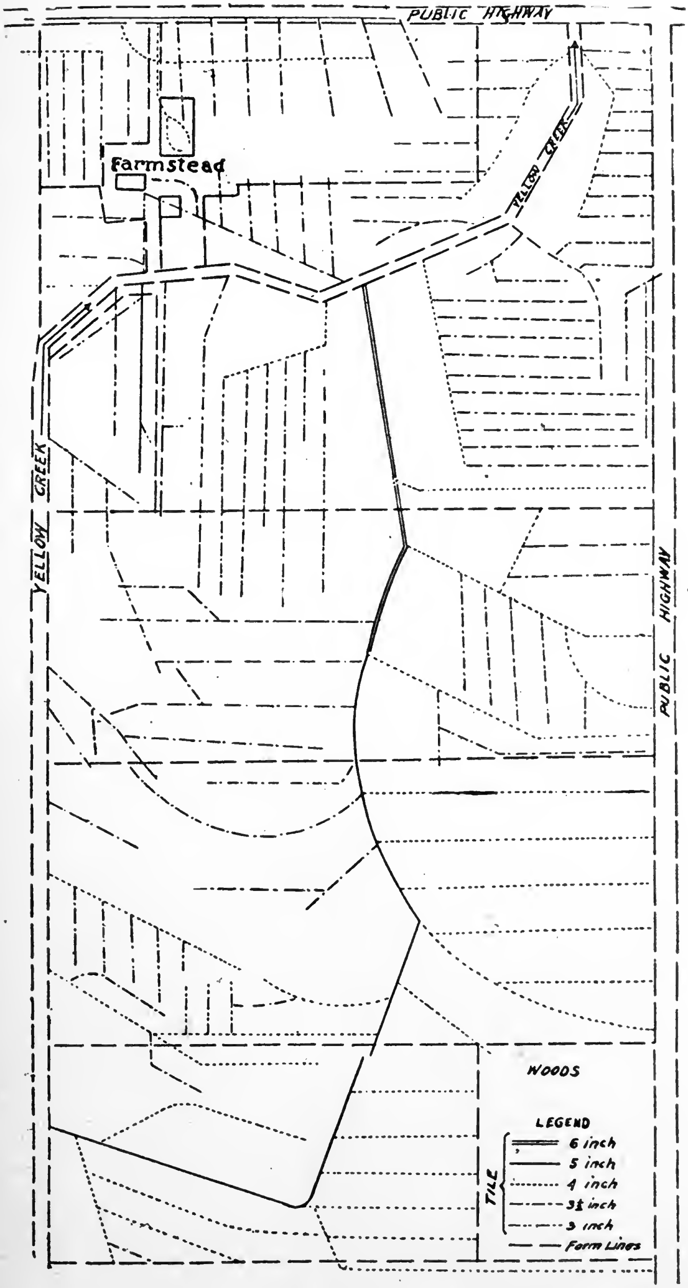


FIG. 6. This map prepared by the owner of this 80-acre farm, shows a complete system of drainage planned and installed on an ideal farm in the corn belt.

On the average farm there is very little regard for definite plans and systems for future use in drainage; consequently the practice is now generally followed of putting in "strings" of tile in low wet places without regard to future requirements or improvements.

There should be a drainage plan for the farm.

There should be a map showing location, depth, and size of tile.

A map will be of great importance when drains need to be cleaned, repaired or when new drains are to be installed.

EXERCISES.

1. Draw plans for a complete drainage system for the home farm or some convenient tract of land adjacent to the school grounds.

2. Draw plans for draining the school grounds.

PROBLEMS FOR SOLUTION.

1. If the capacity of tile to carry water varies as to the square of the diameter, how many times as much water will 6-inch tile carry as 4-inch tile?

2. If in doubling the grade or fall for 100 feet of a tile drain, its capacity for carrying water is increased about one-third, how much will the carrying capacity be decreased if the grade is lowered by one-half?

The Cost of Tile.

3. A study of 21 Ohio farms slightly above the average in farm management, showed an average investment of $366.43 per farm for drainage; if the average size of the farms was 165 acres, what was the amount expended per acre for tiling?

4. At an expense of $20 per acre, how many acres could be thoroughly tiled for $366.43?

The price of tile usually varies with the locality. An investigation of the cost in various parts of Ohio, as reported by reliable authorities show that on an average:

Two and one-half inch tile cost 14 to 16c per rod.
Three inch tile cost 16 to 20c per rod.
Four inch tile cost 19 to 25c per rod.
Five inch tile cost 30 to 36c per rod.
Six inch tile cost 40 to 50c per rod.

Eight inch tile cost 70 to 80c per rod.

Ten inch tile cost \$1.00 to \$1.40 per rod.

5. Find the cost per thousand of each of the above sized tile at the average price quoted above?

NOTE. (Average price of 5 inch tile $= 30 + 36 \div 2 = 33$)

Tile are usually sold by the thousand or hundred; 16 tile being counted per rod.

Cost of Tiling.

The cost of digging the ditch, laying the tile, and filling the ditch is a simple problem and can be easily solved.

The wages for good ditchers can usually be computed at 25c per hour.

The following table has been compiled by a competent, practical drainage engineer:

APPROXIMATE COST PER ROD OF DIGGING DITCH, LAYING TILE, AND BLINDING UNDER CONDITIONS NAMED ABOVE.

Depth of Ditch.	*For 4 inch, 5 inch or 6 inch tile.*	*For 8 inch tile.*	*For 10 inch tile.*
2 feet	25 cents	34 cents	42 cents
2½ feet	28 cents	38 cents	47 cents
3 feet	32 cents	42½ cents	53 cents
3½ feet	35 cents	48 cents	60 cents
4 feet	40 cents	54½ cents	68 cents
4½ feet	45½ cents	62 cents	77 cents
5 feet	52 cents	70 cents	87 cents

Where the ground is so hard that it will require the use of a pick or bar, the cost will be much higher than given in the above table.

PROBLEMS.

1. A 40 acre farm has a complete system of drainage; the main drain consists of 80 rods of 8 inch tile laid at an average depth of three and one-half feet. What was the cost of digging, laying and blinding @ 48c per rod?

2. What was the total cost of the tile drain described in problem 1, if the cost of the 8 inch tile in the field were \$50 per thousand?

3. If the laterals on the farm described in problem 1, are (of 4 inch

tile) 100 feet apart and require 436 tile per acre, what was the total cost of the laterals for a complete drainage of the 40 acres @ 1.5 per tile plus 28c per rod for putting in the tile at a depth of 2 feet and 10 inches?

4. What was the total cost of putting in the complete system in the 40 acres mentioned in the three foregoing problems?

5. If a 40 acre field which is thoroughly drained yields 70 bushels of corn per acre, which is 50 per cent more than the yield before it was drained, how many such crops will be required to pay for the cost of tiling as given in the solution of problem 4, if the corn is sold at the present market price?

Experiments.

CAPILLARITY AND OSMOSIS.

1. Fill two glass jars of equal size with water. In one of these submerge the roots of a healthy growing plant. Note carefully the difference in the amount of water evaporated from each jar in a given time.

2. Equipment.

(a). Soils of different kinds, sand, clay, gravel, etc.

(b). Cans or jars of equal size and weight.

Directions. Fill each can or jar to the same depth with a different type of soil. Pour equal quantities of water into each. Mix thoroughly. Weigh each day and note the amount of water evaporated from each and tabulate the results for one week. What is the per cent of moisture lost from each kind of soil at the end of the experiment?

3. Show by means of glass tubes of different diameters, how the water in the tube of least diameter will rise to the greatest height.

4. Cut slices from a pared potato and place some in pure water and some in salt solution. In the course of about an hour, examine and compare results.

5. Get a thistle tube or lamp chimney and cover the end with parchment or piece of bladder. Fill with a strong solution of salt. See that the tube or chimney will hold the liquid when poured into it. Fasten the tube into a jar partly filled with water, so that the water in the jar is just level with the salt solution in the tube. After an hour observe the rise of water in the tube above the level of the water in the jar. The process by which the water enters the tube is called osmosis.

6. Place a young green plant with its root system in a jar. Pour into the jar enough water to cover the roots. Cover the top of the jar around the stem so as to prevent evaporation of water. Weigh carefully at certain intervals and find loss of weight by water passing upward through the plant. What is this movement called?

7. Fill a two-inch gas pipe with water. Stopper each end to prevent water from running out. Place the pipe in a horizontal position, so it will be as nearly level as possible. Remove the stopper at one end.

Note results. How long did it take the water to run out? Was there any water left in the pipe?

8. Perform the same experiment as in (7) giving the gas pipe an amount of fall at one end at the rate of 3 inches per 100 feet; 5 inches per 100 feet, 10 inches per hundred feet; and in each case find the time required for the water to run out.

Farm Lands:

Let pupils use sand to show topography of immediate locality; draw map of a well-drained farm and illustrate elevations, depressions with relief worked out in sand; show water courses; arrangement of fields. Show location of buildings, orchards, wells, woodlands, pasture lands, crops and other important features of farm management.

Questions.

1. What effect does a tile drain have on percolation?
2. What effect does tile drainage have on erosion?
3. How does drainage increase the feeding area of plants?
4. How does drainage affect the growth of plants in dry weather?
5. Can a soil be too well drained or aerated?
6. If the water level is three inches below the mouth of the tile at the outlet, how much rainfall will be required before the water will run through the tile?
7. Make a list of tools required for constructing tile drains.
8. What is a catch basin, how constructed? Give use.
9. In what type of soils are tile drains apt to become filled up? Why?
10. Describe the difference between the two systems of draining rolling and level land.
11. Will a tile drain in a basin "draw" or drain a larger area than a drain in a level field?
12. Describe some of the soils that have natural drainage.
13. What are some of the disadvantages of a leachy self drained soil?
14. Is land that requires tiling and ditches usually the most valuable land? Why?
15. What effect has drainage had upon the flood areas of the country?
16. What is the difference between irrigation and drainage?
17. Describe a system of irrigation.
18. Explain how freezing caused heaving in wet soils.
19. What is a dead furrow? What are its uses and inconveniences?
20. How does a tile drain reduce the effects of erosion?

21. How should the outlet of a drainage system be protected?

22. Why is sand very soft and yielding under water and why is it immediately hard after the water is withdrawn? (Observe results on the beach or shore of a body of water).

23. Why is sand soft and yielding when dry and why is clay that has lost in moisture very hard and firm?

24. How do growing crops help the tile drains to dry the soil?

25. How do growing crops expand the growing surface of the soil?

26. What is the relation of tillage to tilage?

27. What is Dry Farming?

28. What is a reservoir? Describe different uses.

29. What becomes of the rain that falls on the farm?

30. In what 3 forms does water exist in the soil? Which form is most useful to plants?

31. What is capillary water? Hygroscopic water?

32. What kind of soil holds the most capillary moisture? The least?

33. What effect on conservation of moisture does rolling have on loose soils?

34. What is a dust mulch? Its effect? How made?

35. What should distance between tile drains depend upon?

36. How do you determine the depth at which soil should be drained?

37. What is stagnant water, and the cause of alkali lands?

38. Why should the fall for a tile drain be uniform and if possible not less than 2 inches per 100 feet?

39. Explain how irrigation, surface culture and drainage may effect the climate of a region.

40. How does drainage effect vegetation, as to forestry? as to field crops? as to weeds?

41. Will all the water run out of a level drain?

Reference for Collateral Reading.

BOOKS.

1. Irrigation & Drainae—King*, 8-12—Macmillan Co., $1.50.
2. Irrigation Institutions—Mead, 8-12—Macmillan Co., $1.25.
3. The Conquest of Arid America—Smythe, 8-12—Macmillan Co., $1.50.
4. Practical Farm Drainage—Elliott, 8-12—John Wiley and Sons, $1.50.
5. Physics of Agriculture—King, 8-12—F. H. King, Madison, Wis., $1.50.
6. Farm Drainage—French.
7. Drainage for Profit—Waring.

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*Figures 8-12 indicate grades to which book is adapted.

Bulletins, U. S. Department of Agriculture.

FARMERS' BULLETIN.

Number.

40. Farm Drainage.
524. Tile Drainage on the Farm.
187. Drainage of Farm Lands.
371. Drainage of Irrigated Lands.
158. How to Build Small Irrigation Ditches.
263. Practical information for Beginners in Irrigation.
373. Irrigation of Alfalfa.
399. Irrigation of Grain.
404. Irrigation of Orchards.
329. Dry Farming.
138. Irrigation, in Field and Garden.

CHAPTER III.

Fertilizers.

FACTS ABOUT FERTILIZATION.

1. Soils of equal fertility do not respond with equal satisfactory results.
2. The average result is probably the accurate measure of relative efficiency.
3. It is impossible to determine even approximately the profit or loss resulting from use of fertilizers on a basis of one year's use as an experiment; the estimate must be based on results requiring a period of time of sufficient length to determine its effects on succeeding crops.
4. The full benefits to be derived from scientific use of fertilizers may be fully realized when properly applied for periods ranging from 10 to 20 years and even longer.
5. The results may be determined from the average price and production for a series of years with rotation of crops.
6. Statistics show that the average yield per acre in Wayne County, Ohio, for the ten years 1900-1909, were as follows: corn—28 bushels; wheat—18 and one-half bushels; oats 30 bushels.
7. The Ohio Experiment Station at Wooster, Wayne Co., Ohio, demonstrated with the use of lime, manure and fertilizers, in a four year rotation of corn, oats, wheat and clover on a soil representing the average fertility of the soil in Wayne Co., that the average production annually can be brought up to the following figures: corn—76 bushels; wheat—36 bushels; oats—60 bushels.
8. On the unfertilized plots at the experiment station on land that was of originally the same character as the high producing plots before they were fertilized, the rotation was the same but the yield was only; corn—28 bushels; wheat—13 bushels; oats —27 and one-third bushels.

Principles of Fertilization.

1. Fertilizers should be suited to the crop to be supplied.
2. All plants do not require the same quantity of each element in plant food.

3. Some crops require sturdy vegetative growth, as, celery, beans, peas and onions.
4. Some crops require less nitrogen and more phosphorus which must often be supplied as in wheat, corn and other grains.
5. Briefly stated the functions performed by three of the most essential elements are as follows:
   (a) Nitrogen increases the rapidity of plant growth and makes the leaves dark green and lengthens the period of growth.
   (b) Phosphorus assists in starch formation and increases the number of seeds and hastens maturity.
   (c) Potash strengthens the straw, increases the size of the roots, and grain, and helps to give color and flavor.
6. Asparagus, celery, onions, cabbage, and other similar plants require quick growth to have tenderness, and barnyard manures and suitable fertilizers as supplements are required that there may be plenty of nitrogen, phosphoric acid and potash in an available form. A liberal amount of nitrogen with a medium amount of phos. acid and potash is best suited for these crops.

Read — (O. A. E. S.) Cir. 79., C. E. Thorne. Wooster, O.

Facts About Fertilizers.

1. The farmers of the United States paid out 104 million dollars for commercial fertilizers in 1909 according to a report of the U. S. Census Bureau.
2. A complete commercial fertilizer is one that contains some of each of the three elements,—nitrogen, phosphorus and potassium.
3. Nitrogen is usually expressed in the term of the compound called ammonia;
   Phosphorus is usually expressed in the term of the compound called phosphoric acid;
   Potassium is usually expressed in the term of the compound called potash.
4. One of the common complete commercial fertilizers in the U. S. is a 2-8-2 fertilizer; this means that in 100 pounds of this fertilizer there are 2 pounds of ammonia, 8 pounds of available phosphoric acid, and 2 pounds of potash.
5. In terms of actual plant-food elements, one ton of 2-8-2 fertilizer would contain 33 pounds of nitrogen, 80 pounds of phosphorus, and 33 pounds of potassium.
6. One per cent ammonia equals .82 per cent nitrogen.

A fertilizer formula is a statement showing the percentage of each of the three elements, nitrogen, phosphorus and potash contained in a mixed fertilizer. For example a 3-5-10 fertilizer means 3% nitrogen, 5% phosphorus, 10% potash. Thus a formula always indicates that the elements are given in the following order:

AVERAGE COMPOSITION OF FERTILIZERS.

Name of Fertilizer.	Per cent			
	Nitrogen.	Phosphoric acid.	Potash.	Lime.
Nitrogenous Fertilizers.				
Nitrate of soda	15–16	....	....	....
Ammonium sulphate	20	....	....	....
Dried blood (red)	13–14	....	....	....
Tankage	4.5–12	3–14	....	....
Cotton-seed meal	5–7.5	1.5–3	....	....
Linseed meal	.5.5	....	....	....
Phosphoric Acid Fertilizers.				
Tennessee Phosphate Rock	....	30–32	....	....
Florida phosphate rock	....	18–40	....	....
South Carolina phos. rock	....	26–28	....	....
Ground raw bone	3–4	22	4–8	....
Ground steamed bone	2–4	18–32	5–10	....
Boneblack	....	32–36	....	....
Basic slag (iron phosphate)	....	15–20	....	....
Potash Fertilizers.				
Kainit	....	....	12	....
Sulphate of potash	....	....	50–52	....
Muriate of potash	....	....	49–59	....
Wood ashes (unleached)	....	1.5–2	4–7	30–33
Wood ashes (leached)	....	1–1.5	1–2	27–29

PROBLEMS.

1. If a 50 bushel crop of corn takes from the soil 75 pounds of nitrogen, 12 pounds of phosphorus, and 36 pounds of potassium, how many pounds of a 2-8-2 fertilizer would be required to supply the potas-

sium? How many pounds to supply the nitrogen? Is this a well balanced fertilizer for corn?

2. Ordinary complete fertilizer is made by taking one ton of ground phosphate rock and adding to this one ton of sulphuric acid and two tons of filler; to this is added a small amount of nitrogen and potassium. How many tons are there in this mixture and how many pounds of potassium and nitrogen if it is a 2-8-2 mixture? What per cent of the weight could be saved upon which freight is paid if the filler and sulphuric acid are left out?

It has been estimated that there are at least 5 billion tons of high grade natural phosphate rock in the United States found principally in Tennessee, South Carolina, and Florida, and that there are still more extensive deposits of lower grade phosphate found in a number of other states.

According to circular 165 of the University of Illinois Agricultural College, fine-ground natural rock phosphate can be delivered at the farmers' railroad stations, in most parts of the corn belt, for less than $8.00 per ton.

Long continued investigations have clearly established the fact that phosphorus can be liberated as needed from the fine-ground natural rock phosphate if it is plowed under in connection with the decaying organic manures. It is therefore evident that the extra expense of *acidulation of phosphate rocks is wholly unnecessary.

PROBLEMS.

1. If 4 tons of a 2-8-2 fertilizer containing one ton of phosphate rock, one ton of sulphuric acid, 132 pounds of nitrogen and 132 pounds of potassium, cost $114, what would be saved by buying one ton of phosphate rock @ $7 a ton and 132 pounds of nitrogen @ 15c a pound and 132 pounds of potassium @ 5c a pound?

When a farmer buys a ton of an average commercial fertilizer he buys in reality only about 300 pounds of actual plant food. A cheap fertilizer may have less than that amount while a high grade fertilizer may have as high as 600 pounds.

Cost of mixing, handling, freight and all things considered,

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* Acidulation is produced by mixing phosphates with sulfuric acid. Under the average conditions on a farm this is no longer advocated, for it is neither practical nor profitable according to the statements of some of the best authorities on soils and fertilizers.

the plant food in a high grade fertilizer can be purchased cheaper per pound than in a low grade fertilizer.

Purchasing a brand of fertilizer that has less than 2 per cent ammonia or potash is useless and a waste of money.

PROBLEMS.

1. An inspection of fertilizers in Vermont in 1908 showed that the average selling price of mixed fertilizers was $31.24 per ton, but the materials for mixing could have been purchased at retail in Boston or New York for $20.75. What was the per cent cost of the mixed fertilizer above cost of materials.

The value of a fertilizer as a profitable investment depends upon the value of the crop to be raised.

2. If a certain fertilizer is used and increases the value of a crop 10 per cent; what will be the difference in gain, between a corn crop that amounts to $25 per acre and a truck crop that amounts to $150 per acre?

When a farmer decides to use fertilizer it is just as important to know the requirement of a certain crop as it is to know the condition of the soil. For instance, corn, oats, rape and potatoes will each require a different formula.

Home Mixing of Fertilizers.

Although there has been a vigorous and prolonged protest from certain sources against the practice of "home mixing" fertilizers, the economy in the purchase of plant foods, the thoroughness with which the operation can be performed by the farmer himself and the greater efficiency of the home mixed fertilizer over the factory mixed brands frequently found on the market, have been so repeatedly and conclusively demonstrated that there can now be no logical or tenable objection advanced against the practice. It has been urged "That the compounding of fertilizers is an intricate and difficult operation, requiring extensive acquaintance with chemistry, costly machinery and great technical skill. When applied to the production and manufacture of fertilizing materials—that is the selection and quarrying, grinding and acidulation of phosphatic rock; the drying and grinding of slaughterhouse refuse, the production and refining of such materials as nitrate of soda, sulphate of ammonia and muriate of potash—the statement is entirely correct, because all these are distinctly manufacturing processes that do require technical knowledge, skill in manipulation and expensive machinery. But these operations are entirely separate and distinct from the compounding of mixed fertilizers. Each of the materials named comes from the manufacturer in condition to be used by itself as a fertilizer, and each is so used for special purposes. But the compounding, or putting together of these materials in different proportions into a mixed fertilizer is no more a manufacture than is mixing together a ration of bran and cornmeal for a cow. The only difference is that a ration which is designed to be distributed uniformly to thousands or millions of plants requires to be more carefully mixed than that fed to a single cow. If each plant were being fed individually, or if each element in a fertilizer were being applied at different times, as for instance, when we apply acid phosphate and muriate of potash to wheat in the fall, and nitrate of soda in the spring, no mixing would be necessary.

"This point of the essential difference between those operations which are legitimately called 'manufacturing' and those which are simply mixing, should be clearly understood."*

Let the farmer who desires to do his own mixing decide on the grade of fertilizer he desires to use, that is, the percentage of ammonia, phosphoric acid and potash that the fertilizer shall contain, and on the fertilizing materials that he wants to use as carriers or sources of these compounds, and the proposition becomes a simple problem in percentage.

In the following table are given the composition of raw materials which is here used for the purpose of illustrating the method of calculating a fertilizer formula:

	Ammonia. %	*Phos. Acid.* %	*Potash.* %
Steamed bone meal	2	28	..
Acid phosphate	..	14	..
Muriate of potash	..	..	50
Nitrate of soda	19	..	..

* Bull. 93, Ohio Exp. Sta.

These materials represent only a few of those which are available for the compounding of fertilizers, but for the immediate matter in hand these will be sufficient for our purpose.

For the purpose of illustrating the method of calculating a formula we will assume that the farmer wants to use a fertilizer containing about 2.85% ammonia, 10.5% phosphoric acid and 5% potash. With this percentage composition how many pounds of ammonia, phosphoric acid and potash would a ton of the mixed fertilizer contain? To answer this question it is only necessary to multiply the number of pounds in one ton of fertilizer by the percent of each essential ingredient, as follows:

$2{,}000 \times .0285 = 57$ lbs. ammonia.
$2{,}000 \times .1050 = 210$ lbs. phosphoric acid.
$2{,}000 \times .0500 = 100$ lbs. potash.

Having thus ascertained the number of pounds of the various essential ingredients that one ton of fertilizer will contain our problem now is to determine how much nitrate of soda, acid phosphate and muriate of potash respectively will be required to supply them; assuming that we have decided to use these particular raw materials as carriers. This is done by dividing the *amount* of any particular ingredient in the mixed fertilizer by the *percent* of this same ingredient in the raw material from which it is derived. Thus to find how many pounds of nitrate of soda (containing 19% ammonia) would be required to furnish 57 pounds of ammonia we would say—

$57 \div 0.19 = 300$ lbs. nitrate of soda.

Similarly for the other ingredients we find that—

$210 \div 0.14 = 1{,}500$ lbs. acid phosphate.
$100 \div 0.50 = 200$ lbs. muriate of potash.

Assembling our figures therefore into a systematic formula we should have—

	Ammonia.	Phos. Acid.	Potash.
Nitrate of soda 300 lbs. containing........	57 lbs.	.....	.....
Acid phosphate 1,500 lbs. containing........	......	210	.....
Muriate of potash 200 lbs. containing........	......	.....	100
Total 2,000 lbs........................	57	210	100
Percentage	2.85	10.5	5.0

Thus we have our complete formula for a ton of fertilizer having the percentage composition that was wanted.

In case it is desired to use a raw material containing both ammonia and phosphoric acid, steamed bone meal for instance, the method of calculation would be only slightly modified. To indicate this we will assume that a high grade fertilizer is desired, which shall contain 4.03% ammonia, 16.1% phosphoric acid and 4% potash, and in which it is desired to use 800 pounds of steamed bone meal.

With the perecents as given a ton of mixed fertilizer would contain 80.6 lbs. ammonia, 322 lbs. phosphoric acid, and 80 lbs. potash. Of these ingredients 16 lbs. ammonia and 224 lbs. of phosphoric acid would be contained in the 800 lbs. steamed bone. This would leave 64.6 lbs. of ammonia and 98 lbs. of phosphoric acid to be supplied from the nitrate of soda and acid phosphate respectively. Making the same calculation as in our first formula it is found that —

$64.6 \div 0.19 = 340$ lbs. nitrate of soda.
$98.0 \div 0.14 = 700$ lbs. acid phosphate.
$80.0 \div 0.50 = 160$ lbs. muriate of potash.

Our formula would then be—

	Ammonia.	Phos. Acid.	Potash.
Steamed bone meal 800 lbs. containing....	16 lbs.	224 lbs.	.....
Acid Phosphate 700 lbs. containing.......	......	98	.....
Nitrate of soda 340 lbs. containing........	64.6	....	.....
Muriate of potash 160 lbs. containing....	......	....	80
Total, 2,000 lbs. containing.........	80.6	322	80
Per cent	4.03	16.1	4

Thus you are providing a ton of fertilizer having the desired composition, and best of all, you have made it yourself and know what there is in it.

If the purchaser of commercial fertilizers will observe the suggestions herein set forth he will be able to compound for himself any grade of fertilizer desired, and also one which will meet the actual needs of his particular soil and system of cropping, whether the fertilizer be for general or special use.

Table for Home Mixing of Fertilizers.

	Ammonia.			Phosphoric Acid.			Potash.		
	From Nitrate of Soda 18 per cent.	From Sulphate of Ammonia 25 per cent.	From Tankage 7 per cent.	From Acid Phosphate 14 per cent.	From Acid Phosphate 16 per cent.	From Tankage 8 per cent.	From Muriate of Potash 50 per cent.	From Sulphate of Potash 50 per cent.	From Kainit 12 per cent.
1	110	80	285	143	125	250	40	40	116
2	220	160	570	280	250	500	80	80	330
3	330	240	860	430	375	750	120	120	500
4	440	320	1140	570	500	1000	160	160	660
5	550	400	1430	710	625	1250	200	200	830
6	660	480	1710	860	750	1500	240	240	1000
7	770	560	......	1000	875	1750	280	280	1160
8	880	640	......	1140	1000	2000	320	320	1330
9	990	720	......	1280	1125	......	360	360	1500
10	1100	800	......	1430	1250	......	400	400	1660
11	1200	880	......	1570	1375	......	440	440	......
12	1320	960	......	1720	1500	......	480	480	......

EXAMPLE: To make a 2-8-10 fertilizer from Nitrate of Soda, 16 per cent Acid Phosphate and Muriate of Potash. By looking in the Percentage column for 2 per cent, in the Nitrate Soda column we find 220 bls., in the 16 per cent Acid Phosphate column opposite 8 per cent we find 1,000 lbs., and in the Muriate of Potash column opposite 10 per cent we find 400 lbs. The sum of these amounts would make 1,620 lbs. containing the same amount of plant food as a ton of 2-8-10 factory made fertilizer.

Approximate cost of a 2-8-10 home mixed fertilizer:

220 lbs. Nitrate of Soda	@ $55 00 per ton —	$5 94
1000 lbs. Acid Phosphate	@ 14 00 per ton —	7 00
400 lbs. Muriate of Potash	@ 45 00 per ton —	9 00

RANGE OF PRICES OF RAW MATERIALS.

Nitrate of Soda	$55 00—$62 00
Sulphate of Ammonia	65 00— 75 00
Acid Phosphate 16 per cent	12 00— 16 00
Muriate of Potash	45 00— 48 00
Sulphate of Potash	54 00— 60 00
Kainit	15 00— 18 00

NOTE: Lime should never be mixed with any fertilizer.

PROBLEMS.

Given the formula and composition of the material, mixing fertilizers are simple problems in arithmetic.

1. Mix the equivalent of a ton of potato fertilizer having an analysis of ammonia 3 per cent, available phosphoric acid 6 per cent, potash soluble in water 10 per cent; how much nitrate of soda 18 per cent ammonia, acid phosphate 14 per cent phosphoric acid and sulphate of potash 50 per cent potash will be required?

2 Suppose we wish to derive the ammonia required in problem 1, from three sources, for instance, one-third from sulphate of ammonia, 25%, one-third from tankage 7%, and one-third from nitrate of soda, 18%, how many pounds of each would be required?

3. A southern planter wished to derive his nitrogen from cotton seed meal 6 per cent nitrogen, sulphate of potash 50 per cent potash, Tennessee phosphate rock 30 per cent phosphoric acid; what amount of each will be required for one ton of 9-6-10 fertilizer?

4. A cotton planter wishes to mix the equivalent of a ton of cotton fertilizer as recommended by the U. S. Department of Agriculture for a sandy soil,—a-3.6-8-5 fertilizer; how much cotton-seed meal 5% acid phosphate 14%, and muriate of potash 50% will be required?

5. Suppose that we wish to mix the equivalent of a ton of 10-2-2 fertilizer calculate the amount of 14 per cent acid phosphate, 7.5 per cent cotton-seed meal and 12 per cent kainit that will be required?

6. Calculate a mixture same as in problem 5, except use 18% basic slag instead of acid phosphate.

7. An excellent mixture for small grain to be followed by clover or grass, is 50 per cent muriate of potash 400 pounds; what is the formula?

8. Suppose we wish to raise the potash content of 1 ton 2-8-2 fertilizer, to a 2-8-8 fertilizer, for corn, how much 50 per cent muriate of potash will have to be added?

9. On the basis of one ton, how many pounds of muriate of potash or sulphate of potash (each 50 per cent) will be required to increase the potash content 1 per cent in a 2-8-2 fertilizer?

10. How much 30% phosphate rock (ground), must be added to a

ton mixture to raise the phosphoric acid content 2 per cent in a 3-8-10 fertilizer?

11. Write the formula for a ton mixture of fertilizer that contains 300 pounds of ammonium sulphate 20%, 200 pounds of 40% acid phosphate, 100 pounds of 50% muriate of potash?

12. Write a good formula for wheat, one for oats, one for corn, one for alfalfa, and one for clover.

13. If we wish to use 1,000 pounds of a 5-6-9 fertilizer per acre for truck land, what will be the required amount of nitrate of soda 18%, acid phosphate 14%, and sulphate of potash 50%, for a ton mixture?

14. For legumes such as clover, cowpeas, beans, it is desired to use a 10-10 fertilizer of basic slag 15% and muriate of potash 50%; what will be the number of pounds of each required in a mixture of two thousand pounds?

15. For flowering plants, mix 4 pounds of bone meal 4% nitrogen, 28% phos. acid, and 8% potash, with one pound of 50% sulphate of potash per square rod; what is the formula?

16. For hay fields 100 pounds of nitrate of soda 18%, 100 pounds of acid phosphate 16%, and 50 pounds of muriate of potash 50% is used per acre by many successful growers. What is the formula?

PROBLEMS.

1. To produce a quick growing, tender plant like celery, lettuce, cabbage, onions, asparagras or similar plant, what will be the cost of supplementing barnyard manure with 1,000 pounds of a 3-6-6 fertilizer, if ground phosphate rock can be purchased @ $8 per ton, and the cost of nitrogen is 17c. per pound and potassium is quoted @ 4 and one-half cents a pound?

2. To produce turnips, carrots, beets, which require soundness and tenderness, a fertilizer should be used carrying 4 per cent ammonia, 6 per cent phosphoric acid, and 10 per cent potash; what will be the cost of this 4-6-10 fertilizer to supplement manure, if 1,000 pounds are required for one acre?*

3. Find the cost of 600 pounds of fertilizer for sweet corn, tomatoes, and potatoes that require a long period for growth; the available plant food required being but 3-8-6.

4. A prominent strawberry grower used 15 tons of manure per acre, and 1,000 pounds of 1.5-10-7.5 fertilizer; find the cost of the fertilizer used to reinforce the manure at the price of ingredients for home mixing.

5. Find the cost of one ton of home mixed 3-8-10 fertilizer for use in growing raspberries.

*In problems 2, 3, 4 and 5, figure cost of nitrate of soda @ $55 per ton; Acid phosphate @ $14.00 per ton; Muriate of potash @ $45.00 per ton.

MISCELLANEOUS PROBLEMS.

1. How much nitrogen, phosphoric acid and potash would be removed from an acre of land yielding 20 bushels of wheat and 2,000 pounds of straw?

2. How much nitrate of soda 18%, acid phosphate 14% and muriate of potash 50% would be required to replace the plant foods removed by the crop in No. 1.

3. At current prices for nitrate of soda, acid phosphate and muriate of potash what would be the value of the nitrogen, phosphoric acid and potash removed by the crop in first problem?

4. An animal receives a daily ration of 12 pounds clover hay, 5 pounds cornmeal, 3 pounds bran, 30 pounds corn silage. If 65 per cent of the nitrogen, phosphoric acid and potash respectively is recovered in the manure how many pounds of each would be produced in 30 days?

5. If the animal produces 50 pounds of manure per day, what per cent of nitrogen, phosphoric acid and potash would this manure contain, using the solution of No. 4 as a basis of calculation?

6. Given nitrate of soda (18% ammonia) acid phosphate (14% phosphoric acid) and muriate of potash (50% actual potash), how many pounds of each would be required to make one ton of mixed fertilizer containing 2.85% ammonia, 10.5% phosphoric acid and 5% potash?

7. To the materials given in No. 6 add steamed bone meal (2% ammonia and 28% phosphoric acid) and calculate the amount of bone meal required for one ton of fertilizer containing 4.03% ammonia, 16.1% phosphoric acid and 4% potash.

Exercises.

1. Get samples of the different fertilizer materials, manures, peat soils, lime, different kinds of bacteria cultures, scales for weighing, and seeds of different varieties of staple crops of your locality.

2. A small area of ground may be laid out or plotted into plots of any size convenient for making demonstrations or experiments. Where there is no land available, use may be made of pots but there will be more or less difficulty about the proper distribution of moisture and in thus obtaining natural conditions.

The plots may be one-tenth, one-twentieth, one-fortieth, one-eightieth of an acre or the plots may be on the basis of a square rod or the fraction of a square rod.

3. Write to your state experiment station for instructions in trying out a series of experiments. The station will tell you what is the best method and most practical experiment to make in your locality. The station will advise and probably co-operate with you.

4. In all experiments an accurate record should be kept of all expenditures based on the cost of fertilizers, seed, labor and value of crop per acre.

Suggestions for Plat Work.

Nothing, check.	Nitrate of soda at the rate of 160 lbs. per acre.	Acid Phosphate, 320 lbs. per acre.	Nothing, check.	Muriate of potash, 80 lbs. per acre.	Nitrate of soda, 160 lbs. Acid phosphate, 320 lbs.	Nothing, check.	Nitrate of soda, 160 lbs. Muriate of potash, 80 lbs.	Muriate of potash, 80 lbs. Acid phosphate, 320 lbs.	Nothing, check.	Nitrate of soda, 160 lbs. Acid phosphate, 320 lbs. Muriate of potash, 80 lbs.	Barnyard manure, 10 tons per acre.	Nothing.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14

Similar plot work may be used to demonstrate the effects of lime in the seeding to clover, alfalfa or other legumes. (See chapter on School Gardens).

Questions.

1. How many different chemical elements are absolutely essential to plant growth? Name them.
2. What are the two general sources of plant food?
3. What elements of plant food are derived from the soil and what from the air?
4. What elements of plant food are most likely to be deficient in soils?
5. How does the plant get its food from the air? How from the soil?
6. Name at least three reasons why wet land should be drained.
7. What do we mean when we say a soil is "heavy"?
8. What do you understand by acid or sour soil?
9. How may acid in the soil be overcome?
10. Name some of the more important fertilizing materials, giving their source and composition.
11. What is the difference between nitrogen and ammonia?
12. What are the principal reasons for decrease in soil fertility?
13. Distinguish between acid phosphate and phosphoric acid.
14. Name the three principal forms of lime and distinguish between them.
15. How would you determine whether or not a soil needs lime?
16. What is meant by crop rotation?
17. Indicate what you consider a good rotation for your community. Give reasons.

18. What do you understand by the "physical" condition of soils?
19. Do all crops grow equally well on all soils? Give reasons.
20. How much water will a plant take from the soil in producing 100 pounds of dry matter, as an approximate average?
21. What do you understand by the terms, capillary water, water table, percolation?
22. In what three ways may water be lost from the soil?
23. Why does shallow cultivation tend to prevent evaporation?
24. Explain the term "humus".
25. How is the humus of the soil obtained and what is its general effect on the soil?
26. Explain the terms "quicklime", "carbonate of lime", and "hydrated lime".

Books for Reference.

1. Fertilizers — Vorhees, 8-12 — Macmillan Co.................. $1 25
2. Soils and Fertilizers — Snyder, 8-13 — Macmillan Co.......... 1 25
3. Fertility of the Land — Roberts, 8-12 — Macmillan Co........ 1 50
4. Soils — Lyon & Fippin, 8-12 — Macmillan Co................. 1 75
5. First Principles of Soil Fertility — Vivian, 8-12 — Orange Judd 1 00
6. Fertilizers and Crops — Van Slyke, 8-12 — Webb Publ Co...... 2 00
7. Soils — Hilgard, 8-12 — Macmillan Co....................... 1 00
8. Manures and Fertilizers — Wheeler, 8-12 — Macmillan Co...... 1 50

U. S. Bulletins Dept. of Agriculture.

FARMERS' BULLETINS.

Number.
222. Home Mixing Fertilizers.
225. Home Mixing of Fertilizers.
44. Commercial Fertilizers.
259. Use of Commercial Fertilizers.

IMPORTANT BULLETINS.

Circular No. 12 The Purchase and Home-Mixing of Fertilizers, by F. W. Taylor. The New Hampshire Experiment Station, Durham, New Hampshire.

Extension Bulletin. Formation of the Soil. Ohio State Agricultural College.

Circular No. 131. Maintenance of Soil Fertility. Ohio Agricultural Experiment Station, by Chas. E. Thorne.

Circular No. 79. By Chas. E. Thorne. Ohio Agricultural Experiment Station, Wooster, Ohio. "How to Determine the Fertilizer requirements of Ohio Soils".

Circular No. 165. Shall we Use Complete Commercial Fertilizers in the Corn Belt? by Cyril G. Hopkins, University of Illinois, Urbana. Ill.

CHAPTER IV.

Liming the Soil.

There are two classes of chemical compounds each of which has the power of neutralizing the characteristic properties of the other.

Lime when applied to the soil has the power as a basic material to neutralize the effects of harmful acids. It is the natural basic material of the soil.

It is found in abundance and is easily obtained in various forms or compounds, such as limestone, quick lime and water-slaked lime. It is a combination of four substances known as calcium, magnesium, carbon and oxygen.

Lime is burned from limestone. (Calcium carbonate).

Quick Lime.

If we burn 100 pounds of pure dry limestone there are 44 pounds of (CO_2) carbonic acid gas driven off by heat and there remains 56 pounds of quick lime.

Water-Slaked Lime.

If to 56 pounds of quick lime we add 18 pounds of water, the quick lime takes up the water and becomes 74 pounds of water-slaked or hydrated lime (calcium hydrate).

Air-Slaked Lime.

Water-slaked lime exposed to the air for several months, absorbs carbonic acid gas, which was driven off by burning the limestone; this continues until it has returned to its original weight of 100 pounds. This is then called air-slaked lime.

In these different forms of lime such as quicklime, water-slaked lime, and air-slaked lime, there remains the same amount of calcium and magnesium as in the original 100 pounds of limestone.

The minerals, calcium and magnesium are the essential elements in neutralizing acids. Oxygen and carbon combine with calcium and magnesium and are rendered into usable forms.

It therefore follows that burning and slaking do not change the power to neutralize acids, and thus 100 pounds of pure ground limestone, 56 pounds of quicklime, 74 pounds of water-slaked lime, and 100 pounds of air-slaked lime are equal in their power to neutralize acids.

Some of the important effects of using lime on the soil may be stated in the following important points:

1. Ground limestone and air-slaked lime are less destructive in their action on the soil than quick-lime or water-slaked lime and are therefore to be preferred.
2. Calcium and magnesium have similar effects in their action on the soil.
3. Calcium and magnesium are equally necessary as plant foods, therefore lime considered as a source of these elements may be considered as a plant food.
4. Lime used on the soil should be from a limestone containing a high per cent of calcium and a low percentage of magnesium.
5. To be beneficial the application of lime will vary according to conditions from one to three tons or even more per acre.
6. Equivalent Weights.

   2,000 pounds of burned lime is equal to:
   2,702 pounds of hydrated lime.
   3,572 pounds of ground limestone or marl.
   2,702 pounds of air-slaked lime (new).
   3,572 pounds of air-slaked lime (old).
   About 3,000 pounds of hardwood ashes.

Sources of Lime.

The term "Agricultural Lime" may be very misleading, and unless the purchaser understands the composition of the mixture offered for sale the term "agricultural lime" is indefinite and does not signify anything as to composition or value.

A few of the sources of lime with the percentage of lime contained is given here to furnish some very desirable information.*

* Send for Circular 123, Ohio Experiment Station.

Oyster shells contain about 95 per cent calcium carbonate or approximately 43 per cent lime.

Wood ashes which contain about 5 per cent potash and .1 to 1.5 per cent phosphoric acid also contain about 50 per cent calcium carbonate. If the calcium carbonate in wood ashes is equal in value to calcium carbonate in ground limestone, which yields 56 pounds of lime per hundred pounds, 100 pounds of wood ashes will contain 28 pounds of lime.

Marl which is a loose deposit of earth consists of clay intermingled with calcium carbonate. The amount of calcium carbonate in marl may vary from 10 to 90 per cent.

PROBLEM.

If 1,000 pounds of marl contains 60 per cent calcium carbonate of equal value to the same amount of calcium carbonate in limestone, what is the number of pounds of lime contained in the above amount of marl?

Waste carbonate of lime from soap factories if properly dried may prove to be an excellent form of calcium carbonate.

Quicklime is used in the manufacturing of sugar from sugar beets. It is used to purify the juices before their conversion into granulated sugar. Waste lime from the sugar beet factories is partly hydrated and partly carbonated lime. The hydrated lime will change into carbonate and an analysis of lime waste from a sugar beet factory has shown over 42 per cent calcium carbonate.

PROBLEM.

How much lime would there be in two tons of this refuse containing 40 per cent calcium carbonate, if this amount of calcium carbonate is equal in value to the same amount of ground limestone—(800 lbs. of calcium carbonate)?

Lime is also obtained from water-softening plants and from acetylene gas generators and may be obtained from basic slag which is a by-product from the manufacture of steel from pig iron.

The important problem in the purchase of any product containing carbonate of lime is to determine the percentage of lime than can be obtained.

Rules for Purchasing Lime.

Large amounts of silica, clay, and other insoluble matter may make it unsafe to buy any kind of lime without first having it analyzed.

The relative value of the various kinds of lime must be inversely proportional to the amounts required to neutralize a given weight of acid. Therefore the price of limestone should be less than the price of quick lime in the ratio of 56 to 100; the price of air-slaked lime less in the ratio of 56 to 100; and the price of water-slaked lime less in the ratio of 56 to 74; upon this basis quick lime at $5.00 per ton and ground limestone at $2.80 per ton are relatively proportional in values, if they are all equally pure.

Freight and hauling are two of the principal items of expense in handling large quantities, and it is a profitable calculation to determine whether quick lime or slaked lime will be cheaper even though purchased at a greater cost per pound of acid neutralizing power. And it is well to consider the destructive power of quick lime on the soil and the difficulty in handling.

It is also true that there are grades of limestone running from 70 per cent to 95 per cent pure, that should effect the price according to quality.

Generally speaking, the most economic way to buy lime is to get that form which furnishes the greatest amount of basic material for the least money. It is the calcium and magnesium carbonate that produces the desired effect in the soil.

To illustrate this point, let us suppose that ground limestone and quicklime are offered at the same point of shipment at $1.25 per ton for the former and $5.00 for the latter. Let us assume that the freight will be $1.50 per ton, and the cost of hauling from the car and spreading $1.00 per ton. Our account will then stand as follows:

	Quicklime *1 ton*	*Ground stone* *2 tons*
Cost at point of shipment	$5.00	$2.50
Freight	1.50	3.00
Hauling and spreading.....................	1.00	2.00
Total	$7.50	$7.50

PROBLEMS.

1. What will be the cost of applying one ton of quicklime @ $6 a ton f. o. b. kiln, freight rates $1 per ton, hauling 60c, and cost of applying same $1 per acre?

2. A ton of hydrated lime is quoted at $5 per ton, freight $1, hauling 60c, application $1. What is the cost of liming one acre?

3. If a ton of ground limestone can be purchased @ $1.50 per ton f. o. b. quarry, freight $1, hauling 75c, application $1, what will be the cost of applying 2 tons per acre on 10 acres?

4. Which is the cheaper, one ton of burned lime @ $5 a ton f. o. b. factory, or two tons of ground limestone @ $2.00 a ton; the cost of transportation $2 per ton for each, cost of applying each $1 per ton, if 56 pounds of quicklime are equal in value to 100 pounds of ground limestone?

The United States Dept. of Agriculture has analyzed several limestones and ascertained that some of the injurious limestones were found to contain 38 to 42 per cent magnesium carbonate, while the beneficial limestones contained less than 1 per cent of this substance.

An Experiment and Problem.

In an experiment field in Johnson Co., Illinois, according to a report of the Illinois Experiment Station, the result was as follows:*

The effect of ground limestone applied five years before, increased the crop yields in 1907 by 12.5 bushels of corn, 6.9 bushels of wheat, and 1.11 tons of clover hay, per acre.

The quality of the crops was improved.

Clover on plots 1 and 2 without limestone was half weeds.

Clover on plots 3, 4, 5 with limestone was good and clean.

PROBLEM.

At 35c a bushel for corn, 70c for wheat, and $6 a ton for air-dry clover hay, what was the total value of the increase for the three crops, produced by ground limestone?

Things to Remember About Lime.

1. Clover has long since ceased to grow in regions where it formerly grew luxuriously and abundantly.
2. A limestone soil that was once rich in lime may become deficient in lime. Its former store of lime may be exhausted or leached out.
3. Lime is nature's remedy for correcting acid soils.
4. Try out the amount needed by experiments on your own farm.

* Read Bulletin 279, Ohio Experiment Station.

5. A lime spreader is an economical implement to use in spreading costly material.
6. Lime should not be mixed with either fertilizer or manure.
7. It should be worked into the soil separately.
8. Haul the lime when there is a slack time and if possible when the roads are good.
9. The primary object of lime is to increase the availability of plant food.
10. If there is no plant food in the soil, the application of lime will be unavailable.
11. It will correct the acidity of any soil but it cannot promote bacterial activity without plant food for the feeding of soil organisms.
12. The promotion of the growth of legumes is the one result above all others which makes lime one of the most important factors in scientific agriculture.
13. Effects on a new leguminous crop will not show its full value until the crop has become thoroughly innoculated.
14. Innoculation may not take place till the second or third year.
15. Lime will neutralize the effects of certain toxic or poisonous substances in the soil which are believed to be caused by continuous raising of one crop (without rotation).
17. Limestone and phosphate rocks are among the most important of the earth's conservations of our natural resources. These rocks were stored away ages ago, and we are now just beginning to learn their real value.

Effect of Lime on Plants.

Plants greatly benefited by lime.	*Plants slightly benefited by lime.*	*Plants indifferent to lime.*	*Plants injured by lime.*
Spinach,	Spring wheat,	Millet,	Watermelon,
Beans,	Oats,	Potatoes,	Sheep sorrel,
Beets,	Corn,	Carrots,	Dewberries,
Celery,	Blue grass,	Red top.	Strawberries.
Onions,	Timothy,		Cranberries.
Cabbage,	Radish,		
Alfalfa,	Turnip,		
Peas,	Tomato,		
Clover,	Buckwheat,		
Barley,	Potato (early rose).		
Wheat,			
Tobacco,			
Sorghum,			
Cucumber,			
Cantaloupe,			
Rape.			

The use of agricultural lime has been growing at a remarkable rate according to the statements made by some of the experiment stations.

According to a statement from Purdue University the use of lime in 1911 exceeded the amount (total) used in the three preceding years.

Great care should be taken in teaching the use of lime to have the student understand that lime will not take the place of a fertilizer.

1. He should understand thoroughly that the full effect of lime will only be obtained on land that is well fertilized or manured.
2. Lime is not a fertilizer, but it is one of the essential elements of plant food.
3. Red clover or alfalfa are a good index to denote the supply of lime. Each of these legumes contains several times as much lime as any of the cereals, hence they are the first to indicate the deficiency of lime.

Superiority of Ground Limestone.

Experiments by The Pennsylvania and Maryland stations tend to show the superiority of carbonate of lime over burned lime.

A 20 Years' Experiment.

In Pennsylvania, plats receiving 2 tons of ground limestone once in 2 years, produced greater total yields and showed more nitrogen and humus in the soil than adjoining plats which had been treated with 2 tons of slaked burned lime per acre once in 4 years.

Care in Using Quick Lime.

Quick or hydrated lime should not be applied within a week of planting time because it may injure the young plants.

There is danger that this kind of lime may hasten the burning out of organic matter or humus in the soil.

It is caustic and destructive in its effects.

One ton of quick lime will correct as much acidity as two tons of pulverized limestone, and it acts quickly and is almost immediately effective.

Too Much Lime.

There should be just lime enough to be constructive in its effect.

Too much lime is destructive instead of constructive and enriching.

Too much lime will liberate more plant food than the plant can assimilate, because the combustion of organic matter is too rapid.

Too much liberation of plant food results in exhausting the soil.

When more plant food is available than can be used it will leach out.

Brief Summary.

The forces that lime exerts on the soil may be summed up as: chemical, physical and biological.

1. Chemical action—
   - (a) Changing insoluble potash compounds into available plant food.
   - (b) Neutralizing acids.
2. Physical action—
   - (a) It causes baked soils to become granulated, pulverized or flocculated.
   - (b) It binds together the loose particles in sandy soils.
3. Biological action—
   - (a) It renders the condition of the soil favorable for the development of bacteria.

Lime sweetens the soil.

Lime hastens the decay of organic matter in the soil.

Heavy clay soils require about twice as much lime as sandy soils.

To make lime effective it should be spread on the surface and harrowed into the soil thoroughly.

It should not be exposed on the surface over night or during a storm.

All essential elements to soil fertility must be present to insure a profitable use of lime.

Land should be tested occasionally to determine if there is need of lime.

Facts About Bacteria and Nitrogen.

1. The increase of the number of organisms or bacteria, continues almost proportionately to the application of lime in amount up to three tons per acre.
2. The nitrogen-fixing powers of soils or the amount of nitrogen fixation is almost directly proportionate to the increase in the number of nitrogen fixing bacteria, both increasing in the proportion to this application of lime up to three tons per acre.

Relation of Lime to the Supply of Nitrogen in the Soil.

1. The supply of available nitrogen in the soil for the use of plants, depends upon the fixation of atmospheric nitrogen.
2. Certain kinds of bacteria take nitrogen from the air.
3. The continued growth of certain plants called legumes depend upon the chemical changes brought about by the bacteria that form nodules on the roots of alfalfa, clover, beans, vetches and soy-beans.
4. Nitrogen fixing bacteria do not thrive in acid soils, which accounts for the fact that legumes do not grow in soils containing acids.
5. Research Bulletin No. 2, Experiment Station at Ames, Iowa, shows that the application of lime is a determining factor in the increase of bacteria.

The experiments showed the following results:

1. Applications of ground limestone increase the number of bacteria in the soil.
2. The increase of bacteria continued almost proportional to the size of the application of lime up to three tons per acre.
3. A test of ground limestone in earthenware pots each containing 30 pounds of soil, showed that a half ton application of the limestone per acre caused an increase of 534,000 bacteria per gram of earth.
4. An application of one ton per acre caused an increase of 939,000; an application of 2 tons caused an increase of 1,649,000, and an application of 3 tons resulted in an increase of 2,710,000 per gram of earth.

A Valuable Experiment.

To determine the relative effect of liming the soil on different plats, try liming a part of a field that is to be sown to alfalfa or clover. Try lime in different quantities on different plats or parts of the field. Note the differences if any between the plats receiving and those not receiving lime.

Testing Soil for Lime.

Pour muriatic acid on a small quantity of soil taken from the part of the field and depth of soil to be tested, and if there is lime in the soil the acid will produce an effervescence.

Experiments.

1. Dry a lump of pure limestone and burn it. What was this called before and what is it called after burning? What was the weight before, and after burning? What has been driven off by burning?

2. Pass your breath through a tube into the bottom of a tumbler of limewater. Observe the white cloud formed by the union of carbon di-oxide of the breath with the lime dissolved in the water. This reverses the results attained by burning. What is the white cloud now called? Is it any different than the limestone in the quarry?

3. Expose a lump of freshly burnt lime to ordinary moist air; in the course of a few days or weeks, depending largely upon the amount of moisture in the air, it will be found to have crumbled into a fine powder. What is this kind of lime called? Weigh the lime before and after the experiment.

4. Pour water on a lump of fresh burnt lime. It will crumble into powder immediately, with the evolution of considerable heat. This shows that chemical action and a change is taking place. There is a chemical combination of water and lime. If the proper amount of water is used the powdered lime will be as dry as the quicklime. What is this lime called? Weigh lime before and after the experiment.

Litmus paper can be secured from a druggist. Place the litmus paper in contact with the moist soil. After some moments the color of the paper will change. If the soil turns red litmus paper blue, the soil is alkaline. If the soil turns blue litmus paper red, the soil is acid. A neutral effect shows neither lime nor acid.

Drop a small lump of soil into a glass containing strong vinegar; if lime is present, bubbles will come from the lump and will continue to rise for a few minutes.

Still better and more accurate than the litmus paper test is the acid test by means of the "Standard Soil Tester." (See page 60).

FIG. 1. Pots of Red Clover, Showing the Effect of Lime on a Soil Unfavorable to the Growth of Clover. 1.—Unlimed. 2.—Limed at the Rate of 2,000 Pounds to the Acre. 3.—Limed at the Rate of 4,000 Pounds to the Acre.

1 2 3 4

FIG. 2. Effects of Lime and Inoculation on Growth of Alfalfa. 1.—No Inoculation. 2.—Inoculation. 3.—Lime. 4.—Lime and Inoculation.

FIG. 3. A Lime Spreader at Work.

Questions.

1. When muriatic acid is poured upon a piece of limestone rock, what chemical changes take place?
2. Of what use is lime in the structure of bones?
3. If a bone is placed in muriatic acid; what part remains?
4. Burn a piece of fresh bone to destroy animal matter and what is left?

The "Minimum Quantity of Lime" or "Lime Limit."

Of heavy soils is 3 tons of lime per plowed acre.

Of light soils is 2 tons of lime per plowed acre.

(Plowed acre means: A top layer 6 inches deep one acre in size.)

Dr. F. Heinrich, Agronomist of the Halle Agricultural Experiment Station, Halle, Germany, discovered the necessity of the "Lime Limit" for different crops.

He simply used a soil which tested to be free of lime and showed a neutral reaction on Litmus paper, mixed this soil with agricultural lime in pots in proportions of 5-100%, 1-10%, 2-10%, 3-10%, 5-10%, 1%, and found that a soil must have at least 3-10% of Carbonate of Lime under normal conditions, in order to bring Alfalfa to full growth.

The following table explains his experiments:

Alfalfa.

Each Pot was Numbered	*Per cent of Lime Applied per pot*	*Equal to an Application of Agricultural Lime per acre*	*Ounces of Cured Hay Harvested per pot*
1	no lime	no tons per acre	0
2	5/100%	½ ton per acre	0
3	1/10%	1 ton per acre	1.6
☛ 5	2/10%	2 tons per acre	9.7
5	3/10%	3 tons per acre	16.8
6	5/10%	5 tons per acre	17.4
7	1%	10 tons per acre	17.8

Clover.

1	no lime	no tons per acre	3.4
2	5/100%	½ ton per acre	3.9
3	1/10%	1 ton per acre	4.2
☛ 4	2/10%	2 tons per acre	16.8
5	5/10%	5 tons per acre	17.6
6	1%	10 tons per acre	18.2

Peas.

Each Pot was Numbered	Per cent of Lime Applied per pot	Equal to an Application of Agricultural Lime per acre	Ounces of Cured Hay Harvested per pot
1	no lime	no tons per acre	3.2
2	5/100%	½ ton per acre	3.8
3	1/10%	1 ton per acre	5.2
☛ 4	2/10%	2 tons per acre	18.5
5	3/10%	3 tons per acre	19.4
6	5/10%	5 tons per acre	20.2

Mark the difference in increase between Pot No. 4 and No. 5 with Alfalfa. There is a yield increase of 73% caused by the application of 1 ton of lime per acre on top of the two tons already in the soil and only a yield of 3% caused through the application of 2 tons of lime per acre on top of the 3 tons of lime already in the soil.

FIG. 4. The Standard Soil Tester.

Courtesy Standard Soil Tester Co., Milwaukee, Wis.

By means of the "Standard Soil Tester" the amount of acidity or lime may be determined in any soil.

No agricultural laboratory is complete without it. It is even more important to agriculture than the Babcock test.

It is a simple experiment and will tell just how much lime is in the soil and where there is need of lime and how much.

NOTE — For directions for using the Standard Soil Tester write to the above named Co. or to the author of this book.

This table shows the proper quantities of lime to be applied per acre to put soil in proper conditions.

In using Standard Soil Tester If Gauge on Soil Tester Shows as Follows:	It Means Your Soil Has the Following Percentages of Lime	Kind of Soil	Figures and Suggestions Hereunder Show Quantities of Lime to be Applied Per Acre on Heavy and Light Soils to Produce Best Results in Growing the Most Important Crops			
			For Alfalfa	For Clovers	For Peas, Beans, Cow Peas, Soy Beans, Vetch	For Intensive Tiling of Corn, Grains, Beets
NO LIME Reaction of Soil: markedly acid	0%	On Heavy Soil	4 Tons Agr. Lime or Marl	3 Tons Agr. Lime or Marl	3 Tons Agr. Lime or Marl	3 Tons Agr. Lime or Marl
		On Light Soil	2 Tons Agr. Lime or Marl	1½ Ton Agr. Lime or Marl	1½ Ton Agr. Lime or Marl	1½ Ton Agr. Lime or Marl
TRACE OF LIME Reaction of Soil: alkaline	0%	On Heavy Soil	3 Tons Agr. Lime or Marl	2 Tons Agr. Lime or Marl	2 Tons Agr. Lime or Marl	2 Tons Agr. Lime or Marl
		On Light Soil	1½ Tons Agr. Lime or Marl	1 Ton Agr. Lime or Marl	1 Ton Agr. Lime or Marl	1 Ton Agr. Lime or Marl
1 TON per acre	1/10%	On Heavy Soil	2 Tons Agr. Lime or Marl	1 Ton Agr. Lime or Marl	1 Ton Agr. Lime or Marl	1 Ton Agr. Lime or Marl
		On Light Soil	1 Ton Agr. Lime or Marl	½ Ton Agr. Lime or Marl	½ Ton Agr. Lime or Marl	½ Ton Agr. Lime or Marl
2 TONS per acre	2/10%	On Heavy Soil	1 Ton Agr. Lime or Marl	Do Not Apply Any Lime	Do not Apply Any Lime	Do not Apply Any Lime
		On Light Soil	½ Ton Agr. Lime or Marl	Do Not Apply Any Lime	Do not Apply Any Lime	Do not Apply Any Lime
3 TONS per acre	3/10%	On Heavy Soil	Do Not Apply Any Lime	Do Not Apply Any Lime	Do not Apply Any Lime	Do not Apply Any Lime
		On Light Soil	Do Not Apply Any Lime	Do Not Apply Any Lime	Do not Apply Any Lime	Do not Apply Any Lime

If Burned Lime (Quick Lime) is to be used, take one-half of the above amounts.
If Hydrated Lime is to be used, take three-quarters of the above amounts.

PART II.
PLANTS.

CHAPTER V.

The Plant.

Constituent Elements of Plants.—The plant requires for its nourishment, the same elements as those of which it is composed. It has been determined by analysis that there are ten elements that are absolutely necessary to the development of all vegetables; there are certain other elements utilized by a plant, but they are not indispensable to its life.

The first ten with their symbols are (C) carbon, (H) hydrogen, (O) oxygen, (N) nitrogen, (P) phosphorus, (K) potassium, (Ca) calcium, (S) sulphur, (Mg) magnesium, (Fe) iron.

There are usually a few other elements found in the composition of plants, such as silicon, chlorine, and sodium.

If any of the first ten elements are missing, there is a defect in the plant, and its development will be in proportion to the presence of the element most feebly represented. This is the law of the minimum given by Liebig.

The plant absorbs the elements by which it is nourished; from the air through its leaves, and from the soil through its roots. Plants obtain from the air all the elements, that escape in the form of gas, from smoke or watery vapor, arising from combustion; such as carbon, oxygen, hydrogen and a part of nitrogen. They obtain from the soil all those elements that remain in the ashes after combustion—phosphorus, potassium, calcium, sulphur, iron, magnesium, and some parts of nitrogen, sodium and silicon.

Relative Importance of the Different Elements in *the Plant.* — Carbon, oxygen and hydrogen form the bulk of our cultivated plants, but agriculture does not concern itself with these elements for they are furnished directly by air and water.

It is therefore very important that the student of agriculture should know the constituent elements of the soil, that he is to cultivate. Then when he has learned the requirements of the plant that he wishes to grow he can provide for these requirements in the use of fertilizers.

Plants are the soil's chief sources of fertilization. Plants collect the elements necessary to their growth and deposit them near the surface of the earth, where they may be of greatest service to man, in the production of other plants, and in feeding animals.

A plant is an organic being. In the higher forms of the vegetable kingdom, plants possess organs known as roots, stem, leaves, flowers and fruit. Each organ has some distinct function. In a perfect plant we have very little difficulty in distinguishing between the roots and the stem. We can readily recognize that there are two parts, that grow in opposite directions, — the roots growing downward into the soil and the stem growing upward into the air.

The organs of the stem have a different function to perform than the roots. In most of our plants, roots have no buds and grow in darkness and often in water, while the part of the plant growing above the soil, requires light and the elements of the atmosphere.

Forms of Roots.

Roots — In the study of roots we discover that there are many different kinds, but that they may be divided into a few general classes, as follows:

Taproots, such as the roots of the maple and alfalfa.
Fassicled, such as the roots of the sweet potato, dahlia, rhubarb.
Fibrous, such as the roots of corn, timothy.

Functions of Roots.

These distinctions have important bearings on the science of agriculture. A taproot will force its way far down into the subsoil, and get its nourishment from the lower strata of earth, where there is a greater abundance of material for plant growth, and where there is more soil moisture to resist periods of drouth. Taproots may take the form of the turnip, the carrot, or radish, having a fleshy structure, suitable for food. This is the store of nourishment provided by the biennial plant to be used up the second year in producing a crop of seed. The second year the root is dry and tasteless.

It is the new and delicate parts of roots that perform the office of absorption; hence we should take great care in preserving the fine roots or fibrils of plants that are to be transplanted. (Let the pupils examine carefully the root-hairs of a young radish plant, or of a young corn plant.)

But roots are not always necessary to start plants. House plants, alfalfa, clover and other plants can be grown from cuttings. Currants, grapes, cottonwoods, and willows are often propagated by cuttings, and even leaves of certain plants will form roots and grow new plants.

Old roots do not perform much of the work of absorption; their chief purpose is to carry food absorbed by the young roots and to hold the stem in a fixed location and position. The sap in the cells of young roots secretes an acid that passes from the root to the soil and aids in the preparation of food. This acid dissolves certain constituents of the soil, such as carbonate and phosphate of lime which are then absorbed by osmosis.

In leguminous plants we find roots performing still another function. The roots become the media through which bacteria perform an important service for the agriculturist, in preparing food for plants. Bacteria form the nodules on the roots of beans, cowpeas, clover, alfalfa, and vetches. When soil is without available nitrogen, these minute organisms take the nitrogen of the air in the soil and prepare a nitrogen compound that can be used by the plant. Thus leguminous plants and bacteria supply the soil with the nitrogen necessary for the growth of other plants.

The chief function of the root is to bring food from the soil to the plant in the soluble form. Hence plants require a prodigious amount of water. 90 per cent of the green plant is water. It is necessary to understand by what means this water is conducted from the soil to the body of the plant.

An examination of a transverse section of a root, reveals the facts pertaining to the functions of roots. At the extremity of the root is the root-cap made up of old cells that are rubbed off as the root forces its way through the soil. Roots prepare food in soluble form and carry it to the stem or other parts of the plant for assimilation.

When all other essential factors are present, the limit of plant growth will depend upon the conditions of the water supply. The amount of water required by certain plants to perform their normal functions is one of the important studies of agriculture.

The amount of water contained in different plants, or in the same plant at different stages of growth and maturity is subject to great variation.

NOTE. — For water content of various foods, see table page 368.

Functions of Water in Plant Life.

1. Water carries dissolved minerals into the plant.
2. It forms an essential part of plant food.
3. It is the medium of vital processes in plant growth.
4. It cools the plant by evaporation.

The amount of water transpired by plants is remarkable. From 250 to 400 pounds of water is transpired for every pound of dry matter produced.

PROBLEM.

1. Estimated from the transpiration of a small plant, an apple tree 30 years old would evaporate 36,000 pounds of water in one growing season; how many tons of water would be transpired by an acre of 40 such trees in one season?

The Root System.

The entire mass of roots belonging to a plant is called its root system. Some idea of the importance of the root system of a plant may be gained, when it is estimated that if all the roots of a thrifty corn plant were placed end to end they would reach a mile. This shows the importance of studying the subject of moisture supply and the effects of deep and shallow cultivation. This great root system is dependent upon every root to perform a function necessary for maximum results.

The part of a plant above ground will usually indicate the condition and the extent of its root system.

How Roots Feed.

We have aquatic, aerial as well as soil plants. Thus we have roots that derive their food from water; those that feed on other plants; and those that derive their food from the soil. The different kinds of roots are known therefore as water roots, parasitic roots, and subterranean roots. And we have also the aerial and the adventitious roots.

Water Roots.

Floating and immersed plants such as bladder wort and horn wort grow in water and have water roots.

Soil Roots.

Soil or subterranean roots as those of alfalfa and clover derive nourishment from the soil.

Aerial Roots.

Aerial roots of epiphytes or air plants get their nourishment from the air as "Spanish moss," and in some plants they are subsidiary to soil roots and serve the purpose of climbing roots for vines.

Parasitic Roots.

The mistletoe and dodder are examples of plants that derive their nourishment by having roots that penetrate the substance of other plants.

Adventitious Roots.

The gardener takes advantage of plants that grow adventitious roots from nodes and buds, and by layering or burying part of a vine or the limb of a tree, he can propagate new plants.

In summing up the work of roots we may state in a general way that they serve five important purposes:

1. To prepare food by means of acid and bacteria.
2. To absorb food through root-hairs by osmosis.
3. To serve as anchors and braces for support.
4. To aid in the propagation of plants.
5. To serve as food for plants and animals.

Stems.

Plants are either annual, biennial or perennial.

Annual and biennial plants usually have herbaceous stems, while perennial plants generally have woody stems.

We have herbaceous and woody stems, that grow upright as trees and grasses, and we have vines that twine or climb, and we have plants that trail upon the ground. The purpose of the stem in its different forms is always to bring its foliage into the best position to receive air and sunlight.

As to growth we distinguish two distinct classes; as for examples the corn plant and the oak. The corn-stalk has an inside growth and the oak has its growth from the outside. So we call the outside growing stem exogenous; and the inside growing stem endogenous.

The stem is the ascending axis as the root is the descending axis. The ascending axis bears buds and leaves. If buds appear on the roots they are adventitious or as the term indicates they appear by chance.

Stems grow according to the nature of the plant, either erect as the maple trunk, or prostrate as in certain bushes and vines.

All stems do not grow above ground. Botanists have therefore described various forms of underground stems, as the tuber (potato), the bulb (onion), the corm (indian turnip), the rhizoma (calamus).

Stems are subject to various modifications, and they serve various purposes. The study of stems is of interest to the agriculturist because of their products. They may bear flowers and fruit; they may be used for food; they may furnish timber for building purposes. We find them used in the material of many manufactured products.

The uses of stems may be briefly stated as follows:

1. To serve as a framework and support for limbs, leaves, buds, flowers, and fruit.
2. To bring the various organs above ground into the best position to receive light and air.

3. To carry soluble plant food from the roots to the different parts above ground.
4. To serve as a storehouse for foods and various other commercial products.

Leaves.

Leaves are the organs of plants that grow on the stems and branches. There are but a very few varieties of plants that can grow without leaves.

Facts About Leaves.

1. Deciduous leaves are those that live but one season.
2. Evergreen leaves are those that live more than one year.
3. The color of living leaves is generally green.
4. They form a very important part of food products. (See alfalfa.)
5. Leaves and flowers are the most beautiful and interesting parts of plants.
6. The changing color of the leaves in the fall of the year is one of the most delightful scenes in the phenomena of nature.

Functions of Leaves.

1. The leaves are the "lungs" of the plant.
2. Their extensive surface exposes the sap of the plant to the air and light.
3. Leaves give off oxygen and absorb carbon dioxide (carbonic acid gas).
4. The stomata are the organs of transpiration.

Some of the most brilliant investigations of science have been made in determining the relations of leaves to the earth's supply of organic matter. The leaf-green or chlorophyll contained in the leaf, is the strongest link that binds organic matter to the sun, which is the source of available energy upon the earth. The important work of chlorophyll is the absorption of light, or the taking over of energy, thus the green plant is our foremost conservator of energy. It is therefore one of the most interesting parts of agriculture to study the green plant, which is the noiseless machine or part of the great laboratory of nature engaged in manufacturing organic material upon which life depends.*

*For a list of books relating to Agronomy and Plant Physiology — see references at end of this chapter.

Goethe has clearly shown that the various parts of the plant from the seed to the blossoms are but modifications of the leaf, that all the parts of the flower calyx, corolla, stamens and pistil are only leaves adapted for certain functions. They are formed of the same elements and are arranged upon the same plan. In the changes which they undergo and in the relation which they bear to each other they follow the same laws of development.

In the variety of leaves and flowers we find perhaps the greatest diversity of beautiful forms in nature. Every kind of plant known to botany has its own peculiar kind of leaf and flower.

The Flower.

We have learned in the study of horticulture that there are several ways by which we may reproduce plants, such as layering, cuttings, grafting and budding, but the chief organ of reproduction in plants is the flower.

The flower is the sexual part of the plant, and its chief function is to produce a seed which contains in embryo a miniature plant of the same variety as that which bore the flower.

Pollen is the fertilizing part of the flower, and the transfer of the pollen to the stigma is pollination. Cross-fertilization is where the pollen from one flower is transferred and fertilizes the pistil of another flower. Self-fertilization is where a flower fertilizes itself.

If the anthers that contain the pollen are cut off before they open and discharge the pollen, and the flower is covered with a paper bag to prevent any other pollen from falling on the pistil, it will soon die and fall. If pollen is brought from another flower and is deposited upon the stigma, the pistil will live, mature and form seeds. The office of pollen is to produce seeds, hence upon this important truth hinges much of the success of such men as Burbank in their new creations in plant life.

Variation.

On account of the universal differences that exist between all things in nature, we have an unlimited field for producing new things among types and species, for among plants and animals there is an infinite variability. No two things that grow could possibly be exact counterparts as no two living things can be born, and live under the same conditions, experiences, and circumstances of time and place. It is this variability that makes improvement and progress possible in the development of new animal and vegetable forms.

Adaptation.

Plants will adapt themselves to almost any condition that will tolerate plant existence. We find plants growing through almost every degree of drouth and humidity from the cactus on the dry plains to floating aquatic plants; luxuriant vegetation flourishes under the tropic's burning sun and mosses and lichens grow in the arctic regions on the borders of the land of perpetual snow and ice.

It is this principle of plant life that enables us to breed for acclimatization and adaptation of plants.

The Sexual Organs of the Flowers.

The two most important organs of the flower to the plant breeder who wishes to make crosses, are the so-called sexual organs, the stamens and the pistils. The ends of the stamens are the male organs and are known as anthers; and the female organ is the pistil which consists of the stigma which receives the pollen and the ovary where the pollen assists in bearing the seeds.

Breeding.

The real purpose of plant breeding should be to give refinement and pleasure and practical results in the improvement of species and in the creation of new forms of life. Some of the important underlying principles of plant breeding may be briefly stated as follows:

1. Crossing of plants to produce variation and new combinations.
2. A constant broadening of the field of breeding for varieties in selection.
3. Radical changing of environments and intelligent application of nature's forces.

4. The guiding of inherent life-forces in the direction of an ideal product.

Since we have determined that the basic facts of plant-improvement are breeding and selection, the method of procedure should be the next important step if the work is to be carried on in the garden, orchard and greenhouse.

Steps in Plant Breeding.

1. Wait till the flowers are in full bloom, before the work of pollination begins.
2. The amateur should begin plant breeding with simple problems.
3. Begin the work by taking the single flower instead of the composite one.
4. The beginner should commence crossing sweet peas, geraniums, petunias, and Japanese pinks or violets.
5. The sweet pea and the violet offer unusual opportunities.

A Concrete Example.

Take a variety of sweet peas for an experiment. Decide upon some particular improvement that it is desired to bring about. Have an ideal firmly set in the mind. If the stems are too long, select for shorter stems. If the blossom is too small, select for a larger blossom. If the color is pink and you want it red, pollinate for a crimson hue. Keep only those plants that are developing the characteristics for which you are breeding. Destroy all the others or they may cross-pollinate with those selected for the test and prevent desired results.

Selection.

Great care should be exercised in selecting and saving seeds for the next crop. Let them be kept in air-tight jars. From the plants grown from the new seed, select the plant that comes nearest to the ideal. The seeds from this plant should be planted, where they may be identified. Seeds from a few of the next best types may be sown to afford a larger crop for the next generation.

The selection of the fittest or nearest to the ideal must continue. Always save the best. This may be carried on for generations.

How to Pollinate.

Breeding is accomplished by sifting the pollen of one plant upon the stigma of another plant and is called pollination. When this results in fertilization nature may bring forth a new plant. There may be many failures.

Let the beginner provide himself with a pair of jeweler's forceps or pincers, a small but powerful microscope, a pair of scissors, a sharp knife, a saucer or watch-crystal for holding the pollen, a soft brush for sifting or dusting the pollen from the saucer or watch-crystal to the stigma.

The pollen may be placed upon the stigma with the finger-tips. The fertilizing must be thoroughly done. Some flowers are difficult to pollinate. It may be necessary to cut away stamens, petals and sepals to keep insects from being attracted and protected by the flower. It is therefore not necessary to cover the flower that is pollinated for in many cases covering may result in more harm than good.

The flower should be isolated from its fellows and carefully guarded. When the bees are upon the flowers it is a good indication that the flower is ready to be pollinated.

Luther Burbank is quoted as saying that there is no barrier to obtaining fruits of any size, form or flavor desired and none to producing plants and flowers of any form, color or fragrance. All that is needed is a knowledge to guide our efforts in the right direction, undeviating, patient and cultivated eyes to detect variations of values.

AN EXPERIMENT WITH CORN.

Select varieties of the type desired that have been grown in the same locality for a number of years. See that the varieties are pure. Get varieties that will mature and shed the pollen at about the same time.

In most plants fertilization takes place before we can determine the relative value of the plants. It is therefore necessary to make careful selections before planting. A good method for eliminating the effects of crossing with inferior individuals is to save part of the ear, that has been selected, for the following year. Thus the remnants of the ear that has shown its superiority should be planted the second year of the experiment in an isolated place. This seed should be planted in rows which alternate with those to be crossed on them.

The rows of corn from the remnants of ears first selected are to be detasseled. In this way parentage may be controlled in the second generation.

Experiments.

CORN.

1. Cross varieties of uniform color. Plant these rows in an isolated place. Detassel one row and pollinate the detasseled row from the row bearing tassels.

2. Cross a variety having a white endosperm with a variety having a yellow endosperm. Note results.

3. Cross white corn with yellow. What will be the immediate result in color? Plant some of this seed in an isolated place the next year and note colors.

4. Cross sweet corn with dent corn. Cross popcorn with sweet corn.

5. Plant some pod corn by itself and note different results. There will be stalks bearing kernels in the tassel, and ears with kernels each covered with husks and ears without husks surrounding each kernel.

5. Plant dent corn and sweet corn in alternate rows. Detassel the sweet corn and pollinate it from the dent corn. Examine the ear of sweet corn when it is mature. Is the cob or stalk of sweet corn effected?

6. Plant some crossed or hybrid kernels of dent or sweet corn. Note the kinds of ears resulting. What is the ratio of dent corn grains to sweet corn grains?

7. Study composition of kernel and breed for high-protein, low-protein, high-oil and low-oil content.

Questions.

1. Can experiments in plant breeding be carried on successfully on the home farm?

2. Which gives the best results self-fertilization or cross-fertilization?

3. Will continuous self-fertilization reduce the yield?

4. How does hybridization effect growth?

5. Is there any fixed relation between type and yield?

6. What is Mendel's Law?

7. What is the ear-to-row method?

8. What are the advantages of using remnants of best ears for foundation stock?

9. What is inbreeding in plants?

10. Why does a stalk of corn standing by itself frequently have an imperfect development of kernels even though it is not detasseled?

11. Name some of the plants that are raised from seeds sown in hot-beds and which are taken up and planted in the garden.

12. Have you ever studied an experiment station bulletin on cutting potatoes and potato culture?

13. From what kinds of stems do we get turpentine? Maple syrup? Molasses?

Laboratory Exercises and Experiments.

Study the structure of a cornstalk. Learn the names of its different parts. Notice the arrangement of the grooves and leaves. Where do you find the buds? Cut a cross section midway between the nodes, and observe the composition of the interior. Compare a green stalk with an old dry stalk. Find the vessels or ducts that convey the sap from the roots to the leaves and from the leaves to the roots.

Cut a cross section of oak. Study the comparison between the section of a twig from one to three years old and a section of an old trunk of many years growth.

Compare a lily bulb with an oak bud.

Place a plant in a dark room or box having but little light coming from but one direction and note in which direction the plant grows.

Plant a hill of corn in an isolated place. Detassel the corn so that it will receive no pollen on the silk. Examine the matured ear of corn and note if any part of the ear is not developed. Give explanation for cause.

Dissect a kernel of corn and show in which part of the kernel each of the following are located,—starch, oil, protein?

Budding, Grafting, Layering.

EXPERIMENTS IN PLANT PROPAGATION.

CUTTINGS.

Equipment.—Secure twigs of willow, currant, cottonwood and grape and store in a cellar during winter. Make or secure a box of the size desired and fill with sand to a depth of ten or twelve inches. Secure herbaceous cuttings of geranium and other plants.

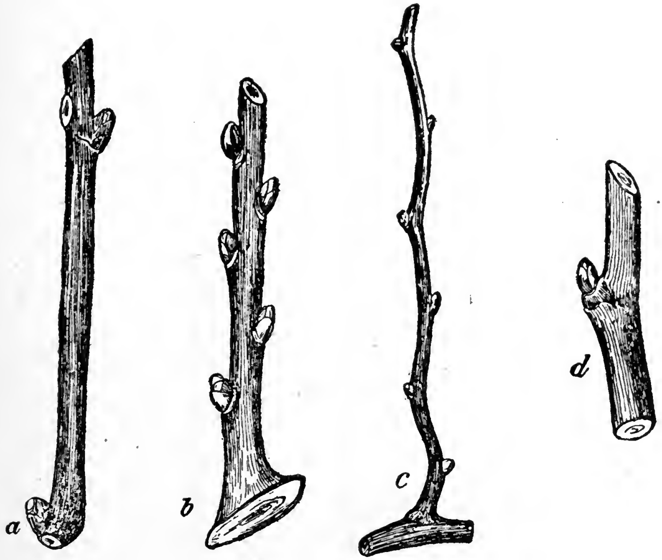

FIG. 1. a. b. c. d. Cuttings.

Directions.—Wet the sand thoroughly; insert the twigs in the sand and press the soil firmly about the stems. After the root system develops sufficiently the cuttings may be transferred to the nursery or pots.

LAYERING.

Bend a branch of a grape vine to the ground. Fasten it in this position and cover it with soil. After the stem takes root it may be severed from the parent plant. It will then grow as a separate plant. Note how strawberry plants start.

TUBERS.

A potato is a modified form of stem and can be propagated by cutting into pieces if each piece contains one or more "eyes". Sprouts will start from the "eyes". Each sprout will produce a plant.

BULBS.

Plant hyacinth, tulip and lily bulbs, in rich soil. Plant the bulbs at about twice their depth. Roots will start from the lower surface.

BUDDING.

Equipment.—Have a place in the school or home garden that is large enough to contain as many seedlings as desired. They should be planted in rows about two feet apart and about one foot apart in the row. This is the nursery. About all that is required for a budding outfit is a knife and some twine, cotton cord, yarn or strips of waxed cloth.

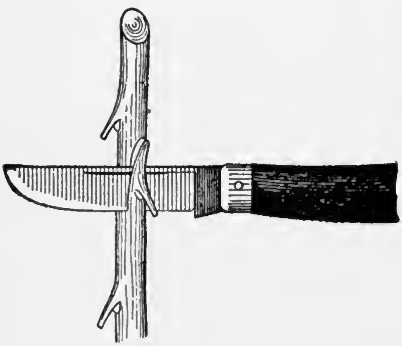

FIG. 2.—Cutting the bud.

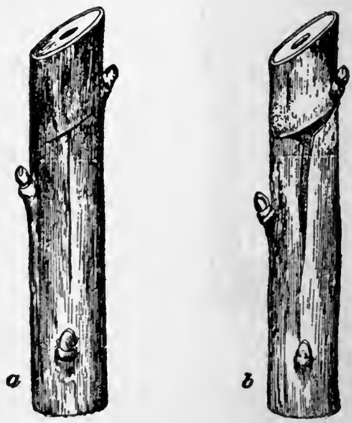

FIG. 3.—Budding: Preparing the stock.

FIG. 4.—Budding: *a,* Inserting the bud; *b,* tying; *c,* cutting off the top.

Directions. — Make a vertical cut in the stock to be budded. The cut may be less than an inch in length. Make another cut that is horizontal near the top of the vertical cut. Be careful not to injure the cambium layer. From an orchard bearing the desired fruit, cut off a few branches bearing buds. Cut the bud from the branch so that there will be enough bark attached to the bud to fill the space between the cambium layer and the bark opened up on the seedling or stalk to be budded. Slip in the bud and bind in place.

CLEFT GRAFTING.

Equipment.—Grafting knife, small mallet, saw, grafting wax and cions (twigs or small branches).

Directions—Make grafting wax by melting together by weight, four parts resin, two parts beeswax, and one part tallow. Melt thoroughly. Cool in water. After it becomes hard it should

FIG. 5.—Grafting tool.

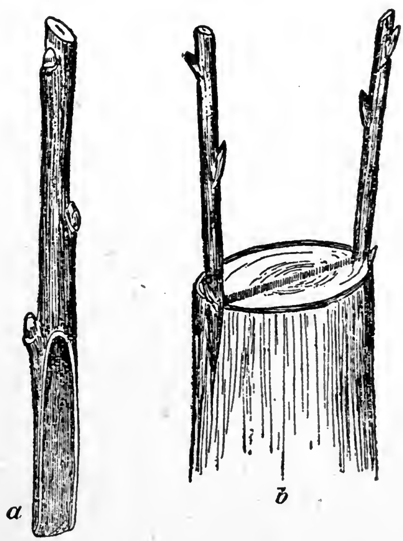

FIG. 6.—Cleft grafting: *a*, Scion; *b*, scions inserted in cleft.

be worked until it becomes tough. In handling, grease hands with tallow.

Directions.—Select an apple tree that is barren or produces inferior apples. Saw off the limbs where they are from one-half inch to one and one-half inches in diameter. The diameter of limbs will vary in a large tree. The limbs should be cut off in grafting so that the top may present a symmetrical appearance. They should not be cut too near the stem.

Make a cleft by splitting the end of the limb to be grafted. Cut the cion so that the cut surface will fit into the cleft of the stalk. Insert the cion on the side, or if two cions are to be used, place one on each side of the cleft. Be sure that the cambium layer of the outside of the cion comes in contact with the cambium layer of the stalk. To make the contact more certain, place the cions at a slight angle.

Cover every portion of the wounds with grafting wax.

Try grafting a tree with a great variety of apples. Have among the varieties on the same tree — harvest, fall and winter apples.

TOP GRAFTING OF SEEDLINGS.

The process is the same as that employed in grafting old trees except that seedlings may be used for the stock by sawing off the stem one or two feet above the ground. One cion is inserted and left to grow upward forming the upper part of the stem from which the branches are to grow. Small seedlings one or two years old may be grafted by whip, or tongue grafting.

ROOT GRAFTING.

Root grafting is the method employed in the commercial nurseries. The root grafts can be made during the winter. The process used almost exclusively in the production of young nursery stock is the whip graft. The work of root grafting is divided up into piece-root grafts and whole-root grafts. In ordinary propagation by means of whip grafts, the cion is cut with two or three buds, and the whole root stock (which is the best) should be united with the cion so that the point of union shall be just below the surface of the ground.

FIG. 71.—Whip grafting: *a*, The stock; *b*, the scion; *c*, stock and scion united.

Directions for whip graft.—Cut off the stalk diagonally with a very sharp knife giving the stalk a smooth surface three-fourths of an inch long. Cut the lower end of the cion in the same manner as that used in cutting the stalk. The two ends should be nearly of the same size so that they will fit neatly. Each should be split one-third of the distance from the end of the cut surface. The two parts are then forced together and this union is wrapped firmly with several turns of waxed cord. When this work is done in winter, the grafts are packed in moist sawdust and kept in cold storage cellars until spring.

Book References.

First Lessons with Plants—Bailey, 5-8—Macmillan Co............ $0 40
Plants and Their Children—Dana 6-8—American Book Co........ 65
First Studies of Plant Life—Atkinson, 6-8—Ginn & Co............ 60

Advanced.

New Creations in Plant Life—Harwood, 8-12—Macmillan Co...... $1 75
Principles of Plant Breeding—Bailey, 7-12—Macmillan Co........ 1 25
Plant Physiology—Duggar, 7-10—Macmillan Co.................. 1 60
Chapters on Plant Life—Herrick, 8-12—American Book Co........ 60
Practical Course in Botany—Andrews, 8-12—American Book Co... 1 25

Bulletins From the U. S. Department of Agriculture.

Plant Production—Bulletin, 186...........Office of Experiment Stations
Propagation of Plants—Farmers' Bulletin, 157..Department of Agriculture
School Exercises in Plant Production—Farmers' Bulletin, 408.... ....U. S. Dept. of Agriculture

State Bulletins From Colleges and Experiment Stations.

Experimental Studies of Plant Growth—Davis.....................
...........................Ohio State Normal College, Oxford, O.
Experiments with Plants and Soils—Edwards...University of Cal., Cir. 58
Laboratory Exercises............Maine State Department of Education
Principles of Plant Production.................................
...............University of Missouri, Public School Bulletin, No. 2
Seeds and Seedlings...
New Hampshire Col. of Agriculture, and Mechanic Arts, Bul. No. 3

CHAPTER VI.

Legumes.

Leguminous plants may be classed in three groups: perennials, biennials and annuals.

A few legumes are given in the following groups:

Perennials; Alfalfa, Alsike, White Clover.

Biennials; Red Clover, Mammoth Clover.

Annuals; Crimson Clover, Soy beans, Cow peas.

Alfalfa.

Alfalfa is one of the oldest plants known to history. It has been grown in the old world for more than two thousand years, and has been growing in some parts of the new world for several centuries. In some countries it is known as lucerne.

It has a long tap-root that goes far down in the soil for its nourishment. The roots will go to a depth of many feet below that reached by any other farm crop.

Its high yielding and feeding value has been thoroughly demonstrated by many experiment stations. In recent years many experiments have been made by the stations in the United States so that there is an abundance of available information for those who wish to make a study of this important plant.

It has been demonstrated that it can be grown on almost any type of soil from light sandy or gravelly loams and mucks to heavy clays, if they are well drained, sweet and supplied with sufficient plant food.

In Indiana, experiments conducted by the State showed that in 378 trials conducted in five years up to 1911, alfalfa was successful in:

68 out of 83 trials in clays,
167 out of 188 trials in loams,
69 out of 77 trials in sandy soils.

It is therefore very evident that failures in these instances were due to other causes than types of soil. According to reports it is shown that weeds cause more failures in alfalfa culture than any other one thing.

There are at least five essential factors that must be considered in the culture of alfalfa. They may be summed up as follows:

1. Thorough drainage
2. A sweet soil
3. Humus in the soil
4. A clean field
5. Nitrogen fixing bacteria.

FIG. 1. A test of the effect of Alfalfa Bacteria in growing Alfalfa in ordinary soils without fertilizers.

Bacteria will not thrive where there is acid in the soil. Lime and innoculation are important factors in alfalfa growing. Lime supplies the needs of the plant and corrects any possible acidity.

It has been very truthfully said that "where alfalfa is queen, corn in king," and that: "Alfalfa makes two blades of grass grow where but one grew before."

A chemical analysis shows that alfalfa contains forty-two pounds of lime per ton, while timothy contains but seven pounds per ton. This shows the importance of a good supply of lime in growing alfalfa. A luxuriant growth of alfalfa is an indication of an abundance of lime.

In testing soil for lime use muriatic or hydrochloric acid. Get a sample of the type of soil to be tested; place in a glass tumbler and pour the acid on the soil; if there is an effervesence or a bubbling similar to water boiling in the soil this is proof that there is lime in the soil. Thus the hydrochloric test will detect one of the requirements of a successful alfalfa soil.

When a stand of alfalfa looks yellow and sickly it is an indication that it may need liming or harrowing. This should be done at once after cutting a crop of hay. It has been frequently found that soil that did not respond to the acid test, had an abundance of lime at a depth of two or three feet from the surface. The effect therefore of liming such soil in a new seeding of alfalfa is to assist the new plants to grow until the roots can penetrate to the limestone subsoil.

The nitrogen-fixing bacteria of alfalfa and sweet clover are very similar, and they readily adapt themselves from one to the other. Thus where we find sweet clover growing there is a good innoculation for alfalfa. It shows the same fondness for lime that is common to alfalfa and the clovers. A comparative analysis of alfalfa and sweet clover shows the following:

COMPARATIVE ANALYSIS OF ALFALFA AND SWEET CLOVER.
(PER CENT)

	Protein.	Fat.	Nitrogen, (free extract)	Crude fiber.	Ash.
Alfalfa	16.48	2.03	42.62	31.38	7.49
Sweet Clover	20.93	3.09	42.46	25.21	8.87

DIGESTIBLE COEFFICIENTS.

	Dry Matter.	Protein.	Fat.	Nitrogen, (free extract)	Crude fiber.	Ash.
Sweet cloverhay (Melilotus)	60.88	75.46	30.94	72.04	33.63	65.79
Alfalfa	61.95	77.56	38.46	73.29	46.04	47.04

Sweet Clover Hay.

For hay it should be cut just as it is coming into bloom and is handled in much the same way as alfalfa. A second cutting can usually be secured forty to sixty days later if not pastured. The leaves shatter even worse than alfalfa and great care is necessary in order to make good hay. It has also been cut and put into the silo and fed successfully.

CAUSE OF FAILURES.

Many failures in growing alfalfa in the past have undoubtedly been due to lack of information. They may have been due to some of the following reasons:

1. A wet undrained soil.
2. A sour soil needing lime.
3. Seed bed poorly prepared.
4. Need of innoculation.
5. Poor seed, not properly tested.
6. Soil not sufficiently rid of weeds.
7. Clipping at the wrong time, or too close.
8. Cutting at the wrong time.
9. Pasturing too closely or at the wrong time.
10. Cutting too close to the ground.

Important Facts.

Alfalfa should be cut for hay when the new shoots are about an inch in length. But little attention should be paid to the time of blossoming. The alfalfa grower must get down on his knees and examine the shoots that are coming on for the next crop. If the alfalfa is cut before these shoots are sufficiently started or after they are too long and are cut off by the mower, the crop will be injured.

Horses and sheep are more likely to injure alfalfa by pasturing too closely than cattle or hogs.

There is very little reliable information to substantiate the claim that alfalfa roots do damage to tile drains.

Alfalfa hay will stand more rain than red clover.

Alfalfa requires more care in pasturing than clover to prevent bloating.

Alfalfa has about the same composition as wheat bran. The following table will show the relative value of alfalfa and a few of the important feeds:

PROTEIN CONTENT.

Alfalfa	14.42 per cent
Wheat Bran	11.2 per cent
Oats	9.5 per cent
Corn	7.8 per cent
Clover	7.5 per cent

NOTE.—It should be remembered that similar experiments by the different experiment stations in testing or analyzing feeds do not always bring the same results.

The protein content of alfalfa hay has been reported at from 8 per cent for the first, to as high as 20 per cent for the fourth cutting.

Thirty-four different reports from ten different experiment stations give the average composition of alfalfa as follows:

	Protein.	*Fat.*	*Crude Fiber.*	*Nitrogen Free-extract.*	*Water.*	*Ash.*
Composition	14.42	1.97	29.98	35.81	9.61	9.41
Digestive Co-efficient	75.27	40.57	46.37	68.43		50.08

Value in Feeding.

The South Dakota Experiment Station found that without exception the largest gains ever made in a feeding experiment with lambs were made by feeding alfalfa.

The New Jersey Experiment Station showed that when wheat bran was $22.50 per ton, a ton of alfalfa as a substitute for bran was worth $16.50 a ton, in feeding for milk production.

The Kansas Experiment Station at Manhattan showed by an experiment that alfalfa was even better than wheat bran for milk production.

The value of alfalfa in fattening beef cattle has demonstrated its wonderful results in making Argentina one of the greatest beef exporting nations in the world. Millions of acres of alfalfa of luxuriant growth make it possible to produce beef cheaply. The cattle are easily fattened on alfalfa alone, needing no supplement to the pasture for beef production.

If the United States is to compete with other countries in farm products it is very evident that alfalfa must be grown wherever it can be raised profitably.

For ordinary purposes in mixed farming where it is necessary to follow a scientific plan of crop rotation alfalfa excels every other crop grown in the following characteristics:

1. As a soil renovator.
2. As a drouth resister.
3. As a soil enricher.
4. As a balanced ration.
5. As a profitable crop.

As a drouth register its verdure and luxuriant growth are due to its ability to grow roots that penetrate to the moisture in the subsoils, (that often cannot be reached by other crops) during long periods of drouth. When meadows are dry and grass is dead alfalfa continues to grow and produce crops. Its great value is largely dependent on the fact that it is a dry weather perennial plant. If properly cared for it will grow for many years on the same soil.

As a soil enricher it brings more fertility to the soil than any other legume that can be successfully raised. The roots penetrate to a great depth and draw nourishment from rich stores of minerals that are beyond the reach of other plants. It is a nitrogen gatherer that is associated in its work by nitrogen-fixing bacteria found in the nodules of the roots.

In a rotation with corn the U. S. Govt. speaks of its value in the following terms: "In these two crops, corn and alfalfa, is realized more nearly than in any other combination of crops grown in the corn belt, the maximum of grain and hay yields and of profits that can be secured from an acre of land by ordinary methods of farming. Whenever a farmer can substitute alfalfa for clover and timothy in the rotation without too great a cost, he will be able practically to double his profits."

As a balanced ration it aids in the digestion of other foods. While it may be fed alone with good results, it has been fed with corn and other grains and found most profitable in supplementing other feeds. It is well adapted to various uses. It is used as forage, soiling, ensilage, hay, meal, green manuring, cover cropping, and is eaten by cattle, sheep, horses, hogs and poultry.

As a profitable crop the value of alfalfa is based on its feeding and fertilizing values. It is almost as rich in composition, as some of the concentrates, when used as hay. One acre of alfalfa is often worth as much as six acres or more of our other grasses.

The alfalfa grower's decalogue is:

1. Make a start and keep it.
2. Get ground reasonably free from weeds by summer fallowing.
3. Make a firm solid seed bed by summer fallowing.
4. Don't throw seed away by seeding on poor ground. Manure it.
5. Don't put alfalfa in sour, wet soil.
6. Always cut on time when sprouts at base are starting.
7. Plant 10 pounds to the acre.
8. Get good seed and have it tested.
9. Find out from your experiment station when it is the best time to plant.
10. Make but three cuttings a year.

Before starting to raise alfalfa be sure that you understand the subject thoroughly. Send for some of the literature named in the list given at the end of this chapter.

Getting Alfalfa Started.

Two or three pounds of alfalfa sown with clover and timothy on the rich well drained lands of the corn belt will serve to innoculate the soil and finally faciliate the exclusive culture of alfalfa as a legume for rotation with corn.

For a stand of alfalfa alone, various experiments have demonstrated that it is not advisable to sow less than six pounds nor more than fifteen pounds of seed per acre. Ten pounds of alfalfa per acre means if properly distributed on an average sixty seeds per square foot, and if these should all grow there would be from five to six times as many plants as necessary. In some of the best alfalfa lands of the United States a single plant may take a space nearly equal to one square foot, while in some of the poorer regions there may be five or six plants per square foot.

Every farmer should make a seeding experiment when he sows his alfalfa. A trial application of lime should be made on some part of the field.

The results should be noted carefully, as this will be the best possible test in determining whether the soil needs liming.

NOTE. — (See Liming the Soil, Chapter V.)

The same tests in the use of lime should be made in seeding red clover. Good soil, inoculation, lime and manure, with about the same care given to alfalfa will insure success with June and mammoth clover.

NEED OF PLANT FOOD.

Lime and inoculation alone will not insure success in growing alfalfa. A ton of alfalfa hay removed from the field takes with it about twelve pounds of phosphoric acid and about thirty-six pounds of potash; it is therefore important that manure or fertilizer rich in phosphoric acid and potash be supplied especially in starting a new crop, even on fields that have been in alfalfa and have produced good yields. Where a field is deficient in phosphorus and potash it is advisable to use a 2, 8, 8, or a 2, 10, 10, fertilizer.

After alfalfa has a good start and has become thoroughly inoculated it will furnish its own supply of nitrogen, which amounts to thirty-five pounds per ton on an average.

A practical method of inoculating land, which has not been growing alfalfa or sweet clover, is to take from 200 to 2,000 pounds of soil for each acre from an established alfalfa field, or from a field growing sweet clover (melilotus) and scatter it in a finely pulverized form over the field and harrow it in before the sunlight kills the germs.

Once a field has a well-established stand, it will last from four to ten years. It is claimed that there are places in the new world as well as in Europe where alfalfa has been growing continuously for centuries without re-seeding.

PROBLEMS.

1. If there are on an average 60 seeds of alfalfa per square foot on a field when we sow 10 pounds of seed per acre, how many seeds are there in a bushel of alfalfa?

2. How many bushels will be required to seed 20 acres using 15 pounds per acre, and how many seeds will there be on an average per square foot?

3. What will be the cost of seeding 5 acres, using 8 pounds of seed per acre when seed is selling at $12 per bushel?

4. If there are 35 pounds of nitrogen in one ton of alfalfa hay and an acre of land produces 1.5 tons of hay, and two-thirds of the notrogen in an alfalfa plant is in the roots, what is the value of the nitrogen left in a 5 acre field after the hay crop has been removed, basing the calculation on the present price of nitrogen, at 15c a pound?

5. An acre of alfalfa produced 4 tons of hay in one season; 60 per cent of the hay was stem, 40 per cent was leaves; 40 per cent of the protein was in the stem and 60 per cent of the protein was in the leaves, which is the most valuable part of the hay? Why should we be careful to save the leaves?

6. In the four tons of hay given in problem 5, 20 per cent of the fat was in stems, and the percentage of fat in the leaves was 80, how many pounds of fat were there in each the leaves and the stems in the four tons? (See table page 85.)

7. If we should lose half of the leaves in making a hay crop that yields 1 ton per acre, how many pounds each of protein and fat would be lost?

RELATION OF VALUE OF LEAVES TO STEMS.

Quantity	
In Stem	60 per cent
In Leaves	40 per cent
Protein	
In Stem	40 per cent
In Leaves	60 per cent
Fat	
In Stem	20 per cent
In Leaves	80 per cent

8. Find the number of pounds of the following feeds that will have the equivalent in digestible protein of 1 ton of alfalfa, if the percentage is as follows:

Name.	*Per Cent digestible protein.*
Alfalfa	11.0
Cotton seed meal	37.2
Wheat bran	12.2
Red Clover hay	6.8
Timothy hay	2.8

9. According to a report of the Nebraska Experiment Station, in 1911, an average of reports for two years shows that it costs 29.6 cents per bushel to produce corn; 54.9 cents per bushel to produce wheat; 32.5 cents per bushel to produce oats; $5.87 a ton to produce wild hay; $4.18 a ton to produce clover; and $3.10 per ton to produce alfalfa hay; which is the most profitablé crop at present market prices if the yield is as follows:

Corn	25.8	bushels	per acre
Wheat	17.03	bushels	per acre
Oats	26.41	bushels	per acre
Wild Hay	0.97	tons	per acre
Clover	1.5	tons	per acre
Alfalfa	3.04	tons	per acre

10. The following table shows the

ACREAGE, VALUE, AND YIELD OF WISCONSIN HAY CROP (1910).

	Alfalfa	*Timothy Alone*	*Clover Alone*	*Timothy and Clover*
Acreage	18,000	767,000	119,500	1,600,000
Value per acre	$31.00	$14.00	$14.00	$14.00
Ave. yield per acre	2.8 T.	1.4 T.	1.7 T.	1.6 T.

Allowing $10 for rent of land and for labor in the production of clover and timothy and $15 per acre for the production of alfalfa, how many times greater was the net profit on alfalfa per acre than that of clover or timothy?

Soy Beans.

The soy bean is a legume and is therefore a nitrogen gathering plant.

It is an annual plant. It is well branched and bushy, growing from 20 to 50 inches in height.

It is a native of China and Japan, where it has been grown for centuries. It is used in those countries for human food.

The acreage in the United States is rapidly increasing. It is being used in this country as a livestock food and as a soil renovator. It has proven to be an excellent crop in a four or five course rotation. A good course established by the Ohio Experiment Station is a four-year rotation of corn, soy beans, wheat, clover.

Soy beans are an excellent crop after which to sow or seed wheat, because plowing is unnecessary if the ground has been

FIG. 2. Field of Soy Beans raised by Johnson Bros., Stryker, O.

kept clean. Disking the soy bean stubble for wheat may be sufficient.

Soy beans are a poor-land crop. They do fairly well on a wet soil, and yet they can resist much dry weather.

As a soil builder compared with clover, the soy bean when plowed under for green manuring yields the same amount of nitrogen as plowing under an equal yield of green clover.

According to experiment station reports, for every ton of air-dried clover removed from a field there remains about twenty pounds of nitrogen in the roots and stubble, and for every ton of thoroughly dried soy bean hay removed from the field there remains in the roots and stubble six pounds of nitrogen.

One of the chief values of the soy bean crop therefore is to supplement the clover crop when the latter is not a decided success.

Soy beans used with corn for ensilage constitute a well-balanced ration if they are put in the silo at about the proportion of one part soy beans to two or three parts corn. If the proportion of soy beans is too great when fed to dairy cattle, they may impart disagreeable taste to milk and butter.

For the best quality of hay they should be drilled solid using six or eight pecks of seed per acre.

When sown for the purpose of harvesting for seed, the best yield in Ohio has been from beans drilled in rows twenty-eight inches apart, using three pecks of seed per acre.

With a ten hoe drill the feed cups can be stopped up so that four rows twenty-one inches apart, or three rows twenty-eight inches apart, or two rows forty-two inches apart can be drilled at one time.

If a ten-hoe drill is used and the rows are drilled twenty-eight inches apart, three rows will make a strip seven feet wide.

Taking 1/5 of an acre or 8,710 sq. ft. and dividing by 7 the quotient is 1,244 2/7 feet which is the distance a drill must go in drilling 1/5 acre. Divide 1,244 2/7 by the circumference of the drill wheel and the quotient will be the number of revolutions of the wheel made in drilling 1/5 of an acre.

Raise the drill and turn the wheel by hand the required number of times or revolutions for seeding 1/5 acre catching the soy beans on a canvass spread under the drill. From the amount thrown out by the drill it can be determined how to regulate the drill to sow the required amount per acre.

Value of Soybeans Compared with other Crops.

In nutritive value soy beans rank ahead of red clover and are nearly equal to alfalfa. Make a study of the Henry tables and compare nutritive value of alfalfa, red clover and soy beans.

Soy beans should be seeded after danger of frost is past;

for northern Ohio about June 1, and for southern Ohio, about May 15, are good dates for seeding.

For selection of variety adapted to your region, write to your states experiment station.

Fig 9.—Typical soy-bean plant.

Tests made at some of the experiment stations show that in some cases innoculation has increased the nitrogen content in soy bean plants as high as 50 per cent. This has been demonstrated particularly by the Michigan Experiment Station.

At the Wisconsin Agricultural Experiment Station an analysis of both roots and stalks showed that inoculated soybeans produced $2.34 worth of nitrogen more per acre than did uninoculated soybeans.

It must be borne in mind that the tubercle bacteria of soybeans, alfalfa, red clover and peas are different.

Soybeans should be cultivated three or four times per season when planted in rows far enough apart for cultivation. They should be cut for hay, when the pods are a little less than half filled, and cut for seed when three-fourths of the seeds are ripe.

Facts About Soy Beans.

1. Soybeans can be planted late and harvested early.
2. They are a poor-land crop.
3. They will resist much drouth.
4. They will survive wet weather better than corn.
5. They can be grown in most soils and climates adapted to corn.
6. The soybean has few insect enemies.

7. They are a successful crop on rich land.
8. Soybeans are free of fungus diseases.
9. Winter weather does not injure the seed.
10. Soybeans are grown for grain, hay, silage, soiling, pasture and soil enrichment.
11. The hay is not easily damaged by rain.

PROBLEMS.

1. Measure the circumference of a drill wheel and find the number of revolutions required in seeding 1 acre of soy beans in rows 28 inches apart, seeding 3 rows at a time.

2. Find the number of revolutions required in seeding ½ acre in rows 42 inches apart.

3. The average production of soybeans in Ohio is about 18 bushels per acre, and the average price of seed is $2 per bushel; how will this compare in value with the average production of wheat (13 bu.) in Ohio at the present price?

4. If soybeans in the value of their composition are equal to cotton seed meal or oil meal when the latter sell at $33 per ton, what is the feeding value per acre, when soybeans yield 10 bushels per acre with soy bean straw valued at $5.66 per acre for manure?

NOTE. — Soybeans weigh 60 pounds per bushel.

5. A field has been thoroughly innoculated and produces 2 tons dry soybean hay per acre and leaves 6 pounds of nitrogen in the roots and stubble for every ton of soybean hay produced; find the value of the nitrogen left in a ten acre field if the cost of nitrogen as purchased in commercial fertilizers is 18c per pound.

6. Compare the value of the nitrogen left in the stubble and roots in an acre of clover producing 2 tons of hay per acre and the value of the nitrogen left on an acre producing a like amount of soybean hay.

7. *Compare the value of the nitrogen left on one acre after removing 2 tons of alfalfa with the value of the nitrogen left after removing two tons of soybean hay per acre.

Exercises and Questions.

1. Describe fully the two varieties of red clover.
2. Can you distinguish all clovers by their seeds?
3. Examine samples of clover seeds under a strong glass.
4. Compare the cost of different legume seeds.
5. What is the most important hay plant in U. S.?
6. Make a collection of all the popular grass seeds.

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* NOTE — There are 35 pounds of nitrogen in 1 ton of alfalfa hay, and ⅔ of the nitrogen in an alfalfa plant is in the roots.

7. Secure samples of timothy, Kentucky blue-grass, red-top, Canada blue-grass or wire grass, Brome grass, orchard grass, Bermuda grass, and Johnson grass.

8. What are the advantages of sowing a mixture of grasses and clovers?

9. Recommend a good mixture for a meadow to be left two or three years.

10. Recommend a mixture of proper proportions for a permanent pasture.

Alfalfa Literature.

BOOKS.

"Alfalfa in America" (480 pg. $2.00), Jos. E. Wing, Mechanicsburg, Ohio.
"The Book of Alfalfa", F. D. Colburn, (344 pg. $2.00), Topeka, Kans.

FARMER BULLETINS, U. S. DEPT. OF AGRICULTURE.

Number.
194. — Alfalfa Seed.
339. — Alfalfa.
273. — Irrigation of Alfalfa.

The following is a partial list of available alfalfa literature. Write some of these addresses for such literature as they issue on the subject:

University of Wisconsin, Cir. 35, Madison, Wisc.
The Pennsylvania State College, State College, Pa.
Agricultural Experiment Station, Bul. 113-181, Wooster, Ohio.
Agricultural Experiment Station, Geneva, N. Y.
University of Missouri, Bul. 106-40, Columbia, Mo.
Agricultural Experiment Station, Bul. 94-120-133-141, Brookings, S. D.
The University of Minnesota, Bul. 6, University Farm, St. Paul, Minn.
Michigan Agricultural College, Bul. 271, East Lansing, Mich.
Agricultural Experiment Station, Cir. 36, Lafayette, Ind.
Iowa Experiment Station, Bul. 137, Ames, Iowa.
University of Illinois, Bul. 76-134-14, Urbana, Ill.
Agricultural Experiment Station, Bul. 155-176, Manhattan, Kans.
"Alfalfa" Farmers Bul. 194-339, U. S. Department of Agriculture, Washington, D. C.
"Alfalfa Growing in Illinois," Bul. No. 18, H. A. McKeene, Springfield, Ill.

Write to your experiment station for bulletins on soy beans, vetch, cowpeas, and clover.

CHAPTER VII.

The Corn Crop in the United States.

If he who made two blades of grass grow where only one grew before is a public benefactor, then he who reduces the fertility of the soil so that only one ear of corn grows where two have been grown before is a public curse. — *Cyril G. Hopkins.*

"More corn of better quality on every acre of ground" is the motto of every corn-grower in Iowa. Let us each strive to grow more and better corn this year than we did last. This is the secret of success. This will make us love our work. Drudgery is work without thought, without interest, without love for it. "The man who can make two ears of corn, or two blades of grass, grow on the spot where only one grew before, would deserve better of mankind and render more essential service to the country than the whole race of politicians put together."— *P. G. Holden.*

Outlines for Corn Study.

Corn is one of our country's great farm crops. There is no other crop that affords a greater or better opportunity for study, and for the improvement of our agricultural conditions.

Corn offers many lessons and advantages for study to the class in agriculture, because it responds so quickly to the influences of careful and painstaking efforts in breeding.

The student should make use of the corn plant in connection with the use of the text book or government bulletins.

There should be a collection of the six different varieties of corn, pod corn, soft corn, pop corn, sweet corn, flint corn and dent corn.

The solution of the corn problem depends upon an intelligent study of this plant with relation to some of the following points:

1. Study the history of corn, and its influence on the development of the United States.
2. Make a collection of different types, and learn names.
3. Secure a specimen of an excellent corn plant.
4. Begin the study by making a drawing of a complete plant.
5. Examine the different parts of the stalk and ear, and learn names.

Study the important factors effecting the corn crop as:

1. Elements usually deficient in our soils.
2. The natural and artificial means by which nitrogen, phosphorus and potassium are supplied for plant growth.
3. Effects of clover, alfalfa and other legumes in preparing available nitrogen for corn growth.
4. Effects of manure and commercial fertilizers.

Each of the following topics should also be carefully considered in the following order: 1. Thorough Draining. 2. Early Plowing. 3 Humus in the Soil. 4. Available Plant Food. 5. A Sweet Soil. 6. Thorough Preparation of Seed Bed. 7. Seed Selection. 8. Seed Testing. 9. Careful Planting. 10. Scientific Cultivation. 11. Harvesting. 12. Feeding and Marketing.

PROBLEMS.

1. In 1910 the total corn crop in the United States was 3,125,000,000 bushels; what will be the size of a cube that will represent the same number of bushels?

2. If the population of the U. S. was 92,000,000 in 1910, what was the average production of corn per capita?

3. If the average wagon box holds 30 bushels of corn, how many such boxes would have been necessary to hold the total corn crop of 1910?

4. Allowing 30 feet for each wagon, how long a wagon train would have been required to transport the product of 1910, and how many times would this train of wagons have reached around the earth at the equator?

5. How long a train of box-cars, each holding 1,000 bushels, would be required to carry our average product of 2,500,000,000 bushels in the U. S.? (Allowing 38 feet for each car.)

6. The seven great corn producing states of the central west are: Ohio, Indiana, Illinois, Iowa, Missouri, Kansas and Nebraska. These states are known as the corn belt, and in 1911 they produced 1,753,835,000 bushels on 54,353,000 acres; what was the average production per acre?

7. From the Year Book of the U. S. Department of Agriculture, find the total corn crop of the U. S. for last year and also the total crop in the corn belt and find the average production per acre in the U. S. and also in the corn belt.

8. What is the combined area of the seven states of the corn belt?

9. What proportion is this of the land area of the U. S.?

10. What part is this of the land area of the globe?

11. What part is the corn production of the seven states of the corn belt of the total corn production of the U. S.?

12 What part is the corn production of the corn belt of the total corn production of the world?

Products of Corn.

The following statistics from the Products of Corn Refining Co., of New York City, shows the importance of some of our great manufacturing industries resulting from corn:

Corn manufactured into corn products....	50,000,000 bushels
Corn Syrup..............................	800,000,000 pounds
Starch	600,000,000 pounds
Corn Sugar..............................	230,000,000 pounds
Gluten Feed.............................	625,000,000 pounds
Oil	75,000,000 pounds
Oil Cake................................	90,000,000 pounds

What is the total production?

There were consumed in the U. S. in 1910, 800,000,000 pounds of candy. How many pounds of candy is that per capita, if our population was 92,000,000? If 200,000,000 pounds of Corn Syrup were used in the manufacture of this candy, what per cent of it was a corn product?

The total number of people employed in these industries is given at 6,000 and the annual wages, $4,500,000. What is the annual average income of each employee?

The fact that $90,000,000 are invested in these industries, shows how great the production of corn on the farm is becoming as a manufacturing source of wealth; and the manufacture of corn into so many products adaptable in many ways as foods and in the arts, makes corn an object worthy of the study of all who are interested in the industrial development of the country.

Reports show that there are about 35,000,000 bushels of corn used in the manufacture of alcoholic beverages by brewers and distillers in the U. S., annually.

Products Made from Corn.

Among the products of corn, the following list includes some of the most important: Starch, sugar, syrup, oil, gum, gluten feed, corn hulls, oil cake meal, dextrine, refined grits, paragol, corn flake, corn meal, and alcohol.

Prices and Values.

1. If our average corn crop for the last five years ending with 1912 has been 2,500,000,000 bushels of corn and the average price has been about 40c per bushel, what is the annual corn crop worth in the United States?
2. If 2 per cent. of the corn crop of the U. S. was exported each year, what was the number of bushels exported annually?
3. What must be the production of corn per acre at the present price of corn to equal six per cent. interest on land that is valued at $200 per acre?
4. If the total cost for rent and labor is $14 per acre, what must be the yield to cover the total expense?
5. A farmer produces 100 bushels per acre on land that cost $200 per acre, his taxes are $1 per acre, the cost of labor in producing the crop is $9 per acre, how much interest does he receive on his investment at the present market price of corn?

Estimating the Profits.

Bulletin 122 of the Nebraska Agricultural Experiment Station 1910 makes the following report on the cost of growing corn in that state:

Interest and taxes or rent	$5.278
Plowing	1.276
Harrowing	.305
Disking	.481
Seed	.283
Planting	.408
Cultivating	1.415
Harvesting	1.688
Interest and depreciation on machinery	.380
Miscellaneous	.578
Total cost per acre	$12.092

PROBLEM.

1. If the average production of corn was 21 bushels per acre, and the average price was 55c per bushel, was there a loss or gain and how much for the average farmer in Nebraska?

Thorough investigations and data collected in Indiana gave the following results:

Plowing	$1.89
Harrowing	.63
Fertilizer	1.50
Seed	.41
Planting	.32
Cultivation	1.84
Harvesting	1.41
Rental value or interest on investment	4.79
Total cost per acre	$12.79

2. If the average yield of corn in Indiana was 36.5 bushels in 1911, and the average price of corn was 40c, what was the profit per acre?

Another state reports cost of producing an acre of corn as follows:

A LOW ESTIMATE.

Plowing at $1.00 per acre	$1.00
Harrowing at 15c per acre (twice)	.30
Discing at 25c per acre (twice)	.50
Planting at 17c per acre	.17
Seed at 50c per acre ($2.50 for seed)	.50
Cultivating at 25c per acre (three times)	.75
Hoeing once at 20c per acre	.20
Husking at $1.25 per acre	1.25
Marketing at $1.25 per acre	1.25
Plant food at 71c	.71
Rent at $3.00	3.00
Interest on investment (equipment)	.50
Total	$10.13

The government reports for 1910 give the average cost of producing corn in the corn belt at $14.63 per acre.

PROBLEMS.

1. If the ten-year average yield of the corn belt states was 30.9 bushels and the average farm value was 42.4c per bushel, what was the loss or profit per acre for the 10-year period?

2. How much corn must be grown per acre at the cost of production and price of corn given above to make corn raising profitable in the corn growing states?

3. Based on a cost of production of $14.63 per acre, what would be the profits from a yield of 35 bushels, 50 bushels, 75 bushels, per acre?

4. The records of the Nebraska Experiment Station show that 31 farmers reported an average yield of 34.5 bushels of corn per acre before seeding to clover and alfalfa and 68.2 bushels after crops of these legumes. What was the profit per acre before and after at 42.4c per bushel, allowing $12 per acre as cost of production?

5. What would be the profit of a farmer who produces just double the amount of the average corn crop of the corn belt (30.9) at a cost of $14.63 per acre with corn bringing the average price, $42.4c?

6. If the average production of corn in Ohio for 1912 was 38 bushels per acre on 3,000,000 acres, what would be the gain in Ohio, if the production could be raised to 50 bushels per acre, with corn selling for 50 cents per bushel?

SEEDING PROBLEMS.

Selecting and breeding for high yielding ears and proper care for the selected ears are among the most important problems of corn production.

1. The United States Department of Agriculture in 1910 conducted an experiment with four bushels of corn that were harvested and divided into two equal parts; one part was well dried and kept in a dry seed house, and the other part was kept in an ordinary seed crib; both kinds were planted in rich bottom land. The well-preserved seed produced 18 bushels more per acre or 27 per cent. more than the cribbed seed. What was the yield of the poorer seed?

2. On poor upland the same experiment as in problem one resulted as follows: The well-preserved seed produced 12 per cent. more than the crib seed. At that rate what would a farmer lose by planting 10 acres with the poor seed if his yield was 30 bushels per acre?

Selecting the Seed Ear.

After having determined the type of corn that it is desired to plant, the next important step is the study of ear characteristics; scientific selection is based upon the following facts:

1. The best selection can be made from standing corn.
2. The value of the ear depends upon the environment of the stalk.
3. The maturity of the ear is influenced by the character of the soil.
4. If a field has different types of soil, it is necessary to know from what part of the field each ear is selected.
5. Every ear should be true to the breed type.
6. The type should stand the test for maturity, and market requirements.
7. There should be uniformity of butts, tips, color, size and length of ears.

8. Kernels should be deep and uniform in size.

9. Rows of kernels on the ear should be as nearly straight as possible.

10. The proportion between the weight of grains and cobs should be determined.

11. The weight of the grains should be from 85 to 90 per cent. of the weight of the ear.

12. The ear should be sound and free from any fungus growth, or disease.

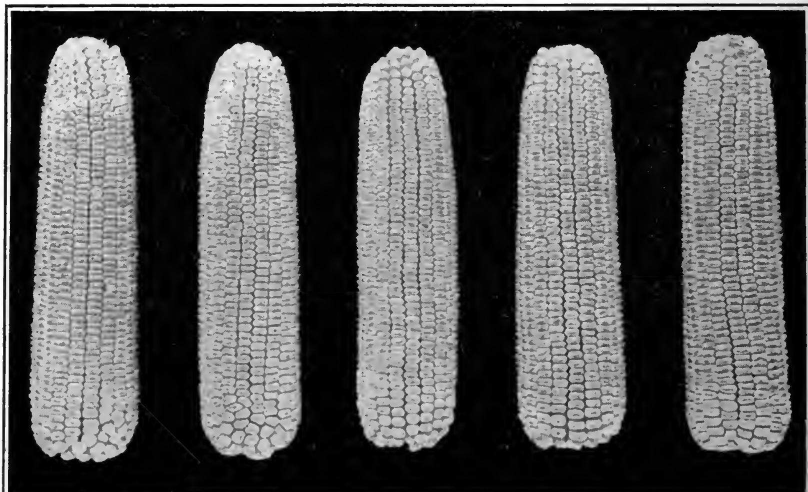

FIG. 1. A Good Selection.

Importance of Selection.

The following problems are given to demonstrate the importance of selection as a factor in the yield of corn.

1. If a bushel of seed corn will plant 7 acres, and a good selection of seed will increase the yield 10 bushels per acre, how much more is one bushel of this seed worth than a bushel that will not increase the yield, when corn is selling for the present market price?
2. In Logan County, Ohio, 30 farmers entered a corn growing contest; all planted at the same time in one field; the condition of the soil was uniform in all parts; all parts received the same care and cultivation; each farmer selected his own choice of seed and variety. The lowest yield was 53 bushels and the highest yield was 80 bushels

per acre. What was the per cent. gain of the best variety over the poorest yielding variety?

3. In Putnam County, O., a number of farmers planted 16 varieties of corn; soil, care and cultivation was uniform. The following difference, therefore, came from the kind of seed planted: Highest yield 96 bushels and lowest yield 75 bushels per acre. What was the loss per cent. in planting the poorer seed instead of planting the seed giving highest yield?

4. In a variety test conducted in Indiana to determine the kind of corn best suited to the soil and climatic conditions, resulted in a difference of 40 bushels per acre; 108 bushels was the highest, and 68 bushels was the lowest yield per acre. What was the loss of the farmer who had land capable of producing the highest yield, if he planted the variety giving the lowest yield on a field of 7 acres, if the price of corn was 40c a bushel?

5. If a farmer raising 70 bushels of corn per acre has increased his production 25 per cent by careful selection of variety, what was his yield per acre before making the selection?

PROBLEMS.

1. At the Ohio Experiment Station, tests conducted with 5 different varieties of corn for a period extending over 5 years, showed that seed ears ranging in length from 9 to 10.5 inches yielded about 4 bushels more per acre than seed ears ranging in length from 6.5 to 8.2 inches in length; what was the gain in profit in planting a field of 10 acres with the larger ears if the corn was sold at 43c per bushel?

2. It has been demonstrated by both the Ohio and the Nebraska Experiment Stations that smoother types of kernels outyielded the rougher types. The smooth types on 100 tenth acre plots outyielded the rough types by 2.42 bushels per acre; if the production was 70 bushels per acre, what was the gain per cent. by planting smoother kernels?

*3. In an experiment it was determined that ears with filled tips produced 3 per cent. more per acre in a four-year test than ears with poor tips; what was the gain in bushels of the farmer using the ears with filled tips in planting 32 acres of corn that yielded 75 bushels per acre?

4. It has been shown by tests carried on under supervision of the U. S. Government in a number of states that field selected ears produced 16 bushels more per acre or 20 per cent. more than crib-selected ears. What was the number of bushels produced per acre by planting field selected ears?

5. Seed ears selected from high yielding rows in an ear-to-row breeding plat produced 18 bushels per acre or 16 per cent. more than field selected ears from a field of the same kind of corn. What would be the gain in bushels by using seed from high yielding ears selected from a breeding plat to plant 20 acres giving same results as above stated?

* Continual selection of ears with filled tips will eventually result in shortening the ear of corn.

6. Which is the better ear, one weighing 27.2 ounces with a percentage of 81.9 grain, or an ear weighing 20.8 ounces and yielding 86.8 per cent. grain? What was the difference in weight of grain of these two prize winners at the Blue Grass Corn Show in Kentucky in 1909?

7. Six ears of white dent corn placed on exhibition by six different Kentucky growers, yielded on an average 84.2 per cent. of grain. If the average weight of grain was 18.63 ounces per ear, what was the average weight of the ears?

8. The six ears with the highest percentage of grain shelled at the Blue Grass Show in Kentucky in 1909, produced on an average 87.19 per cent. grain; the average weight of the ears was 16.95 ounces. What was the average weight of the cobs?

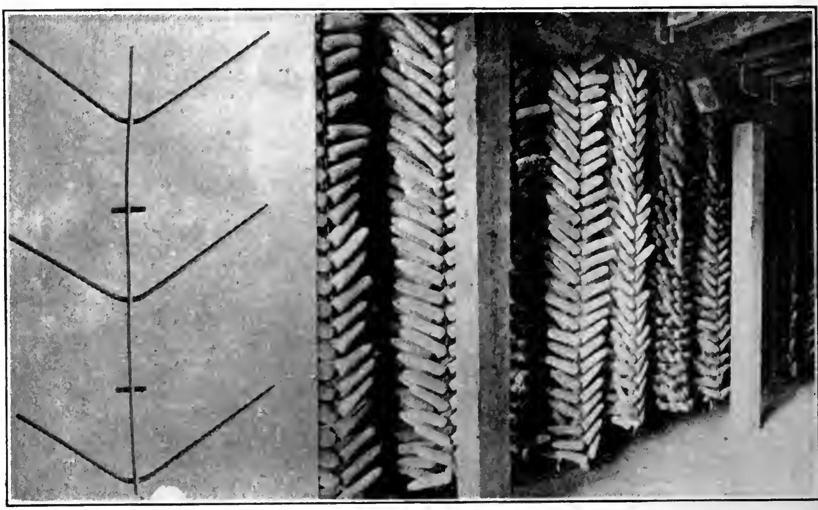

FIG. 2. Electrically welded wire fencing, cut without waste, into wire racks for drying and storing of seed corn. Without touching and in a breezy location the seed ears dry promptly and retain their full productivity.

9. If the circumference of a well proportioned ear of corn should be to the length as 3 is to 4, what should be the length of an ear 7.5 inches in circumference? What should be the circumference of an ear 9 inches in length?

10. If 1,700 pounds of corn were shelled from 2,000 ears of corn, and the weight of the cobs was 300 pounds, what per cent. of the weight of the ear was cob? What was the average weight of the ears? What was the average number of ounces of grain per ear?

An Ideal Kentucky Ear.

The following is from Bulletin No. 145, Kentucky Experiment Station:

"A white dent variety, producing a cylindrical ear ten inches long, the surface moderately smooth (as in Reid's Yellow Dent), with 18 to 20 straight rows, the tip and butt completely and symmetrically filled, the seed wedge-shaped and rather deep, the cob white, of medium size; the total weight of ear when cured, 18 to 22 ounces; the weight of grain 16 to 18 ounces; the percentage of grain 80 to 87; the plant above medium in size, producing a good growth of blades, and with a tendency to produce a single ear complying with the above standard of perfection."

According to the statements made in the bulletins of several of the State Corn Growers' Associations in the corn states, the weight of shelled corn at husking time should be at least 85 per cent of the total weight of the ear, and the weight of the shelled corn at husking time should be not to exceed 15 per cent moisture.

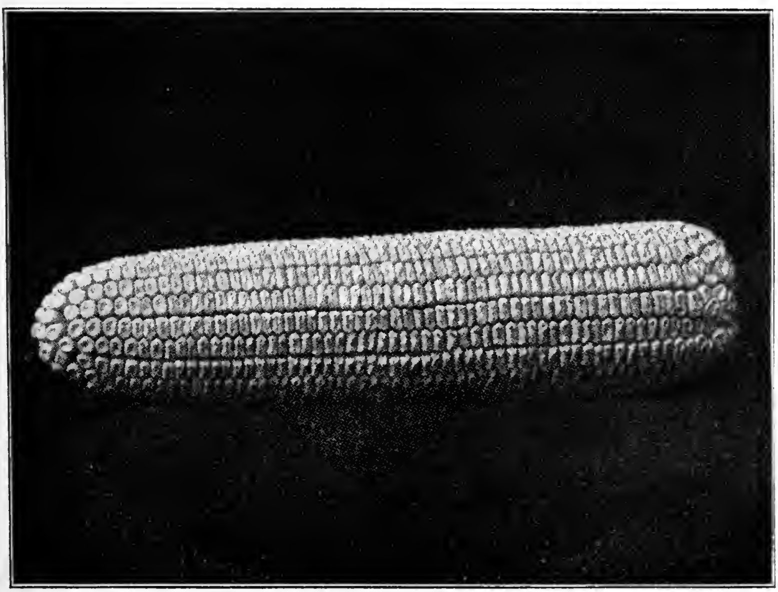

FIG. 3. A $250 Ear.

PROBLEMS.

1. If an ear of corn is 84.5 per cent. grain, and the moisture content of the kernels is 12 per cent., what is the number of ounces of dry matter in the kernels of an ear weighing 18 ounces?

2. If an ideal ear of seed corn has 20 rows of 60 grains each, and an allowance is made for one-third off for butts and tips, how many hills of three grains each can be planted from this ear?

3. How many ears of the above description will be required to plant one acre of corn with three grains to the hill, rows three feet six inches apart each way?

4. How many ears, as in problem 2, will be required to plant a twenty-acre field?

5. If twenty of these ears in problem 4 have been injured by freezing, bad ventilation, moisture, or by other reasons are injured so that the embyro is dead, what will be the percentage of a perfect stand on this twenty-acre field, if all the other ears produced a 95 per cent. stand?

6. If each hill produces 3 ears, and the average weight of the ears in this field is four-fifths of a pound, what will be the yield per acre?

7. A field of corn contains a perfect stand, rows 42 inches apart, 3 stalks per hill, with an average production of one ear per stalk; the yield is 75 bushels per acre; what is the average weight per ear?

8. Allowing 12.25 square feet for each hill of corn in a field planted with 3 grains per hill, there were 3,500 dead kernels; this would be equivalent to a loss of what part of the area of a five-acre field based on the assumption that each stalk missing has an average value of one-third of a hill?

From the facts demonstrated by the foregoing problems, we would naturally conclude that a good stand is dependent upon proper selection for germinating power and uniformity in size of kernels to be used in the planter.

We can, therefore, place reliable dependence upon the following rule: That whenever all other conditions are favorable for a maximum crop of corn the determining factor in the yield per acre will be the stand of corn.

But we cannot attribute the low yield of corn as a rule to a deficiency of stand alone. There are other causes that are likely to be vital factors, varying according to conditions of soil fertility, germination, type of seed, adaptability, climate, weather, cultivation and breeding.

Seed Testing.

Before the introduction of scientific methods of seed selection and seed testing, farmers as a rule waited until after corn had been planted to examine it for the purpose of determining whether it was germinating and growing satisfactorily. The scientific agriculturist now determines its germinating power and vitality before planting.

Experiments and demonstrations by scientific men in every state of the corn belt have established some of the following facts:

1. Seeds with weak germinating power produce:
   (a) Barren stalks, or stalks with small ears or nubbins.
   (b) A weak root system that cannot take up sufficient nourishment for the production of a large stalk or ear.
2. An ear of corn may have strong, weak and dead kernels at the same time in different parts of the ear.
3. Ears from the same variety and from the same field may have a low or high protein content.
4. Horny kernels make more rapid growth than starchy kernels.
5. Ears with rapid early growth in the field give the highest yield.
6. Some ears of perfect vitality are slower in starting than others and when classed as weak may be classed as strong at a later reading.
7. In selecting kernels for a test, take one kernel from each side of the ear two and one-half inches from the butt, one kernel from each side of the ear at the center, and one kernel from each side about two inches from the tip.
8. Use six kernels in making a test of an ear of corn.
9. It may be estimated that proper germination counts for at least 25 per cent. in judging seed corn.

One of the most important factors that enters into the problem of securing a stand of corn that will insure a maximum yield, is the selection of the right kind of seed through proper seed tests.

To understand properly the principles of seed testing, it is important that the student should be familiar with some of the facts relating to various methods employed:

1. Moisture, heat and air will germinate corn.
2. A kernel of corn contains nutriment enough to feed root and stalk until the test is complete.
3. Hard, oily kernels that are not soaked under water from 12 to 18 hours will not have an even start with soft, starchy kernels.
4. Kernels do not germinate under water.
5. The proper temperature for germination of corn is about 70 to 75 degrees Fahr.
6. If corn is soaked in water, it is ready for the test in 3 or 4 days.

In reading the test and making the selection of ears the following facts should be carefully observed:

1. That a kernel is weak which makes a feeble growth when compared with other kernels from the *same* ear.
2. Kernels with large germs make more rapid growth than those with smaller germs.

The important points determined by experiments carried out at some of the stations are:

1. When ears test 5 strong and 1 weak kernel, the stand of corn will be less than 95 per cent.
2. When ears test 5 strong and 1 dead kernel the stand will be less than 90 per cent.
3. Six weak kernels of uniform vitality will produce next highest in yield to six strong kernels.

The following table is compiled from an Iowa experiment giving the average for three tests:

Germination.			*No. of Ears.*	*Per Cent. of Stand.*	*Bu. Yield Per A.*
6	0	0	6,134	73.3	55.5
5	1	0	1,899	68.3	52.8
4	2	0	1,236	66.7	52.3
3	3	0	733	66.3	50.0
2	4	0	504	63.0	49.0
1	5	0	257	65.5	51.4
0	6	0	234	69.5	53.5

NOTE. The figures in the first column under "germination" indicate strong kernels. Those in the second column indicate weak kernels. The third column would represent dead kernels if ears with dead kernels were tested. No ears with dead kernels were used.

PROBLEMS.

1. Where the test above shows 5 strong and 1 weak kernel, what was the decrease per cent below the stand made by 6 strong kernels.

2. In yield of bushels per acre what was the decrease per cent. in ears testing 6 weak below ears testing 6 strong?

3. In an experiment made by an experiment station it was found that in using ears testing 5 strong and 1 dead kernel the loss was 10.8 per cent. or 6.2 bushels below the production of ears testing 6 strong. What was the yield per acre with 6 strong kernels?

5. In another experiment or germination test it was shown that an ear with 5 strong kernels and 1 weak kernel in comparison with an ear

testing 6 strong kernels, resulted in a decrease of 8.1 per cent. in stand or 5.3 bushels yield per acre; at that rate of production what would be the loss to the farmer who plants 10 acres with the weaker seed when corn is 40c per bushel?

The Seed Tester.

1. What will be the dimensions of a seed tester that will be large enough to test 100 ears, if 4 square inches are allowed for each 6 kernels per ear? Construct a 200 ear tester, giving dimensions, allowing 9 square inches for each 6 kernels per ear.

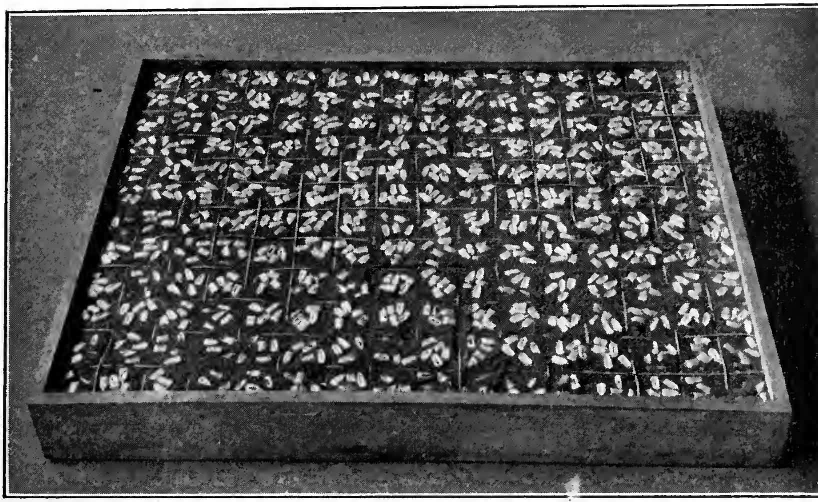

FIG. 4. The best looking seed corn may contain some bad ears. The seed tester will detect them.

Time for Maturing.

Corn must be adapted to the region. Corn that requires 120 days in which to mature cannot be successfully raised in a latitude where the growing season is shortened by early frosts.

In some localities it is not advisable to plant late varieties. Different kinds of corn will vary in time required for maturing from 90 to 120 days.

1. If corn is planted on May 12, and there is a heavy frost on September 5, how many days are there in which the corn can mature?

2. Corn is planted on May 1, and there is no frost until Sept. 15, how many days are there in which it can mature?
3. A field of corn is planted on June 1 and there is a frost on September 20. What is the time for growth?
4. A 120-day variety is planted on June 1. On what date will this corn be safe from frost, if weather conditions are favorable for ripening?
5. A 100-day variety of corn is planted on May 15. What will be the date of the earliest possible frost without injury?

FIG. 5. When all other conditions are favorable for a maximum crop, the determining factor in the yield is the stand of corn.

Relation of Stand to Yield.

ON AN ACRE OF GROUND.

Number of hills 3 feet 6 inches apart	3,555
Number of stalks, 3 per hill	10,665
Number of bushels with 1 pound ears on 100 per cent. Stand	152.4

PROBLEMS.

1. How many bushels of corn are there on an acre, that has a stand of 80 per cent. with 12-ounce ears?

2. How many bushels of ears on an acre with a 90 per cent. stand, averaging one-half pound ear per stalk.

3. If each stalk averages one ear weighing 4 ounces, and the stand is 60 per cent., what is the yield per acre?

4. If the average yield in Ohio for ten years was 36.8 bushels, and the stand was about 80 per cent., what was the average weight per ear?

5. Allowing a farmer $5 per day for 3 days time in selecting seed corn, testing, reading tests, selecting ears after test, what would be the net profit if the yield on 10 acres is increased 20 per cent. in a yield of 32 bushels per acre when corn is selling at 40c per bushel?

6. A farmer planted two acres of corn in a field of uniform fertility; the corn was all planted at the same time and received the same treatment from the beginning, except that one acre was planted with tested seed and the other was planted with seed that was not tested; the tested seed yielded 50 bushels, or 25 per cent. more than the untested seed; what was the yield of the acre planted with untested seed?

7. If on an average we can produce a one-pound ear on a certain field, and we plant 800 kernels from an ear that is dead, it will be equivalent to a loss of how many bushels? If we plant ten such ears, it will mean a loss of how many dollars, if corn is selling for 50c a bushel?

Planting.

In Illinois the Experiment Station has found that for ordinary corn land in Northern Illinois, it is best to plant corn 36 inches apart, with 3 seeds per hill; in Central Illinois in certain localities it is advisable to plant 30.6 inches apart with 3 seeds per hill, and on certain poor lands it is advised that corn be planted 36 inches apart with only 2 seeds per hill.

The Georgia Experiment Station reached the conclusions that for upland soils, corn should be planted in rows four feet apart with one plant every two feet; the Indiana Experiment Station obtained best results from rows 3 ft. 8 in. apart with one stalk every 11 inches.

In Ohio corn is planted on an average about 42 inches apart in rows both ways across the field.

PROBLEMS.

1. Which will produce the greater number of stalks, a field of corn planted in rows 42 inches apart each way, with 3 stalks to the hill, or a field planted or drilled with 1 stalk every 12 inches in rows 42 inches apart? What would be the difference in the number of stalks between the two methods in planting a 5-acre field?

2. If corn in drilled rows with stalks 12 inches apart shows a gain of 10 per cent. over any other method in production under certain conditions, what would be the gain to drill a field instead of planting with a check rower, if a 10-acre field of drilled corn produced 80 bushels per acre?*

3. What would be the difference between the number of stalks produced in a 10-acre field planted with 3 kernels per hill, 42 inches apart each way, and a field of the same size drilled with 1 stalk every 10 inches in rows 40 inches apart? If the drilled corn showed a gain of 8 per cent. over the check-rowed corn, what was the gain in 10 acres that were drilled and produced 120 bushels per acre?

Harvesting Corn.

1. If the hills are 42 inches apart each way in a five-acre field, how many shocks of corn will there be in the field if the corn is cut and shocked 8 hills square?
2. How many shocks will there be in a ten-acre field if the corn is cut and shocked 10 hills square? How many shocks will there be in a ten-acre field if the corn is cut and shocked 8 by 10 hills?
3. Which is the more expensive method, to hire corn cut 8 hills square at 4c a shock, or to pay 6c a shock 10 hills square?
4. Based on the customary price paid per bushel for husking by hand and the price paid per bushel for machine husked corn, which is the cheaper method in your locality?
5. Make a comparison of the cost of putting 10 acres of corn into the silo and putting the same field into the crib and mow.

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*Corn should not be drilled where there will be great difficulty in keeping the field clean. Many failures with drilled corn result from grass and weeds getting a good start during a wet season.

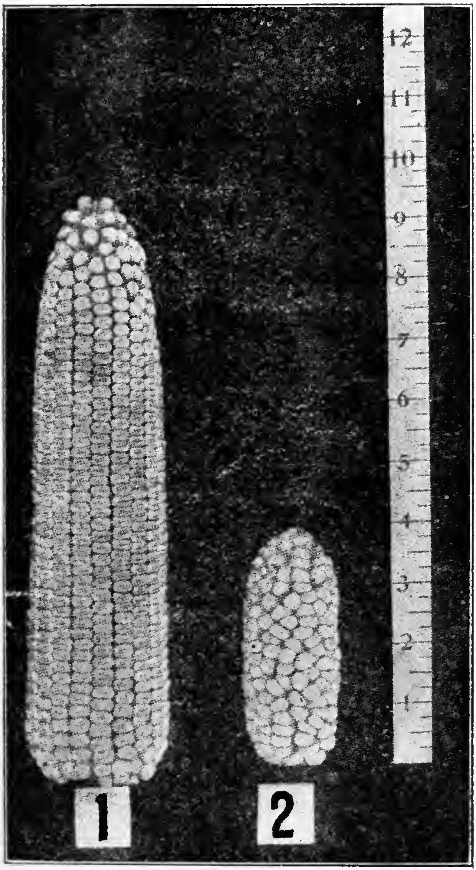

FIG. 6.

The Corn Crop of a Corn State.

The following *illustration represents the difference between what Ohio's corn crop is and what it ought to be.

Since 1900, the U. S. has had on an average about 100,000,000 acres of corn annually.

The production has averaged about 27 bushels per acre.

If there should be 10,665 ears of corn per acre on a perfect stand — find approximately the size and weight of the ear that will represent the corn crop of the United States.

Figure 1 represents an ideal ear of corn weighing one pound.

Figure 2 represents a nubbin about four inches long and weighing less than four ounces. A calculation based on the amount of corn planted in Ohio shows that this is the average size of the ears or of the corn crop.

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* Courtesy, Ohio Experiment Station.

A Perfect Stand.

PROBLEMS.

1. If the average rate of planting corn for the whole state, including both hilled and drilled corn, is 3 kernels to the hill planted three and a half feet each way, this would amount to how many hills and how many stalks per acre if there is a perfect stand?

2. If there is a perfect stand and the average weight of the ears is one pound, what will be the number of bushels produced per acre if planted three and one-half feet each way, three plants to the hill?

3. If a farmer plants an acre according to the average Ohio plan and gets a stand of only 65 per cent. of stalks and a yield of one ear per stalk averaging one pound in weight, what will be his yield per acre?

4. Find the number of acres of corn planted in your own state; the average production per acre, the average number of hills per acre planted according to your methods, and calculate the weight of the nubbin representing your corn crop as compared with an ear weighing 1 pound.

Increasing the Yield.

PROBLEMS.

1. If the average yield in a state is 38 bushels per acre, and the average ear is a four-ounce nubbin, how many bushels is the yield per ounce?

2. If we can add one ounce to the weight per nubbin by good drainage, and one ounce to each nubbin by selection of better seed, what would be the gain in production where the average is 38 bushels per acre?

3. If a good system of crop rotation, manuring, fertilizing and good cultivation will each add one ounce to the weight of the 6-ounce nubbin in problem 2, what will be the yield per acre?

4. If the average production of corn in the corn belt is about 30 bushels per acre, what will be the yield per acre, if we can increase the production by improvement at least five per cent.?

Early plowing. It has been proven by many reliable experiments that early plowed ground contains more moisture and soluble nitrogen than late plowed ground. Early spring plowing enables the soil to retain more moisture; it increases the activity of nitrogen producing bacteria; it is therefore of great advantage to plow early if the soils can be found in proper condition for early spring work.

In many instances it has been found that fall plowing is equally as desirable as early spring plowing.

PROBLEM

1. If the early plowed land in an experiment that was carried out, yielded 59.6 bushels of corn, and the late plowed land produced but 47.4 bushels per acre, what was the per cent. gain by early plowing?

Deep Plowing. The practice of subsoiling has been proven to be of distinct advantage in clay soils for some of the following reasons:

1. It loosens up the structure of the subsoil.
2. It facilitates root penetration, and increases humus content.
3. It increases the rate and depth of percolation.
4. It aids in the capillarity or film movement of water.
5. It increases the capacity of the soil to hold water.
6. It prevents washing in a hilly region.

Deep plowing is not advisable in some of the following instances:

1. Where there is not a good supply of organic matter.
2. In a poor, light, sandy soil.
3. Where the subsoil is too wet and becomes puddled.
4. Where the subsoil is too dry and remains loose and lumpy.
5. In regions that are very dry.

Methods of Cultivation.

An examination of the rooting system of a corn plant as shown in the following figure (7) will serve to illustrate the importance of making a careful study of the important problem of corn cultivation.

1. The Ohio Experiment Station has shown that on an average for 9 seasons shallow cultivation of corn, one and one-half inches deep, produced on an average 4 bushels more per acre and 200 pounds more stover per acre than corn cultivated 4 inches deep. At that rate what would be the loss to the man who cultivated 6 acres of corn in a similar manner to a depth of 4 inches, if corn is worth 50c a bushel and corn stover is worth $6 a ton?

2. Thirteen experiment stations made over 60 tests to determine the difference between deep and shallow cultivation, and the result was a gain on an average of 9.8 bushels more per acre of shallow cultivation over deep culture. If the average yield by shallow cultivation was 60 bushels per acre, what was the gain per cent.?

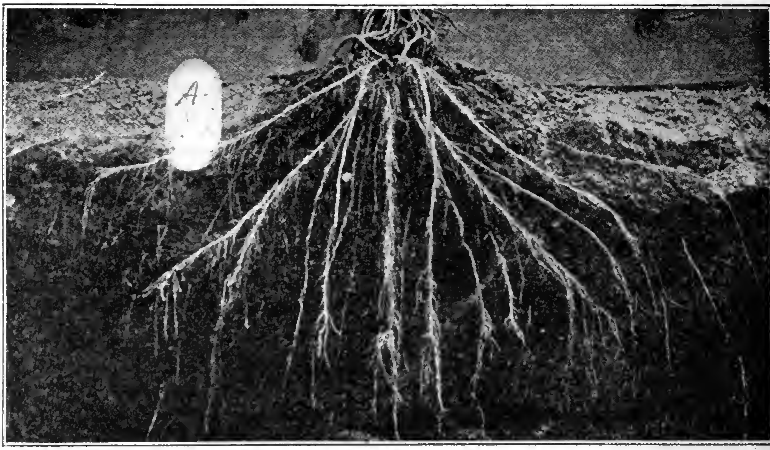


FIG. 7. Distribution of corn roots, showing how late deep cultivation affects the roots.

Shrinkage in Corn.

Experiments covering periods of from one to eight years carried on in different states showed that the average shrinkage in these instances was about 3 per cent from November to February 1st, 5 per cent for the first six months, and about 9 per cent for a period of one year. But experiments made in Ohio, Illinois, Iowa and in Kansas show that it is impossible to compute an average shrinkage or to determine what the variation in price should be in order to fix a price that will balance the losses caused by storage for a fixed period of time. There is a constant variation in the moisture content depending upon the variation of the seasons, so that the only fair way to determine the price is to use the artificial test.

Composition of Dry and Green Corn Compared.

The composition of the dry and green corn according to the U. S. Department of Agriculture is as follows:

	Per Cent. in Dry Corn.	*Per Cent. in Green Corn.*
Water	10.8	75.4
Ash	1.5	0.7
Protein	10.0	3.1
Carbohydrates	73.4	19.7
Fat	4.3	1.1
	100.	100.

Corn may be termed dry corn when the moisture content does not exceed 12 per cent.

The commercial value of corn is coming to be largely determined by the amount of moisture that it contains.

The Moisture Content of Corn.

According to a report of the New York Experiment Station, the following is given as the weight of corn at different stages of growth:

YIELD PER ACRE IN TONS.

	Corn.	*Water.*	*Dry Matter.*
1st stage, fully tasseled	9.0	8.2	0.8
2nd stage, fully silked	12.9	11.3	1.6
3rd stage, kernels mixed stage	16.3	14.0	2.3
4th stage, kernels glazed	16.1	12.5	3.6
5th stage, ripe	14.2	10.2	4.0

1. What per cent. of corn is water when in the third stage? In the fourth stage?

What per cent. of the corn is dry matter in the first stage? In the fifth stage?

3. What is the difference between the weight of the corn on an acre, in the first stage and the third stage? Between the third and fifth stages?

4. Which stage is in the best condition to cut for the silo?

The Moisture Test.

The Brown-Duvel moisture test is made as follows:

A quantity of 100 grams of shelled corn is placed in a glass distillation flask and covered with heavy cylinder oil. The flask is stoppered and connected to a conductor; a flame is placed under the flask and the oil is heated to 190 degrees Centigrade. The high temperature drives off the water in the form of steam, which is condensed and collected in a graduated tube in which 1 cubic centimeter corresponds to 1 per cent moisture in the 100 grams of shelled corn.

The time required to make this test is 30 minutes.

PROBLEMS.

1. Cribs of corn have been tested showing a moisture test as high as 25 per cent; when 12 per cent corn is selling for the present market price, what should be the price of corn that tests 25 per cent moisture?

2. What would be gained by buying corn that tested 9 per cent for the same price commanded by 14 per cent corn?

3. A grain dealer buys two cribs of corn, each containing 1,000 bushels of corn; the moisture test shows that one crib is 15 per cent moisture, and that the other crib is 20 per cent moisture; what should be the difference in price if 12 per cent corn is selling for 50c per bushel?

44. A farmer wishes to buy 2,000 bushels of corn for feeding stock; at the elevator he can get the corn that tests 12 per cent moisture at three cents above market price; and he can purchase the same number of bushels with a moisture test of 18 per cent at 3 per cent below market price; the difference in the cost of hauling is 2 cents greater per bushel from the elevator, which is the better bargain?

5. The Kansas State Board of Agriculture gives an account of an experiment made to determine the loss of weight in corn by drying in cribs. The quantity put in footed exactly 16,155 bushels of 70 lbs., each; this corn was cribbed from Oct. 22 to Dec. 17; it was weighed and sold June 1, and the total weight of the corn when taken out was 14,896 bushels; what was the shrinkage in bushels? What was the loss in weight per cent?

The loss in shrinkage is not due to loss of water alone, for it has been pointed out that there is a decrease in the weight of dry matter, probably due to oxidation.

A full stand of corn has a total leaf area equal to twice the area of the land on which the corn is growing. The daily water loss per plant through transpiration and evaporation may vary from 3 to 10 pounds daily, depending on humidity, and on the wind, hence corn must have plenty of water to yield a good crop.

Range of Temperature and Rainfall in Some Prominent Corn Growing States, Average of Fifteen Years' Record.

1912

AVERAGE MONTHLY TEMPERATURE, DEGREES FAHRENHEIT.

	Dec.	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.
Madison, Wis...	23	16	19	30	46	58	68	72	70	62	50	34
Lansing, Mich...	28	23	22	32	46	57	67	71	68	61	50	37
Columbus, Ohio.	33	29	31	39	53	63	71	75	73	66	55	42
Indianapolis, Ind.	33	28	31	40	52	63	72	76	74	67	55	42
Springfield, Ill...	32	27	29	40	53	63	72	76	74	67	56	42
Columbia, Mo...	34	31	30	42	56	65	74	77	76	69	58	43
Lexington, Ky...	37	34	34	43	55	64	73	76	75	69	57	45
Des Moines, Ia..	26	20	23	35	51	61	70	75	73	65	53	37

AVERAGE MONTHLY RAINFALL INCHES.

Madison, Wis...	1.7	1.7	1.6	2.2	2.4	3.5	4.2	4.1	3.1	3.2	2.5	1.8
Lansing, Mich...	1.8	2.1	2.0	2.4	2.4	3.2	2.8	2.7	2.5	2.6	2.2	2.5
Columbus, Ohio.	2.7	3.0	3.2	3.3	2.9	3.8	3.6	3.6	3.1	2.5	2.3	3.2
Indianapolis, Ind.	3.0	2.8	3.3	3.8	3.4	4.0	4.4	4.2	3.2	3.3	2.8	3.7
Springfield, Ill...	2.4	2.2	3.0	3.0	3.3	4.7	4.5	2.8	2.7	3.3	2.7	2.8
Columbia, Mo...	1.8	2.2	2.2	3.1	3.8	4.9	4.8	4.4	3.1	3.4	2.1	2.2
Lexington, Ky...	3.3	4.0	3.4	4.8	3.2	3.6	4.2	4.0	3.8	2.5	2.1	3.6
Des Moines, Ia..	1.3	1.2	1.1	1.6	2.9	4.8	5.0	3.7	3.5	3.0	2.8	1.5

PROBLEMS.

1. A corn plant performs the remarkable task of pumping into its stem and leaves from a comparatively dry soil, 2.896 pounds of water daily for 13 consecutive days; how many gallons is this?

2. A determination of the moisture content of soil in the spring as late as May 14, proved that late fall plowed ground may contain fully 6 pounds per square foot more water in the upper 4 ft. than similar adjacent ground not plowed; this difference represents how many inches rainfall?

3. Two immediately adjacent pieces of ground, in every way alike, were plowed in the spring, 7 days apart; the early plowed ground contained, at the time the second piece was plowed, a little more moisture in the upper 4 ft. than it had 7 days before; while the ground which had not been plowed had lost, in the same interval of time, an amount of moisture from the surface 4 ft. equal to 1.75 inches, a full eighth of the rainfall of the growing season of that locality. What was the total rainfall of the growing season?

4. According to reports from the U. S. Department of Agriculture, the amount of useless water that goes to market in American corn annually, is 436,682 tons.

How many freight cars of 30 tons capacity each would be required to carry this amount of water if it were to be separated from the corn and shipped alone?

Different Uses and Values of Corn.

It has been estimated that nine-tenths of the corn crop is fed to live stock. One-tenth is used in manufacturing various products such as corn meal, breakfast foods, hominy, starch, oil, glucose, sugar, syrup, candy, alcohol, and other products. Husks, stalks, pith and cobs are also used for manufacturing certain products.

When the stalk and leaves of a corn plant are used as fodder they represent about one-fifth of the value of the corn crop, but when they are used as ensilage they represent about one-third the value of the corn plant.

From 15 to 20 per cent of the value of fodder is in the leaves. A large share of the loss sustained in field curing is due to the loss of leaves. When corn is put into the silo there is also a loss of as high as 10 per cent, due to fermentation.

Fuel Value of Corn Compared.

Corn	1,800 calories per pound
Wheat	1,750 calories per pound
Rye	1,750 calories per pound
Oats	1,720 calories per pound
Buckwheat	1,600 calories per pound

Corn Smut.

In the treatment of corn smut the following facts should be observed:

1. Seed treatment has not been of any value.
2. Rotation of crops has a decided influence in preventing corn-smut.
3. Corn-smut will live in the soil a few years, only.
4. Manure containing smut should be well rotted.
5. Smut-masses should be cut out of the corn field, while the crop is growing, and burned.
6. The loss from smut is usually greater in the Northwestern states.
7. The loss caused by smut is in the deformed and damaged ears and in the vigor and yield of the plants.

Questions.

1. Explain why corn is at the present time the most important crop in the states of the middle west.
2. Is corn a well balanced ration? Why.
3. Compare the composition of corn with that of alfalfa.
4. Name some of the causes that injure seed corn.
5. Give four reasons for cultivating corn.
6. What is a good rotation for your locality including corn?
7. Why should there be a legume in the rotation?
8. What is the fertilizing value of a bushel of corn?
9. How can this fertility be returned to the soil?
10. Make a list of products made from corn.
11. Which is supposed to be the primitive type of corn?
12. How can corn be improved by selection.
13. Name the different steps in the evolution of planting.
15. Make a list of all the modern machines used in corn production.
16. What is shallow cultivation? Deep cultivation of corn?
17. How does corn become mixed?
18. What is the average length of the season between frosts in your locality?
19. Why should we feed corn on the farm?
20. When corn is fed alone, how many pounds of corn are required to produce a pound of gain in hogs?

21. Why should hogs be fed alfalfa or clover with corn?
22. What effect does corn rations alone have on egg production?
23. How do animals become foundered or stunted on corn?
24. What is the digestion coefficient of corn?
25. Compare the digestible nutrients of corn with five other grains.
26. Can the protein content of corn be increased by selection?
27. Why does analysis show a difference in composition of corn in different fields and sections of the country?
28. Is it possible to produce an ear of corn that is worth more than its weight in gold?
29. Does it pay to test seed corn?

Score Card.

CORN

Institution ....

Scale of Points.		No. of Sample.							
1. Type and Uniformity.....	10	....	....	....	....	....	....	....	....
2. Maturity and Market Condition	10	....	....	....	....	....	....	....	....
3. Purity. (a) Kernel	5	....	....	....	....	....	....	....	....
(b) Cob	5	....	....	....	....	....	....	....	....
4. Shape of Ear.............	10	....	....	....	....	....	....	....	....
5. Length of Ear...........	10	....	....	....	....	....	....	....	....
6. Circumference of Ear....	5	....	....	....	....	....	....	....	....
7. Shape of Kernel..........	5	....	....	....	....	....	....	....	....
8. Uniformity of Kernel.....	5	....	....	....	....	....	....	....	....
9. Character of Germ.......	10	....	....	....	....	....	....	....	....
10. Butts	5	....	....	....	....	....	....	....	....
11. Tips	5	....	....	....	....	....	....	....	....
12. Space Between Rows.....	5	....	....	....	....	....	....	....	....
13. Size of Cob..............	10	....	....	....	....	....	....	....	....
Total	100	....	....	....	....	....	....	....	....

VARIETY STANDARDS.

RECOGNIZED VARIETIES.		
Yellow.	*Length.*	*Circumference.*
Reid's Yellow Dent	10 to 10½	7¼ to 7½
Leaming	10 to 10½	7½ to 7¾
Legal Tender	10 to 10½	7¼ to 7½
White.		
Boone County White	10½ to 11	7½ to 7¾
St. Charles White	10 to 10½	7¼ to 7½
OTHER VARIETIES.		
Yellow.	*Length.*	*Circumference.*
Cartner	9 to 9½	7¼ to 7½
St. Charles Yellow	10½ to 11	7¼ to 7¾
White.		
Silvermine	9 to 9½	7 to 7¼
Johnson Co. White	10½ to 11	7½ to 7¾
General Entries	9½ to 10½	7¼ to 7¾

Variety Judged ....

NAME ....

....

DATE ....

Sample ....*Standing*..............%

Ohio Corn Improvement Association.

SCORE CARD FOR DENT CORN.

		Standard.
1	Adaptability	25
2	Seed condition	15
3	Shape of kernel	15
4	Uniformity	15
5	Weight of ears	10
6	Length and proportion	10
7	Color of grain and cob	5
8	Butts and tips	5
	Total	100

Books.

1. The Corn Crops—Montgomery, 8-12—Macmillan Co.
2. The Study of Corn—Shoesmith, 8-12—Webb Pub. Co., 50c.
3. Manual of Corn Judging—Shamel, 8-12—Webb Pub. Co., 50c.
4. The Book of Corn—Myrick, 8-12—Webb Pub. Co., $1.50.
5. Corn Plants—Sargent, 8-12—Houghton, Mifflin Co.
6. Corn—Bowman & Crossley, 8-12—Ames, Iowa.
7. The A. B. C. of Corn Culture—Holden, 7-8.

Bulletins and Literature on Corn.

UNITED STATES DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETINS.

Number.

414. Corn Cultivation.
199. Corn Growing.
366. Corn Breeding.
81. Corn-Growing for the South.
229. The Production of Good Seed Corn.
253. The Germination of Seed Corn.
272. A Successful Hog and Seed-Corn Farm.
400. More Profitable Corn Planting Method.
415. Seed Corn.
303. Corn Harvesting Machinery.
313. Harvesting and Storing Corn.
325. Small Farms in the Corn Belt.
257. The Weed Factor in the Cultivation of Corn.
298. Food Value of Corn and Corn Products.
202. Pop Corn. 553. Pop Corn for the Home. 554. Pop Corn for the Market.
317. Shrinkage of Corn in Cribs.

SPECIAL SCHOOL BULLETINS.

409. School Lessons on Corn.
385. Boys' and Girls' Agricultural Clubs.
537. How to Grow an Acre of Corn.

Circular 104. Special Contests for Corn-Club Work.
Organization and Instruction in Boys' Corn-Club Work.

Aside from the work that is being done by the national government, nearly every state in the Union has published some valuable corn bulletins that are especially adapted to state conditions. Many of these have been prepared either to encourage the cause of agriculture or that of education. The following list will give some idea of what is being done and will serve to suggest what can be received in your own state:

EDUCATIONAL BULLETINS.

Bulletin, No. 153. Boys' Corn Clubs and Improved Methods of Corn Growing, Kentucky Agricultural Experiment Station, Lexington, Ky.
Extension Bulletin. "An Elementary Study of Corn." Ohio State Agricultural College, Columbus, Ohio.
Nebraska Boys' and Girls' Associations, University Bulletin, Lincoln, Neb.
The Mississippi School Boys' Experiment Club, Agricultural College, Miss.
Extension Bulletin, No. 11, Agricultural and Industrial Work, Purdue University, Lafayette, Indiana.

AGRICULTURAL BULLETINS.

Bulletin 168, Improvement in Corn, Connecticut Experiment Station, New Haven, Conn.
Circular 117, Varieties of Corn in Ohio, Ohio Experiment Station, Wooster, Ohio.
Bulletin 87, Variety Tests of Corn, Experiment Station, Columbia, Missouri.
Bulletin 143, Hogging Down Corn, Experiment Station, Ames, Iowa.
Bulletin 155, The Corn and Cotton Wire Worm, Experiment Station, Clenson College, S. C.
Press Bulletin 25, Corn Tests and Corn Testing, Experiment Station, Ames, Iowa.
Bulletin 314, Cooperative Tests of Corn Varieties, Cornell University, Ithaca, New York.
Bulletin 59, Corn Improvement for Missouri, Experiment Station, Columbia, Missouri.
Bulletin 116, Corn Growing in the East, Experiment Station, State College, Pennsylvania.
Circular 8, Bud-Worms in Corn, Experiment Station, Auburn, Alabama.
Bulletin 135, The Germination Test of Seed Corn, Experiment Station, Ames, Iowa.
Bulletin 37, Corn Culture, Experiment Station, Stillwater, Oklahoma.

SEED-CORN SELECTION.

Bulletin 116, Agricultural Experiment Station, Kingston, R. I.
Bulletin 122, Agricultural Experiment Station, Lexington, Ky.
Agricultural College Extension Bulletin 1, Vol. II, Columbus, Ohio.
Agricultural and Mechanical College Bulletin 2, Teachers' Series, Stillwater, Okla.
Farmers' Bulletins 193 (pp. 20-26), 225 (pp. 9, 10), 229, 244 (pp. 5-7), 253.

SEED-CORN TESTING.

Special Bulletin 47, Agricultural Experiment Station, East Lansing, Mich.
Agricultural College Extension Bulletin 7, Vol. II, Columbus, Ohio.
Agricultural and Mechanical College Bulletin 2, Teachers' Series, Stillwater, Okla.
Farmers' Bulletins 229 and 253, U. S. Department of Agriculture.

TIME AND METHODS OF PLANTING

Bulletins 55, 65, Agricultural Experiment Station, Experiment, Ga.
Bulletin 147, Agricultural Experiment Station, Manhattan, Kans.
Bulletin 104, Agricultural Experiment Station, Clemson College, S. C.
Bulletin 134, Agricultural Experiment Station, Auburn, Ala.
Planting and Replanting Corn, Farmers' Bulletin 92 (pp. 6, 7), U. S. Department of Agriculture.

FEEDING CORN TO LIVE STOCK.

Bulletin 102, Agricultural Experiment Station, Urbana, Ill.
Farmers' Bulletins 22 and 32.
Corn *vs.* Wheat, Farmers' Bulletin 56 (p. 4).
The Value of Corn as a Forage Crop, Farmers' Bulletin 65 (pp. 6, 7).
Corn Stover as a Feeding Stuff, Farmers' Bulletin 84 (pp. 12–14) U. S. Gov't.
The Feeding Value of the Corn Plant at Different Stages of Growth, Farmers' Bulletin 97 (pp. 9-12). U. S. Gov't.
Feeding Moldy Corn, Farmers' Bulletin 122 (pp. 26, 27). U. S. Gov't.

USES OF CORN FOR HUMAN FOOD.

Nebraska Corn Book, Department of Public Instruction, Lincoln, Nebr.
Farmers' Bulletins, 249, 281 (pp. 18-22), 298. U. S. Gov't.

CORN DISEASES AND PESTS.

Corn Smut, Farmers' Bulletin 69 (pp. 18-20). U. S. Dept. of Agriculture.
Cultural Methods of Controlling Corn Billbugs and the Corn Root-louse, Farmers' Bulletin 259 (pp. 20, 21). U. S. Dept. of Agriculture.
The Larger Cornstalk Borer, Bureau of Entomology Circular 16, U. S. Department of Agriculture.
The Corn Root-worms, Bureau of Entomology Circular 59, U. S. Department of Agriculture.
The Slender Seed-corn Ground-beetle (*Clivina impressifrons* Lec.), Bureau of Entomology Circular 78, U. S. Department of Agriculture.

CHAPTER VIII.

Oats, Wheat and Cotton.

Oats is one of our nation's staple products. The three great cereal crops of the United States in the order of their importance are *Corn, Wheat* and *Oats.*

The states that lead in the production of oats, in the order of the amount of yield are as follows: Iowa, Illinois, Minnesota, Wisconsin, Ohio, Indiana, Michigan, Nebraska.

PROBLEMS.

1. The average yield of oats in the United States for the ten year period, 1900-1909, was 29.5 bushels per acre; the average price per bushel on December 1, for the same ten year period was 35.5 cents per bushel. What was the average gross income per acre?

2. In 1900 we had 27,365,000 acres sown and harvested. In 1910 there were 37,548,000 acres sown and harvested. In the period from 1900 to 1910 there was a gradual increase in the number of acres sown. The year 1910 shows what per cent gain over the year 1900?

3. In the year 1910 the production of oats was 1,186,341,000 bushels, and the average price December 1, 1910, was 34.4 cents; what was the value of the oats crop to the farmers of the United States?

4. Referring to the Yearbook of the Department of Agriculture, what was the average production and total production and the average price December 1, and the total farm value of the oats in your state in 1910?

The experiences of several of the great oats growing states are summed up briefly in the following statements so that the student may understand the chief essentials of success in growing this crop.

To Increase the Yield of Oats.

The best authorities are agreed upon the following practices:

1. Selection of variety of greatest yield known to the state.
2. Let the experiment station import new varieties and make tests.
3. Get your information from your own state experiment station.

4. Select a variety that has been tested and found successful.
5. There must be thorough preparation of the seed bed to a uniform depth.
6. If there is danger of having smut, treat the seed with formaldehyde.
7. Use a drill for seeding, to get even and uniform distribution of seed.
8. Sow the right quantity of seed. (Study your state experiment station tests).
9. Oats should be cut and shocked as soon as ripe.
10. To get oats that is bright in color and crisp in texture, let them "sweat out" in the stack or mow.

Loss From Smut.

1. It has been estimated that 5 per cent of Iowa's oat crop is annually destroyed by smut. If the total production of oats in Iowa in 1910 was 192,780,000 bushels, what was the total loss in bushels caused by smut?
2. If the loss of oats is approximately 2 bushels per acre and results in a loss on the average of 80 bushels per farm in Iowa, what would have been the net gain if this loss had been prevented at a cost of $1.00 for formaldehyde and $1.00 for labor?

Write to your experiment station for directions in treating oats for smut.

Make a list of causes of poor oats and wheat crops in your neighborhood and write on this page.

Oats, Wheat and Cotton.

REPORT — 1912.

Ohio Agricultural Experiment Station. Experiments with Oats at Wooster, Ohio.

Seven years' average yield of twenty-five varieties of oats and one variety of emmer.

Variety.	Side or branching.	Color of grain.	Bus. per acre.	Pounds — Straw per bu. of grain.
Siberian	Br.	W. & Y.	71.52	43.6
Sixty Day	"	Yellow	69.91	36.7
Big Four	"	White	69.21	43.5
Improved American	"	"	68.70	51.3
Silver Mine	"	"	68.26	46.3
Illinois German	"	"	68.24	46.8
Czar of Russia	"	"	67.23	46.2
Green Mountain	"	"	66.62	50.2
American Banner	"	"	66.34	50.8
Joanette	"	Black	66.28	51.7
Wilson's Prolific	"	White	65.89	47.6
Morgan Feller	"	"	65.85	47.8
Lincoln	"	"	65.47	50.4
Swedish Select	"	"	64.48	48.3
Long's White Tartar	Side	"	64.24	47.9
Watson	"	"	63.72	47.7
Golden Fleece	Br.	"	62.67	44.6
Twentieth Century	"	"	62.60	45.3
Welcome	"	"	61.88	56.9
Monarch	"	Black	61.80	46.6
Alaska	"	White	60.67	51.5
Clydesdale	"	"	60.54	51.4
Early Champion	"	"	59.68	48.1
Seizure	Side	Yellow	59.36	57.9
Wideawake	Br.	White	59.21	64.2
Emmer	....	....	37.24	....

Variety tests of oats in different states show that a variety producing the greatest in one state will not produce the highest yield in another state. For instance in Ohio, Siberian oats produced the highest yield while in other states some of the varieties named above among the Wooster tests gave a better yield than the Siberian.

PROBLEMS.

1. What would be the difference in income between a 10 acre field of Siberian oats and a 10 acre field of Twentieth Century at current prices, if each kind yielded an amount equal to that in the foregoing table?

2. What per cent of a sheaf of Sixty Day oats is included in the grain?

3. What per cent of 100 pounds of Monarch sheaves is straw?

In the 11 year thick and thin seeding test with oats, at Wooster, it was found that the average yield of four different varieties used was as follows:

Seeding.	*Bus. per acre.*
1. Four pecks per acre	43.50
2. Five pecks per acre	46.61
3. Six pecks per acre	47.07
4. Seven pecks per acre	48.14
5. Eight pecks per acre	48.91
6. Nine pecks per acre	51.28
7. Ten pecks per acre	50.87
8. Eleven pecks per acre	51.72

4. Which was the more profitable; sowing 9 pecks to the acre with a yield of 51.28 bushels per acre, or sowing 11 pecks with a yield of 51.72 bushels per acre?

5. If 9 pecks are sown to the acre and the yield is 51 bushels per acre, what would be the per cent loss by sowing 6 pecks and getting a yield of 47 bu. per acre?

6. Make an estimate of what it costs to produce an acre of oats.

Make a list of the different varieties of wheat and oats raised in your neighborhood and write on this page. Secure samples.

Score Card.

OATS.

Institution ....

Scale of Points	Perfect.	Corrected Students	Corrected Students.	Corrected Students.	Corrected Students.	Corrected Students.	Corrected Students.	Corrected Students.	Corrected Students.
1. Uniformity of Grains......	10	....	....	....	....	....	....	....	....
2. Color	10	....	....	....	....	....	....	....	....
3. Size and Plumpness........	15	....	....	....	....	....	....	....	....
4. Per cent Hull..............	15	....	....	....	....	....	....	....	....
5. Per cent Foreign Matter...	15	....	....	....	....	....	....	....	....
6. Per cent Damaged Grain...	15	....	....	....	....	....	....	....	....
7. Weight per Bushel.........	20	....	....	....	....	....	....	....	....
Total	100	....	....	....	....	....	....	....	....

Remarks and reasons for Placing.

Variety ....Standing..........%

Student's Name ....

Date ....

Questions.

1. Is there the latest copy of the Yearbook of the National Department of Agriculture in your school?

2. Give an approximate average of the production of oats in the school district.

3. Is the oats in your locality fed on the farm? If any is sold, about what per cent is sold?

4. What are the advantages of raising oats?

5. Does oats afford any advantages in the rotation of crops?

6. Is oats a well balanced ration? What is the Nutritive ratio?

7. Give the percentage of each of the three chief elements found in the composition of oats?

8. What amount of each of the following elements will be removed from an acre yielding 50 bushels of oats; nitrogen; phosphorus; potash?

9. What are the advantages of oats as a grain feed for horses?

10. In what ways is oats used as a feed for cows; hogs; poultry; sheep?

How deep should oats be planted?

Information.

1. Write to your state experiment station for information relative to oats production in your state?

2. The following bulletins are recommended from two great oats growing states and the national government:

Bulletin 257. Oats, Experiment Station, Wooster, Ohio.

Bulletin 128. Some Data for Oat Growers, Agricultural Experiment Station, Ames, Iowa.

Farmers' Bulletin, No. 424. Oats; Growing the Crop, United States Department of Agriculture.

Farmers' Bulletin, No. 420. Oats; Distribution and Uses. United States Department of Agriculture, Washington, D. C.

Circular 30. Improvement of the Oat Crop. U. S. Dept. of Ag.

Wheat.

England after a thousand years of cropping is still raising 33 bushels of wheat per acre.

The wheat crop stands second in importance among the cereal crops of the United States. We raise about one-fifth of the world's production, and yet our production per acre is far below that of most of the wheat producing countries of the old world. The states of the Union that lead in the production of wheat in the order of their rank are North Dakota, Kansas, Washington, Minnesota, Illinois, Nebraska, Ohio, Missouri and Indiana.

PROBLEMS.

1. The average yield for the period 1902-1911, in the countries named is as follows:

Germany	29.8 bushels per acre.
Austria	19.4 bushels per acre.
Hungary proper	18.4 bushels per acre.
France	20.3 bushels per acre.
United Kingdom	33.0 bushels per acre.
United States	14.0 bushels per aere.

What is the average yield for these six countries?

2. If the average yield for the period of 1902-1911 in the United States was 14 bushels per acre, what per cent is that of the yield of the average for Germany, Austria, Hungary, France and the United Kingdom combined?

3. If by proper methods of farming we could increase our production of 14 bushels, 50 per cent, what would be the total production of the United States when we are sowing 50 million acres annually?

4. The highest average yield ever attained in the United States was 15.4 bushels per acre in 1909. The average production for the period 1891-1910 was 13.1 bushels. How many per cent greater was the yield of 1909 than the yield of the 1891-1910 period?

5. In 1911 the average production of wheat per acre for certain countries was given as follows: Scotland 43 bushels per acre; England 38 bushels per acre; New Zealand 30 bushels per acre; Wales 30 bushels per acre; France 25 bushels per acre; Germany 23 bushels per acre; India and China 21 bushels per acre; the United States 13.5 bushels per acre.

How much is the average production of the United States below the average production of the first ten states named in the list?

PROBLEMS.

1. The average yield of wheat per acre in the United States for the 10 year period 1900-1909 was 14.1 bushels per acre. The average yield for the period from 1870 to 1900 was 12.5 bushels. What was the per cent increase?

2. The number of acres sown in 1870 was 19,000,000; the total yield was approximately 236,000,000 bushels; the total farm value was approximately $223,000,000; what was the approximate value per bushel?

3. The total number acres of wheat sown in 1911, was 49,543,000; the total number of bushels produced was 621,333,000; the farm value was $543,063,000. What was the average farm price per bushel?

4. If 50 million acres of wheat are sown in the U. S. and the average production is 14 bushels per acre, what would be the value of the wheat raised if we could double the production at the present price of wheat? (See market reports.)

5. If the average consumption of wheat in the United States is 6.5 bushels per capita, how many bushels of wheat will be required to supply the demands of a population of 95,000,000 people?

6. When the United States has reached a population of 200,000,000, what will be the number of bushels required to feed this nation at 6.5 bushels per capita?

7. If the acreage should remain the same and our population were to be doubled, what would be the required production per acre to supply the United States at 6.5 bushels per capita?

Seeding.

The important points in seeding are about the same as those observed in the successful growing of other cereals.

The main points in the order of their importance may be stated as follows:

1. Proper drainage.
2. Required amount and kind of plant food.
3. Thorough preparation of the seed bed.
4. Seed that is acclimated and has quality and produces quantity.
5. Treated for smut if infested.
6. Drilled at the proper time and depth.
7. Sowing proper amount of seed per acre.

PROBLEMS.

1. In Ohio the experiment station tests show that the most profitable amount of seed to use is 8 pecks per acre. If this amount is used on an average throughout the State, what is the value of the seed used in Ohio, in seeding 2,000,000 acres if the seed is valued at 90 cents per bushel?

2. Experiments made by the Kentucky Experiment Station seem to indicate that in that state 6 pecks of seed per acre produces the best results. At that rate what will it cost to seed a 15 acre field when wheat is worth 89 cents a bushel?

The results of the tests made at a number of the different experiment stations show that the production of wheat can be more than doubled.

The following figures show what has been done by the Michigan Experiment Station:

	Bu. per acre.
Selection, American Banner	42.8 bu.
Average for Michigan	18. bu.
Selection from Shepherd's Perfection	39.3 bu.

PROBLEMS.

1. If a farmer had 20 acres of wheat that produced 18 bushels per acre, which was the average yield in Michigan in 1911, what would have been gained, if he had sown American Banner wheat and harvested 42.8 bushels per acre, @ 88 cents a bushel?

2. The Ohio Experiment Station has demonstrated in a three year test, 1908-1910, that the following varieties of wheat averaged approximately 45 bushels per acre:

 1. Early Ripe Selection 6414.
 2. Poole Selection 6545.

3. Golden Bronze.
4. Extra Early Windsor.
5. Poole Selection 6400.
6. Dawson's Golden Chaff.

3. If the average yield of wheat in Ohio in 1910 was 16.2 bushels, what would the experiment station have lost per acre by following the methods of the average farmer if wheat in 1910 was selling for 90 cents per bushel on December 1?

The student of agriculture who wishes to understand the methods employed at the Experiment Station to produce these record breaking yields, should write to his state station and ask for bulletins on wheat experiments.

Score Card.

WHEAT.

Institution ....

Scale of Points.	Perfect.	Corrected Students.	Corrected Students.	Corrected Students.	Corrected Students.	Corrected Students.	Corrected Students.	Corrected Students.	Corrected Students.
1. Uniformity of Kernels....	10	....	....	....	....	....	....	....	....
2. Color and Purity..........	10	....	....	....	....	....	....	....	....
3. Size and Plumpness of Kernel	15	....	....	....	....	....	....	....	....
4. Hardness	15	....	....	....	....	....	....	....	....
5. Per cent Foreign Matter...	15	....	....	....	....	....	....	....	....
6. Soundness	20	....	....	....	....	....	....	....	....
7. Weight per bushel.........	15	....	....	....	....	....	....	....	....
Total	100	....	....	....	....	....	....	....	....

Remarks and Reasons for Placing.

Variety Judged..................................Standing...........%

Students' Name ....

Date ....

Smut.

Smut of grain has been pronounced by various experiment stations to be a parasitic disease.

Smut is easily distinguished as a dark mass of powder, found on the head of wheat, oats, barley and other grains.

It may be in the form of a compact ball or as a loose powdery collection.

In corn it is found on the leaves, tassel, and other parts as well as on the ear.

Fungi reproduce themselves by means of spores. Like bacteria they are plants but are very different from bacteria.

SUMMARY OF FACTS ABOUT SMUTS.

1. Smuts are of different kinds.
2. Each kind is a distinct disease.
3. Smut of one kind of plant will not infest another kind of plant.
4. Smut is a parasitic plant that propagates itself by the addition of spores.
5. Five thousand of these spores placed side by side would make a line an inch long.
6. A spore is a single round cell with walls that protect it from drying and injury.
7. When spores encounter favorable conditions they will germinate and reproduce.
8. Spores get food from the plant.
9. The smut cell produces a threadlike growth in the grain-plant and grows in length and produces branches.
10. The stems and branches break up into cells or spores, each of which is again capable of reproduction.
11. The addition of millions of these spores will thus produce a smut mass.
12. Each spore can produce a thread which may start the disease in another plant.
13. Smut spores may be carried by the wind, in seed, in manure, or be left in the field in refuse or in the soil.

Some of the fungus diseases that cause great loss to our farmers are:

1. Loose smut of oats.
2. Stinking smut of wheat.
3. Corn smut.
4. Potato scab.

5. Crown Gall.
6. Apple Scab.

Among the best preventatives of fungus diseases are:

1. Clean seed from uninfested fields.
2. Use of manure that contains no fungi.
3. Rotation of crops.
4. Burning all fungus growths.

Seed Treatment.

Both the loose or head smut of oats and the stinking smut of wheat are controlled by the treatment of seed, using 40 percent formaldehyde, commercially known as formalin. To treat seed wheat or seed oats use 1 pint or pound of the formalin to 40 gallons of water. Sprinkle piles of grain on tight floor or canvas with this solution by means of sprinkler, meanwhile shoveling the grain over so that every kernel is moistened—it will require three-fourths gallon to one gallon of solution per bushel of grain. When grain is so treated, allow it to lie in pile 2 or 3 hours or over night; then spread to dry. After treating, handle the grain in disinfected bags, mills and drills.

To disinfect bags, soak same in the solution used to treat oats. Mills and drills may be sprinkled with the same solution or wiped with a cloth moistened in it.

Cotton.

COTTON STATISTICS.

The states of the Union that lead in the production of cotton are given in the following order of their production: Texas, Georgia, Mississippi, South Carolina, Alabama, Arkansas, Louisiana, and North Carolina.

The world's production of bales in 1911 was 23,421,055.

The total production of the U. S. in 1911 was 15,692,701 bales.

PROBLEMS.

1. What per cent of the total production of the world does the U. S. produce?

2. The total value of the crop in 1911 was $732,420,000, what was the average value per bale in the United States?

3. If the average bale of cotton weighs about 500 pounds, what was the weight of the cotton crop of 1911, and what was the average price per pound?

4. If the average price for picking cotton is 60c per hundred, what does the picker earn if the average day's labor is 200 pounds of seed cotton per day, and what did it cost to pick the crop of 1911?

Cotton is a valuable crop for the fiber or lint produced which is used for manufacturing cloth and for the seeds which are used for manufacturing purposes and also as food for live-stock.

Cotton and wool are the two chief products that clothe the people of the world. Cotton is by far the most important. Cotton is spoken of in ancient history as a tree wool.

5. If there is on an average two pounds of cotton seed for every pound of cotton lint produced what was the total number of pounds of cotton seed produced in 1911?

6. If the value of cotton seed is 1.5c per pound, what was the value of the cotton seed crop in 1911?

Cotton seed meal mixed with hulls is used very extensively for dairy rations. (See dairy rations under the chapter on Feeding Dairy Cows.)

One ton of cotton seed meal contains about three times as much protein as wheat bran.

The fertilizing value of cotton seed meal is given as follows:

Nitrogen	135.8 pounds per ton valued at	$27.00
Phosphoric acid	57.6 pounds per ton valued at	2.80
Potash	17.4 pounds per ton valued at	.87
Total value...		$30.67

For use of cotton seed meal as a fertilizer see chapter on fertilizers.

The Cotton Plant.

Some of the most important of the desirable qualities of the cotton plant are the (a) length, (b) fineness, (e) strength, (f) uniformity of color.

The problem of breeding cotton for certain characteristics is much the same as in the improvement of other crops. The great problems of agriculture in the south is to improve the quality and to increase the quantity per acre.

The question of fertilization is therefore one of the important concerns of agriculture in raising cotton. The lint removes a very small small amount of fertility or plant food from the soil, but an analysis of the seed as shown in the foregoing table shows that when the seeds are made into oil, meal and other products and sold that the fertility of the soil becomes depleted very rapidly.

Experiments have demonstrated that fertility may be maintained by the growing of alfalfa, cowpeas, clover and other legumes reinforced with manure or commercial fertilizers for phosphates and potash.

Nitrogen will give the plant a good vegetative growth.

Potash will make the plant hardy and able to withstand diseases.

Phosphoric acid increases the yield of lint and hastens maturity.

PROBLEMS.

1. In an experiment in Georgia with land that was representative of land in many other parts of the state, the land was deeply broken, properly cultivated, cowpeas were turned under, a light application of manure and a thousand pounds of three-four fertilizer was applied to the soil and in five years, the production was increased from one-third of a bale to three bales per year. What was the gain per cent in gross income if cotton was selling at 12 cents per pound?

2. The result of tests at various experiment stations seems to indicate that the best distance between rows, on a average, is four feet, with the plants 12 to 18 inches apart in the rows. If a 10 acre field is planted in rows 4 feet apart and with plants on an average 12 inches apart. How many cotton plants are there in the field if no plant is missing?

Books.

1.—The Cereal Crops in America—Hunt, 8-12—Macmillan Co.
2.—Farm Crops—Burkett, 8-12—Webb Pub. Co., $1.50.
3.—The Book of Wheat—Dondlinger, 8-12—Webb Pub. Co., $2.00.
4. Wheat Culture—Curtis, 8-12—Webb Pub Co., $0.50.

Bulletins From The U. S. Dept. of Agriculture.

Farmers' Bulletins.

Number. WHEAT.

Write to your State Experiment Station for bulletins.

OATS.

420.—Oats: Distribution and Uses.
424.—Oats: Growing the Crop.
189.—Emmer: A Grain for the Semiarid Regions.

COTTON.

36.—Cotton Seed and its Products.
48.—The Manuring of Cotton.
209.—Controlling the Boll Weevil.
223.—Miscellaneous Cotton Insects.
286.—Comparative value of Whole Cotton Seed and Cotton-Seed Meal in Fertilizing Cotton.
333.—Cotton Wilt.
364.—A Profitable Cotton Farm.

CHAPTER IX.

Horticulture.

"Tis an art that doth mend nature—aye change it rather,
for the art itself is nature". —*Shakespeare.*

Fruit Culture.

The essentials of successful fruit culture are markets, location, elevation, soil, varieties, planting, culture, pruning, spraying and thinning.

Fruit growing is the refinement of farming, and the orchardist himself is the greatest determining factor of success.

Markets.—For successful market orcharding the first essential of success is the shipping point. There must be railway facilities or the city market within driving distance. The problem of the fruit grower is to measure his opportunities and possibilities for production to supply the demand of an increasing population in thriving cities.

Location.—The orchard site should be selected where the best advantages are afforded. An elevation may afford the necessary drainage. Cold air settles in the lowlands, while warm air rises. The altitude of the orchard therefore, often determines the extent of the injury from late frosts in spring. An orchard on the north side of a hill will blossom later in the spring than an orchard on the south slope. A southeast slope is an ideal location for an orchard in a hill country. A large body of water such as Lake Erie will protect an orchard from extremes of temperature. The growth of vegetation may be thus retarded until the danger of late frosts is past.

Soil.—Trees must have food. The food elements essential to the growth of trees are the same as those required by other plants. The soil must be in a good fertile and physical condition. A soil filled with humus will act as an insulation against extremes of cold and heat. A soil covered or full of humus retains moisture. Potassium gives strength to the woody fiber of the tree; phosphorus is essential to the development of the seeds, and nitrogen gives to the leaves their green and healthy color. The tree must be fed a balanced ration.

Culture.—There are three methods of culture known to orcharding. These are cover-crop culture; mulching; and sod-culture.

Cover Crops.

A cover crop is one that is sown for the purpose of being turned under the following spring.

The use of a cover crop as determined by various experiments in orchards are as follows:

1. A cover crop checks the growth of trees in late summer.
2. It thus protects trees from early frosts.
3. It takes up soluble plant food that would otherwise leach away during winter and spring.
4. It acts as a blanket, holding snow and preventing root injury.
5. It adds humus to the soil when plowed under.
6. Clover, vetch, cowpeas, soy beans, are good cover crops.

There are two distinct classes of cover crops—

(a) Those that die in the fall as, cowpeas, soy beans, turnips, rape and buckwheat.

(b) Those that live over winter, as, clovers, vetches, rye, and alfalfa.

Group (a) makes a larger growth and is probably best for soil fertility.

Group (b) furnishes the best protection to roots, and soil during cold weather.

Question — Which plants among the above named groups are nitrogen gathering plants? Which are not?

Mulching.

This method of culture consists in keeping the orchard in grass which may be cut late in the spring and spread under the trees in a circle reaching just beyond the tips of the branches. Any coarse vegetable matter may be used for mulching. It may be spread upon the ground to a depth of from four to six inches. This may be done every year or every other year.

The objects of mulching are as follows:

1. To hold the rainfall and to conserve moisture.
2. To keep the ground over the roots cool in summer.
3. To prevent deep freezing in winter.
4. To supply plant food by the decay of vegetable matter.

The results of mulching are: vigorous growth, early bearing, firm texture, and high coloring.

Sod-culture is the method employed where little attention is given to the care of orchards. The soil becomes impoverished and is not in a fit physical condition for the production of fruit. It does not afford protection from drouth and extremes in temperature.

Varieties of Apples to Plant.

The difference in climate and soil conditions in the same state makes it necessary to study the problem of selection of varieties carefully for successful orcharding. The prospective fruit grower should consult his state experiment station. For instance the Ohio Experiment Station has determined that the following varieties of apples are well adapted for Northern Ohio: Grimes Golden, Jonathan, Baldwin, Gano, Stark, Soy, Rhode Island Greening, Maiden Blush, Wealthy, Early Harvest, Duchess, Yellow Transparent, Baltimore, Liveland Raspberry, Red Canada.

For Southern Ohio: Rome Beauty, York Imperial, Stayman's Winesap, Rawles Janet, Duchess, Wealthy, Grimes Golden, Jonathan, Maiden Blush, Ensee, Yellow Transparent, Liveland Raspberry, and Early Harvest.

Three systems of arrangement.—The following diagrams will illustrate three methods of planting:

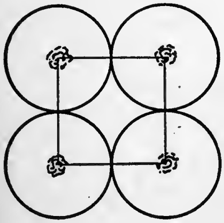


Fig. 1.
Square.

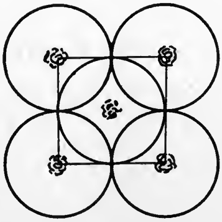


Fig. 2.
Quincunx.

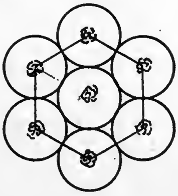


Fig. 3.
Hexagonal.

The Rectangular or Square system is used more than any other. A tree is planted at each corner of the rectangle. When the trees are planted as in figure 1, there is considerable waste of land, which may be seen between the circumference of the circles in the center of the square.

PROBLEM.

When the distance between the trees is 40 feet in the rectangular system, as in figure 1, which is a square, what is the area of the waste land?

In the quincunx arrangement it is shown in figure 2 that there is overlapping of the circles. Thus when the tree foliage has spread until it covers a space equal in area to the circles there is a crowded condition.

PROBLEM.

What is the area of space overlapped by the circles in figure 2 if the trees are planted 30 feet apart?

The hexagonal system is shown in figure 3 and shows by the following problem that it is a more economical use of land than either of the other systems given.

PROBLEMS.

In planting seven trees according to the figure given under the hexagonal plan, what is the amount of land wasted if the distance between the trees is given as 35 feet in figure 3?

In a ten-acre orchard the trees were planted 40 feet apart according to the rectangular system; how many more trees would there have been if they had been planted the same distance apart under the hexagonal system?

Fruit.

PROBLEMS IN PLANTING.

Rule.—Multiply the distance in feet between the rows by the distance the plants are apart in the rows and the product will be the number of square feet for each plant or hill; divide this number into the number of square feet in an acre (43,560) and this will give the number of hills or plants per acre.

PROBLEMS.

1. An examination of plans adopted in New York State shows that over 90 per cent of the apple orchards are planted on the square plan; and the typical distance is 33 x 33 feet. According to this plan, how many trees are there on an acre? On ten acres?

2. The investigation of orchards in New York State showed that the average income from orchards for four years was as follows:

1.	Trees planted 30x30	$ 96 54 per acre annually.
2.	Trees planted 33x33	110 02 per acre annually.
3.	Trees planted 35x35	107 28 per acre annually.
4.	Trees planted 40x40	107 32 per acre annually.

3. According to above results, what would be the difference between the income from two orchards, one planted 33x33 and the other 30x30, if each orchard occupied 10 acres?

(It has been demonstrated by the U. S. Department of Agriculture that trees 30x30 or closer in old orchards, are too close for profit.)

4. A fruit grower on the thin hilly sections of Ohio, may plant trees 25x25; on rich ground the distance is often best at 35x35; and on very fertile soil the distance should not be less than 40x40 ft. each way. Find the difference in number of trees in two orchards, of 5 acres each, one planted 25x25 and one planted 40x40 feet each way?

5. The following table gives the distance for planting generally adopted by fruit growers:

Standard pears and cherries	20 x 20 feet each way
Standard plums, apricots, peaches and nectarines	18 x 18 feet each way
Dwarf pears	10 x 12 feet each way
Grapes	Rows 9 to 10 feet apart
	Plants 7 to 10 feet apart
Currants and gooseberries	3 to 4 feet apart
Raspberries and blackberries	3 to 4 by 5 to 7 feet apart
Strawberries for field culture	1 to 1½ by 3½ to 4½ apart
Strawberries for garden culture	1 to 2 feet apart

Find cost by consulting seed and nursery catalogs.

NOTE TO TEACHER — Give problems to find number of plants per acre.

The Pleasure and Profit of Fruit Growing.

Every home in America, where there is sufficient ground about the home should have a fruit garden and if possible, in addition, an orchard of sufficient size to produce an abundant quantity and variety of fruits for home use.

From one-half to an acre will produce enough apples, pears, plums, cherries and peaches, to supply the average family.

In a small fruit garden, surrounded with poultry fence, grapes, raspberries, blackberries, currants, strawberries may be planted in rows and produce an abundance of fruit for family use.

NOTE—See Planning and Adorning The Farmstead, Etc., Chapter 25.

There are many fruit and Poultry farms of from 3 to 10 acres that are yielding good profits in various localities because they are managed on a scientific basis.

The amount of time required by the owner to take care of a small orchard would not prevent him from engaging in other regular occupations.

The work of orcharding and fruit growing when properly associated with study, will give pleasure and recreation as well as profit and satisfaction.

Orchard Profits.

The following figures with reference to yield, expense and prices and sales show the results of good care of orchards by some successful fruit growers:

PROBLEMS.

1. One acre, 9 years old.

Yield of Ben Davis—

38 trees, 119.6 bbls., $2.90 per bbl.	$346 84
Windfalls, 11 bu., 50c per bu.	5 50

Yield of Jonathan—

27 trees, 79.6 bbls., $3.50 per bbl.	278 60
Windfalls, 6 bu., 50c per bu.	3 00
Total	$633 94
Expense spraying, picking, packing, etc.	172 75

What was the net profit from this orchard?

2. One and one-fourth acres, 24 years old, 52 trees.

Summer Apples—	
62 bu., 51c per bushel	$31 62
125 bu., 20c per bushel	25 00
Winter Apples—	
Firsts, 412 bushels, 77c per bushel	317 24
Windfalls, 50 bushels, 47c per bushel	23 50
Cider Apples, 100 bu., 20c per bushel	20 00
51 bushels, 75c per bushel	38 25
Total	$455 61
Expense spraying, picking, etc.	87 00

Find the net profit.

Problems.

1. In 1909, the Ohio Experiment Station sprayed part of an orchard of 450 apple trees for an Ohio farmer; the orchard was 34 years old and the experiment resulted in a profit of $475 on the acre that was sprayed. If the whole orchard, consisting of ten acres of trees of the same average condition had been treated uniformly, what would have been the total profit?

2. A class in agriculture in 1913 took charge of an orchard, with the following results: Only 5 per cent of the apples in this orchard were windfalls, and the good apples brought 20 cents more per bushel than the apples from an untreated orchard that produced 60 per cent windfalls. If each of these orchards produced 500 bushels, and the price received from windfalls from each orchard was 40 cents per bushel, what was the difference in the receipts from the two orchards if the apples that were not windfalls from the treated orchard sold for $1.00 per bushel?

Marketing Apples.

The price of fancy apples is one of the important factors of success in fruit growing and depends to a great extent upon proper pruning, thinning and sorting.

PROBLEM.

1. If perfectly sound and well colored apples below $2\frac{1}{4}$ inches in diameter are only worth 15c a bushel, and the same kind of apples $2\frac{3}{4}$ inches in diameter are worth $1.25 per bushel, how many times has increasing the diameter $\frac{1}{2}$ inch, increased the market value? How many per cent?

The Coddling Moth.

The coddling moth is one of the principal pests of apples, pears, and other fruits.

The coddling moth causes damage to fruit growers, variously estimated at from 12 to 15 million dollars per year and an expense of 3 to 4 millions more spent for control of this moth.

The woodpecker is the coddling moth's worst enemy. There are over 30 varieties of other birds that help to destroy this moth.

LIFE OF THE CODDLING MOTH.

It flies at night.

It lives from one to four weeks.

In warm weather it begins to lay eggs in two or three days, and in cool weather in from 10 to 12 days.

The egg on a leaf or apple, looks like a small white blister, about the size of a pinhead.

This moth lays nearly all the eggs upon the upper or under side of the leaves.

Eggs hatch on an average in about eleven days.

The majority of eggs do not hatch until about four weeks after the blossoms fall.

When the egg hatches, the young larvae or apple worm is about one sixteenth of an inch long.

These worms may feed upon foliage and transform without entering the apple.

When the worms reach the apples, about two-thirds of them enter the apples at the blossom end.

The seeds of the apple seem to be the most relished part by the worms.

The worms attain their full growth in from 20 to 25 days. and when leaving the apple often leave through the side.

A full-grown worm is about three-fourths of an inch long.

About the last of July the full grown worms begin to leave the apples to form their cocoons.

They continue to leave the apples till the fall of the year.

Cocoons are formed under the bark, where most of the larvae pass the winter.

Those larvae which are full grown by the first of August, may give rise to the second brood of moths in the same year.

In some of the states it is claimed that there are as many as three broods.

A large portion of the damage done to picked fruit is by the second generation of larvae.

TREATMENT FOR CODDLING MOTH.

Arsenate of lead and paris green are said to be the only arsenical insecticides in general use for this pest.

Arsenate of lead is to be preferred, because of its adhesiveness.

The composition of Arsenate of Lead is as follows:

Arsenate of soda, 4 ounces.
Acetate of lead, 11 ounces.
Water, 3 to 5 gallons.

Dissolve the ingredients, each in one-half to one gallon of warm water. Mix together and put into spray tank containing from 50 to 100 gallons of water. Add the milk of lime from two to three pounds of freshly slaked stone lime.

While costing more than paris green, arsenate of lead is generally regarded as more economical in the end because of its adhesive quality.

For most purposes the commercial product should be used in the proportion of 3 pounds of the arsenate of lead to 50 gallons of water.

See spray calendar for time of spraying.

San José Scale.

One of the most destructive insects that has infested the orchards of America is the San José Scale.

This scale is circular in form, and quite flat. The center is dark and the surrounding color is gray. It is difficult to distingish them from the color of the bark.

When full grown they are about one-sixteenth of an inch in diameter.

They are sucking insects and are closely attached to the bark of the tree.

When they become abundant they form a thick scurfy layer, being of a light color obscuring the natural color of the bark.

Millions of these insects will quickly suck out the sap from the bark.

The eggs are laid under the scale. Early in June in the latitude of New York the young insects begin to crawl out. In a few days they attach themselves to the bark, leaves or fruit.

They complete their growth in about 4 weeks. Only the males have wings.

NOTE — For treatment of scale, see spray calendar at end of this chapter.

Miscellaneous Problems.

1. A fruit grower wishes to protect a young orchard of 500 trees from rodents, such as mice, rats and rabbits, etc.; he purchases a wire netting No. 22, ¼ inch mesh, 36 inches wide, at $3 per roll of 100 linear ft; he cuts a 12 inch strip across the end of the roll, which is sufficient to encircle a tree; what will be the cost of protecting his orchard?

One of the intricate problems of orchard management is that of feeding the trees.

The time was when it was generally believed that orchards did not need fertilization. Now the application of a good balanced ration, in the way of a manure or fertilizer is one of the problems that is being solved by scientific horticulture.

It has been determined that the fertilizer requirements of an orchard are dependent upon some of the following conditions:

1. The age of the trees.
2. The vigor as indicated by the annual growth.
3. The nature of the variety.
4. The character of the soil.
5. The cultural system employed.
6. The kind of cover crop used.
7. The nature and amount of other crops grown in the orchard.
8. The availability of the fertilizing material.
9. The severity of pruning.
10. Size of the expected crop.
11. The character of the season.

The treatment of fruit trees is therefore one of the most perplexing and yet important problems of the farm. The neglect of proper care and study of trees has resulted in a loss of what should have been one of the chief incomes of farms having orchards.

Orchard Fertilizers.

The following table shows the methods employed at seven experiment stations, where the question of orcharding has been studied extensively:

Fertilizers Found Beneficial on Apple Orchards.

State.	Fertilizers Giving (Amount	Best Results. Per Acre.)	Instructions for Applying.
Mass.	Nit. of Soda..100 lbs. Bone Meal.....800 lbs. Muriate of Pot.400 lbs.		
New Hampshire.	Complete Fertilizer. Nitrogen .... 5.0% Phos. Acid........ 8.3% Potash 8.3%	1,210 lbs. per acre.	Apply first in spring at leafing time. ¼ sq. yd. to 30 to 50 sq. yards area.
Penn.	Fertilizer carrying Nitrogen ..... 30 lbs. Phos. Acid.... 75 lbs. Potash .... 50 lbs. per acre. Use cover crops or 10	2,000 lbs. per acre of a 1.5-3.75-2.5 fertilizer. tons manure per acre.	Apply in spring every alternate year. Alternate with manure.
Maine.	"Fisher" Fertilizer Nitrogen .... 8.6% Phos. Acid....... 3.5% Potash 11.9%	"Station" Fertilizer. Nitrogen .... 3% Phos. Acid......... 6% Potash 8%	Apply 10 lbs. per tree.
Ohio.	Nit. of Soda..100 lbs. Bone Meal....200 lbs. Sulph. of Pot.100 lbs.		Apply nitrate at budding time. Apply bone and potash in fall.
Conn.	Nit. of Soda..200 lbs. Sulph. of Pot.250 lbs. Raw Bone.....400 lbs. Acid. Phosph..150 lbs. per acre.		Apply fertilizer at time of plowing in spring. Bone may be applied in summer.
North Carolina.	Growing Trees. Nitrogen.. 5% (500 lbs. Phos. Acid.. 8% (per Potash ..... 2% (acre	Fruiting Trees. Nitrogen.. 3% (500 lbs. Phos. Acid.. 8% (per Potash .....10% (acre	Apply in spring. Apply after heavy crop is harvested.

Rejuvenation of Orchards.

The results of the reawakening of a practically lost industry in a section of Ohio where that industry was many years before of considerable importance is shown by the following marvellous change:

Previous to 1909 one county in Ohio was buying apples for home consumption. In 1909 the Ohio Experiment Station began a series of demonstration experiments with the result that the sale of apples from unsprayed trees amounting to $5,000 in 1909 increased to $65,000 in 1910; and in 1911 the income from the apple crop advanced to $200,000, and the work has but fairly been begun.

AN OHIO "RECORD ACRE" OF FORTY ROME BEAUTY TREES.

This acre was scientifically sprayed and thinned, with the following results in 1911:

First grade, 2½ inches and above in diameter..............	1,158 bushels
Second grade, 2½ down to 2 inches in diameter..........	120 bushels
Good "drops" knocked off during picking.................	123½ bushels
Defective and below 2 inches in diameter.................	28 bushels
Total product from the acre..............................	1,429½ bushels

PROBLEMS.

1. At the above rate of production what would be the income from a 20 acre orchard at the present price for first grade apples?

2. An average gain of $4.72 per tree was obtained on the poor soils of southeastern Ohio, in three orchard expeirments, by the use of nitrogenous fertilizers, at a cost of not to exceed 15 cents per tree. At that rate what would be the net income on an investment necessary to fertilize 500 trees?

A well thinned orchard of 62 trees in Ohio, produced but 21 pounds of apples under 2 inches in diameter, while a single unthinned tree of the same age and variety in the same orchard produced 28 pounds of apples under 2 inches in diameter.

3. If the total cost of spraying, fertilizing and thinning a tree is $1.00, and produces an increased yield of $6.00 per tree over trees that are untreated, what is the percentage of income on the investment in spraying, fertilizing and thinning?

Score Card.

FRUIT.

VARIETY..................

Institution ....

Scale of Points.	Possible Score.	Points. Student Score.	Corrected.
1. Size of Exhibit, (Quantity Exhibited)......	20	....	....
2. Size of Fruit..............................	15	....	....
3. Color	15	....	....
4. Form	15	....	....
5. Quality	15	....	....
6. Freedom from Blemishes.....................	20	....	....
Total	100	....	....

Remarks ....

Sample ....Date ....

Student ....Standing ....%

Spraying.

In using the spray calendar on following pages it is well to observe the following suggestion:

"The strength of Bordeaux mixture best adapted to one's use upon apple trees, varies with the spray appliances employed; with hand pumps and low pressure of the spray a 4 x 4 x 50 formula may be used with safety, while with high pressure and heavy applications of spray a 3 x 3 x 50 strength is safer even in earlier sprayings—for later ones a greater strength than 2 x 2 x 50 is seldom desirable."

Spray Calendar.

APPLES.

Pests affected.	What to use.	When to spray.
Apple scab, leaf soot canker.	*Bordeaux mixture, 3-3-50, or lime-sulfur, 4-50.	1st Spraying.
Curculio, bud moths, tent caterpillars, canker worms, and other insects.	Arsenate of lead, 3 pounds to 50 gallons.	After the cluster buds expand and before the blossoms open.
Coddling moth, curculio.	Arsenate of lead, 3 pounds to 50 gallons of water, or lime-sulfur combined with arsenate of lead 3 pounds to 50 gallons.	2nd Spraying. Just after the blossoms fall.
Coddling moth, apple scab, and leaf-eating insects.	Same as second spraying.	3rd Spraying.
Bitter rot, blotch, and scab.	Bordeaux mixture 4-4-50.	Ten days later.
Bitter rot, blotch, rust.	Bordeaux mixture, 2-2-50.	4th Spraying.
Second brood of coddling moth.	Arsenate of lead, 2 pounds to 50 gallons of water.	July 1st to 10th.
Blotch, bitter rot.	Ammoniacal Copper Carbonate.	5th Spraying. Two weeks and if needed also four weeks later than 4th spraying.

* BORDEAUX MIXTURE. Copper sulfate (blue vitriol) 3 pounds Quicklime (*not air slaked*) 3 pounds. (Of dry air slaked lime or hydrate of lime one-fourth more.) Water to make 50 gallons.

APPLES — Concluded.

Pests affected.	What to use.	When to spray.
San Jose scale.	Lime-sulfur or Soluble oil.	6th Spraying.
Oyster shell scale. Scurvy scale.	Lime sulfur or kerosene emulsion.	Dormant season. Late fall, winter, or early spring.

PEARS.

Pests affected.	What to use.	When to spray.
Leaf blight.	Bordeaux mixture.	1st Spraying.
Canker worm and bud moth.	Arsenate of lead.	Just before blossoms open.
Scab.	Bordeaux mixture.	2nd Spraying.
Coddling moth and curculio.	Arsenate of lead.	Just after petals fall.
Scale pests.	Same as under apple.	3rd Spraying.

PEACHES.

Pests affected.	What to use.	When to spray.
Leaf curl, rot and scab.	Bordeaux mixture.	1st Spraying. Before buds start.
Leaf curl, rot, scab. Pustular spot.	Bordeaux mixture.	2nd Spraying. Just after calyx drops.

PEACHES — Concluded.

Pests affected.	What to use.	When to spray.
Curculio.	Arsenate of lead.	3rd Spraying. Ten days after bloom falls.
Brown rot.	Lime-sulfur solution.	4th Spraying. Four weeks after petals fall and again four weeks before fruit ripens.

PLUMS.

Pests affected.	What to use.	When to spray.
Curculio.	Arsenate of lead.	1st Spraying. Just before the blossoms open.
Brown rot.	Bordeaux mixture or lime-sulfur.	
Curculio.	Arsenate of lead.	2nd Spraying. Just after the blossoms fall.
Brown rot and leaf spot.	Bordeaux mixture.	
Same purposes.	Same as second spraying.	3rd Spraying. 15 days after blossoms fall.
Same purposes.	Same as second spraying.	4th Spraying. Four weeks after blossoms fall.
Fruit rot and leaf spot.	Ammoniacal Solution of Copper Carbonate or Lime-Sulfur, or Soda Bordeaux mixture.	5th Spraying. As fruit begins to color.

PLUMS — Concluded.

Pests affected.	What to use.	When to spray.
Lice.	Soap solution or Nicotine sulfate.	6th Spraying. When aphis or lice appear.
Scale.	Same as for apples.	7th Spraying. When trees are dormant.

CHERRIES.

Pests affected.	What to use.	When to spray.
Curculio, leaf spot.	Arsenate of lead, or lime sulfur.	1st Spraying. Just before they open.
Fruit rot.	Arsenate of lead.	
Rose Chafer, curculio, rot.	Arsenate of lead, or lime sulfur.	2nd Spraying. Just after blossoms fall.
Fruit rot and leaf spot.	Ammoniacal Copper Carbonate.	3rd Spraying. Fifteen days after blossoms fall.
Leaf spot and slugs and other insects.	Bordeaux mixture with arsenate of lead.	4th Spraying. Just after fruit is picked.
Lice.	Soap solution or Nicotine sulfate.	5th Spraying. Any time when aphis first appear.
San Jose Scale.	Lime-sulfur or Soluble oil.	6th Spraying. Before buds open.

General Treatment for All Kinds of Plants.

Leaf eating insects such as slugs, caterpillars, beetles, etc.	Paris Green or other arsenical when insects first appear.
Sucking insects such as plant lice, true bugs, etc.	Tobacco dust, nicotine, sulfate, soap or kerosene emulsion.
Scale insects such as scurfy, bark louse and San Jose scale.	Spray with lime sulphur solution in spring before the buds are open.

School Demonstration Work.

Have a number of boys who are in the class in Agriculture select two or more trees in the home orchard if it has been neglected and make an experiment.

1. Begin with mulching soil this year.
2. Apply fertilizers to soil next Spring.
3. Trim the trees.
4. Spray for fungi and insects.
5. Thin the fruit.
6. Pick and pack scientifically.
7. Marketing.
10. (This may be conducted as a contest on basis of quantity and profit.)
   This will be an important demonstration of what your teaching can do.
   Make the work practical.
   Get results.
   Have pupils write composition on their work in Agriculture.
   Topics may be treated in the following order:
11. Object of club work.
12. Life history of apple.
13. Soil study, fertilizing, mulching.
14. Management of diseases and insects.
15. Management of the crop-picking, crating and marketing.
16. Exhibits, their relation to school work.
17. Use of products—their food value; recipes for dishes.
18. Report of yield—pounds—amount used for home consumption —amount sold—profit on investment—amount received for labor, etc.

19. State briefly what your club work or agricultural education has done for you, in interest, instruction, health, comfort and in financial benefits.

Questions.

1. What is a nectarine?
2. Explain the propagation of dwarf pears.
3. What kind of grafting produces pear trees known as standards?
4. How would you convert a pear tree into a half standard?
5. Why are trees planted on elevated ground sloping North, not so liable to injury from frost and sun scald, as if planted on a southern slope?
6. Name some of the advantages of planting on an Eastern or on a Southeastern slope?
7. What kind of soils yield the most satisfactory result in the following fruits: Apples, pears, cherries, peaches, plums?
8. Name some of the best varieties of your locality.
9. What conditions are most favorable to pear blight?
10. How far apart should we plant trees of different kinds in this locality? How many can we plant to the acre of each?
11. What is the effect of girdling trees by mice and rabbits, etc.?
12. Will mulching or tilling affect the time of blossoming?

Suggestions for Teachers.

Have the class in agriculture secure a neglected orchard and make a test of the effects of fertilizers, pruning, spraying, thinning. This may have the effect of reviving an interest in fruit growing and result in great financial benefits to the community. This will help to earn respect for your work and create a better school sentiment in your school district.

The following experiment may be carried out by the student in agriculture in the old home orchard. Nine trees will be sufficient for the experiment by the pupil or class.

If the test is made by the farmer and it is desired to try more tree the instructions in the following table may be observed.

Experiments.

PLAN FOR LOCAL ORCHARD-FERTILIZER TEST.

(Pounds for a Mature Tree in Bearing.)

1. Check (Unfertilized).
2. Nitrate, 2½ lb.; Dried blood, 3½ lb.; Acid phosphate, 10 lb.
3. Nitrate, 2½ lb.; Dried blood, 3½ lb.; Potash, 2 lb.

4. Acid phosphate, 10 lb.; Potash, 2 lb.
5. Check
6. Nitrate, 2½ lb.; Dried blood, 3½ lb.; Acid phosphate, 10 lb.; Potash, 2 lb.
7. Same as VI, plus lime, 12 to 25 lb.
8. Manure, 400 lb.
9. Check.

This test should be located in a typical part of the orchard, and should include not less than 9 average trees of the same variety and age, in each plat. All the trees should be labeled and carefully measured at a fixed point on the trunk, and definite records of their growth and yields should be kept for at least 3 years. Frequently, good indications of the orchard's needs may be obtained in less time than this, but at least this amount of time should be allowed and more if necessary.

The same time and methods of application should be followed as described above. The materials are indicated here in amounts per bearing tree and the same proportionate reductions should be made for younger trees. If only a third of the ground is to be covered, then only about a third of these amounts should be used.

In observing results, notice effects on color of leaves; on size of fruit; on twig growth.

Nitrogen produces strong wood growth which is desirable in old trees that are not vigorous. Too much nitrogen produces wood at the expense of buds and fruit.

Potash and phosphoric effects are found to a considerable extent in the leaves and fruit.

Remember.

A tree needs food and must have a balanced ration to produce the maximum crop of fruit.

Experiments.

Pear trees propagated by budding the pear upon quince stock are known as dwarfs.

The Angers variety of quince are principally used for this purpose.

Trees produced by grafting or budding improved varieties on seeding pear stock produces what is known as standards.

A half standard is produced by taking a dwarf tree and slitting it just above the point of union with the quince root on which it has grown and then planting the tree deep enough so that the point of union will be several inches under ground. The slit should be made with a sharp knife. The cut should be through the bark in an upward direction. A callus will form as a result of this wound and from this point roots will begin to grow. Finally they will become strong enough to sustain the tree. The tree will continue to produce after the quince roots have ceased to act.

Some varieties of pear trees are infertile and should be intermingled with some other varieties that are good pollenizers.

SCORE CARD—FRUITS.

(Lenox, Mass., Horticultural Society, 1913.)

Points.	Grapes.	Peaches and Nectarines.	Melons.	Strawberries.	Figs.	Apples and Pears.	Plums	Cherries.	Raspberries and Blackberries.	Currants. Size Only.	Gooseberries.
Size and form of bunch	50									50	
Size of berry	25									50	
Color	25			15		25	40	20			
Size		50		50	50	50	60	30	50		50
Finish		50			50						
Flavor			75	25				50	50		50
Form			25	10		25					
Totals	100	100	100	100	100	100	100	100	100	100	100

References for Reading on Fruit Culture.

BOOKS.

1. The Fruit Garden—Barry, 7-8—Orange Judd & Co., $1.50.
2. Principles of Fruit Growing—Bailey, 8-12—Macmillan Co., $1.50.
3. Popular Fruit Growing—Green, 8-12—Webb Pub. Co.
4. The American Apple Orchard—Waugh, 8-12—Webb Pub. Co., $1.00.
5. Dwarf Fruit Trees—Waugh, 8-12—Webb Pub. Co., $0.50.
6. Berry Book—Biggle, 8-12, $0.50.
7. Plum and Plum Culture—Waugh, 8-12—Webb Pub. Co., $1.50

8. The Pruning Book—Bailey, 8-12—Macmillan Co., $1.50.
9. Bush Fruits—Card, 8-12—Macmillan Co., $1.50.
10. Peach Culture—Fulton, 8-12—Webb Pub. Co., $1.00.
11. How to Make a Fruit Garden—Fletcher, 8-12.
12. Beginners' Guide to Fruit Growing—Waugh, 8-12—Orange Judd Co
13. Small Fruit Culturist—Fuller, 8-12—Webb Pub. Co., $1.00.
14. Strawberry Culturist—Fuller, 8-12—Webb Pub. Co., $0.25.
15. Grape Culturist—Fuller, 8-12—Webb Pub. Co., $1.50.
16. Pear Culture—Quinn, 8-12—Webb Pub. Co., $1.00.
17. Quince Culture—Meecho, 8-12—Webb Pub. Co., $1.00.
18. Fruit Harvesting, Storing and Marketing—Waugh, 8-12.
19. Grape Grower's Guide—Chorlton, 8-12—Webb Pub. Co., $0.75.
20. The Orchard and Fruit Garden—Powell, 8-12, $1.00.
21. The Nursery Book—Bailey, 8-12—Macmillan Co., $1.50.
22. Fruits and Fruit Trees of America—Downing, 8-12, $5.00.
23. American Horticultural Manual—Budd & Hanser, $3.00.
24. Cyclopedia of American Horticulture—Bailey, $20.00.
25. Spraying of Plants—Lodeman,—Macmillan Co., $1.25.

Publications of the U. S. Dept. of Agriculture on Fruit Growing.

FARMERS' BULLETINS.

No. *Title.*

154. The Home Fruit Garden.
113. The Apple and How to Grow It.
181. Pruning.
198. Strawberries.
213. Raspberries.
238. Citrus Fruit Growing in the Gulf States.
243. Fungicides.
30. Grape Diseases on the Pacific Coast.
283. Spraying for Apple Diseases in the Ozarks.
284. Insect and Fungus Diseases of Grapes East of the Rocky Mountains
401. The Protection of Orchards in the Pacific Northwest from Spring Frosts by Means of Fires and Smudges.
440. Spraying Peaches for the Control of Brown-rot Scab and Curculio.
471. Grape Propagation, Pruning and Training.
127. Important Insecticides.
172. Scale Insects and Mites on Citrus Trees.
171. Control of the Coddling Moth.
482. The Pear and How to Grow It.
118. Grape Growing in the South.
176. Cranberry Culture.
491. The Small Apple Orchard.

No.	*Title.*
156.	Home Vineyard.
404.	Irrigation of Orchards.
538.	Sites, Soils, and Varieties for Citrus Groves in the Gulf States.

Ohio Experiment Station Publications.

Apple Culture, Nos. 137, 217, 224, 171.
Spraying, Nos. 191, 169, 199, 216, 232.
Renewal of old Orchards, No. 180.
Protection of Fruit Trees from Rodents, No. 208.
Dependable Fruit, Circular No. 55.
Raspberries, Notes on, Nos. 98, 146.
Strawberries, Notes on, Nos. 146, 154, 166, 178, 186, 236.
Plums, Comparison of varieties, No. 113.
Plums for Home and Market, No. 170.
Currants, Notes on varieties, No. 98.

Important State Bulletins.

Bulletin No.	
156.	Peach Growing in Alabama—Ag. Ex. Station, Alabama.
164.	Strawberries, Indiana.
46.	The Grape, Missouri.
154.	Orchard Heating, Indiana.
66.	Apple Growing in New England, Connecticut.
130.	The Pear Slug, Iowa.
121.	Orchard and Garden Spraying, Minnesota.
11.	Organization of a Fruit Distributing System, Utah.
207.	Management of a Bearing Orchard, Wisconsin.
143.	The Coddling Moth, New Hampshire.
139.	Circular—Packing Indiana Apples, Indiana.
196.	Control of Apple Blotch, Kansas.
121.	Fertilization of Apple Orchards, Pennsylvania.
157.	Some Apple Diseases and Their Treatment, New Hampshire.
144.	Cold Storage for Iowa Apples, Iowa.
128.	The Apple in Pennsylvania, Pennsylvania.
127.	Spraying Practice, Iowa.
168.	Fertilizers in a Cultivated Orchard, New Hampshire.
129.	Orchard Heating, Iowa.
214.	Handbook of Diseases of Cultivated Plants, Ohio.

CHAPTER X.

Forestry.

OUTLINE FOR TREE STUDY.

1. Date. Deciduous. Evergreen.
2. Name. Common. Scientific.
3. Where found in the state.
4. On what type of soil does it grow—sand, muck-clay, or loam.
5. On dry high altitudes or on low wet lands.
6. Height to which it grows. Diameter.
7. Its economical value as lumber (per M.)
8. Botanical description of stem, leaves, roots, flowers, fruit and seeds.
9. Commercial value of each part.
10. To what particular purpose it is adapted for woodwork construction.
11. Does it grow slowly or rapidly.
12. Is it permanent or short lived.
13. Does it resist decay or rot quickly.
14. Is the timber heavy or light. Specific gravity.
15. Does the trunk divide into branches or does it extend straight up through the top as in a cone bearing tree?
16. How far from the ground do the first branches come off?
17. Make drawing of outline.

Forestry in the United States.

The United States stands second among the nations of the world as to the extent of its forests. Russia (European and Asiatic), comes first, and Canada comes third.

The ownership of forests in the United States is divided about as follows:

	Acres.
Private and unreserved public forests (unclassified)	442,000,000
National Forests (belonging to the U. S. Government)	100,000,000
State Forests (belonging to states)	3,000,000
Total	545,000,000

There are within the national forests approximately 15,000,000 acres of land that is unproductive and that the government believes is capable of supporting tree growth. These large areas are covered with worthless brush, or are bare of vegetation. In many of these places the forests have been swept away by fires.

The government estimates that at least half of the area can be reforested only through artificial planting.

The Forest Service of the United States has already begun the work of experimenting by sowing seed on some 20,000 acres annually.

In 1911 the Forest Service had on hand for this purpose 161,401 pounds of seeds. 54,000 pounds were seeds from foreign countries, mostly of European species, suitable for introduction in this country.

The work of gathering seeds by the Forest Service has therefore become a work of considerable magnitude. To give an idea of this work it may be stated than on an average a single tree bears no more than 2.5 bushels of cones. Most of the seeding has been of the cone bearing varieties, conifers in general and the pines in particular because they grow rapidly and produce good lumber.

PROBLEM.

1. It requires one bushel of cones to produce one pound of seed; if the government is planning to reforest 30,000 acres per year, and 6 pounds of seed are sown on an average per acre, what is the number of bushels of seed that will be required to sow this amount annually?

It is an interesting fact that most of the tremendous amount of work required to furnish the supply is done by squirrels. When cones are abundant squirrels lay by a great store of seeds, much more than they can eat during winter. They are experts at collecting seeds and they make collections of good seeds for they know which cones have the plumpest seeds. Thus with man's help they become a great factor in reforestation of our country.

The Forest Problem.

According to the statements of the Department of Agriculture it is now recognized that taking the world as a whole, wood consumption now exceeds its production.

In 1911 we shipped out of the United States, forest products to a total value of over $100,000,000. We consumed at home 23 billion cubic feet of wood.*

FIGS. 1 and 2. Two Forestry Experts.

PROBLEMS.

1. The Bureau of Corporations of the Department of Commerce and Labor has estimated that the existing supply of saw timber in the United States is less than 3,000 billion board feet. What is this amount equal to in cubic feet?

2. At the present rate of shipment and home consumption how many years will it take to consume the products of saw timber in the United States if we consume all of our product at home?

We are already importing woods for certain purposes. We are now annually consuming 5 million cords of wood for pulp. Nearly half of this amount is imported.

Since 1902 a systematic study of the strength and uses to which woods may be put, has resulted in large economies in consumption.

* With an annual cut of about 23,000,000,000 cubic feet of standing timber and a forest area of about 545,000,000 acres, the cut per acre is 42 cubic feet, while the annual growth on the area has been estimated at 12 cubic feet per acre.

It has been found that large quantities of cheap and available species of woods can be substituted for spruce in the groundwood process for news print paper.

A test of the physical properties of timber has determined the uses to which it may be placed to the greatest advantage economically.

PROBLEMS.

1. If the land area of the 48 states of the Union is 1,908,428,000 acres, and there are approximately 500,000,000 acres in forests, what per cent of the total area is in forests?

2. How many square miles of forests are there in the United States?

3. The area of the forests in the United States are how many times as large as your own state?

4. How many acres of forests in your state? (See Bulletin 83, Forest Service, U. S. Dept. of Agriculture.)

5. What per cent of the land area of your own state is in forests?

Write to your state experiment station for bulletins on forestry, preservative treatment of timbers, treatment of forest trees, reforestation, commercial forestry, etc.

Read instructions for planting catalpa seeds in the "Nursery Planting Table for Forest Trees", in the chapter on "Planning and Adorning the Farmstead and School grounds".

Catalpa has been planted under such a wide range of condition that there has been a wide difference in results. The success of catalpa raising will depend upon the following points:

1. A suitable site for planting.
2. Proper spacing.
3. Proper cultivation and care.

Study carefully instructions given by the National Government.

Catalpa Trees.

Investigations made by the U. S. Government as reported by Gifford Pinchot, in Circular 82 U. S. Dept. of Agriculture, Forest Service shows the returns that may be expected from plantations of hardy catalpa under a variety of conditions in different states.

PROBLEMS.

1. Two plantations in Marion Co., Mo., in which the trees were spaced 4 by 8 feet when set out, contained at the end of 20 years, respec-

tively, 392 trees and 616 trees per acre. The average height of the trees in the first grove was 47 feet; those in the second grove were 55 feet. The product per acre of the first grove were 1,515 first-class posts and 320 second class posts; the product of the second grove were 1,930 first-class posts and 540 second-class posts per acre. If the first-class posts were worth 12c per post and the second-class posts were worth 9c a piece what was the value of the posts per acre of each of the two groves? What was the difference in value between an acre from the first grove and an acre from the second grove?

2. A plantation in Sangamon Co., Ill., in which the original spacing was 4 by 5 feet, contained at 21 years of age 800 trees per acre; the yield was 1,920 posts per acre; they were all first class; what was the average number of posts per tree and the value of an acre of trees at 25c each?

3. A 25-year-old plantation in Nebraska yielded 1,829 first-class and 854 second-class posts per acre; what was the total value at 10c for firsts and 8c for seconds per acre?

4. In a plantation in Pawnee County, Nebr., the owner kept a strict account of all expenses incurred in establishing, maintaining, and harvesting his plantation and of the final proceeds. The seedling trees, at $1.15 per thousand, cost $3.13 an acre; the preparation of the ground, planting, cultivating, and pruning cost $18.46—a total of $21.59 per acre. At 5 per cent compound interest this was increased, in the 16 1/3 years during which the plantation grew, by $26.34. Cutting and marketing the crop added $61.90 per acre to this, so that the full cost at the end of the experiment for the 20 acres was $2,196.

The returns were:

31,397 third-class posts, at 5 cents	$1,569 85
17,349 second-class posts, at 10 cents	1,734 90
4,268 first-class posts, at 12½ cents	533 50
270 first-class posts, at 15 cents	40 50
211 8-foot posts, at 20 cents	42 20
9 10-foot posts, at 25 cents	2 25
4 10-foot posts, at 30 cents	1 20
258 10-foot posts, at 35 cents	90 30
41 12-foot posts, at 40 cents	16 40
167 14 and 16 foot poles, at 50 cents	83 50
Total for posts and poles	4,114 60
214 cords of wood, at $5.25	1,123 50
Total income from 20 acres	5,238 10

What was the total profit for the 20 acres?
How much was the income per acre per year?

A number of railroads have been planting forest trees to serve as a source of supply for ties.

PROBLEMS.

1. The average number of ties per mile used by the railroads in the United States is 3,000. The average life of ties is about 6 years; the average cost of ties is about 30 cents. The number of miles of railroad in the United States is 250,000; what is the average cost of ties for the railroads of the United States annually?

2. In 1911 one eastern railroad had planted 2,950 acres to locust, red oak, Scotch pine, European larch, Norway spruce, catalpa, pin oak, white pine, black walnut, and some other species making in all 4,617,626 trees. When these trees have reached a size sufficient to produce three ties per tree, how many miles of railroad will they supply in ties at 3,000 ties per mile?

It is therefore very evident that the tie problem has become a problem of great interest to the railroads and that it may be of great concern as well as profit to the forester.

The need of farm buildings on the average farm, the high cost of material and timber are already becoming serious problems in agriculture.

It has been said truthfully, "We produce wealth with wasteful painfulness, and we destroy it with reckless prodigality". Our forest resources have certainly been wastefully and recklessly destroyed.

3. The average value of houses, barns and other buildings per farm in the United States is about $1,000. The average barn such as is needed for the economical management of a farm of today cannot be built for less than $1,000. If there are 6 million farms in the United States and $500 were to be expended in lumber for better buildings per farm, what would be the value of the lumber needed for this item alone?

PROBLEMS.

1. If the billion posts and rails used annually are valued on an average at 10c apiece, what is the total annual cost of this timber for building fences?

2. It has been estimated that this billion posts and rails are the equivalent of 6 billion board feet; if the total value of this lumber is estimated at $100,000,000 what is the value per M.?

Decay of wood is caused by low forms of plant life, known as fungus organisms. Various experiments have been made to determine whether these fungi can be prevented from developing by use of some preservative treatment.

The methods of prolonging the life of posts are given in the order of their efficiency, and cost as follows:

1. Peeling and seasoning.
2. Charring.
3. Painting.
4. Dipping.

Creosoting.

Creosote is a derivative of coal tar and has come into extensive use for treating ties, posts and other timbers which on account of quality and exposure are subject to rapid decay.

Send for Farmers' Bulletin No. 377, The Preservative Treatment of Farm Timbers. U. S. Dept. of Agriculture.

Purposes of Forestry.

The principles of forestry are founded upon some of the important truths stated in the following paragraphs:

1. Tree planting should come under either one of two heads:
   (a) Planting for ornaments, windbreaks, shade, parks, groves, and wood-lots.
   (b) Planting trees for forests to produce wood, posts, lumber and other commercial products.

Forest Uses.

1. Trees conserve moisture, modify climate and purify the air.
2. Forests serve often as a protection against floods and tornadoes.
3. Forests render a service in the protection of streams, for fishing, birds, and game preserves.

Propagation.

In the propagation of trees it will be of importance to observe some of the following facts:

1. To get a model for forest planting, visit an ideal forest noted for its commercial value and note the varieties that grow successfully, and observe the distances between trees, the height of trees, the arrangement of limbs. Compare trees growing to a great height in the forest with a tree or trees of the same variety growing in fields or open places.

FIG. 3. — A winter scene on the farm.

2. Low-growing trees may be planted among high-growing trees. This will afford shade, help to conserve moisture and hasten the growth of all the trees. Trees that grow rapidly are usually short-lived and may temporarily fill areas while trees of slower and more permanent growth are coming to the proper size. There should be a sufficient number of trees and denseness of foliage to furnish annually a leaf mulch for helping to retain moisture in the soil.
3. Variety will also check drouth, disease and insect ravages; gives beauty and increases interest; insures marketable products; produces greater variety of food and shelter for birds and other animals.

PROBLEMS.

How to Measure a Tree.

1. To guess at the height of a tree, take a stick five or ten feet long; set it up at the side of the trunk; then at some distance from the tree estimate how many times the length of this stick would be required to reach to the top of the tree.

2. On a bright sunny day either before noon or afternoon place a stick by the side of the tree. Measure the length of the shadow of the stick and the length of the shadow of the tree. If the stick is 6 feet long and its shadow is 8 feet and the shadow of the tree is 80 feet then the solution is: 8 : 6 : : 80 : (?)

3. Measure with a tapeline, from the foot of the tree to a point from which a line can be drawn to the top of the tree at an angle of 45°. The distance from the foot of the tree to this point will be the height of the tree.

4. Let the horizontal distance between two perpendicular sticks be 6 feet. Let the outside stick be 6 feet high, and the inside stick of sufficient height, that the tops of the two sticks shall be in line with the top of the tree.

Draw a horizontal line from the top of the outside stick to the trunk of the tree. From these measurements, drawings may be made showing that we have two similar right angled triangles from which we can easily compute the height of the tree.

5. To find the diameter of the trunk divide the circumference by 3.1416.

6. To find the number of feet of lumber in a log or tree, see "Board Measure and Lumber Problems" in Chapter 28.

Questions.

1. Should a wood-lot be used as a pasture?
2. How does a forest effect soil moisture and soil temperature?

3. On which side of a tree do we usually find moss growing in a thick forest?

4. How does the distance apart effect the shape of trees?

5. Why does one kind of lumber resist decay longer than another?

6. Does the weight of lumber have any effect on the period of life?

7. Why does paint or creosote keep timber from rotting?

8. What is dry rot?

9. Why does wood remain well conserved under water?

10. What kinds of trees are most often struck by lightning?

11. Name several reasons why decaying wood and dead limbs and injured trees should be removed from the wood-lot.

12. In what parts of a large tract of woodland or forest do you find the most dead and injured trees? Name some causes.

13. Name some of the causes of forest fires. What are the effects?

14. What are some of the methods adopted in fighting fires in the woods and fields?

15. Why does green wood of some varieties burn more readily than green wood of other varieties?

16. What kinds of trees are best for framing timber, rough lumber. finishing timber, posts, telephone poles, roofing, floors, siding, lathing, ties, bridges, walks, wagon wheels, wagon boxes, wagon tongues, handles, ladders, baskets, pulp, butter dishes, crates, and fancy woodwork. Give reasons for your answers.

17. How will a study of the use of woods result in great economy in the conservation of valuable timber?

18. Name some of the champions of forest conservation and reforestation in the United States.

19. What great work has been accomplished by Gifford Pinchot?

20. Why do trees grow taller in the thick forest than in an open space or field? How does this effect the value of timber? How should we prune fruit trees?

Laboratory Exercises.

1. Mount samples of wood for study.
2. Make collections of nuts, cones, and other seed.
3. Make collections of leaves, buds, flowers.
4. Cut circular sections to show rings of growth.
5. Get specimens of quarter sawed lumber.
6. Get samples of knot-holes caused by dead limbs.
7. Make a demonstration of the use of cement in treating decayed spots in trees.
8. Make a collection of twigs bearing different kinds of nuts.
9. Have samples showing methods of branching of different kinds of trees.

10. Compare direction of growth of different kinds of stems, by use of samples.

11. Make collections of apple twigs showing flowers in clusters, young apples in clusters, and finally how one apple persisted and all the others perished.

12. Get samples of seeds showing nature's provisions for carrying seeds by the wind.

13. Make demonstrations showing the difference in swelling, shrinking and warping of different kinds of wood.

14. Get samples of the different kinds of roots mentioned in chapter on plants.

15. Make a collection of different kinds of bark, such as shagbark-hickory, sycamore, cottonwood, linden, elm and birch, etc.

16. Classify woods as to durability when exposed to the weather.

17. Classify woods as to weight. Classify trees of your vicinity as to value. Secure samples of wood effected with rot from different causes.

Make drawings of trees before leaves appear in spring.

"I see yonder leafless trees against the sky,
How they diffuse themselves into the air,
And, ever subdividing, separate,
Limbs into branches, branches into twigs,
As if they loved the element, and hasted
To dissipate their being into it." EMERSON.

Study a tree and name different parts; functions of parts; plant foods; sources of nourishment; study relations of air and leaves; roots and soils. Learn to recognize some of the common trees of the forest; name the best kinds of firewood; some of the best commercial woods; study treatment for lengthening the durability of buildings, post, ties, paving blocks, shingles.

Field Work.

1. Find the height of trees in the woods.
2. Make a calculation of the number of feet of lumber in a tree.
3. Find trees that probably came up from seeds dropped by birds.
4. Study appearance of the landscape with reference to trees in winter, spring, summer and autumn.
5. Study nature's methods for distribution of seeds along fence rows.
6. Visit a forest if possible to study effects of tornadoes and forest fires.
7. Write on some subject relating to forestry. See following titles of books and bulletins for topics.

References for Reading of Best Literature on Forestry in the United States.

Tree Books.

Apgar: Trees of the Northern United States.
Brisbin: Trees and Tree Planting.
Britton: Trees.
Chase: Cone-Bearing Trees of the California Mountains.
Collins and Preston: Key to New England Trees.
Dame and Brooks: Handbook of Trees of New England.
Emerson and Weed: Our Trees and How to Know Them.
Flagg: A Year Among Trees.
Going: With the Trees.
Hough: Handbook of the Trees of the Northern United States and Canada.
Huntington: A Study of Trees in Winter.
Jepson: Trees of California.
Keeler: Our Native Trees.
Lounsberry: A Guide to the Trees.
MacFarland: Getting Acquainted With the Trees.
Mathews: Familiar Trees and Their Leaves.
Maury: The Native Trees of Kentucky.
Mosher: Fruit and Nut Trees.
Mosher: Our Cone-Bearing Trees.
Mosher: Oaks and Maples.
Newhall: Trees of Northeastern America.
Roth: A First Book of Forestry.
Rogers: Among Green Trees.
Rogers: The Tree Book.
Rogers: Trees Every Child Should Know.
Sargent: A Manual of Trees of North America.
Schwartz: Forest Trees and Forest Scenery.

PARK AND STREET TREES.

Fernow: The Care of Trees in Lawn, Street, and Park.
Solotaroff: Shade Trees in Towns and Cities.

GENERAL FORESTRY.

Bruncken: North American Forests and Forestry.
Fernow: Economics of Forestry.
Fernow: A Brief History of Forestry.
Gifford: Practical Forestry.
Graves: The Principles of Handling Woodlands.
Green: Principles of American Forestry.
Roth: A First Book of Forestry.

Government Bulletins.

Those advertised by the U. S. Department of Agriculture for sale and free distribution are as follows:

		Bulletin Number.
1.	*Publication of the Forest Service, Circular II.*	
2.	Forest Products of the United States	74
3.	Wood Preservation in the United States	78
4.	Protection of Forests from Fire	82
5.	The Forest Resources of the World	83
6.	Windbreaks; Their Influence and Value	86
7.	Light in Relation to Tree Growth	92
8.	Reforestation on the National Forests	98
9.	Forest Nurseries for Schools	423

CIRCULARS.

		Number.
1.	Suggestions to Prospective Forest Students	23
2.	Arbor Day	96
3.	Forestry in the Public Schools	130
4.	Forests of the U. S.; Their Use	171
5.	The Timber Supply of the U. S	166
6.	Forestry and Lumber Supply	25
7.	Experiments on the Strength of Treated Timbers	39
8.	Strength Values for Structural Timbers	189

FARMERS' BULLETINS.

		Number.
1.	A Primer of Forestry (In two parts)	173
2.	Forest Planting and Farm Management	228
3.	Maple Sugar and Syrup	252
4.	The Preservative Treatment of Farm Timbers	387

CHAPTER XI.

Rotation of Crops.

The rotation of crops is one of the most important problems of farm management. It is the science of growing crops in their proper order. There are certain crops that are peculiarly adapted to the preparation of the soil conditions for succeeding crops; for instance a corn or potato crop that has to be cultivated and kept free from weeds will leave the soil in good condition for seeding to hay or cereal crops. A legume will prepare available nitrogen for nonleguminous crops.

The fundamental principles and advantages of crop rotation may be briefly stated as follows:

1. Soil renovation, and change of soil structure.
2. Equitable distribution of work.
3. More uniform utilization of plant nutrients.
4. Inoculation of soil with nitrogen producing bacteria.
5. Checking plant diseases.
6. Checking growth of weeds.
7. Destruction of insect pests.
8. Destruction of toxic substances.
9. Preservation of plant food in the soil.
10. Facilitating decomposition of organic matter.
11. Supplying the various needs for home consumption.
12. Diversification, preventing total failure in crops.
13. Distribution of income.
14. Giving variety and interest in agriculture.

Generally speaking it is a poor system of cropping where the same crop is grown on a field more than two or three years in succession, for some of the following reasons:

1. Different plants feed at different depths.
2. There is difference in feeding capacity of different plants.
3. Some crops are useful in restoring fertility.
4. Some crops remove fertility and add nothing to the soil.
5. Cover crops serve to preserve fertility.
6. Pasturing maintains fertility.

A wise system of cropping will make use of all the factors that are essential to the maintenance of soil fertility.

Applying some of the approved practices of scientific agriculture to an 80-acre farm which is about the average size in some of the Middle states, we would have something similar to the following in a five-year rotation as shown by the following diagram:

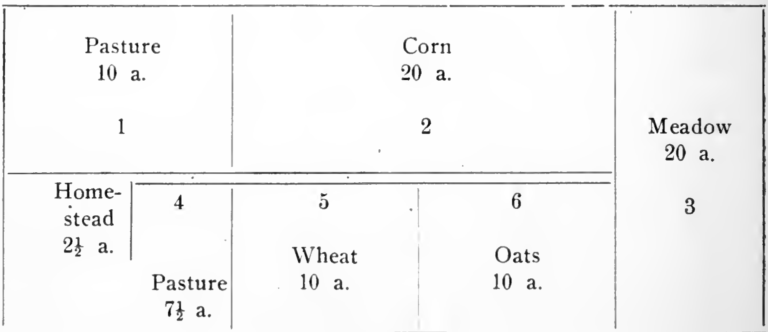


FIG. 1.

This farm in a high state of fertility will produce:

2,000 bushels of corn.
40 tons of hay.
600 bushels of oats.
300 bushels of wheat.

This farm will afford from 10 to 20 acres of pasture annually for live stock by carrying on the following plan of rotation:

	Field No. 1	*Field No. 2*	*Field No. 3*	*Field No. 4*	*Field No. 5*	*Field No. 6*
1st year	Pasture	Corn	Meadow	Pasture	Wheat	Oats
2nd year	Corn	Oats	Pasture	Corn	Meadow	Wheat
3rd year	Oats	Wheat	Corn	Oats	Pasture	Meadow
4th year	Wheat	Meadow	Oats	Wheat	Corn	Pasture
5th year	Meadow	Pasture	Wheat	Meadow	Oats	Corn

PROBLEM.

Based on crops in Fig. 1.

1. From the facts stated above, find the average production per acre of each of the crops named.

2. What is the total value of the crops given above at the present market price of each, if the hay is sold as timothy and clover mixed?

3. Make an estimate of the fertility value removed from the farm by the sale of these crops.

Principles of Rotation.

LEGUMES IN A ROTATION.

One of the most profitable plans of rotation is a system of cropping that includes a legume for the supply of nitrogen, which is one of the most expensive elements essential to plant growth.

Each of the different legumes seems to be adapted to certain climatic conditions and soil types. The principal legume used in the rotation of crops in the corn belt is red clover, with the exception of Kansas and Nebraska, where the key to rotation is rapidly coming to be alfalfa.

In 1910 there were nearly 3 million acres of alfalfa grown west of the Missouri River while there were perhaps less than half a million acres grown east of that territory in the U. S. Red clover is grown principally east of the Mississippi River and North of the Ohio River. In the southern states the principal legume used in rotation with cotton is the cowpea. The soybean is rapidly increasing in acreage in the southern States and in the territory just north of the Ohio River. Crimson clover is grown along the Atlantic Coast from central New Jersey to Georgia.

The following system of rotation has generally been adopted where each of the following is a leading crop:

CORN.

Four Year Rotation.

Corn	Oats	Wheat	Clover

ALFALFA.

Six to Eight Year Rotation.

Alfalfa (3 to 5 yrs.)	Corn	Corn	Corn Manured

BARLEY.

Three Year Rotation.

Barley	Clover	Corn

RYE.

Three Year Rotation.

Rye	Clover	Corn

POTATOES.

Three Year Rotation.

Potatoes	Wheat or Oats	Clover
	or	
Potatoes	Corn	Clover

COTTON.

Three Year Rotation.

Cotton	Corn with Cowpeas	Oats and Cowpeas

TIMOTHY.

Five Year Rotation.

Timothy	Corn manured	Oats	Wheat	Clover and timothy

TOBACCO.

Three Year Rotation.

Tobacco	Wheat	Clover

A *catch crop* may be grown between two regular crops. Rye may be seeded at the time of the last cultivation of a field of corn. It may serve for pasture, for a cover crop or for green manuring. Cowpeas, soy beans, clover and vetch are often sown in this way for plowing under the following spring.

Plans for Special Methods of Farming.

Dairy Farms — Grain and seeding, clover hay, pasture, corn.
Hog Farms — Grain and seeding, clover or alfalfa, pasture, corn.
Sheep Farms — Grain, clover and timothy, pasture, corn.
Grain Farm — Grain and seeding, clover, corn.
Fruit Farm — Cover crop, grass, mulch.
General Stock Farm — Grain, hay, pasture.

The following table shows methods of farming from the poorest to one of the best conducted systems; the letters to the left represents different farmers and the explanation to the right shows the methods employed:

Seven Stages of Cropping.

A. No method. No system of farming.
B. Corn — Oats — Wheat. Clover.
C. Corn — Oats — Wheat. Clover, Manure.
D. Corn — Oats — Wheat. Clover, Manure, Lime.
E. Corn — Oats — Wheat. Clover, Manure, Lime, Fertilizer.
F. Corn — Oats — Wheat. Clover, Manure, Lime, Fertilizer, Cover Crops.
G. Corn — Oats — Wheat. Clover, Alfalfa, Soybeans, Manure, Lime, Fertilizer, Cover Crops.

The same steps in progression may be shown by classifying farmers according to the amount of tools they use.

Have the pupils classify farmers according to their farm equipment to test their observation of farm practices.

The amount and kind of stock raised on the farm will also serve to demonstrate the difference between the poorer and better classes of farmers.

Kinds of Farms.

The Terry rotation was used by T. B. Terry in Ohio. It was found successful in building up a run-down clay farm. The rotation consists of Clover, Potatoes, and Wheat.

One of the noted systems of England is the Norfolk rotation. It consists of a four-course rotation—Turnips, Barley, Clover, and Wheat.

Labor and market conditions where we have large farms in the corn belt states would make it unprofitable to raise turnips or potatoes in a rotation, therefore the Terry and Norfolk rotations can only be profitably adopted where farming is carried on in a small way.

Farms are divided into various classes — according to the chief source of income. When more than 50 per cent of the income from a farm comes from the sale of fruit it is known as a fruit farm; if more than 50 per cent of the income from a farm arises from the dairy it is called a dairy farm; if more than 50 per cent comes from the sale of stock, it is a stock farm; thus there are various kinds of farms.

PROBLEMS IN PLANNING ROTATIONS.

In the following problems, the solution should be accompanied with diagrams showing shape and size of farms and fields, location of farmstead with arrangement of buildings, gardens, orchards and windbrakes. In some of these problems, where a farm in the neighborhood is used as a concrete example, there may be included with the plans for rotation a map showing topography, drainage, soil types and soil ingredients.

PROBLEMS.

1. Plan a good rotation for a farm of 80 acres for the production of corn, oats, wheat and clover.
2. Plan a rotation for a 120 acre farm for raising alfalfa and lambs.
3. Plan a rotation for a 160 acre farm for raising corn and swine.
4. Plan a rotation for a 60 acre dairy farm having a 12-cow dairy.
5. Plan a 100 acre tract for grain production.
6. Plan a 40 acre poultry farm for keeping 1000 hens.
7. Plan a rotation for a 200 acre general purpose farm.
8. Plan a rotation for an 80 acre farm that will include 20 acres of sugar beets.
9. Plan a 100 acre farm for a southern plantation that raises 20 acres of cotton.
10. Plan a 40 acre farm to be devoted to fruit, poultry and dairying.
11. Plan a farm of 10 acres for fruit within 10 miles of your nearest city.
12. What is the difference between specialization and diversification in farming?
13. Arrange a crop rotation for Ohio; a crop rotation for Georgia; a crop rotation for Iowa; a crop rotation for California; a crop rotation for North Dakota.
14. A field has been in corn ten years continuously and the average production for the ten year period has been 25 bushels per acre; if a rotation of corn, oats and clover had been followed yielding 4 crops of corn of 50 bu. each per acre, 3 crops of oats of 50 bu. per acre, 3 crops of clover each of 2 tons per acre, what would have been the gain of this rotation instead of continuous cropping of corn for 10 years, based on cost of production per acre for corn $13, oats $10, clover $4, at present prices?

Demonstrations and Experiments in Rotation.

On the Wooster plats where there has been continuous cropping of corn for about 20 years it has been demonstrated that it requires twice as much manure and commercial fertilizer to maintain fertility as when used in a rotation of crops.

In the plats where corn is raised continuously without manure or fertilizer the corn crop has become comparatively worthless.

Where there has been rotation with out fertilizers or manure there is still a very good production.

PLAT WORK FOR SCHOOL GARDENS.

FOUR-YEAR ROTATION.

1		Corn	Oats	Wheat	Clover
2		Corn	Corn	Corn	Corn
3		Alfalfa	Alfalfa	Alfalfa	Corn
4		Corn	Oats	Clover	Corn
5		Corn	Corn	Corn	Corn
6		Soybeans	Rye	Clover	Corn
7		Oats	Clover	Oats	Clover
8		Oats	Oats	Oats	Oats
9		Clover	Corn	Oats	Wheat
10		Wheat	Wheat	Wheat	Wheat

THREE-YEAR ROTATION.

11		Potatoes	Clover	Wheat
12		Potatoes	Potatoes	Potatoes
13		Corn and Cowpeas	Oats and Cowpeas	Cotton
14		Cotton	Cotton	Cotton
15		Oats	Clover	Corn
16		Corn	Corn	Corn
17		Wheat	Clover	Tobacco
18		Tobacco	Tobacco	Tobacco

NOTE — No fertilizers are to be used in this plat work as the aim is to demonstrate the effects of rotation only. The plats should be a fractional part of an acre, say, one-tenth, one-twentieth, or one-fortieth of an acre.

The conception of a fertile soil where agriculture has been carried on for many centuries is that a soil is fertile when it is responsive to fertilization, instead of one that is capable of producing crops without fertilizers.

The following 160-acre farm in a splendid state of fertility is used here as a concrete example that offers to the student the solution of the problem of maintaining fertility:

A Typical Five-year Rotation.

CORN. 30 A.	10 A. FARMSTEAD. Garden. Orchards.	PASTURE. 30 A.
OATS. 30 A.	30 A. WHEAT. Seeded to Wheat and Timothy.	MEADOW. 30 A.

Suppose the above farm to be run on a five-year rotation—corn, oats, wheat, meadow and pasture; allowing 10 acres for garden, orchard, lots, lanes, and roads. In five years the total drain of fertility under this system, with the following yields will result as follows:

(According to Professor Ingle.)*

Year.	Crop.	Yield per Acre.	Lbs. Plant Food Removed. Nitrogen.	Phos. Acid.	Potash.
1	Corn	80 bushels	146	57	82
2	Oats	75 bushels	76	28	62
3	Wheat	35 bushels	62	21	29
4	Clover Hay	3 tons	125	23	132
5	Pasture	3 tons	125	23	132
	Total plant food removed per acre in five years.		534	152	437

* Eminent English authority.

PROBLEMS.

(Based on the foregoing plan of cropping on 160 acres.)

1. How many pounds of each of the three kinds of plant foods nitrogen, phosphoric acid and potash are removed per acre annually according to the table given.

2. If 50 head of stock including cattle, horses, sheep and hogs produce 360 tons of manure, .6 per cent nitrogen, .3 per cent phosphoric acid and .7 per cent potash, what is the total amount of each of these plant foods produced per acre annually?

3. If the 30 acre field of corn receives 360 tons of manure and we calculate the value of roots of grass and clover, green material plowed under and manure from pasturing at 80 pounds of nitrogen, 40 pounds of phosphoric acid and 75 pounds of potash, what is the total amount of each of the three elements — nitrogen, phos. acid and potash received every five years?

4. Find the difference between the amount of plant food of each kind removed by crops as given in the table and the amount restored by manures, roots, plants, etc.

5. Mix a fertilizer in the right proportion and amount to balance the losses in fertility each year, occasioned in the foregoing method of cropping and feeding and manuring.

Facts About Rotation.

1. Alfalfa, clover, soy-beans, cowpeas, vetch, crimson clover, or some other legume should be a part of every crop rotation.
2. Legumes, livestock, fertilizers, with a judicious rotation of crops will build up a run-down soil.
3. When clover fails we should sow some annual of the legume family that will keep up the rotation as a nitrogen gatherer.
4. Grain crops remove a large amount of phosphorus.
5. Root crops remove much potash.
6. Hay crops remove much nitrogen.
7. Plants with shallow roots should follow roots that feed deep in the soil.
8. Non-cultivated crops should follow cultivated crops.
9. Nitrogen producing crops should follow potash-using crops.
10. Alfalfa, the true clovers, cowpeas, soy-beans, vetches, Japan clover, and beans are nitrogen producing crops.
11. Legumes leave in the soil more nitrogen than they take out, while other crops use up nitrogen and do not gather any.
12. The abundant use of fertilizers is often depended upon for a time to take the place of crop rotation.

13. The market demand for certain products that command a high price and therefore result in high profits, has often discouraged the use of crop-rotation.
14. Fertilizing material may be relatively cheap in comparison with crop-rotation for enriching soils with nitrogen for garden or trucking purposes and in such a case rotation should not be recommended.
15. The successful production of our great staple crops,—corn, wheat, oats, cotton and some of the minor products will probably always depend upon a scientific rotation of crops.

Questions.

1. Do you follow rotation of crops on the home farm?

2. Does a difference in the size of fields obstruct rotation? Explain.

3. In regions where spring grains are grown extensively, what are some of the troubles likely to be experienced by continuous cropping?

4. How does rotation effect the existence of the chinch-bug, the clover midge, the corn root louse, the corn root worm, potato scab, and similar pests and diseases?

5. Under what conditions of farming do Russian thistles, Canada thistles, wild rose bushes, wild mustard, wild oats, and similar pests seem to thrive?

6. What other methods are there of treating crops for fungus diseases besides rotation of crops?

7. Compare the root system of a corn plant with that of an alfalfa plant.

8. Which should come first in a rotation? Corn or Alfalfa?

Books for Collateral Reading.

1.	The Cereals in America—Hunt, 8-12—Webb Pub. Co..........	$1 75
2.	Forage and Fiber Crops in America—Hunt, 8-12—Webb Pub. Co.	1 75
3.	The Fertility of the Land—Roberts, 8-12—Macmillan Co........	1 50
4.	Forage Crops—Vorhees, 8-12—Macmillan Co.................	1 50
5.	Three Acres and Liberty—Hall, 8-12—Macmillan Co...........	1 75
6.	Ten Acres Enough—Roberts, 8-12—Webb Pub. Co.............	1 00
7.	Our Farm of Four Acres—Webb Co., 8-12—Webb Pub. Co.....	0 30

FARMERS' BULLETINS, U. S. DEPT. OF AGRICULTURE.

Number.

337.—Cropping Systems for New England Dairy Farms.
144.—Rotation of Crops.
98.—Suggestions to Southern Farmers.
289.—Practices in Crop Rotation.
320.—Relation of Sugar Beets to General Farming

YEAR BOOK U. S. DEPARTMENT OF AGRICULTURE.

Year — 1902. — Practices in Crop Rotation.
Year — 1908. — Systematic Rotation of Crops in Tobacco Culture.

Kinds of Farming.

FARMERS' BULLETINS, U. S. DEPT. OF AGRICULTURE.

Number.

272. — A Successful Hog and Seed Corn Farm.
280. — A Profitable Tenant Dairy Farm.
310. — A Successful Alabama Diversification Farm.
325. — Small Farms in the Corn Belt.
328. — Silver Fox Farming.
330. — Deer Farming in the U. S.
355. — A Successful Poultry and Dairy Farm.
364. — A Profitable Cotton Farm.
365. — Farm Management in Northern Potato-Growing Sections.
491. — The Profitable Management of the Small Apple Orchard on the General Farm.
242. — An Example of Model Farming.

Circular 172. — The Ostrich Industry in the U. S.

——. — A Successful Alfalfa and Poultry Farm in Ohio, Ohio Experiment Station. Bulletins Nos. 53, 70, 80 and 109, Minnesota Experiment Station.

PART III.
ANIMALS.

CHAPTER XII.

Animal Husbandry.

Animal Husbandry is that part of the science of agriculture which treats of types, care and feeding of farm animals.

A Study in Types.

A study of types among farm animals reveals the following interesting comparisons:

Heavy Types.		*Light Types.*
	HORSES.	
1.— (a) The Draft Type.		(b) The Driving Type.
	CATTLE.	
2.— (a) The Beef Type.		(b) The Dairy Type.
	HOGS.	
3.— (a) The Lard Type.		(b) The Bacon Type.
	SHEEP.	
4.— (a) The Mutton Type.		(b) The Wool Type.
	POULTRY.	
5.— (a) The Meat Type.		(b) The Egg Type.

Between the heavy and light types of farm animals there are many breeds known as medium or general purpose types which are bred for the purpose of combining two or more desired results.

TABLE 140. — NUMBER OF ANIMALS ON FARMS AND RANGES OF THE UNITED STATES, AS REPORTED BY THE DECENNIAL CENSUSES, ON DATES INDICATED.

Date.	Horses.	Mules.	Milch cows.	Other cattle.	Sheep.	Swine.
June 1, 1870.....	7,145,370	1,125,415	8,935,332	13,566,005	28,477,951	25,134,569
June 1, 1880.....	10,357,488	1,812,808	12,443,120	22,488,550	35,192,074	47,681,700
June 1, 1890.....	14,969,467	2,295,532	16,511,950	33,734,128	35,935,364	57,409,583
June 1, 1900.....	18,267,020	3,264,615	17,135,633	50,083,777	61,503,713	62,868,041
Apr. 15, 1910.....	19,833,113	4,209,769	20,625,432	41,178,434	52,447,861	58,185,676

The Horse.

The horse is adapted by nature to various uses. The result of breeding has produced two distinct types:

1. The light type.
2. The heavy type.

Each type has been divided again according to adaptability to perform some peculiar kind of labor. Breeding for certain characteristics has resulted in the following well-recognized types of light horses:

(a) Running, (b) Trotting, (c) Pacing, (d) Saddling, (e) Coaching, etc.

and the following types of heavy horses:

(a) Light Draft, (b) Medium Draft, (c) Heavy Draft.

Recognizing the fact that modern inventions have resulted in various means of travel that have taken the place of the light types, it is the purpose of this chapter to encourage the production of only those horses that will meet the demands of the market.

The ideal horse for the farm is the draft horse.

The great farm-horse problem is the cost of horse labor for the farm.

The region, the type of farming may be a determining factor, but for general purposes on the average farm, the selection of a work horse should be made on a basis of certain well-defined and recognized facts, among which the following are given for the farm student:

Do not keep geldings, because they return nothing for the cost of maintenance except their labor. By the time a gelding has reached his greatest efficiency as a work animal at 5 or 6 years of age, he begins to depreciate in value.

The number of mature work horses on the farm should be limited to brood mares. The work of the farm can be done by the brood mares and by the colts while they are growing into the maximum value.

PROBLEMS.

1. If a farmer who operates an 80 acre farm has 3 brood mares; and 2 colts are raised each year, how many work horses will this farmer have at the end of four years if colts are available for farm labor at three years of age?

2. A farmer finds that by pursuing the plan adopted in problem 1, he can sell a team each year for an amount that is equal to the cost of keeping the total number of his horses annually. What is the cost of horse labor on this farm?

It must be remembered that the question of greatest profit is a problem of selection and breeding the best type.

The advice of the horseman is: "When you get a pedigree with the horse, see that you get a horse with the pedigree."

A light or medium draft horse may perform the work of the farm satisfactorily but the fact must not be overlooked that the heavy draft horse brings the highest price when placed upon the market for the working type.

The difference between the cost of keeping a heavy type and the cost of keeping a light type for farm work is comparatively small when the value of the two types are considered.

A system of farm management that provides the proper rotation of crops will furnish the greatest and most regular amount of work. The greater the number of hours a horse may be used, the less will be the cost of an hour's labor.

The difference between the cost of keeping a horse regularly employed for a definite number of hours each day and the cost of keeping a horse that is only required to work at irregular intervals is not very great when compared to the difference in the cost of labor per hour.

The question of economy in horse labor is therefore a question of type, market price and farm management.

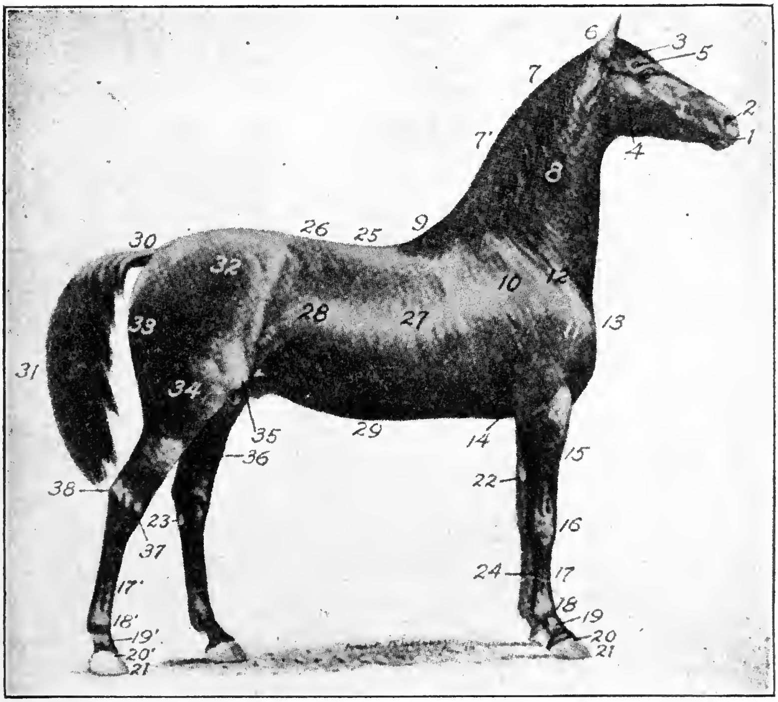
Prior to the introduction of the parcel post, the Interstate Commerce Commission compiled statistics that showed that of the total volume of transportation in the United States, the steamships and railroads combined handle but 15%, leaving 85% to be moved by horse or motor power.

During the period from 1900 to 1910 government statistics show an increase of 8.6 per cent in the number of horses in use on farms, and 11.7 per cent in mules and other draft animals.

The total number of draft animals now in use in the United States is about 26,000,000.

PROBLEMS.

1. From 1908 to 1914, there were produced in the United States approximately 180,000 commercial cars, used for transfer and delivery; if on an average each of these motor trucks displaces three horses, what is the total number of horses thus displaced in the United States?



From Ferguson and Lewis' Elementary Principles of Agriculture.

FIG. 1. Typical horse, showing names of the points.

1. Muzzle.
2. Nostril.
3. Forehead.
4. Cheek.
5. Temple.
6. Poll or nape of neck.
7-7'. Crest.
8. Neck.
9. Withers.
10. Shoulder.
11. Point of shoulder.
12. Slant of shoulder.
13. Breast.
14. Elbow.
15. Fore-arm.
16. Knee.
17-17'. Cannon bone.
18-18'. Fetlock.
19-19'. Pastern.
20-20'. Coronet.
21. Hoof.
22. Chestnut.
23. Ergot.
24. Splints.
25. Back.
26. Loins.
27. Chest.
28. Flank.
29. Belly.
30. Tail head.
31. Tail.
32. Croup.
33. Buttock.
34. Thigh.
35. Stifle joint.
36. Gaskin.
37. Hock.
38. Point of hock.

Courtesy Ferguson Publishing Co. Chicago.

2. The total number of draft animals displaced by motor trucks is what per cent of the total number of draft animals in the United States?

3. If the motor truck has facilitated the transfer from farm and factory, to railroads and steamships, from mine to smelter, from the quarry to the building of highways, from stores to distributing points and patrons, from the farm and garden to the public market, what effect will this have on the demand for more small farms in the vicinity of the city?

Will it increase the demand for more horses?

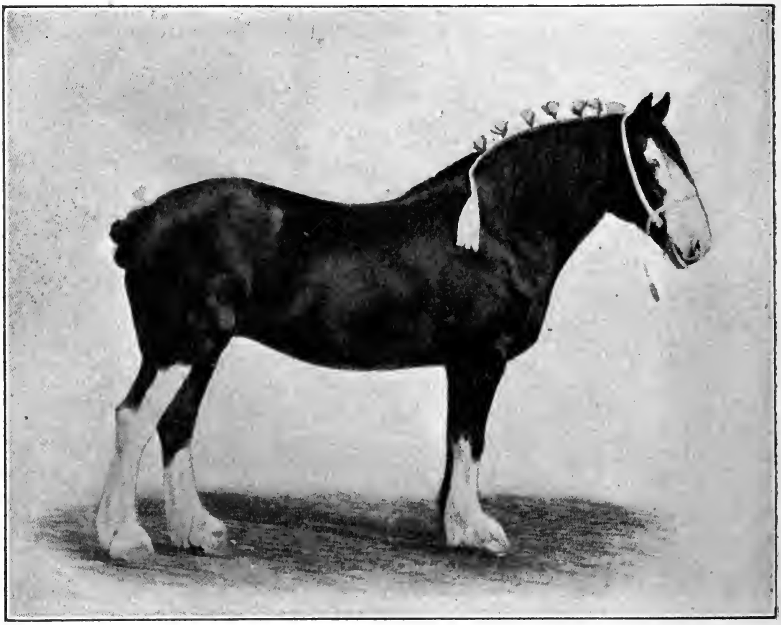


FIG. 2. Clydesdale mare — Draft Type.

4. If the motor truck has increased the production and demand for more necessaries of life, show how this means a better market for the careful breeder of horses?

Quality and Conformation of Draft Horses.

The typical, ideal draft horse, according to A. S. Alexander, of the Wisconsin Experiment Station, stands over 16 hands (5 feet 4 inches) and under 18 hands high, and weighs 1,600 pounds or more in ordinary flesh.

Figure 1 which is an excellent model of the light type of horse will serve well for the purpose of making an extended study of the names in common use for the various parts of a horse.

Figure 2 represents what is generally conceded to be a typical specimen of a draft horse.

The class in agriculture should become familiar with the terms in common use and use these figures in comparison for judging horses.

The leading breeds of horses in the United States in the order of their popularity may be named about as follows:

Draft Breeds.

Percheron from France.
Clydesdale from Scotland.
Belgian from Belgium.
Englishshire from England.

Carriage and Coach Breeds.

Hackneys from England.
French Coach.
German Coach.

Roadster Breeds.

American Trotter.
American Saddle-horse.
English Thoroughbred.

Score Card for Draft and Driving Horses.

Institution ....

Scale of Points	For Draft			For Driving.		
	Possible Score.	Student's Estimate.	Corrected.	Possible Score.	Student's Estimate.	Corrected.
General Appearance: Draft 45; Driving 47..						
Age—Estimated......years						
Actual......years						
Height—Estimated..........hands						
Actual.............hands	....	....	....	8	....	....

Scale of Points	For Draft: Possible Score.	For Draft: Student's Estimate.	For Draft: Corrected.	For Driving: Possible Score.	For Driving: Student's Estimate.	For Driving: Corrected.
Weight—Estimated........pounds						
Actual............pounds	15	....	....	....	....	....
Form.—For draft, low, massive, symmetrical; for driving, high, lithe, indicative of extreme activity.............	9	....	....	6	....	....
Quality—Skin and hair fine.............	8	....	....	10	....	....
Color—According to breed.............	1	....	....	3	....	....
Action—Step, smooth, quick, long; trot, rapid, straight, regular.............	4	....	....	10	....	....
Attitude—Members vertical	5	....	....	5	....	....
Temperament—Lively, pleasant	3	....	....	5	....	....
Head and Neck: Draft 5, driving 6..........						
Head—Lean; length, two-fifths height of withers; width of forehead, more than one-third length of head. For driving, smaller, carried higher and more horizontal	1	....	....	2	....	....
Muzzle—Fine; nostrils large, lips thin; teeth sound	1	....	....	1	....	....
Eyes—Full, bright and intelligent........	1	....	....	1	....	....
Ears—Short, clean, fine, directed forward; wide apart	1	....	....	1	....	....
Neck—Pyramidal, muscled; throat clean, fine; windpipe large. For draft, neck shorter, thicker, more horizontal.....	1	....	....	1	....	....
Forequarters: Draft, 19; driving, 19						
Shoulders—Long point of shoulder to point of withers equals length of head. For draft, shorter and more upright	3	....	....	3	....	....
Knees—Clean cut, wide, deep, strongly supported	3	....	....	3	....	....
Canons—Vertical, 9 to 10 inches long, lean, wide; tendons well attached. For driving, longer................	2	....	....	2	....	....
Fetlocks—Wide, thick, clean, free from puffiness	1	....	....	1	....	....
Pasterns—Angle 45°, fetlock to ground, 7 to 8 inches. For driving, long sloping. for draft, short, more upright..	2	....	....	2	....	....
Feet—Round, even size, horn dark colored, dense; sole concave; bars strong; frog large, elastic; heel vertical, one-half length of toe.........	8	....	....	8	....	....

Scale of Points.	For Draft.			For Driving.		
	Possible Score.	Student's Estimate.	Corrected.	Possible Score.	Student's Estimate.	Corrected.
Body: Draft, 10; driving 9.						
Chest in general—High, long. For draft, wide, half-height of horse. For driving, higher	3	....	....	3	....	....
Withers—Clearly defined for driving....	0	....	....	1	....	....
Breast—For driving, high, projecting. For draft, broad and muscular.......	1	....	....	1	....	....
Ribs—Long, round curvature	2	....	....	1	....	....
Back—Straight, short, muscular; shoulders to haunch equals length of head. For driving, longer	2	....	....	1	....	....
Loin—Wide, short, thick, strongly joined to hips	1	....	....	1	....	....
Underline—Long; for draft, flank low..	1	....	....	1	....	....
Hindquarters: Draft, 21; driving, 19.						
Hips—Level, wide in proportion to other parts; for draft, smooth; for driving, more prominent	1	....	....	1	....	....
Tail—Set and carried high; long, full, fine	1	....	....	1	....	....
Thighs for driving, long. For draft, shorter, more horizontal, muscular...	3	....	....	3	....	....
Hocks—Clean cut, large, straight, deep. For draft wider....................	6	....	....	4	....	....
Canons—11 to 12 inches long, otherwise as for front legs..................	2	....	....	2	....	....
Fetlocks—As above	1	....	....	1	....	....
Pasterns—As above; angle 60°..........	2	....	....	2	....	....
Feet—Compared with above, more oval, more concave; heels higher, more separated; walls more vertical.........	5	....	....	5	....	....
Totals	100	....	....	100	....	....

Other Score Cards.

Horses. New York State College of Agriculture, Ithaca, N. Y.
Draft Mules. University of Missouri, Columbia, Mo.

Animal .... Date..................

Student .... Standing.............%

Two of the most important points in favor of the heavy draft horse are these:

1. The heavy horse is by nature more docile and teachable, more steady and willing than the lighter breeds.
2. The heavy horse will do more work and do it more easily and at lower cost than the lighter horse.

Feeding the Horse.

Economy in feeding is one of the important factors in decreasing the cost of horse power.

Watering.

Watering horses has been much discussed by those who favor watering before feeding and by those who feed before watering. There may be conditions and circumstances favoring each theory but, there is a good plan that certainly can meet with no objections — it is (1) watering, (2) feeding sprinkled grain, (3) moistened hay, (4) watering again.

This will satisfy the horse; he will feed well, consume a sufficient quantity, retain the food in the stomach properly, and he will not be unsatisfied, anxious or nervous.

Rations.

In computing digestible nutrients for horses it is necessary to distinguish between the percentage of food elements digested by ruminants, like the cow, and by nonruminants like the horse.

The average results of a considerable number of tests, show that ruminants digest 26.9 per cent more protein, 5.4 per cent more fat, 16.7 per cent more nitrogen-free extract, and 4 per cent more crude fiber from timothy hay than horses. In the case of oats the amount of protein digested is practically the same, but the ruminants digest 12.8 per cent more fat, and 0.5 per cent more nitrogen-free extract and crude fiber than the horse. Similar results have been obtained with other feeds.

The following table gives the weight of horse, kind of labor performed, weight of each kind of feed in a ration for a certain kind of work:

Kind of Work.	Kind of horses.	Weight.	Where Fed.	Pounds of Feed. Corn.	Oats.	Hay.	Ground Grain.	Corn Meal.	Alfalfa.	Straw.	Bran.	Shorts.	Corn Silage.	Dried Brewers' Grain.	Gluten Meal.
United States Army	Cavalry	1,050	U. S. A.		12.	14.									
	Artillery	1,125	U. S. A.		12.	14.									
	Mules	1,025	U. S. A.		9.	14.									
Light Work	Driving	1,200	Experiment Station, Wyoming						21.25	3.2					
	Carriage	1,050	Experiment Station, Wyoming		10.	12.									
	Fire Company	1,400	Boston, Mass.			18.	9.38								
	Fire Company	1,350	Chicago, Ill.		4.	15.									
Moderate Work	Express	1,400	Richmond, Va.	4.67	5.33	15.		4.16			0.83				
	Express	1,325	Boston, Mass.	12.	5.25	20.									
	Express	1,325	Jersey City, N. J.	2.0	19.	9.5					1.5				
	Cab	1,200	Washington, D. C.	5.	10.	23.									
	Cab	1,350	San Francisco, Cal.		8.	16.									
	Farm	1,000	Experiment Station, Wyoming						13.75	2.25					
	Farm	1,235	Experiment Station, New Hampshire	6.		10.					2.				6.
	Farm	1,100	Experiment Station, Massachusetts	2.73	3.27	18.					2.				
	Farm	1,000	Experiment Station, New Jersey	2 2/7		6.					2.25			8 4/7	
	Farm	1,370	Experiment Station, Utah						25.		5.	5.			
	Farm Mules	1,310	Experiment Station, Virginia	10.5		15.2							10.5		
	Farm	1,325	Experiment Station, Utah			22.8					5.	5.			
Severe Work	Truck and Draft	1,500	Chicago, Ill.		7.5	20.									
	Truck and Draft	1,500	South Omaha, Neb.		15.	12.									
	Heavy Draft	2,000		3.	12.	15.									*6.

* Beans.

Some of the common feeding stuffs are given in the following table, which shows the average composition as determined by analysis, and the digestible nutrients calculated from digestion experiments with horses:

AVERAGE COMPOSITION OF A NUMBER OF FEEDING STUFFS.

Kind of food material.	Percentage composition.						Digestible materials in 100 pounds.				Energy in digestible nutrients in 100 lbs.
	Water.	Protein.	Fat.	Nitrogen—free extract.	Crude fiber.	Ash.	Protein.	Fat.	Nitrogen—free extract.	Crude fiber.	
Green Fodder.	*Per Cent.*	*Per Cent.*	*Per Cent.*	*Per Cent.*	*Per Cent.*	*Per Cent.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Calories*
Red clover........	70.8	4.4	1.1	13.5	8.1	2.1	3.44	......	10.94	3.79	33,796
Alsike clover......	74.8	3.9	.9	11.0	7.4	2.0	3.05	......	8.91	3.46	28,681
Alfalfa	71.8	4.8	1.0	12.3	7.4	2.7	3.75	......	9.96	3.46	31,936
Redtop	8.9	7.9	1.9	47.5	28.6	5.2	4.51	0.39	26.93	11.35	81,234
Orchard grass.....	9.9	8.1	2.6	41.0	32.4	6.0	4.62	.54	23.25	12.86	78,036
Timothy	13.2	5.9	2.5	45.0	29.0	4.4	1.25	1.18	21.29	12.35	69,873
Kentucky blue grass	21.2	7.8	3.9	37.8	23.0	6.3	4.45	.81	21.43	9.13	68,536
Hungarian grass..	7.7	7.5	2.1	49.0	27.7	6.0	4.28	.43	27.78	11.00	81,905
Meadow fescue...	20.0	7.0	2.7	38.4	25.0	6.9	4.00	.56	21.77	10.28	69,415
Italian rye grass..	8.5	7.5	1.7	44.9	30.5	6.9	4.28	.35	25.51	12.11	79,410
Mixed grasses....	15.3	7.4	2.5	42.1	27.2	5.5	4.23	.52	23.87	10.80	74,554
Rowen (mixed)...	16.6	11.6	3.1	39.4	22.5	6.8	6.62	.64	22.34	8.93	73,175
Mixed grasses and clover hay	12.9	10.1	2.6	41.3	27.6	5.5	5.77	.54	23.42	10.96	76,957
Red clover........	15.3	12.3	3.3	38.1	24.8	6.2	6.85	.95	24.19	9.27	78,984
Alsike clover.....	9.7	12.8	2.9	40.7	25.6	8.3	7.13	.83	25.84	9.57	82,630
White clover......	9.7	15.7	2.9	39.3	24.1	8.3	8.74	.83	24.96	9.01	82,942
Alfalfa	8.4	14.3	2.2	42.7	25.0	7.4	10.67	.42	29.98	9.75	95,520
Cowpea	10.7	16.6	2.9	42.2	20.1	7.5	......	......	......	......	....
Wheat straw......	9.6	3.4	1.3	43.4	38.1	4.2	.94	.85	12.20	6.74	40,544
Rye straw.........	7.1	3.0	1.2	46.6	38.9	3.2	.83	.79	13.10	6.89	42,020
Oat straw.........	9.2	4.0	2.3	42.4	37.0	5.1	1.11	1.51	11.91	6.55	42,770
Buckwheat straw.	9.9	5.2	1.3	35.1	43.0	5.5	......	......	......	......	....
Roots and Tubers.											
Potatoes	78.9	2.1	.1	17.3	.6	1.0	1.85	......	17.20	.05	35,525
Carrots	88.6	1.1	.4	7.6	1.3	1.0	1.09	......	7.13	......	15,290
Grains and Other Seeds.											
Corn, dent........	10.6	10.3	5.0	70.4	2.2	1.5	5.95	2.39	62.09	......	136,636
Corn, flint........	11.3	10.5	5.0	70.1	1.7	1.4	6.07	2.39	61.83	......	136,376
Corn, all varieties	10.9	10.5	5.4	69.6	2.1	1.5	6.07	2.58	61.39	......	136,363
Oats	11.0	11.8	5.0	59.7	9.5	3.0	9.39	3.60	45.25	2.82	122,062
Rye	11.6	10.6	1.7	72.5	1.7	1.9	8.51	.72	63.29	1.70	139,747
Corn meal.........	15.0	9.2	3.8	68.9	1.9	1.4	6.99	2.55	64.70	.38	144,454
Oats, ground.....	11.7	11.0	3.9	52.3	18.0	3.1	9.06	3.12	45.03	2.59	118,727

The Coefficient of Digestibility.

PROBLEMS.

1. What is the coefficient of digestibility, or in other words the percentage of digestible protein in clover?

SOLUTION: By referring to the foregoing table page 198 we find from the composition of clover that 4.4 per cent is protein and that 3.44 pounds per hundred is digestible protein; hence the problem is: what per cent is 3.44 of 4.4?

1% of $4.4 = .044$

$3.44 \div .044 = 78^9/_{11}$

$\therefore$ $78^9/_{11}$ is the coefficient of digestibility.

2. What is the percent of digestible fat in timothy?
3. What is the digestible coefficient of crude fiber in oats?
4. What is the digestible coefficient of nitrogen-free extract in dent corn?
5. What per cent of crude fiber in oats, is digestible?

The following experiment was carried out at Fort Riley, through the co-operation of the Kansas State Agricultural College, the Secretary of War, and the Secretary of Agriculture.

Lot Number.	Number of horses.	Average age of horses.	Number of days fed.	Average weight of horses at beginning of test, January 15, 1911.	Average weight of horses at end of test.	Gain or loss of horses during the test.	Daily ration per horse.	Grain and hay daily per 1000 pounds live weight.
		Years		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	76	9.35	140	1,131.2	1,147.5	+16.3	Oats .... 12 Prairie hay....... 14	Oats .... 10.51 Prairie hay......... 12.25
2	76	8.34	140	1,180.9	1,151.6	—29.3	Corn .... 12 Prairie hay....... 14	Corn .... 10.27 Prairie hay......... 11.98
3	74	10.44	140	1,185.0	1,172.1	—12.9	Oats .... 8 Corn .... 4 Prairie hay....... 14	Oats .... 6.78 Corn .... 3.39 Prairie hay......... 11.86
4	76	11.00	140	1,159.3	1,151.6	— 7.7	Oats .... 8 Corn .... 4 Timothy hay...... 14	Oats .... 6.90 Corn .... 3.45 Timothy hay....... 12.08
5	69	11.00	110	1,196.8	1,183.5	—13.3	Oats .... 4 Corn .... 8 Prairie hay....... 14	Oats .... 3.36 Corn .... 6.72 Prairie hay......... 11.75

Lot Number.	Number of horses.	Average age of horses.	Number of days fed.	Average weight of horses at beginning of test, January 15, 1911.	Average weight of horses at end of test.	Gain or loss of horses during the test.	Daily ration per horse.	Grain and hay daily per 1000 pounds live weight.
		Years		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
6	73	11.30	110	1,177.7	1,169.4	— 8.3	Oats .... 4 Corn .... 6 Alfalfa meal...... 4 Prairie hay....... 12	Oats .... 3.41 Corn .... 5.11 Alfalfa meal....... 3.41 Prairie hay........ 10.22
7	79	11.00	110	1,153.0	1,156.0	+ 3.0	Oats .... 4 Corn .... 6 Alfalfa meal...... 4 Timothy hay...... 12	Oats .... 3.44 Corn .... 5.16 Alfalfa meal....... 3.44 Timothy hay....... 10.34
8	75	11.86	110	1,170.5	1,163.8	— 6.7	Oats .... 4 Corn .... 6 Bran .... 4 Prairie hay....... 12	Oats .... 3.39 Corn .... 5.10 Bran .... 3.39 Prairie hay........ 10.12
9	76	10.40	110	1,167.4	1,173.5	+ 6.1	Oats .... 4 Corn .... 6 Bran .... 4 Timothy hay...... 12	Oats .... 3.39 Corn .... 5.09 Bran .... 3.39 Timothy hay....... 10.17
10	77	10.00	110	1,170.0	1,167.5	— 2.5	Oats .... 4 Corn .... 6 Linseed meal...... 1 Prairie hay....... 12	Oats .... 3.41 Corn .... 5.11 Linseed meal...... .85 Prairie hay........ 10.23
11	18	14.00	140	1,181.6	1,163.3	—18.3	Oats .... 12 Prairie hay....... 14	Oats .... 10.26 Prairie hay........ 11.98
11A	3	9.00	140	1,100.0	1,108.3	+ 8.3	Barley .... 12 Prairie hay....... 14	Barley .... 10.86 Prairie hay........ 12.68
12	17	12.00	140	1,163.2	1,188.8	+25.6	Corn .... 8 Oats .... 2 Alfalfa hay....... 10	Corn .... 6.80 Oats .... 1.70 Alfalfa hay........ 8.50
15	22	12.00	140	1,159.3	1,163.2	+ 3.9	Corn .... 6 Bran .... 3 Linseed meal...... 1 Prairie hay....... 14	Corn .... 5.16 Bran .... 2.58 Linseed meal...... .86 Prairie hay........ 12.05
18	18	12.50	75	1,197.7	1,180.0	—17.7	Oats .... 10 Brown sugar...... .5 Prairie hay....... 14	Oats .... 8.32 Brown sugar....... .42 Prairie hay........ 11.65

General Discussion of Table, Tabulating Experiment.

THE HORSES AND LABOR PERFORMED.

1. The horses used in this experiment were the Sixth United States Field Artillery.
2. The average age was about 11 years.
3. The average weight was 1165 pounds.

4. The work done was uniform in amount and kind.
5. The work was rapid light draft.
6. They were used in marching, drilling and hauling heavy wagons and guns.
7. Part of the work was done at a trot and part at a gallop.
8. The work was extremely fatiguing and more severe than the average work done by the farm horse throughout the year.

The Rations Used — With Results.

1. Oats proved to be a better feed for work horses, especially in hot weather, than corn when fed with timothy or prairie hay.
2. Corn and oats proved more valuable than corn alone, but not so valuable as oats alone.
3. Corn and Alfalfa gave good results and were 1/3 cheaper than a ration of oats and prairie hay.
4. The food value of bran and alfalfa meal are about equal.
5. One pound of old-process linseed meal, is equal in feeding value to four pounds of bran, when both are fed with corn, oats and prairie hay.
6. Timothy proves to be of more value than prairie hay.
7. Alfalfa hay fed with corn and oats will reduce the cost of daily rations, when substituted for timothy or prairie hay.
8. Horses fed bran, linseed meal or alfalfa hay showed the best condition.
9. Spirit and endurance depend more upon quantity and quality than upon the kind of feed.
10. A nutritive ratio of about 1:8 is most satisfactory when timothy or prairie hay is fed.

The following rations are particularly recommended:

1. Oats, 4 pounds; corn, 6 pounds; bran, 4 pounds; timothy hay, 12 pounds.
2. Corn, 6 pounds; bran, 3 pounds; linseed meal, 1 pound; prairie hay, 14 pounds.
3. Oats, 2 pounds; corn, 8 pounds; alfalfa hay, 10 pounds.
4. Oats, 4 pounds; corn, 6 pounds; linseed meal, 1 pound; prairie hay, 12 pounds.
5. Oats, 12 pounds; prairie hay, 14 pounds.
6. Although it is not a cheap one, the ration made up of corn six parts, oats four parts, bran four parts, and timothy hay, is probably the best ration that can be fed a work horse.

The New Hampshire Station found that the following rations were moderate in cost and sufficient to maintain horses weighing from 1,200 to 1,300 pounds:

RATION No. 1.	Timothy hay	10 lbs
	Bran	2 lbs
	Corn	6 lbs
	Gluten feed	6 lbs
RATION No. 2.	Timothy hay	10 lbs
	Corn	8 lbs
	Bran	7 lbs
RATION No. 3.	Timothy hay	10 lbs
	Corn	8 lbs
	Linseed meal	4 lbs

PROBLEM.

What would be the cost at the present price of feeds to keep 3 horses one year, one to be fed ration No. 1, one to be fed ration No. 2, and one to be fed on ration No. 3?

The rations for horses, United States Army Cavalry horses weighing 1,050 lbs., 12 pounds of oats and 14 lbs. of hay.

Artillery horses weighing 1,125 pounds — 12 pounds of oats and 14 pounds of hay.

Each of these rations represents the amounts to be fed to a colt in one day:

Feeding Colts.

Animal and Work.	Wt.	Ration.	
		Grain.	Roughage.
Colt, weaning time		2 lb. oats	Hay ad. lib.
Colt, one year old		4 lb. oats	Hay ad. lib.
Colt, two years old		6 lb. oats	Hay ad. lib.
Colt, two years old in training		8 lb. oats	Hay (limited)
Colt, three years old in training and work		10 lb. oats	Hay (limited)

.Mules weighing 1,025 lbs., 9 pounds of oats and 14 lbs., of hay.

PROBLEM.

What is the difference in cost to the government between keeping a mule and an artillery or cavalry horse?

Exercises.

EXAMINING THE HORSE.

1. Examine horse in the stable.
2. Note how he is tied to the manger.
3. Has he been chewing tie-strap or feed boxes?
4. How does he stand in his stall?
5. What is his general behavior when you step to his side?
6. How does he behave while being groomed?
7. Groom him along the belly; back of forelegs; front of hind legs, and about the flank, and note his behavior.
8. Harness the animal. Note manner when harnessed.
9. Note manner while placing headstall over the ears.
10. Note manner of action while placing the crupper and buckling the girth.
11. Take horse from the stall. Does he stumble?
12. Note manner of going in and out of barn.
13. Note carefully when he is turning around, backing, starting, or stopping.
14. Examine effect of bridle rein. Is he uneasy?
15. Does the horse understand and obey?
16. Is he gentle? Is he afraid, especially of autos?
17. Is he willing to pull? Observe method of pulling.
18. Try him for wind. Is he nervous or calm?
19. Does he drive single and double?
20. Is he fast or slow? Note the walk and the trot.
21. Are the feet sound; the limbs clean; well developed?
22. Observe the eyes, nostrils, mouth, hearing.
23. Observe horse while trotting and walking; look at him from front, side and rear while moving.
24. Are there any blemishes, or spots indicating that the horse interferes or has sore shoulders; look for gray hairs to indicate healed wounds. Is the horse sound? What is he worth?

Exercises in Judging Age.

The age of a horse is an important factor in determining value, and the characteristics that indicate certain ages are not hard to learn but the application of this knowledge depends much upon continued practice.

It is not difficult to estimate the age of colts, because size and general appearance are a safe guide — and very old horses are easily detected by general appearance and especially by the white hairs appearing about the temple, eyes, nostrils, and elsewhere. The head becomes pointed — the face depressed — the eyes hollowed, the backbone more prominent and curved, the legs improperly shaped and showing wear.

Estimating Age by the Teeth.

Three years old —

The permanent pair of center nippers replace the temporary ones and are much larger, having deep cups.

Four years old —

The intermediate pair of permanent nippers appear.

The center pair that appeared at three years of age are much worn and the cups are about one-third gone.

Five years old —

The permanent corner nippers appear. The permanent teeth are complete.

The center nippers show two years' wear have changed in shape and the cups are two-thirds gone.

The intermediate nippers show one year's wear and the cups are one-third gone.

Six years old —

The cups in the center pair in the lower jaw have disappeared, or nearly so.

The corner nippers shows one year's wear.

Seven years old —

The cups are gone from the intermediate pair in the lower jaw.

The cups have become quite shallow in the corner nippers.

There is a notch in the upper corner nipper, which overlaps the lower one.

The nippers are thicker from inside out.

They are more curved on the inside and meet at a sharper angle.

Eight years old —

The cups are all gone from the nippers of the lower jaw.

The cups are present in all the nippers of the upper jaw.

Nine years old —

The cups have disappeared from the center upper nippers.

The cups are still present in the intermediate and corner nippers of the upper jaw.

Ten years old —

The cups have disappeared from all but the upper corner nippers.

The teeth are more triangular and meet at a sharper angle.

Eleven years old —

The cups are all gone, except in occasionally some horses of denser bone, when there may be a shallow cup in the upper corner teeth.

Twelve years old —

Judgment of a horse must be formed from general appearance.

Individuality in horses counts for much.

The teeth will show much wear and become more triangular and meet at a sharper angle.

The nippers may become too long for the grinders and will require filing to enable the horse to masticate.

Questions.

1. What is meant by "temperament"? type?
2. What is "spirit" and "disposition" in a horse?
3. What is meant by "good action"?
4. Discuss cause and cure for balky horses.
5. What is meant by "style" and "carriage"?
6. Discuss *endurance*.
7. What is "matching horses"?
8. What is a blemish?
9. When is a horse unsound?
10. Name some visible imperfections of the legs that make a horse unsound.
11. Define and describe symptoms of distemper, sweeney, scratches, gravel, spavin, stringhalt, curb, interfering, colic, asturia, bots, ring-bone.
12. Name the leading breeds of horses in America.
13. Name some of the most popular breeds among the draft type, the carriage and coach type, the roadster type.
14. Explain the chief points of difference between the Percheron and the Clydesdale.
15. What is a thoroughbred?

References for Reading.

BOOKS.

1. Manual of Farm Animals — Harper — Macmillan Co.
2. The Horse — Roberts — Macmillan Co.
3. Types and Breeds of Farm Animals — Plumb.
4. Cyclopedia of American Agriculture — Bailey — Macmillan Co.
5. Animal Breeding — Shaw — Webb Pub. Co.
6. The Horse: How to Buy and Sell — Howden — Webb Pub. Co.
7. Hints to Horsekeepers — Herbert — Webb Pub. Co.
8. The Percheon Horse — Weld — Webb Pub. Co.
9. Modern Horse Doctor — Dadd — Webb Pub. Co.
10. Diseases of Animals — Mayo — Macmillan Co.

UNITED STATES DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETINS.

Number.

170. Principles of Horse-Feeding.
316. Horse-Feeding Tests.
451. Draft Horses, and Care of Mares and Foals.
179. Horseshoeing.

BUREAU OF ANIMAL INDUSTRY.

Number.

37. Market classes of Horses.
137. The Preservation of Our Native Types of Horses.
113. Classification of American Carriage Horses.
124. Suggestions for Horse and Mule raising in the South.
178. Breeding Horses for the United States Army.

CHAPTER XIII.

Cattle.

FEEDING FOR MEAT PRODUCTION.

1. A knowledge of market conditions and of the world-wide influences that affect them is essential to a thorough understanding of the principles of cattle feeding — Mumford and Hall.

Relation of the U. S. To the World's Beef Supply:—1910.

Country	Total Cattle (in millions).	Per cent. (World Supply.)	Cattle per Capita.	Cattle per Sq. Mile.	Exports. Cattle. Number Exported (in thousands).	Exports. Cattle. Value (in millions).	Exports. Beef. Pounds (in millions).	Exports. Beef. Value (in millions).
British India	113	25	0.37	61	......	......	......	......
United States	71	16	0.77	23	139	$12	127	$12
Russia	50	11	0.29	6	......	......	......	......
Argentina	29	6	4.27	26	90	$4	580	$26
Brazil	25	5	1.46	9	......	......	......	......
Germany	20	4	0.33	99	......	......	......	......
Austria-Hungary ..	18	4	0.35	64	......	......	......	......
France	14	3	0.36	69	......	......	......	......
United Kingdom ..	12	3	0.26	97	......	......	......	......
Australia	11	2	2.40	4	......	......	71	$3.5
Canada	7	2	0.98	2	157	$11	1.3	......
Other countries ...	85	19	......	......	......	......	......	......
Total	455	100	......	......	......	......	......	......

Notes on Supply.

Considering size and type of animals, it is estimated that the United States produces approximately one-third of the world's beef supply. (1910).

Taking statistics of the last half century, and it appears that the U. S. has shown a greater increase of cattle per capita than any other country in the world. The number of cattle per capita in 1867 was .51, and in 1910 it was .77. But since 1910 there has been a great decrease in beef production.

Facts about Feeding.

Feeding steers is one of the arts by which we may reduce farm crops into a concentrated market product.

Feeding steers is one of the most profitable methods of maintaining soil fertility by saving the waste products of the farm.

Manure is one of the chief sources of profit to be obtained from feeding beef cattle.

It is cheaper to transport animals fed for market, than to ship the crop products of the farm.

The gradual rise in market price of beef cattle has encouraged the feeding of steers, and for many years it has been one of our most profitable industries for those who understand the philosophy of buying, feeding and selling.

The following are some of the chief reasons for the advantages of feeding cattle for beef:

1. There is less labor in feeding beef cattle than in caring for dairy cattle.
2. They are well adapted to the utilization of roughage.
3. They require a small outlay in buildings.
4. They return to the soil a large percentage of the plant food consumed.
5. They graze on rough land not well adapted to other purposes.

Facts about Feeders and Profits.

1. In producing beef cattle the profit depends upon type, breeding, quality, cost of feed, gain in weight and the market price.
2. A high grade calf from a pure bred sire is worth on an average a hundred per cent more than a "scrub."
3. The two chief factors which determine the value of a steer are breeding and feeding.
4. Breeding determines type and quality, and feeding determines condition, form and nutritive value of meat.

Effects of Breeding on the Market Price.

1. Well bred steers are better in quality than those poorly bred.
2. The difference in types is well known and the result is constantly in evidence in the market quotations.
3. Steers of fine quality and flesh readily sell for top notch prices while other steers fed on the same feed are a drag on the market at much lower prices.
4. The Iowa Experiment Station fed cattle of different breeds; they were fed for the same period of nine months; when they were sold in Chicago the strictly beef-bred animals brought $2.225 more per hundred than those that were not beef-bred.
5. The Shorthorns, Aberdeen Angus and Hereford steers were sold at a much higher price than the Jersey and Holstein steers.

Typical Market Quotation Taken from Daily Paper.

Tuesday: Receipts 3,000 head. Market strong.

Fancy steers, 1,300 to 1,600 lbs	$6 60@6 85
Choice steers, 1,200 to 1,600 lbs	6 25@6 50
Good steers, 1, 300 to 1,500 lbs	5 75@6 20
Medium steers, 1,200 to 1,350 lbs	5 00@5 70
Fair steers, 1,000 to 1,350 lbs	4 60@4 95
Common steers, 900 to 1,000 lbs	4 00@4 50
Choice to extra heifers	4 25@5 30
Medium to good heifers	3 50@4 00
Fair cows and heifers	3 10@3 45
Choice to extra bulls	3 75@4 50
Bologna bulls	3 00@3 60
Common to good cutters	2 50@3 00
Rough to good canners' stock	1 25@2 25
Fair to choice feeders	4 00@4 90
Common to choice stockers	3 00@4 35
Good to choice calves	7 00@7 50
Common to good calves	3 00@6 75
Milkers and springers, each	25 00@55 00

Read the market report today.

Beef Cattle.

A BLOCK TEST.

A block test conducted by the Missouri Experiment Station showed the following results:

Breeds.	*Weight of all cuts.*	*Weight of Porterhouse and Sirloin.*
Shorthorn	1,046 pounds	127 pounds
Hereford	1,007 "	109 "
Angus	980 "	109 "
Scrub	824 "	82 "

PROBLEMS.

1. What per cent of the weight of the cuts in the Shorthorns are porterhouse and sirloin? Of the Hereford? Of the Angus? Of the Scrub?

2. Two steers were sold on the market, each weighing 1,200 pounds; they both received the same amount of feed; one was sold as a "Prime steer" @ $8.75 per hundred; the other was sold as a medium steer @ $8.00 per hundred; what was the difference in the amount received?

3. The prime steer in problem 2 dressed 64 per cent (cold basis); the medium steer dressed 62 per cent (cold basis); a butcher paid at the packing house, 13.5c per pound for the prime dressed steer, and 12.75c per pound for the medium dressed steer. What did he pay for each? What was the difference in total cost of the steers?

4. The weight of the porterhouse and sirloin in the prime steer as per weight in problem 3, was 12 per cent; and in the medium steer the weight of the porterhouse and sirloin was 10 per cent of the dressed weight; what was the difference in weight of the porterhouse and sirloin in the two steers?

5. If the butcher received 25c a pound for the porterhouse and sirloin from the two steers named in the above problems, and on an average 12c per pound for the balance of the cuts, what was the difference in profits on the two steers?

6. A Kansas farmer operates a large farm for feeding cattle; this farm has four great concrete silos; cattle are brought directly from the ranches of Texas and Oklahoma; only desirable, selected breeds are fed; they are fed scientifically so that the cost of production is less than on the average farm; a load of steers from this farm averaged 1,496 pounds each, and brought $10.50 a hundred lbs., in the Kansas City stock yards. What was the price received for 20 of these steers?

PROBLEMS.

1. Assuming that a 2-year-old steer costing $5 per hundred, will weigh 1,000 pounds and requires 300 pounds for finishing, what will be the profit if the feed cost $30 and he sold at 7c when his weight was 1,300?

2. What would be the lowest price at which the steer mentioned in problem 1, could be sold without loss, without calculating the value of the fertilizer saved in the manure?

3. If a steer weighing 1,000 pounds can be finished with an additional weight of 200 pounds, what will be the profit if he is sold at $6.15 per hundred, if he cost $50 and the cost of the feed was $20?

NOTE.—When heavy steers similar in age, quality, type, and condition, require the same increase in weight as lighter steers, for finishing, and can be purchased at the same price per pound as light steers, the profit will be greater in feeding heavy steers.

4. A farmer purchased two steers of the same age, type, and condition; he paid 5c per pound for each; one weighed 1,000 pounds, and the other weighed 1,100 pounds; he finished each with an additional 350 pounds; the cost of corn at 61c per bushel made the cost of each 350 pounds about $35; the steers were sold at $6.50 per hundred weight; what was the difference in profit between the two steers?

5. What should the farmer have paid for the lighter steer in problem 4, so that the profit would have been the same from both steers?

6. A man buys 2 steers, one being a high grade and the other an inferior grade beef steer; he pays 5c a pound for the former and 4 and one-half cents for the latter; he feeds them till each makes a gain of 300 pounds; the cost of gain was $30 for each steer; he sells the high grade steer @ $6.75 per hundred and the inferior steer @ $5.75 per cwt. What was the profit or loss on each?

7. What would have been the financial results if this man had paid the same price, 5c per lb., for both feeders described in problem 6?

8. If it requires 200 pounds to finish a 1,100 pound steer, and the cost is $35, when corn is 60c per bushel; at that rate of increase what will it cost to put 200 pounds of weight on the same type of steer when corn is 45c per bushel?

Feeding Methods.

The character of the ration depends upon the purpose in feeding and the conditions of the steer.

Thin cattle will make rapid physical gains on roughage alone.

An excellent ration may be made of corn silage, leguminous forage crops, such as alfalfa, clover or cowpeas.

After being sufficiently fattened, grain should be used, especially with corn as a grain basis, with high grade nitrogenous concentrates, such as linseed and cottonseed meal or gluten feed.

Fattening cattle should have all the roughage that they will consume readily without waste.

Grain rations should be limited to what they can consume in from one-half to three-quarters of an hour.

Six pounds of concentrates daily for 1,000 pounds of live weight, divided into two feeds of equal amount will do for a starter; this is to be increased as conditions warrant at the rate of one-half pound per day, until each steer consumes from 12 to 14 pounds of concentrates per day.

Time for feeding, 6:00 A. M. and 4:30 P. M.

Standard Feeding Rations.

APPROXIMATE REQUIREMENTS OF NUTRIENTS PER DAY PER HEAD FOR GROWING FAT CATTLE.

	Age.	Average Live Weight per Head.	Digestible Nutrients. Protein.	Carbo-hydrates.	Fat.	Fuel Value.	Nutritive Ratio.
	Months.	Lbs.	Lbs.	Lbs.	Lbs.	Calories	
Growing cattle	2–3	150	0.60	2.10	0.300	6,288	1:4.6
	3–6	300	1.00	4.10	0.300	10,752	1:4.7
	6–12	500	1.30	6.80	0.300	16,332	1:5.3
	12–18	700	1.40	9.10	0.280	30,712	1:6.8
	18–24	850	1.40	10.30	0.260	22,859	1:7.7

Rations for Cattle.

Average Number of Pounds Per Day For One Animal.	No. of Experiment.	No. of Animals in Experiment.	Number of Days in Experiment.	Average Initial Weight.	Average Final Weight.	Average Gain Per Head.	Average Daily Gain.
FOR FATTENING STEERS.							
63. silage	1	4	90	773	989	216	2.4
31.5 silage + 9.6 of wild hay	2	4	90	757	869	112	1.25
5.89 cotton seed meal + 20.3 cotton seed hulls	3	7	122	945	1,101	156	1.28
7.5 cotton seed meal + 30.6 corn silage	4	7	122	890	1,094	205	1.70
2 oats straw, 14.¼ shelled corn + 3 cotton seed meal, 27.65 corn silage	5	10	100	1,076	1,316	240	2.40
51 silage + 4.11 cotton seed meal	6	7	139	838	1,156	318	2.30
32¼ silage + 4.48 shelled corn, 2.86 cotton seed meal + 2.11 ear corn	7	12	140	900	1,174	274	1.94
12.5 alfalfa + 2 grain	8	18	140	446	578	132	.94
13.8 shelled corn + 2.31 oats straw, 2.8 cotton seed meal + 25.26 corn silage	9	10	160	969	1,353	384	2.40

Average Number of Pounds Per Day For One Animal.	No. of Experiment.	No. of Animals in Experiment.	Number of Days in Experiment.	Average Initial Weight.	Average Final Weight.	Average Gain Per Head.	Average Daily Gain.
2.6 cotton seed meal + 4.6 rice + 27.5 Kaffir forage	10	8	33	952	1,012	60	1.80
8.14 cotton seed meal + 35.36 corn silage	11	8	112	947	1,107	160	1.40
19.3 corn + 14 prairie hay + 1.9 oilmeal	12	6	127	877	1,181	304	2.39
FATTENING TWO-YEAR-OLD STEERS.							
16 shelled corn + 4 clover hay, 3 cotton seed meal + 15 corn silage	13	......	......	1,010	....	......	......
18 shelled corn + 7 Timothy hay	14	......	......	1,017	....	......	......
16 shelled corn + 5.4 cotton seed meal + 8.8 Timothy	15	......	......	1,054	....	......	......
10 snapped corn + 22 Alfalfa hay	16	......	......	977	....	......	......
20 ear corn + 10 clover hay	17	......	......	893	....	......	......
10 snapped corn + 18 prairie hay	18	......	......	975	....	......	......
18 shelled corn + 3.2 cotton seed meal + 9.5 clover hay	19	......	......	966	....	......	......
FATTENING YEARLING STEERS.							
21 shelled corn + 3.5 cotton seed meal + 11 clover hay	20	......	......	685	....	......	......
19 shelled corn + 4.5 clover hay, 2.5 cotton seed meal + 18 corn silage	21	......	......	854	....	......	......
17.5 shelled corn, 2.5 linseed oil meal + 11 prairie hay	22	......	......	799	....	......	......
19 shelled corn + 11 Alfalfa hay	23	......	......	808	....	......	......
17.5 shelled corn + 2.5 linseed meal + 15 cornstalks	24	......	......	777	....	......	......
17.5 shelled corn, 2.5 linseed oil meal + 15 sorghum	25	......	......	788	....	......	......
YEARLINGS FATTENED ON PASTURE.							
14 shelled corn + 3.1 gluten feed + pasture	26	......	......	774	....	......	......
14 shelled corn + 3.5 linseed meal + pasture	27	......	......	723	....	......	......
14 shelled corn + 3.5 cotton seed meal + pasture	......	......	......	730	....	......	......
16 shelled corn + pasture	......	......	......	730	....	......	......
TWO-YEAR-OLDS FATTENED ON PASTURE.							
11 shelled corn + 2.8 cotton seed meal + 2.8 wheat bran + pasture	......	......	......	859	....	......	......
16 shelled corn + 2.5 gluten feed + pasture	......	......	......	940	....	......	......
16 shelled corn + 2.5 linseed meal + pasture	......	......	......	933	....	......	......
FATTENING THREE-YEAR-OLD STEERS ON PASTURE.							
12 shelled corn + 2 cotton seed meal + pasture	34	......	......	1,269	....	......	......
14 shelled corn + pasture	35	......	......	1,251	....	......	......
FATTENING CALVES.							
22 shelled corn + 3 cotton seed meal + 12 clover hay	36	......	......	457	....	......	......

Average Number of Pounds Per Day For One Animal.	No. of Experiment.	No. of Animals in Experiment.	Number of Days in Experiment.	Average Initial Weight.	Average Final Weight.	Average Gain Per Head.	Average Daily Gain.
18 shelled corn + 2.5 cotton seed meal + 18 corn silage + 5 clover hay....	37	......	......	534	....	......	......
18 shelled corn + 3 cotton seed meal + 4.5 clover hay + 19 corn silage..	38	......	......	508	....	......	......
RATIONS FOR WINTERING CATTLE WITHOUT FATTENING.							
16 Timothy hay	39	......	......	736	....	......	......
20 whole corn stover......................	40	......	......	707	....	......	......
15 shredded corn stover..................	41	......	......	667	....	......	......
44 corn silage	42	......	......	743	....	......	......
10 corn stover + 10 clover hay..........	43	......	......	771	....	......	......
20 cowpea hay............................	44	......	......	788	....	......	......
4 shelled corn + 16 Timothy hay.......	45	......	......	765	....	......	......
4 shelled corn + 9 corn stover, 9 clover hay	46	......	......	767	....	......	......
4 shelled corn + 19 cowpea hay........	47	......	......	783	....	......	......
6 shelled corn + 17 Timothy hay........	48	......	......	783	....	......	......
6 shelled corn + 19 clover hay..........	49	......	......	783	....	......	......
6 shelled corn + 17 Alfalfa hay.........	50	......	......	783	....	......	......
6 shelled corn + 17 cowpea hay.........	51	......	......	783	....	......	......
6 shelled corn + 9 corn stover, 9 clover hay	52	......	......	783	....	......	......
6 shelled corn + 8 clover hay, 8 wheat straw	53	......	......	783	....	......	......

Age, Gain and Profit.

Meat producing animals are now placed on the market at a younger age than formerly.

It has been shown that the cost of gain depends directly upon the age.

The following table is from the facts demonstrated on The Central Experiment Farm of Canada in feeding cattle of different ages:

Ages.	*Daily gain.*	*Gain in 186 days.*	*Cost of 100 pounds gain.*	*Profit per steer.*	*Profit per 1,000 pounds live weight.*
3 years	1.65 lbs.	307 lbs.	$6 22	$16 53	$12 80
2 years	1.67	311	5 70	20 50	19 10
1 year	1.85	345	4 65	26 07	27 80
Calf	2.14	398	3 60	14 11	31 00

Reports from Argentina show that beef cattle are marketed a year younger than in the United States, on account of the natural pasturing advantages.

Facts about Markets.

Local conditions have a decided influence upon the value of feeders.

In grazing regions where but little grain is produced, feeders are much cheaper than in localities where there are small farms producing corn and other concentrates.

The large markets of Chicago, Kansas City, Omaha, Buffalo, and Indianapolis determine the value of feeders.

Where there is a surplus of feeders, the home value is usually determined by the market value less the shipping expenses.

In Pennsylvania, Ohio, and other Eastern states, the value of feeders is determined by the Chicago market price plus freight, feed, yardage, loss by shrinkage, middle-man's profits, and probable loss from accident and disease.

Feeders are cheaper in the fall, when large numbers of Western cattle are shipped from the ranges.

Grass fed cows and heifers in the fall, decrease the demand for light killing steers.

In spring there is always a good demand for thin cattle to be used for grazing purposes.

July and August is an excellent time for purchasing feeders when the markets are frequently glutted.

The supply of grain and roughage throughout the nation has a decided influence upon the price of feeders.

When there is prospect of an abundant crop of corn, there is a probability that there will be a strong demand for heavy feeders, ranging from 1,000 to 1,100 pounds each.

If a farmer has much roughage, he should buy thin cattle; if he has an abundance of grain, he should buy and feed heavy, fleshy feeders.

When industrial conditions are good and labor is fully employed, and there is general prosperity, the demand for beef is always good.

Financial depressions, panics, strikes and hard times generally effect the cattle market adversely.

The high cost of meat has become a serious problem and the rise in price of meats is now known to be the natural result of a shortage in production.

The United States Department of Agriculture has recently announced that an estimate shows the per capita consumption of meat in the U. S. has fallen from 162 pounds in 1909 to 152 pounds in 1913.

PROBLEMS.

1. How many per cent less was the consumption of meat in 1913 than in 1909?

2. When we have a population of 100,000,000 people in the United States how much greater would be our consumption in total number of pounds if they were consuming 162 pounds per capita instead of 152 pounds as in 1913?

3. If meat furnished 16 per cent of the total food consumed in the ordinary American family when we were consuming on an average 162 pounds per year, now that consumption has fallen to 152 pounds per year, what per cent does meat furnish of the total amount of food?

4. When meat furnished 16 per cent of the total weight of products consumed per capita (162 pounds) what was the total weight of the food consumed per capita?

5. What was the total weight of food (in tons) consumed when we had a population of about 90 millions?

How We Can Increase Beef Production.

1. The two great fundamental factors in meat production are—*feed*, and *cost*.
2. Meat production in the West is falling off, because the areas of the ranges are decreasing.
3. The farming sections have the feed but *not the* pastures.
4. The problem of restoring a normal production of live stock in the United States is therefore a question of the cost of farm pastures.
5. There are millions of acres in the U. S. now lying idle or it is land that is cultivated at a loss, that would make excellent and permanent pastures.

(See Waste p. 365.)

These changes involve the problems of:

1. Destroying brush.
2. Treatment of soil for grass.
3. Best mixtures of grass.
4. Systems of grazing.
5. Preventing growth of weeds.

This work may be considerable and expensive, but it is possible, and conditions may be made permanent and profitable, and once it is done, the live stock industry of the U. S. will be upon a sound basis with relation to meat producing animals.

The needs of the situation will demand the solution of still other important problems.

For instance.

1. Control or eradication of contagious diseases.
2. Skill in breeding cattle.
3. Skill in feeding cattle.
4. The study of supply and demand.
5. The study of markets.

There is unlimited possibilities and opportunities for live stock production in the United States.

Score Card.

BEEF CATTLE.

(UNIVERSITY OF ILLINOIS. DEPARTMENT OF ANIMAL HUSBANDRY).

	Stockers and Feeders.
**Weight;* Estimated.........lbs.; actual.........lbs. according to age.........	6
Form, straight topline; deep, broad, low set, compact, symmetrical..........	10
Constitution, heart girth large; chest capacious; barrel roomy but not paunchy; bone strong..........	8
Quality, hair fine, skin pliable and loose; even covering of flesh; bone fine; features refined but not delicate; head clean cut and free from coarseness	10
Condition, medium; general thrift indicated by smooth hair, mellow skin and clear eyes..........	4
Disposition, quiet and gentle, but not sluggish..........	2
Head, clean, symmetrical; muzzle broad; mouth and nostrils large; lips moderately thin; eyes large, clear, placid; face short, expression quiet, forehead broad, full; ears medium size, fine texture, erect.....	5
Neck, short, blending neatly into shoulder; throat clean..........	2
Shoulder, compact, free from coarseness..........	3
Brisket, well developed, breast wide..........	1
Dewlap, not too loose and drooping..........	1
Crops, full, broad; fore flank full..........	4
Ribs, long, arched, smoothly fleshed..........	8
Back, broad, straight, evenly fleshed..........	8
Loin, long, wide, level, evenly fleshed..........	8
Flank, full, low..........	2
Hooks, width in proportion with other parts; not prominently wide nor high	2
Rump, long, level, wide, tail smoothly set on..........	3
Pin Bones, not prominent, width in proportion with other parts..........	1
Thighs, well fleshed, deep, wide..........	4
Twist, low	4
Leg, straight, short, set well apart; bones smooth and strong; standing up well on feet..........	4
	100

* The most practical and valuable part of stock judging is estimating the weight of beef cattle. Let the class in agriculture get this experience by judging weight at the stock yards.

Other Score Cards.

University of Missouri, Columbia, Mo.
American Hereford Cattle Breeders' Association, R. J. Kinzer, Sec., Kansas City, Mo.

Types of Cattle Compared.

The problem of selecting and breeding cattle for certain specific purposes has been a study of deep concern to dairymen and feeders for many years. Breeding has been carried on chiefly along two distinctive lines, viz.,—breeding the dairy type and breeding the beef type.

The best known dairy types are the Jersey, Guernsey, Ayrshire, Holstein-Friesian and Brown Swiss.

The leading beef types are the Shorthorn, Hereford, Aberdeen-Angus, Galloway, and Sussex.

Studying the Physical Characteristics.

The following figures will show the difference between the dominant characteristics of the dairy and beef types. The figures placed side by side show very clearly the contrasting points between the two types.

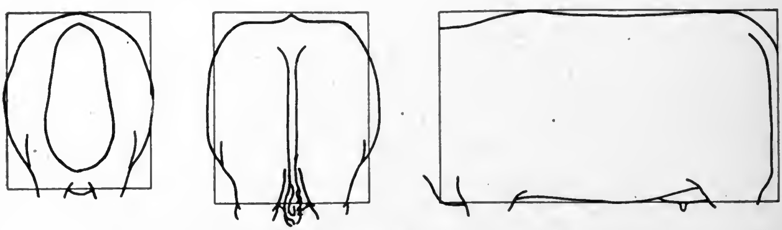


FIG. 1. Showing Rectangular Form of Beef Type.

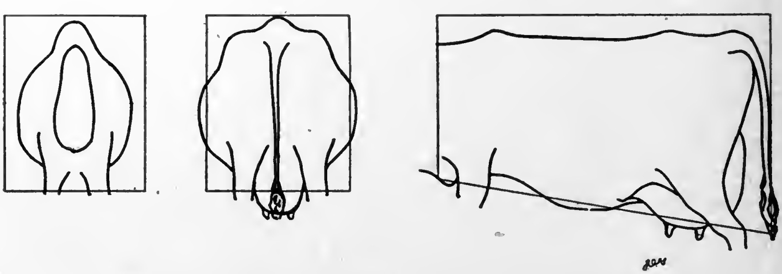


FIG. 2. Showing Triangular Form of the Dairy Type.

A careful study of the two widely different types will show distinctly some of the following characteristics:

1. Types are controlled by the demands made on the body of the animal.
2. In the dairy type the food goes to produce milk, and in the beef type food goes to produce flesh.
3. In the dairy type fleshiness is objectionable; in the beef type the tendency to fatten is desired.

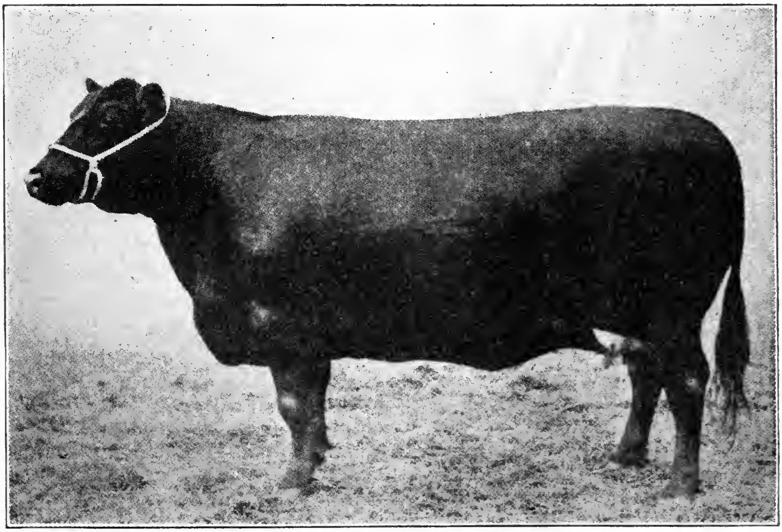


FIG. 3. A Good Beef Type.

Outline for Studying the Cow.

1. Breed..............
2. Weight.............. Age..............
3. Native of what country................
4. For what is this breed noted.............
5. Compare size with other breeds.
6. General color.............. Markings..............
7. Milk production .... Quantity..........Quality..........
8. Cream production........... Quantity..........Quality..........
9. Butter production .... Quantity..........Quality..........
10. Ration required for her present work............

Breeds of Dairy Cows.

The breeds of dairy cattle named in the order of their popularity in the United States are given in the following list together with some distinguishing feature in products:

1. The Jersey, for butter production.
2. The Holstein-Friesian, for market milk.
3. The Guernsey, for quality of cream.
4. The Ayrshire for home milk and cheese.

Some of the less common dairy breeds in the United States are: French Canadian, and Dutch Belted.

The Dairy Type.

There are two ways of judging the dairy cow.

1. The use of the Babcock test and the milk scale.
2. Selecting a cow from physical characteristics.

The first method is an infallible test for determining the true income from the cow.

The second method is not a sure and final test.

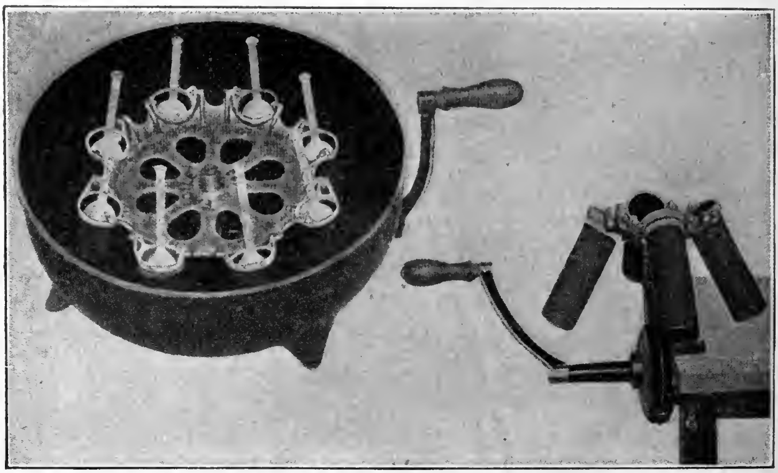


FIG. 4. Different styles of hand testers. To get accurate results, the tester should run smoothly, and be given the proper number of revolutions per minute. The lid must be kept on while in motion. The capacity of tester will depend upon the size of the dairy.

The Babcock Test.

1. Take samples of equal amount from at least six consecutive milkings; the samples should not be taken until the milk in the pail is thoroughly mixed by pouring or stirring.
2. Place samples in glass jar, and keep in a cool place and cover so as to prevent evaporation. This is a composite mixture.
3. When ready for the test place jar containing composite mixture into an other vessel containing water heated to about 100 to 110 degrees Fahr.
4. Before removing the required amount for the test the milk in jar must be thoroughly and completely mixed.
5. Draw out the amount of milk required with the pipette and deliver it to the test bottle.
6. The value of the test will depend upon the care and accuracy of the operation.
7. Use sulphuric acid having a specific gravity of 1.82 to 1.83 for testing.
8. The quantity of acid required for each sample is 17.5 c.c. and the quantity of milk should be 17.6 c.c.
9. The temperature of milk should be as near 60 degrees Fahr., as possible; too much above 60 degrees will burn or char the casein and sugar, and too far below 60 degrees will not dissolve the casein.
10. Place milk in test bottle first, then add the sulphuric acid carefully so as not to run the acid through the milk.
11. Mix the acid and milk thoroughly by a rotary motion. The chemical action will produce great heat. They should then be placed immediately while hot in the centrifugal or tester.
12. They should be whirled at full speed from 5 to 6 minutes. This will separate the fat and bring it to the surface. If any casein remains in the milk shake the sample again.
13. Add soft hot water to the bottle until the contents rise to the neck of the tester bottle, then whirl again at full speed from 2 to 3 minutes.
14. Add more hot water until the fat reaches the 8 or 9 per cent mark on the graduated neck of the test bottle. Whirl one minute.
15. If the operation has been carried out properly the fat should be clear, yellowish or straw color.
16. The line of separation between water and fat should be always distinct.
17. In testing milk it is recommended that tests be made in duplicate, and if the numbers correspond in the graduated tube, the results may be considered reliable.

18. In turning crank of machine, give it the speed according to directions (usually 75 turns per minute).

Summary.

Following are the various steps necessary in testing milk:

1. Secure a representative sample.
2. Measure out the required amount of milk with the 17.6 c. c. pipette and deliver it to the test bottle.
3. Add 17.5 c. c. sulphuric acid for whole-milk, 20 c. c. for skim-milk; mix gently, but thoroughly.
4. Place in centrifuge and whirl at full speed for 5 or 6 minutes for whole-milk, 7 or 8 minutes for skim milk.
5. Add hot water to bring the fat up to the neck of the bottle.
6. Whirl again at full speed for 2 or 3 minutes for whole-milk, 3 or 4 minutes for skim milk.
7. Add hot water again to bring the fat up in the neck of the bottle to the 8 or 9 percent mark.
8. Give final whirling at full speed for at least one minute.
9. Read the test at 125 to 140 degrees Fahr.
10. Record the test and empty the bottles immediately; cleanse thoroughly by shaking to remove sediment.

Dairy Herd Records.

From 1899 to 1908 (inclusive) The U. S. Dept. of Agriculture canvassed 13 states (Ia., Wis., Ind., O., N. Y., Penn., Ct., Vt., Minn., Mich., N. H., Mass., and Ill.) and reported the records of 2.163 herds, containing 28,447 cows.

The herds examined were representative herds, showing fairly the equipment and practice prevailing in the territory covered.

The results showed that:

1.	The yearly cost of feed per cow was $33.43.	
2.	The number of pounds of milk per cow yearly was	4,213 lbs.
3.	The pounds of butter yearly per cow was	196 lbs.
4.	The pounds of butter fat yearly per cow was	158.4
5.	The price received per 100 pounds of milk was	1,036
6.	The price of butter per pound was	0.186
7.	The price of butter fat per pound was	0.249

8.	Returns for $1 worth of feed was..........	$1.24
9.	Net profit per cow yearly was	8.11
10.	Food cost of butter per pound was.........	$0.148
11.	Food cost of butterfat per pound was......	0.213

Total number of herds................................	2,163
Profitable herds	1,531
Unprofitable herds	632

Examine difference between the best and poorest herds in the following summary:

1. In order that the student may not draw wrong inferences from the data and summary, it may be explained here that the exact difference due to certain variations in condition, type and feed of herds cannot be determined. These figures only serve to show that there are certain controlling factors that dominate.

GENERAL SUMMARY BY FEATURES.

Features.	Number of herds.	Number of cows.	Yearly cost of feed per cow.	Pounds of milk yearly per cow.	Pounds of butter yearly per cow.	Pounds of butter fat yearly per cow.	Returns for $1 worth of feed.	Net profit per cow yearly.	Food cost of milk per 100 pounds.	Food cost of butter per pound.	Food cost of butter fat per pound.	Profitable herds.	Unprofitable herds.
Total of canvasses	2,163	28,447	$33.43	4,213	196	158.4	$1.24	$8.11	$0.802	$0.148	$0.213	1,531	632
Herds of good dairy type	652	9,365	33.95	5.104	240	189.0	1.51	17.38	.656	.122	.185	597	55
Herds lacking dairy type	685	8,104	32.01	3,550	162	138.2	1.06	2.03	.908	.178	.23	379	306
Difference in favor of dairy type	....	....	—1.94	1,554	78	50.8	0.45	15.35	.252	.056	.045	....	....
Herds fed silage	329	6,689	34.98	4,760	230	181.8	1.39	13.50	.747	.129	.189	282	47
Not known to be silage fed	1,834	21,758	32.95	4,045	186	151.2	1.20	6.46	.822	.155	.222	1,249	685
Difference in favor of silage	....	....	—2.03	715	44	30.6	.19	7.04	.075	.026	.033	....	....
Herds in good stables	639	9,506	34.53	4,793	240	180.0	1.41	14.12	.75	.124	.187	553	86
Herds in poor stables	323	3,775	32.53	3,514	164	130.0	1.01	0.23	.927	.177	.266	153	170
Difference in favor of good stables	....	....	—2.00	1,279	76	50.0	.40	13.89	.177	.053	.079	....	....
Herds whose owners read dairy literature	464	6,202	34.78	4,809	207	185.0	1.42	14.54	.775	.146	.175	411	53
Herds of nonreaders	753	9,122	35:00	3,584	165	136.7	1.05	1.85	.918	.177	.288	392	361
Difference in favor of readers	....	....	0.22	1,225	42	48.3	.37	12.69	.143	.031	.113	....	....
Herds most profitable	268	3,848	33.66	5,690	271	234.0	1.78	26.18	.595	.105	.145	268	0
Herds least profitable	267	3,459	33.76	2,973	143	102.2	.80	—6.70	1.167	.211	.321	44	223
Difference in favor of most profitable	....	....	.10	2,717	128	131.8	.98	32.88	.572	.106	.176	....	....

PROBLEMS.

1. The owners of 464 herds numbering 6,202 cows were readers of dairy papers; these dairymen reported the cost of feed to be $34.78 per cow, and that they secured $1.42 for each dollar spent for feed; what was the profit per cow?

2. The owners of 753 herds, composed of 9,122 cows who did not read dairy literature fed their cows at a cost of $35 per head; they made an average annual profit of $1.85 per cow; what was the amount received for each dollar spent for feed?

3. In 652 herds of 9,365 cows of good dairy type, the annual profit (excess of receipts over value of feed) per cow was $17.38; while 685 herds, numbering 8,104 cows not of dairy type, returned a profit of $2.03 per head. What is the ratio of profit of a good dairy type over a poor or non-dairy type?

4. Referring to the table under "Summary," page 224 how many times greater is the profit on the annual amount invested in feed for a dairy cow receiving ensilage, than the profit on the yearly cost of feed for a cow receiving no ensilage?

5. Referring to the same table, the ratio of profitable to unprofitable herds is how many times as great among herds in good stables as among herds in poor stables?

NOTE — We have learned from the table that the average cow of 639 herds well stabled has returned to the owner an annual profit of $14.12; while the average cow in 323 herds poorly stabled produced but 23c profit (above cost of feed); but it is only fair to infer that the best stabled cows were better cows, better fed, and better cared for by better dairy men.

6. One of the best single herds examined in Iowa produced 322 pounds of butter per cow, with a net profit of $42.92 per cow; the returns for a dollar's worth of feed was $2.48. What was the selling price of butter?

7. The poorest single herd produced 63 pounds of butter fat per year, at a cost of $28 per cow. Each dollar's worth of feed produced 43c in returns. What was the loss per cow?

8. What was the difference in favor of the best herd?

9. Ten herds in Wisconsin, with an average production of 276 pounds of butter per cow, selling at 17.8c a pound, brought $1.98 for each $1.00 invested in feed; but the feed only cost $25.10 per cow per year. What was the profit per cow?

The difference between some of these herds was very small, and the cost and amount of feed were the material factors in determining profit.

10. Which is the better income from a dairy cow, 56 pounds of milk daily testing $4\frac{1}{2}$ per cent or 36 pounds of milk testing $6\frac{3}{8}$ per cent?

15

11. One cow produces 5230 pounds of milk per year; another produces 3850 lbs., of milk annually; the former tests 4% and the latter tests 6%. If butter is 25c per pound, which cow brings the greater income?

12. Live stock and dairying can be figured on the acreage basis just as easily as grain or fruit. If a farmer with 50 acres handles 25 cows and clears $1,000 per year, what is the net profit per acre?

Feeding Dairy Cows.

To succeed in dairying, involves the solution of at least four important problems, which may be briefly stated as follows:

1. The selection of cows that produce butter fat and milk in large quantities.
2. A careful study of each individual cow in the dairy.
3. Proper care and shelter.
4. Feeding a balanced ration.

In selecting a dairy cow the following points should be kept in mind:

She should be well bred.

She should be gentle.

The milk should be tested for quality and quantity (Babcock Milk Test and Scales).

She should be in perfect health. (Study tuberculin test).

Care and shelter means that:

FIG. 5. Banquet in a Dairy Barn.

Cows should be kept in clean and sanitary stables.

They should be kept in good physical condition.

They should not suffer from exposure to excessive rains or cold weather.

The study of individual cows is essential to successful dairying because:

There is a variation in the needs of different animals.

The needs of the same animal differ from time to time.

Feeds must be varied according to the condition of the cow; according to the quantity and quality of milk.

NOTE. — See table of digestible nutrients required per day by a 1,000 pound cow giving different amounts and qualities of milk (p. 230).

Net energy is what is available for milk production and maintenance after deducting the losses in labor of mastication, digestion, gas, etc.

Maintenance is the required amount of food to keep a cow alive, without giving milk, growing or gaining in weight.

Composition of Feeds and Their Influences on the Composition of Milk.

PROTEIN.

Protein is a compound that contains nitrogen which is very costly in feeds and so we secure large quantities of it, from the air, for dairy purposes through clover, alfalfa and other legumes.

Protein in the dairy cow produces or forms blood, muscle, connective tissue, tendons, etc., as well as the casein and albumen in the milk.

Protein forms nearly one-third of the solid material found in milk.

The average nutritive ratio of the digestible nutrients required by a dairy cow is about 1 :6. Protein is therefore about one-sixth of the nutrients in the ration. The dairy cow therefore requires food rich in protein, such as, linseed meal, gluten feed, bran, cotton-seed meal and other concentrates.

CARBOHYDRATES.

Carbohydrates do not contain nitrogen and are found in large quantities in corn, oats, wheat, and other common grains. It is found in the form of starch, sugar and fiber, etc., and supplies the cow with energy, heat and fat and supplies the sugar with sugar and fat.

Carbohydrates are abundant and are cheap as feeds for dairy cows.

FAT OR OIL.

The third nutrient in feeds is fat and is contained in all feeds. It is used by the cow for the same purposes as carbohydrates. In mixing rations we figure that one pound of fat is equal to two and one-half pounds of carbohydrates.

Producing and Purchasing Feeds.

There are some important facts worthy of careful consideration by the man who is feeding dairy cattle:

1. He should plan his crops for feeding dairy cows.
2. Valuable feeds unsuited to dairying should be sold.
3. Only feeds supplying protein for balanced rations should be bought.
4. Feed only dairy feeds to paying dairy cows.
5. Inferior dairy cows, unbalanced rations, poor management mean loss.
6. The dairyman who has a farm, should not purchase a balanced ration.

There are three kinds of feeds that can be produced for dairy purposes: (a) grains, (b) roughage, (c) succulent feeds.

THE GRAINS:

Corn, utilized as feed in different ways, as:
- A soiling crop. (cut green for feed).
- Stover and fodder corn.
- Ground grain and stalks.
- In the ear or shelled corn.
- Ground corn (corn meal).
- Corn and cob meal.
- Corn bran.
- Silage.

Oats, used in the following ways:
- Hay, grain feed and ground feed.

Barley, used as follows:
- Grain feed.
- Ground feed.
- Brewer's grains, (wet malt) and (dry malt).

Wheat, used as:
- Grain.
- Bran.
- Middlings.
- Shorts.

Soybeans are used in the following ways: as, grains: hay; ensilage; meal.

ROUGHAGE:

Roughage consists in using straw and hay as feed.

Among the hays used are alfalfa, clover, soybean, cowpea, field pea, oats, millet, sorghum, timothy.

Among stalks may be mentioned corn.

Different kinds of straw are also used as, wheat straw, oats straw, etc.

SUCCULENT FEEDS:

Succulent feeds are those feeds which contain a large percentage of water, and are fed green; they take the place of green pasture. They are important feeds for their physiological effects, and are used principally in winter with dry feeds.

Different kinds of silage and roots are used for succulent feeds.
Among the silage feeds are alfalfa, corn, soybeans, clover, etc.
Mangels, sugar beets, turnips, pumpkins can be used to good effect.

To Determine a Balanced Ration.

The following important facts must be determined before it is possible to arrange a ration that is very nearly suited to the needs of the individual cow for a specific purpose:

1. Producing or maintenance ration.
2. Weight of cow.
3. Quantity of milk produced per day.
4. Per cent of butter fat in milk.
5. Condition.

A balanced ration for a cow is a ration containing just the right amount of digestible protein with carbohydrates and fat to supply the needs of the cow when she is to be fed for a certain specific purpose.

A ration balanced for a cow giving a large amount of milk would not be a balanced ration for a cow giving a small amount.

A dry cow requires what is called a maintenance ration that will supply the needs of the body when she is not working or producing milk. Above maintenance a cow requires a feed that is balanced according to the work she does in making milk.

A maintenance ration to keep the body in good condition when no work is performed requires enough feed to supply daily .07 pounds of protein and .72 pounds of carbohydrates and fat for each 100 pounds of animal weight.

PROBLEMS.

1. How many pounds of protein and how many pounds of carbohydrates and fat will be required for a maintenance ration for a cow weighing 1,000 pounds?

2. How many pounds each of protein and carbohydrates and fat will be required to furnish a maintenance ration for a 1,200 cow?

The following table from the Wooster Experiment Station in Ohio gives the amount and kind of feed required for cows giving different amounts of milk.

DIGESTIBLE NUTRIENTS REQUIRED PER DAY BY A 1000-POUND COW GIVING DIFFERENT AMOUNTS OF MILK.

	Pounds.		Nutritive Ratio.
	Protein	Carbohydrate and Fat.	
10 lbs. Milk testing 3 percent fat	1.23	9.35	1 to 7.6
20 lbs. Milk testing 3 percent fat	1.61	11.45	1 to 7.1
30 lbs. Milk testing 3 percent fat	2.03	13.58	1 to 6.7
40 lbs. Milk testing 3 percent fat	2.43	15.58	1 to 6.4
50 lbs. Milk testing 3 percent fat	2.88	17.80	1 to 6.1
60 lbs. Milk testing 3 percent fat	3.28	19.93	1 to 6.0
10 lbs. Milk testing 4 percent fat	1.25	9.74	1 to 7.8
20 lbs. Milk testing 4 percent fat	1.77	12.26	1 to 6.9
30 lbs. Milk testing 4 percent fat	2.30	14.78	1 to 6.5
40 lbs. Milk testing 4 percent fat	2.80	17.31	1 to 6.2
50 lbs. Milk testing 4 percent fat	3.33	19.82	1 to 6.0
60 lbs. Milk testing 4 percent fat	3.80	22.37	1 to 5.8
10 lbs. Milk testing 5 percent fat	1.33	10.16	1 to 7.6
20 lbs. Milk testing 5 percent fat	2.00	13.08	1 to 6.8
30 lbs. Milk testing 5 percent fat	2.55	16.31	1 to 6.4
40 lbs. Milk testing 5 percent fat	3.10	18.93	1 to 6.1
50 lbs. Milk testing 5 percent fat	3.70	21.87	1 to 5.9
60 lbs. Milk testing 5 percent fat	4.32	24.81	1 to 5.7

NOTE — The amounts of nutrients for any amount of milk between those given above can be estimated.

PROBLEMS.

1. How many pounds each of protein and carbohydrates and fat will be required to supply a 1,200 cow giving 30 pounds of milk daily testing 4 per cent fat? What is the nutritive ratio of the feed?

2. A cow weighed 1,300 pounds when she was dry; three months after she was fresh she weighed 1,200 pounds, and gave 60 pounds of 5 per cent milk daily, what was the difference in amount of protein and carbohydrates and fat required when she was dry and when she was in the flow of milk given above?

It is very evident from the foregoing discussion that there should be upon every farm, a good scale for weighing the animals of the farm, a Babcock tester and milk scales.

PROBLEMS.

One of the dairy queens, Finderne Holingen Fayne — a Holstein cow, on March 24, 1915, finished a 365-consecutive day test having produced 24,612.8 pounds of milk and 1,116.05 pounds of butterfat. On the basis of butter which contains 85 per cent of fat, her production was equivalent to how many pounds of butter?

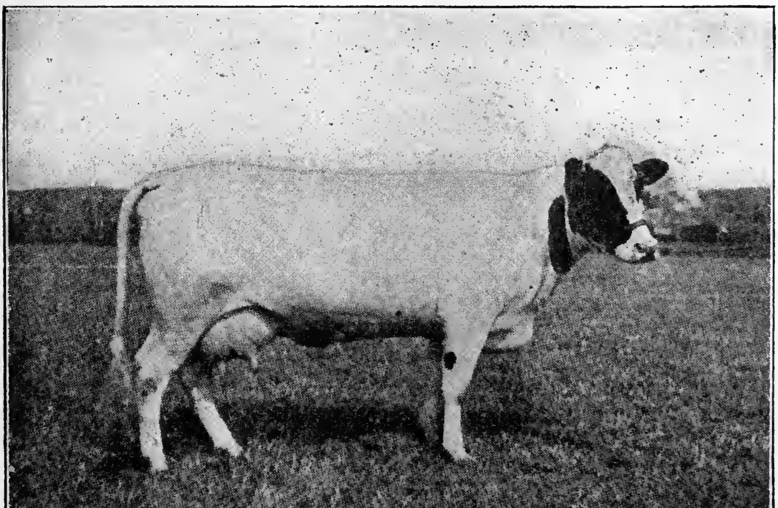


FIG. 6. Finderne Holingen Fayne, Queen of the Dairy World, March 24, 1915.

2. Murne Cowan the famous Guernsey cow produced 1,098.18 pounds of butter fat in one year. This would be equivalent to how many pounds of butter?

FIG. 7. Murne Cowan, greatest Guernsey Cow in the world.

Photograph taken especially for this book. Courtesy of Anna Dean Farm, Barberton, O.

The following table has been compiled by The Ohio Experiment Station, to assist in the selection of feeds.

RELATIVE VALUE PER TON OF GRAINS AND SILAGE LESS PROTEIN ABOVE CORN.

Dent corn per bushel....	$0 40	$0 42	$0 45	$0 48	$0 50	$0 53	$0 56	$0 59	$0 61	$0 64	$0 67	$0 70	$0 73	$0 76	$0 79	$0 82	$0 85	Protein
Dent corn per ton........	14 00	15 00	16 00	17 00	18 00	19 00	20 00	21 00	22 00	23 00	24 00	25 00	26 00	27 00	28 00	29 00	30 00	
Corn and cob meal.......	11 77	12 61	13 44	14 27	15 12	15 95	16 79	17 62	18 46	19 31	20 15	29 98	21 82	22 66	23 49	24 33	26 16	—36
Corn meal	13 08	14 01	14 94	15 87	16 80	17 73	18 66	19 59	20 52	21 45	22 39	23 31	24 24	25 17	26 10	27 03	27 96	—26
Hominy Feed	13 83	14 81	15 79	16 78	17 17	18 74	19 72	20 70	21 69	22 67	23 66	24 64	25 62	26 60	27 59	28 47	29 45	—20
Gluten Feed	10 85	11 62	12 39	13 16	13 93	14 70	15 47	16 25	17 02	17 79	18 56	19 33	20 10	20 87	21 64	22 41	23 19	+305
Oats per ton.............	10 75	11 51	12 27	13 04	13 81	14 57	15 34	16 10	16 86	17 63	18 39	19 16	19 92	20 68	21 45	22 22	22 98	+95
Wheat bran	8 71	9 33	9 94	10 56	11 18	11 89	12 42	13 04	13 65	14 28	14 90	15 51	16 13	16 75	17 37	18 00	18 60	+141
Wheat Middlings	11 49	12 30	13 12	13 94	14 75	15 57	16 39	17 20	18 02	18 84	19 65	20 47	21 30	22 10	22 92	23 74	24 55	+210
Wheat Shorts	10 21	10 93	11 66	12 39	13 11	13 84	14 56	15 29	16 01	16 74	17 47	18 19	18 92	19 64	20 37	21 09	21 82	+146
Barley per ton...........	12 62	13 52	14 42	15 32	16 22	17 11	18 01	18 91	19 81	20 70	21 60	22 50	23 39	24 29	25 19	26 08	26 98	+28
Wet brewers' grains......	2 08	2 23	2 38	2 53	2 68	2 83	2 97	3 12	3 27	3 42	3 56	3 71	3 86	4 01	4 16	4 34	4 56	+75
Dry brewers' grains......	8 36	8 95	9 55	10 14	10 73	11 33	11 92	12 52	13 11	13 71	14 30	14 89	15 49	16 08	16 68	17 27	17 86	+307
Malt sprouts	9 51	10 19	10 86	11 54	12 22	12 89	13 57	14 24	14 92	15 60	16 27	16 95	17 63	18 30	18 98	19 65	20 32	+302
Dry distillers' grains.....	12 03	12 90	13 75	14 60	15 46	16 31	17 17	18 02	18 88	19 73	20 59	21 45	22 30	23 16	24 01	24 87	20 72	+322
Rye	13 19	14 13	15 06	16 00	16 94	17 88	18 81	19 75	20 68	21 63	22 56	23 50	24 44	25 38	26 31	27 25	28 19	+43
O. P. linseed meal........	8 69	9 30	9 92	10 53	11 15	11 78	12 38	13 00	13 62	14 24	14 86	15 47	16 09	16 71	17 33	17 94	18 56	+507
N. P. linseed meal........	7 51	8 05	8 59	9 12	9 66	10 19	10 73	11 26	11 80	12 33	12 86	13 40	13 93	14 47	15 00	15 54	16 07	+546
Cotton-seed meal	7 87	8 43	8 98	9 55	10 10	10 66	11 22	11 78	12 34	12 90	13 46	14 03	14 58	15 14	15 70	16 26	16 82	+610
Soybean meal	10 25	10 98	11 71	12 44	13 17	13 90	14 63	15 36	16 09	16 82	17 55	18 28	19 02	19 75	20 47	21 20	21 93	+468
Corn Silage	2 89	3 08	3 27	3 46	3 65	3 84	4 03	4 22	4 41	4 60	4 79	4 98	5 17	5 36	5 55	5 74	5 93	—4

— indicates less protein than in corn.
+ indicates more protein than in corn.

In solving problems relating to cost and balancing of rations, the student should have a table showing the percentage of digestible nutrients in feeding stuffs. This can be secured from your experiment station or from Henry's "Feeds and Feeding."

HOW TO USE THE TABLE.

If wheat bran and cotton-seed meal are to be compared, proceed as follows: Find the local price of corn in the upper line, say 56 cents per bushel, or $20 per ton. Farther down the same column, on the line headed "wheat bran" are the figures $12.42, which is the value of the nutrients in a ton of bran minus the 141 pounds of surplus protein shown in the last column to the right. Subtract the $12.42 from the local price of bran, say $25 per ton, and the result is $12.58 which is the cost of the 141 pounds of the surplus protein. Divide the $12.58 by 141 and the result shows that the cost of the protein is 9 cents per pound. Farther down the same column, on the line headed "cotton-seed meal," are the figures $11.22, which is the value of the ton of cotton-seed meal minus the surplus protein. Subtract this $11.22 from the local price of cotton-seed meal, say $35 per ton, and the result is $23.78, or the cost of 610 pounds of surplus protein. $23.78 divided by 610 equals 3.9 cents per pound. At these prices the protein in the cotton-seed meal would cost less than one-half as much as in wheat bran.

Cost of Rations.

It has been assumed as approximately true that the digestible protein, carbohydrates and fat in corn are as valuable as in any other feed.

PROBLEMS.

1. One ton of dent corn contains 156 pounds of digestible protein, and 1530 pounds of digestible carbohydrate or, 1686 pounds of digestible nutrients; what per cent of the digestible nutrients is protein?

2. When corn is selling for $20 a ton, what is the cost of one pound of digestible nutrients?

3. If one ton of wheat midlings contains 1256 pounds of digestible carbohydrate, how many pounds of wheat middlings must I purchase to get the same number of pounds of digestible carbohydrate as are contained in one ton of corn?

4. If wheat middlings are 30 dollars per ton, what will be the cost of 2436 pounds of middlings?

5. Find the difference between the number of pounds of protein in one ton of dent corn and 2436 pounds of wheat middlings.

6. If there are approximately 156 pounds of protein in one ton of

dent corn, and 412 pounds of protein in 2436 pounds of wheat middlings, and the digestible protein in the above named amounts of corn and middlings are of equal value; at the present price of corn and middlings, what are we paying per pound for the extra 256 pounds of protein contained in the wheat middlings?

7. If one ton of Old Process Linseed meal contains 950 pounds of carbohydrates and one ton of corn meal contains 1442 pounds of carbohydrates, how many pounds of O. P. Linseed meal will be required to furnish the amount of carbohydrates contained in one ton of corn meal?

8. How many pounds of protein are there in one ton of corn meal? In one ton and a half of linseed meal?

9. At present prices find the difference in cost between the cost of the protein in one ton of corn meal, and one ton of O. P. Linseed meal.

10. A dairyman wishes to mix a feed that shall have a nutritive ratio of 1:6, how many pounds of ground corn and wheat bran should be added to 20 pounds of red clover hay, to make a day's feed for a 1,000 pound cow, giving 50 pounds of milk testing 4 per cent?

SOLUTION.

	Lbs. Protein.	*Lbs. Carbohydrates.*	*Nutritive ratio.*
Required amount for 1,000 pound cow..	3.33	19.82	1:6
Twenty pounds of clover hay (red)....	1.24	7.88	1:6
Balance of mixture (ground corn and wheat bran) required..............	2.09	11.94	...
One pound of ground corn.............	0.044	0.665	1:15
One pound of wheat bran	0.119	0.476	1:4
Two pounds of the mixture.............	0.163	1.141	1:7

The nutritive ratio 1:7 is still too wide, so we must add more bran which has a narrow nutritive ratio of 1:4, in such an amount as will make the required ratio of 1:6.

AN ALGEBRAIC SOLUTION.

Let x = the amount of protein that must be added to 0.163 pounds.
Let y = the amount of carbo's that must be added to 1.141 pounds.

Then we have the equation:

$$x : y :: 1 : 4$$
$$163 + x : 1.141 + y :: 1 : 6$$

$$x = .0815, \text{ and } y = .326 \text{ pounds.}$$

Adding this to the amount of protein and carbohydrates in the 2 pound mixture, we have the following:

	Protein.	*Carbo-hydrates.*	*Nutritive ratio.*
Two pound mixture	0.163	1.141	1:7
$\frac{815}{1190}$ pound of wheat bran	0.0815	0.326	...
	0.2445	1.467	1:6

$\frac{815}{1190}$ of a pound is approximately two-thirds of a pound of bran.

Since the amount of protein wanted in the balance of the mixture is 2.09 pounds, we can divide 2.09 by .2445 and the quotient is 8.2+; therefore we shall require 8.2+ × 3 or 8.2 pounds of ground corn, and 8.2 × 1 and ⅔ pounds of wheat bran which equals 13 2/5 pounds.

This solution is given to show that we can combine feeds in a ration and have it very approximately balanced.

8. Mix a feed for a cow weighing 1,200 pounds, that gives 30 pounds of milk testing 4 per cent butter fat. The ration is to be composed of red clover hay, wheat bran and ground corn.

9. Mix a ration of alfalfa hay 14 pounds, ground corn and New Process linseed meal for a cow that weighs 1,000 pounds, and gives 60 pounds of milk testing 5 per cent fat.

10. Mix a ration of 10 pounds alfalfa hay and 6 pounds of red clover, and cotton seed meal, ground corn and wheat bran for a 1,400 pound cow, giving 60 pounds of 4 per cent milk.

Cow Testing Associations.

Cow Testing Associations have been organized for the purpose of keeping accurate records of the amount of milk and butter-fat produced by every cow included in each herd comprising the organization.

In a cow-testing association in a county in Nebraska, there were 21 herds, numbering in all 435 cows. The man employed by these 21 dairymen to do the testing spent one day each month with each herd belonging to the association. As an expert he gave instructions in feeding and such other information as was necessary to bring about the most economical milk and butter-fat production.

The following table shows the difference in income between ten good cows and ten inferior cows as indicated by results:

TEN MOST PROFITABLE COWS.		TEN MOST UNPROFITABLE COWS.	
1	$123 58	1	$1 62
2	116 96	2	2 84
3	108 74	3	3 85
4	108 10	4	7 10
5	104 15	5	9 09
6	96 66	6	10 27
7	95 59	7	11 14
8	94 97	8	12 07
9	92 11	9	13 57
10	92 02	10	13 73

PROBLEM.

What was the total profit yielded by the ten best cows and what was the total profit yielded by the ten poorest cows in the test shown in the above table?

NOTE. — Write for bulletins 233 and 129 and 2 given in references at the end of this chapter. These will tell you how to organize an association.

One of the most famous dairy cows in the world was purchased for an ordinary price from a man who kept no records of her production and consequently did not know her real value. Her great value was only determined after she was tested and it was learned that she could produce 1,111 pounds of butter in less than a year.

AVERAGE YEARLY PRODUCTION PER COW IN THE U. S.

Year.	Milk pounds.	Butter pounds.	Year.	Milk pounds.	Butter pounds.
1850	1,436	61	1880	2,004	85
1860	1,505	64	1890	2,709	115
1870	1,772	75	1900	3,646	155

PROBLEMS.

1. If the average production of butter in the United States was 155 pounds in 1900, how many times greater was the production of the cow yielding 1,111 pounds of butter than that of the average cow?

2. One of the best yields was 27,432 pounds of milk from one cow; how many times greater is this than the average production per cow in the United States in 1870?

A Lesson From Denmark.

"Denmark is about one-fourth the size of Wisconsin. Much of it was formerly a bleak waste of sand-dune. Only the eastern part of the country and the neighboring islands were considered fit for agriculture. In addition to its poverty in natural resources, the country was further impoverished by the Napoleonic wars in the early part of the nineteenth century. In the second half of the nineteenth century Schleswig-Holstein was taken by the Germans. Practically all of its commerce was gone. The peasant farmers were in a most pitiful condition. Yet today, less than a century later, this same Denmark is, in proportion to its population, the wealthiest country in Europe."

"Denmark is essentially an agricultural country. It has an area of about 10,000,000 acres. More than $90,000,000 worth of butter, eggs and meats are exported by the farmers of Denmark annually. In 1896 the Danes had $208,000,000 in savings banks. Eighty-nine families out of every hundred own their own farms and houses. This mall amount of tenancy is due to the fact that land holdings can be easily acquired."—*Report of Wisconsin State Board of Public Affairs.*

The secret of Denmark's success lies in the following four basic principles:

1. Land is easily obtained for actual workers.
2. The farmers of Denmark are said to be the most thoroughly organized in the world.
3. They study, buy, sell, slaughter and market their stock and their meats co-operatively.
4. They have vocational schools for the training of children in the industries of their country.
5. The course of study is prepared to suit the vocation to be followed by the individual.

The United States is a country of far greater Dairy advantages and opportunities than either Denmark or Holland.

And now the question arises, how can the Dane afford to import and feed our corn and sell his butter and cheese in competition with us?

Holland Milk Problems.

1. One of Holland's greatest exporters of Holstein-Friesian cattle had at one time 30 cows each producing on an average 11,275 pounds of milk and 394 pounds of butterfat per year. If butterfat was worth 25c a pound, what was the gross earnings of this herd of cows annually? What would the milk have been worth at $1 per hundred.

2. In the province of Freisland, Holland, there were 70 co-operative butter and cheese factories each receiving on an average 25,000 pounds of milk per day; the average price paid at the factory was $1 per hundred pounds of milk; find the total amount paid for milk by these 70 factories.

3. There are 1,000,000 dairy cows in Denmark; the amount of butter exported is 200,000,000 pounds per year; the Danes receive $44,000,000 for this export; what is the average price per pound received for the butter exported?

Holland contains but 8,000,000 acres, or less than one-third the area of Ohio. Only one-third of Holland is said to be good land, but the exports of butter and cheese amount to $108,000,000 annually.

There are some important lessons to be learned from the two small countries of Holland and Denmark.

1. Some of the small nations have done some of the really greatest things.

2. Co-operation has been the chief underlying principle of Holland's and Denmark's dairy success.

3. They have incorporated into their ethics the principle that man should not live for self alone, but for his fellowmen, his community and for his nation as a whole.

4. The Danes and Hollanders owe their rapid rise and marvelous success to the fact that they are alive to the demands of the markets of the world. They understand their art. They have the brains, thought and skill. They understand breeding, feeding and caring for stock.

PROBLEMS.

1. There are 22,000,000 cows in the United States. The average production of butterfat per cow per year is 160 pounds. What would be the value of the total production of butterfat per year in the U. S. at 25c a pound.

2. If the average production of butterfat per cow were 320 pounds annually, how many cows would we be feeding now to produce the same amount we now get from the total number of cows in the U. S.?

3. If the cost of keeping cows is on an average $40 per year, what are we gaining or losing by feeding cows that produce 160 pounds of butterfat per year that is worth on the market 25c a pound?

4. What would be gained by feeding cows at $35 per head per year if the production of butterfat were 360 pounds per year and would sell on the market at 25c a pound?

5. The amount of cheese manufactured in the United States annually is 200,000,000 pounds. The value of the product is $29,000,000; what is the average value per pound?

6. If our population is about 100,000,000, what is the average consumption per capita if the annual consumption of cheese is 250,000,000 lbs.?

7. If the average price of cheese is 22c per pound, what is the annual amount expended for cheese in the U. S.?

8. If the annual export is 3,000,000 pounds and the annual import is 50,000,000 pounds of cheese, what is the average consumption of cheese per capita in the United States?

9. The amount of farm butter produced in 1900 was in excess of 1,000,000,000 lbs. What would this amount have brought in gain if every pound would have been sold at an advance of 5c per pound, by having been remedied of the defects of bad flavors, lack of uniformity in color and salt, and lack of suitable packages and lack of uniformity in style of packages.

Butter Fat.

Butter-fat is the portion of milk that produces butter. It exists in the form of very small globules from 1/15000 to 1/25000 of an inch in diameter. They may be seen by examining a drop of milk under a strong microscope.

Butter-fat globules weigh 93 per cent as much as water, while milk weighs 1.03 times as much as water. When milk is allowed to stand quietly, the heavy part of milk settles downward and forces the globules to the surface where they form *cream*.

The amount of fat in the average milk of the different breeds of cattle, expressed in percentages according to tests made at the New York Agricultural Experiment Station, was:

Holstein — Friesian	3.4
Ayrshire	3.6
Shorthorn	4.4
Devon	4.6
Guernsey	5.3
Jersey	5.6

The experiments conducted by the New Jersey Experiment Station with leading dairy breeds show the average yield of different breeds varies slightly from the results obtained in New York.

Holstein — Friesian	3.51
Shorthorn	3.65
Ayrshire	3.68
Jersey	4.78
Guernsey	5.02

A close study of the tests of the experiment stations shows that:

1. There can be a distinct classification of breeds based upon relative yield and quality of milk.
2. Milk from large producers shows average quality.
3. Milk from small producers shows higher than an average quality.
4. Age and health of animals affects the composition of milk.
5. Milk of young animals is richer than that of old.
6. The greater part of variations in the composition of milk is due to breed and therefore indicates the kind of animals best adapted for the production of a specific dairy product.

Score Card.

MARKET CREAM.

Institution ....

SCALE OF POINTS (Numerical)	Possible Score	POINTS Student Score	POINTS Corrected
Flavor	40	....	....
Composition (Fat......per cent)	25	....	....
Bacteria	20	....	....
Acidity	5	....	....
Appearance of Package and Contents	10	....	....
Total	100	....	....

DESCRIPTIVE SCORE. CHECK PROPER DESCRIPTION.

FLAVOR	*Composition* ..	*Bacteria*	*Acidity*	*Package & Contents* ....
Excellent	*Perfect*	*Perfect*	*Perfect*	*Perfect* ....
Good	*Fat....per cent*	*Total*	........*per cent*	*Foreign Matter*..
Fair		*Liquefiers* ...		*Metal Parts*......
Bad				*Unattractive* ....
Flat				*Lumpy* ....
Bitter				*Frothy* ....
Weedy				
Garlic				
Silage				
Smothered				
Manure				
Other Taints......				

Remarks ....

Sample .... *Date* ....

Student .... *Standing* ....%

Skim-milk.

A scientific report gives the value of skim-milk as follows:

"Skim-milk has all the protein and half of the full value of whole milk, and is in most localities the most economical source of animal protein. The food elements in skim-milk are equal in physiological value to those of meats and are far less expensive."

Its value in different uses may be summed up thus:

1. In making bread it gives weight and nutritive value.
2. It is rich in blood and bone building requirements.
3. It is an excellent poultry food.
4. It has been proven to give best returns when fed to young animals.
5. In feeding skim-milk to calves 1 cent's worth of oil-meal will take the place of a pound of butter fat.
6. The use of skim-milk for baking and cheese making may be made to be worth a dollar per cwt. to the consumer.

Buttermilk.

Buttermilk ranks very close to skim-milk in feeding value.

It has become one of the most popular drinks on the market.

Good buttermilk when fresh is more valuable for cooking than whole milk.

The public should beware of sour skim-milk that is often sold for buttermilk.

Comparative Nutritive Value of Cheese and Some Other Staple Food Materials.

Cheese is one of the richest of foods in the quantity of protein and fat that it contains. Cheese like meat, fish and eggs must be used in combination with other foods to form a well balanced meal.

The following tables prepared by the United States Department of Agriculture show the relative value of certain foods:

(Compiled on basis of prices in 1912).

Amounts of protein and energy obtained for 10 cents expended for cheese and other foods at certain assumed prices per pound.

Food Materials.	Price.	10 cents will buy Ounces.	10 cents worth will contain a fuel value of	
			Proteid Ounces.	Cal-ories.
Cheese	22 cents per pound	7.3	1.9	886
Beef, average	20 cents per pound	8.0	1.2	467
Porterhouse steak	25 cents per pound	6.4	1.3	444
Dried beef	25 cents per pound	6.4	.1	315
Eggs	24 cents per dozen	10.0	1.3	198
Milk	9 cents per quart	38.3	1.2	736
Wheat bread	5 cents per pound	32.0	2.9	2,400
Potatoes	60 cents per bushel	160.0	....	2,950
Apples	1½ cents per pound	106.7	....	1,270

PROBLEMS.

1. Find the difference in market value between one dozen eggs and a pound of cheese.

2. Find the difference in the amount of protein and energy in 10 cents worth of porterhouse steak and 10 cents worth of cheese.

3. What is the difference in fuel value between an ounce of cheese and a pint of milk?

4. What is the difference between the number of calories in one pound of wheat bread and the number of calories in one pound of cheese?

5. In point of fuel value and protein, which is the cheaper 10 cents worth of dried beef or 10 cents worth of porterhouse steak?

6. How many percent greater is the fuel value of 10 cents worth of potatoes than the fuel value of 10 cents worth of eggs?

7. If one ounce of cheese is approximately equivalent in food value to one egg, which is the cheaper of the two foods at the present market price?

8. If one ounce of cheese is equivalent in food value to one glass of milk, which is the cheaper at the present prices of each?

9. If one ounce of cheese is equivalent to two ounces of meat (average value of all cuts) which is the cheaper cheese or meat?

Certified and Pasteurized Milk.

The word "Certified" was copyrighted in 1893 by Stephen Francisco, a dairyman of Newark, N. J.,—the first man who voluntarily placed his dairy under the supervision of a Medical Milk Commission. The right to its use has been granted by him to Medical Milk Commissions.

Many states have passed laws, regulating the sale of milk under some form of inspection and certification.

"Pasteurized milk" is milk which has been heated between 60 and 70 degrees Centigrade from 10 to 20 minutes, followed by rapid cooling.

Pasteurization is a definite process which must not be confounded with the terms "sterilization", "scalding", or "boiling" and similar terms.

Pasteurization signifies that the milk has been subjected to a degree of temperature for a sufficient period of time to kill nonsporulating disease germs, but that it has not been markedly altered in character.

The United States Government stands sponsor for the statements made in its bulletins that "The simple method of pasteurization would prevent many a case of typhoid, diphtheria, scarlet fever, Malta fever, children's summer complaint which at best is only an expedient.

Tubercle Bacilli.

There are four recognized types of bacilli, they are human, bovine, avian, and cold-blooded animal bacilli.

Tuberculous sputum reduced to dust and inhaled causes tuberculosis.

Tuberculosis is also induced by ingestion.

The Mills-Reincke phenomenon, which has been given a mathematical equivalent by Hazen's theorem is "When one death from typhoid fever has been avoided by the use of better water, a certain number of deaths, probably two to three have been avoided from other causes." Sedgewick and McNutt have demonstrated this theorem to be sound and conservative.

The following are important facts that will show the danger and the importance of extreme care in the use of water, milk, and in the disinfecting of buildings that have been infected.

1. Tubercle bacilli will live for more than a year in running water.
2. Tubercle bacilli will live in cold storage butter more than ten months.
3. Bovine tubercle bacilli in manure in a garden soil, have been known to live 213 days.
4. Bovine tubercle bacilli in the tissue of a dead guinea pig have been know to live 77 days.
5. Human tubercle bacilli lived in a flower pot 441 days.
6. Human tubercle bacilli in sputum lived 232 days.
7. Human, bovine and avian tubercle bacilli exposed to the direct sunlight die in from one to four minutes.

Warning.

Hang your pails, glass jars, and all other utensils used in the dairy industry, where the rays of the sun will fall directly upon them. These rays will sterilize them and preserve health and promote the happiness and prosperity of your patrons as well as that of your own family.

TYPHOID FEVER GERMS.

A committee appointed by the Medical Society of the District of Columbia made an investigation of the causes of typhoid fever in the city of Washington and reported that its occurrence was traceable to the following responsible factors:

1. Potomac water supply.
2. Pollution of the soil with leakage from privies.
3. From defective sewers.
4. Racking up of sewage from tidal movements.
5. Drinking of well or pump water.
6. Drinking contaminated milk.

One of the gravest responsibilities that rests upon the teachers and other officials of the common schools today is the care and protection of the health of the twenty-five million school children of the United States.

The study of the effects of bacteriology in agriculture should go farther than the effects of bacteria on plant life. It should include the study of the effects of bacteria on the public health.

There should be medical inspection of schools.

To this end the following bulletins are recommended for the use of teachers:

UNITED STATES DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

Circular 153, Bureau of Animal Industry.
Farmer's Bulletin No. 540, The Stable Fly.
Farmer's Bulletin No. 473 Tuberculosis.

Dairy Problems.

OUTLINE FOR STUDY.

Important points to be studied in improving a dairy herd:

1. The individual members of the herd.
2. The yearly cost of feed per cow.
3. The yearly production of milk per cow.
4. The yearly production of butter or butterfat.
5. Returns for each dollar's worth of feed.
6. Yearly cost of milk and butterfat.
7. Food cost of milk and butterfat.
8. Cows showing greatest profit.

Bookkeeping.

There is no part of farming that requires more careful records and accounts to insure the greatest success than dairying.

In the barn there should be a card of sufficient size in a convenient place for posting the ration for reference by employees. There should be scales at suitable locations for weighing cows and milk at stated intervals, and sheets for recording weights.

Laboratory Apparatus for Complete Equipment in Studying Dairy Problems.

1. Scales for weighing milk and its products.
2. A Babcock milk tester, with test bottles acid measure, sulphuric acid bottle, 17.6 c.c. milk pipette, brush for cleaning and cleansing test bottles.
3. A milk cooler.
4. Milk bottles or jars and test tubes for keeping samples of milk.
5. A cream separator, and a churn.
6. A thermometer and a microscope.
7. Preservatives to prevent souring of milk.

A Good Bulletin.

Circular 122, Testing the Dairy Cow. Ohio Agricultural Experiment Station, Wooster, O.

See Bulletin on Equipment.

Exercises.

1. Let each pupil bring a sample of fresh morning's milk from home.

2. Make a test of evening's milk from same cow. Compare the test of morning and evening milkings.

3. A composite sample covering four consecutive milkings is necessary for a fair test. A test covering a week's milking is better.

4. Find out how many owners of cows in your district keep a dairy record.

5. Get records of individual cows. Compare different dairy records.
6. Get the opinions of owners who have studied cows.
7. Keep all data for reference.
8. Compare cost of feeds, cost of cows, production and profits.
9. Compare the Babcock Tester with the Cream Separator.
10. Compare weight of skim-milk with weight of cream.
11. Why does cream come to the top?
12. What is centrifugal force?
13. Explain the cause of cream or butter-fat coming to the top of the test bottle in the Babcock test.

14. Explain how the cream is separated from the milk by the cream separator.

Experiment.

1. Prepare at the same time, a quart of each, sterilized, pasteurized and untreated milk; note difference in taste after 12, 18, 24 and 48 hours.

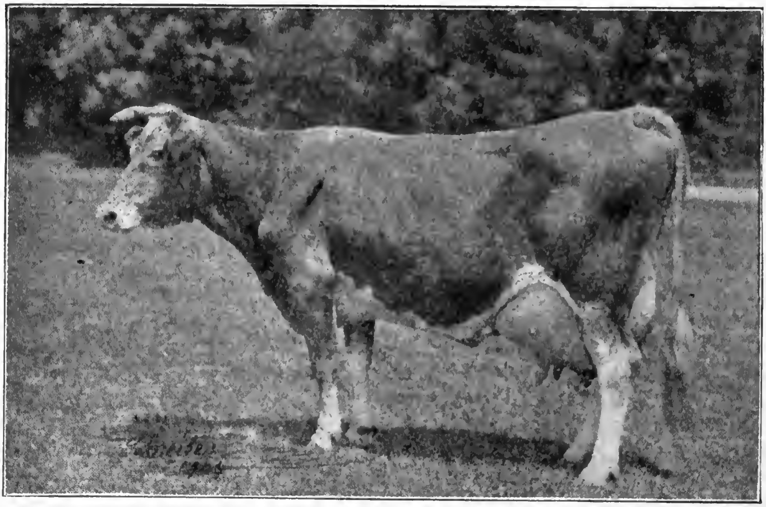
2. Take milk at temperature of milking time, cool one quart to a temperature of 40° Fahr.; let the other quart stand without cooling. Taste and note flavor of each at end of 6, 10, 18, 24 hours.

NOTE. — Agricultural apparatus is not complete without a milk-tester.

Questions.

1. Make a list of the products of milk.
2. What causes milk to become sour?
3. What effect does cooling the milk have on keeping it sweet?
4. What are lactic-acid bacteria?
5. Describe various ways by which disease germs get into milk.
6. What part do bacteria play in the making of cheese?

Selecting a Cow from Physical Characteristics.



Courtesy Washington Experiment Station
FIG. 8.

Fig. 8, is an excellent model of a splendid dairy type. Looking at this figure we may note some of the following characteristics:

1. A clean face, broad forehead, a large bright intelligent eye and prominent veins.
2. A thin neck, sharp lean shoulders, prominent hips and thin thighs.
3. A spare form throughout with great depth of body.
4. A great development of milk vein extending from the front legs along the abdomen to the udder.
5. A splendidly developed udder.

Dairy Score Cards.

Dairy Cattle — Ohio State University, Columbus, Ohio
Guernsey Cattle Club, W. H. Caldwell, Secretary, Petersboro, N. H.
Ayrshire Breeders' Ass'n, C. M. Winslow, Secretary, Brandon, Vt.
The Holstein-Friesian Ass'n of America, F. L. Houghton, Secretary, Brattleboro, Vt.
Butter, University of California Experiment Station, Berkeley, Cal.
Milk, National Dairy Union, G. Whitiker, Washington, D. C.
Inspection of Dairies, State Board of Agriculture, Columbus, Ohio.
Ice Cream, Iowa State College of Agriculture, Ames, Iowa.

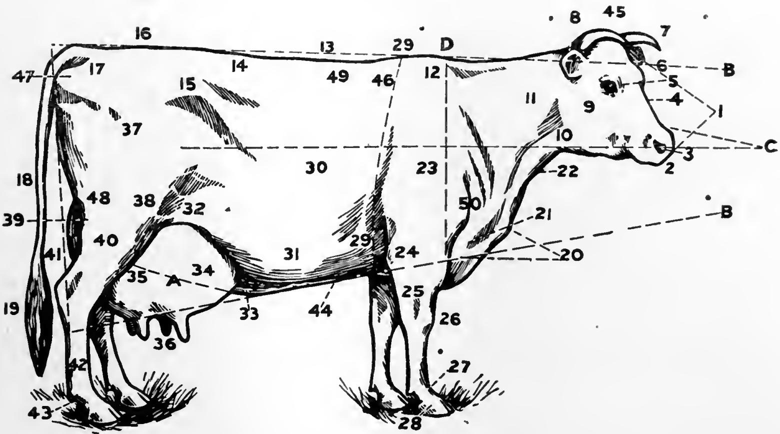


FIG. 9. Dairy Cow, showing Names of Parts.

1. Head.
2. Muzzle.
3. Nostril.
4. Face.
5. Eye.
6. Forehead.
7. Horn.
8. Ear.
9. Cheek.
10. Throat.
11. Neck.
12. Withers.
13. Back.
14. Hip bones.
15. Hip bones.
16. Pelvic arch.
17. Rump.
18. Tail.
19. Switch.
20. Chest.
21. Brisket.
22. Dewlap.
23. Shoulder.
24. Elbow.
25. Forearm.
26. Knee.
27. Ankle.
28. Hoof.
29. Heart girth.
30. Side of barrel.
31. Belly.
32. Flank.
33. Milk vein.
34. Fore udder.
35. Hind udder.
36. Teats.
37. Upper thigh.
38. Stifle.
39. Twist.
40. Leg or gaskin.
41. Hock.
42. Shank or cannon.
43. Dewclaw.
44. Milk well.
45. Pole.
46. Crops.
47. Pin bone.
48. Thigh.
49. Chine.
50. Shoulder points.

A. Circumference of the udder.
B. Vertical wedge.
C. Lateral wedge.
D. Cross sectional wedge.

Score Card.

DAIRY CATTLE.

Institution ....

	Perfect Score.
Breed.............. Age.............. Weight.............. Size..............	
General Appearance — 20 Points.	
1. Form — wedge shaped front, rear, side and top	5
2. Hair — fine, soft	2
3. Skin — Soft, pliable	3
4. Disposition — quiet, gentle	2
5. Temperament — nervous, lean appearance, indicating good milk production.	5
6. Health — thrifty, vigorous	3
Head — 8 Points.	
7. Muzzle — large, broad	1
8. Nostrils — wide, flaring	1
9. Jaw — large, strong	1
10. Face — medium length, slightly dished, clean cut, lean, quiet expression	1
11. Forehead — broad	1
12. Eyes — large, bright, full, mild	2
13. Ears — medium size, yellow inside, fine texture	1
Forequarters — 10 Points.	
14. Neck — medium length, not fleshy, no dewlap, smoothly joined to shoulders	2
15. Throat — clean	1
16. Withers — narrow, thin	2
17. Shoulders — light, sloping, lean	2
18. Forelegs — straight, short, fine, sound, well set	2
19. Brisket — V shaped rather than U shaped, light	1
Body — 24 Points.	
20. Chest — deep, wide, girth large	7
21. Ribs — long, wide apart, well arched	2
22. Back — straight, prominent, strong, processes wide apart	3
23. Barrel — deep, wide, long, capacious	10
24. Loin — broad, strong	2
Hindquarters — 10 Points.	
25. Hips — prominent, wide apart, level	2
26. Rump — long, wide, level	2
27. Pin bones — high, wide apart	1
28. Tail — long, reaching to hocks, switch well developed	1
29. Thighs — thin, long	2
30. Hind legs — far apart, shank fine	2
Milk Organs — 28 Points.	
31. Udder — large, symmetrical, extending far in front and high behind, quarters even	15
32. Teats — convenient size, evenly placed, wide apart	4
33. Milk veins — large, tortuous, prominent on udder	4
34. Milk wells — large, numerous	5
Total	100

Animal .... Date ....

Student .... Standing ....%

Practical Rations for Dairy Cows.

(Fed by sixteen American dairymen producing 325 pounds of butter or more per cow per year.)

1. *Colorado.* — 30 lbs. silage, 10 lbs. alfalfa hay, 10 lbs. clover hay, 5 lbs. wheat bran, 2 lbs. cornmeal.

2. *Connecticut.* — 35 lbs. corn silage, 10 lbs. hay, 3 lbs. wheat bran, 3 lbs. corn and cob meal, 2 lbs. cotton-seed meal, 2 lbs. Chicago gluten meal.

3. *Illinois.* — 7½ lbs. clover hay, 7½ lbs. timothy hay, 12 lbs. corn and cob meal, 8 lbs. bran, 1¼ lbs. linseed meal, 1¼ lbs. cotton-seed meal.

4. *New Jersey.* — 24 lbs. corn silage, 8 lbs. corn meal, 2 lbs. wheat bran, 4 lbs. oats, 2 lbs. oil meal.

5. *New York.* — 20 lbs. hay, 2 lbs. wheat bran, 2 lbs. cotton-seed meal, 2 lbs. hominy meal.

6. *New York.* — 12 lbs. timothy hay, 1 lb. wheat bran, 1 lb. middlings, 2 lbs. corn meal, 2 lbs. cotton-seed meal, 40 lbs. skim-milk.

7. *New York.* — 42 lbs. corn silage, 2½ lbs. clover hay, 2½ lbs. timothy hay, 8 lbs. corn and cob meal, 14 lbs. dried brewers' grains.

8. *North Carolina.* — 30 lbs. corn silage, 8 lbs. fodder corn, 3 lbs. corn meal, 3 lbs. wheat bran, 1 lb. cotton-seed meal.

9. *Pennsylvania.* — 24 lbs. corn fodder, 5.1 lbs. wheat bran, 5.1 lbs. corn meal, 3 lbs. cotton-seed meal, 2 lbs. oil meal.

10. *Pennsylvania.* — 10 lbs. corn fodder, 6 lbs. hay, 3½ lbs. wheat bran, 1½ lbs. cotton-seed meal, 1½ lbs. oil meal, 2½ lbs. corn meal.

11. *Texas.* — 30 lbs. corn silage, 13½ lbs. sorghum hay, 1.3 lbs. corn meal, 2.6 lbs. cotton-seed meal, 2.2 lbs. cotton-seed, 1.3 lbs. wheat bran.

12. *Vermont.* — 30 lbs corn silage, 10 lbs hay, 4.2 lbs. corn meal, 4.2 lbs. wheat bran, 8 lbs. linseed meal.

13. *West Virginia.* — 48 lbs. corn silage, 2½ lbs. corn and cob meal, 2⅓ lbs. ground wheat, 2½ lbs. oats, 2½ lbs. barley meal.

14. *Wisconsin.* — 26 lbs. corn silage, 10 lbs. clover hay, 5 lbs. timothy hay, 8 lbs. wheat middlings, 1½lbs. oil meal.

15. *Wisconsin.* — 50 lbs. corn silage, 5 lbs. sheaf oats, 5 lbs. corn fodder, 1 lb. clover hay, 1 lb. millet, 2.7 lbs. cotton-seed meal, 1.3 lbs. oil meal, 6 lbs. wheat bran.

16. *Canada.* — 40 lbs. corn silage, 7½ lbs. clover hay, 3 lbs. straw, 1½ lbs. oats, 1⅓ lbs. barley, 1⅓ lbs. pea meal, 3 lbs. wheat bran, 1 lb. cotton-seed meal.

Books on Dairying.

1. The Business of Dairying — Lane, 8-12 — Webb Pub. Co., $1.25.
2. Profitable Dairying — Peck, 8-12 — Webb Pub Co., 75c.
3. The Farm and the Dairy — Sheldon, 8-12 — Macmillan Co., $1.00.

4. Dairy Cattle and Milk Production — Eckles, 8-12 — Macmillan Co., $1.60.
5. The Dairyman's Manual — Stewart, 8-12 — Webb Pub. Co., $1.50.
6. Testing Milk and Its Products — Farrington and Woll, 8-12 — Mendota Pub. Co.
7. Milk and Its Products — Wing, 8-12 — Macmillan Co., $1.50.
8. Modern Methods of Testing Milk and Milk Products — Van Slyke, 8-12 — Orange Judd Co., 75c.
9. Bacteria in Milk and Its Products — Conn — P. Blakiston's Son & Co.
10. Clean Milk — Belcher, 8-12 — Webb Pub. Co., $1.00.
11. Science and Practice of Cheese Making — Van Slyke and Purblow, 8-12 — Webb Pub. Co., $1.75.
12. Butter Making — Purblow, 8-12 — Webb Pub. Co., 50c.

References for Supplementary Reading.

The Dairy Industry in the United States has become of such great importance that the National Government has made an extensive study of this industry, and has an abundance of available information for the use of the student of dairying. Write to the U. S. Dept. of Agriculture, for any of the following:

F. B. No.	55	The Dairy Herd; Its Formation and Management.
	196	Breeds of Dairy Cattle.
	413	The Care of Milk and its Use in the Home.
	201	The Cream Separator, on Western Farms.
	348	Bacteria in Milk.
	541	Butter Making on the Farm.
	166	Cheese Making on the Farm.
	355	A Successful Poultry and Dairy Farm.
	280	A Profitable Tenant Dairy Farm.
	337	Cropping Systems for New England Dairy Farms.
	349	The Dairy Industry in the South.
	42	Facts About Milk.
Circulars No.	126	The Importance of Keeping Dairy Records.
	179	Cow-Testing Associations.
	139	The Score Card System of Dairy Inspection.
	153	The Dissemination of Disease by Dairy Products.
	103	Records of Dairy Cows.
	114	Sanitary Milk Production.
	117	A City Milk and Cream Contest.
	143	Milk and Its Products as Carriers of Tuberculosis Infection.

	142	Some Important Factors in the Production of Sanitary Milk.
	151	Competitive Exhibitions of Milk and Cream.
	158	Improved Methods for the Production of Market Milk.
	171	Fermented Milks.
Bulletins No.	92	The Milking Machine as a Factor in Dairying.
	17	Dairy Schools.
	58	The Fat Testing of Cream by the Babcock Method.
	126	The Bacteriology of Commercially Pasteurized and Raw Milk Market.
	194	Medical Milk Commissions and the Production of Certified Milk in the United States.
	70	The Milk Supply of 29 Southern Cities.
	20	The Milk Supply of Boston and Other New England Cities.
	138	The Milk Supply of Chicago and Washington.
F. B. No.	473	Tuberculosis.
	351	The Tuberculin Test of Cattle for Tuberculosis.

Bulletin No.	*Title.*	*State Experiment Station.*
159	Balanced vs. Unbalanced Rations for Dairy Cows	Illinois
233	Cow Testing Associations	California
114	Computation of Dairy Rations	Pennsylvania
13	Protein Requirements of Dairy Cows	Wisconsin
130	Feeding Dairy Cows	Minnesota
2	Cause of Variation in Milk Production	Missouri
5	Maintenance Trials with Five Jersey Cows	Missouri
160	Official Records of Pure-Bred Dairy Cows	Illinois
4	Digestion Trial with Two Jersey Cows	Missouri
129	Results of Douglas Co. Cow Testing Association	Nebraska
26	Studies in Dairy Production	Wisconsin
2	Cost of Milk Production	New Hampshire
164	Milk Required to Raise a Dairy Herd	Illinois
136	Care of the Dairy Herd	Ohio
128	Feeding Dairy Cows	Ohio
122	Testing the Dairy Cow	Ohio
135	Building Up the Dairy Herd of Ohio	Ohio
134	Production of Sanitary Milk	West Virginia
140	Dairy Suggestions from European Conditions	Illinois
160	Milk Fever	Kentucky
299	Bovine Tuberculosis	New York
152	Contagious Abortion of Cows	Illinois

CHAPTER XIV.

Swine.

The leading swine producing States of the Union, in the order of their rank in this industry are: Iowa, Illinois, Missouri, Nebraska, Indiana, Ohio and Kansas.

The following table will serve to show the growth and value of the swine industry as compared with our growth in population:

Year.	*Population.*	*Swine.*	*Value.*
1871	38,000,000	29,000,000	$165,000,000
1881	50,000,000	36,000,000	170,000,000
1891	62,000,000	50,000,000	210,000,000
1901	75,000,000	57,000,000	353,000,000
1911	95,000,000	65,000,000	615,000,000

PROBLEMS.

1. What was the per cent increase in our population from 1871 to 1911?
2. What was the gain per cent in the number of swine produced from 1871 to 1911?
3. What was the per cent increase in value of swine products from 1871 to 1911?
4. What year shows the lowest average value per head? which the highest.

In the growing of swine the farmer should keep in view the following important points:

1. Swine are grown for a single purpose.
1. Preference for pork must be the leading guide.
3. The butcher's preference is guided by the demands of his patrons.
4. Uniformity in size and quality is the most urgent demand.
5. There is a demand for products of the lard type and of the bacon type.
6. Pigs weighing from 225 to 250 command the highest price.
7. Age, weight and condition determine the value.
8. Pure-bred, high-grade swine will fatten easier, mature earlier, and be larger than scrubs.
9. Hogs as well as sheep are scavengers.

10. A few can always be raised with great profit.
11. Pure water, clean pens, pasture, exercise, balanced rations, breeding and quality insure success.
12. Protection from extreme heat or cold will help to produce thrifty hogs.

Breed and Type.

The breeds of swine are classified as:

1st. The Fat or Lard Type.
2nd. The Bacon Type.

The four most important and most popular breeds of the fat or lard type in the United States are:

1. Poland-China.
2. Duroc-Jersey.
3. Chester-White.
4. Berkshire.

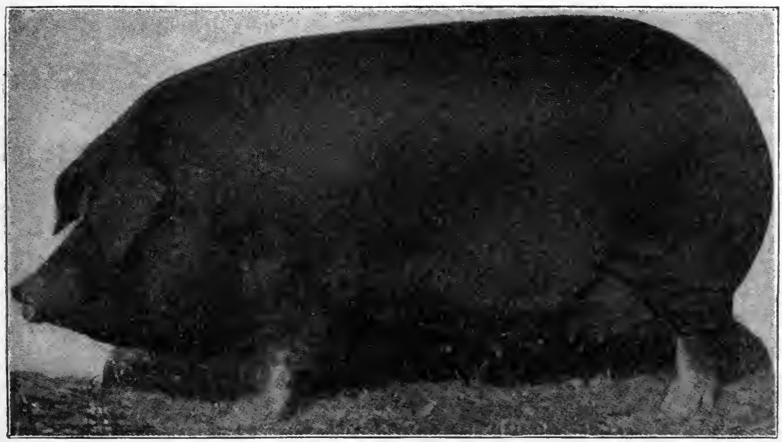


FIG. 1. The Fat or Lard Type.

The most important breeds of the bacon type are the:

1. Yorkshire.
2. Tamworth.
3. Hampshire.

The Poland-China, Duroc-Jersey, Chester-White and Hampshire are American breeds.

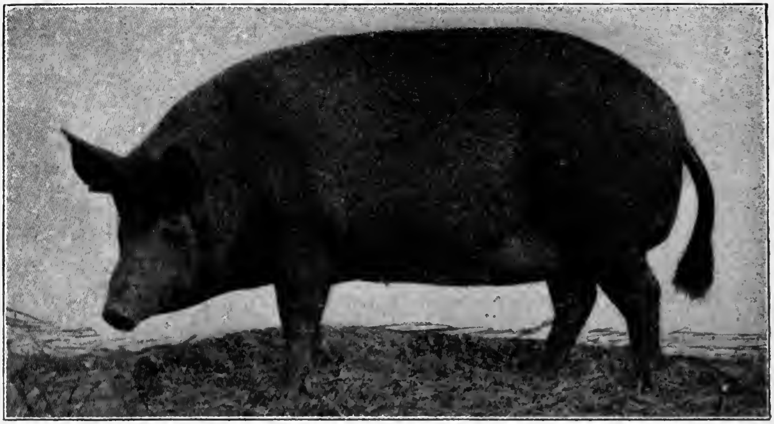


FIG. 2. The Bacon Type.

The Berkshire, Yorkshire and Tamworths are English breeds.

Different Growing Periods of Hogs.

1. The milk period — (First few weeks).
2. The milk and solid food period — (Learning to eat).
3. The growing period — (Weaned).
4. The fattening period — (Before marketing).

There is also a fifth or maintenance ration required for breeding stock. Breeders are somtimes kept until they are five or six years old.

Facts About Feeding Swine.

1. It takes one-third more grain to produce a pound of gain on a 300-pound pig than on a pig under 50 pounds.
2. Feed pigs three times a day until they are 4 months old.
3. The more a hog consumes the greater the gain.
4. Pigs weaned at eight weeks of age if they have been properly managed ought to weigh 38 to 40 pounds apiece.
5. Market hogs should weigh at least 200 pounds when 8 months old.
6. The most economical weight is gained by feeding clover or alfalfa with the ration.
7. The average age at which swine are sold in the United States is 11 months.

Feeding.

When corn alone is used for fattening, the number of pounds of corn required to produce a pound of gain in hogs, will depend upon size and condition of hogs; climatic conditions; nutritive value of corn fed; care, and manner in feeding; shelter exercise, water and many other causes that are important factors in determining the weight gained per pound fed.

The variation might be from 4 to 7 or even more pounds of corn for 1 pound gain.

It is therefore very apparent that the farmer who feeds swine for profit must understand thoroughly the growing, health, development and feeding of animals.

The feeder should be familiar with stock and crop conditions in the U. S. and abroad as given by the best stock journals, daily market reports and government bulletins.

Standard Feeding Rations.

Approximate requirements of nutrients per day per head
For growing fat swine.

Age, Months.	Average Weight per Head.	Digestible Nutrients.		Fuel Value, Calories.	Nutritive Ratio.
		Protein.	Carbo-hydrate Plus Fat.		
2-3	50	0.38	1.50	3,497	1:4.0
3-5	100	0.50	2.50	5,580	1:5.0
5-6	125	0.54	2.96	6,510	1:5.5
6-8	170	0.58	3.47	7,533	1:6.0
8-12	250	0.62	4.05	8,686	1:6.3

The figures in the above table show that the older the swine the wider is the ration required.

Experiments with Various Herds in Different State Experiments.

RATION PER PIG.

Pounds per Pig, per Day.	Number of Days Fed.	Average Initial Weight.	Average Final Weight.	Average Gain per Head.	Average Daily Gain.	
Corn, 5.63 lbs.	94	118.7	220.7	102.0	1.08	1
Corn, 4.86 lbs. + Alfalfa hay.	94	118.5	234.5	116.0	1.26	2
Corn, 4.41 lbs. + chopped alfalfa	94	120.0	245.8	125.8	1.31	3
Corn, 4.31 lbs. + .48 lb. Alfalfa meal	94	134.3	283.6	149.3	1.59	4
Corn, 3.12 lbs. + 8.59 lbs. sweet skim milk	94	92.0	193.5	101.5	1.65	5
Hominy feed, 2.76 lbs. + Shorts, 1.38 lbs.	110	69.9	175.7	105.8	.96	6
Corn meal, 2.97 lbs. + Shorts, 1.48 lbs.	110	69.3	165.0	95.7	.87	7
Corn meal, 4.66 lbs. + Linseed meal, .93 lb.	90	116.0	260.0	144.0	1.50	8
Corn meal, 3.54 lbs. + Wheat middling, 1.77 lbs.	90	114.0	226.0	112.0	1.20	9
Corn meal, 4.31 lbs. + Tankage, .21 lb.	60	176.0	248.0	72.0	1.20	10
Corn meal, 4.31 lbs.	60	114.2	169.0	54.8	.91	11
Corn meal, .853 lbs. + Wheat middlings, 3.98 lbs.	60	117.4	193.4	76.0	1.27	12

Rations suitable for growing market pigs:

Barley 3, wheat 3, tankage 1
Barley 2, shorts 1
Barley 3, shorts 1, skim milk
Barley 15, oil meal 1
Barley, alfalfa pasture
Barley 11, tankage 1, alfalfa pasture
Barley 3, shorts 1, alfalfa pasture
Barley 1, skim milk 3, alfalfa pasture
Barley 9, tankage 1

Corn may be substituted for barley in any of the above rations, and skim milk added to almost any ration for growing pigs will improve it. Any of the supplemental feeds should not be added in large enough quantities to induce scouring.

PROBLEMS.

1. If it requires on an average about $5\frac{1}{2}$ pounds of corn to produce one pound of weight in growing hogs, would it pay to feed 95c corn, to 5c hogs? What would be the gain or loss per pound?
2. At the rate of one pound grain for each 5.5 pounds of corn fed in fattening swine, what will be the results on the ledger in feeding 50c corn to 7c hogs?
3. At the present price of hogs and corn, does it pay to feed corn? (See daily market reports.)

Feeding Hogs.

PROBLEMS.

Tests at the Nebraska State Experiment Station show that hogs fattened on alfalfa hay and corn put on gain at a cost of $3.40 per 100 pounds; while hogs fed on corn alone cost $4.48 per hundred pound gain; what was gained by feeding a drove of hogs on a mixture of alfalfa hay and corn until they gained 1,640 pounds over another lot that made the same gain fed on corn alone?

2. The Kansas State Experiment Station reports that a bunch of hogs fed on corn and alfalfa made a gain of 90.9 pounds per hog in 10 weeks, while a similar bunch fed on corn alone gained 52.4 pounds per head in the same time. Each lot had all the corn they wanted. Those fed alfalfa had better digestion of corn eaten. The hog receiving alfalfa with corn gained how much more than the one that received corn alone? How much gain would that be on 1,000 pounds weight at present prices?

3. It is claimed by good authority that sows kept on alfalfa pasture will raise more pigs, and that at 3 months old they will weigh 25 per cent more than pigs raised without alfalfa pasture; what would be the gain in selling 100 pigs grown by this method if pigs raised by other methods are selling at $2.50 per head when 12 weeks old?

PROBLEM.

The Alabama Agricultural Experiment Station, after three years' work in swine production, gives following result:

1. When corn was used alone the average daily gain for each hog was .375 of a pound; when soybeans were pastured, with a fourth of a ration of corn the gain was 1.102 pounds; soybeans with half a ration of corn produced 1.006, and with three-fourths of a ration of corn the production was 1.329 pounds of gain per hog daily; what was the gain per cent by the use of three-fourths ration of corn with soybeans over the feeding of corn alone?

PROBLEMS.

The Texas Ag. Ex. Station, at the Fort Worth Feeding Station, fed pigs in five lots of seven to ten each; they averaged 108.4 pounds Feb. 3, when experiment was started.

1. Lot 1, consisting of 10 pigs, was fed on cornchops and cottonseed meal; 3661.5 pounds of cornchops and 916 pounds of cottonseed meal produced 1,505 pounds of gain. Find nutritive ratio, and amount of each kind of feed used per pound gain.

2. Lot 2, had 9 pigs which were fed 3,950 pounds of rice and 1022.5 pounds of cottonseed meal and the gain was 1,166 pounds; what was the nutritive ratio? What was the amount of each kind of feed fed per pound of gain?

3. Lot 3, in which 9 pigs were fed, the ration consisting of 4,905 pounds of rice, and 1156.5 pounds of tankage; the gain was 1055.5 lbs.; what was the nutritive ratio? What was the amount of each kind of feed consumed to produce one pound of gain?

4. Lot 4, with 8 pigs fed with 4,116 pounds of rice and 5,824 pounds of alfalfa produced 926 pounds of gain. Give nutritive ratio and amount of each feed per pound gain.

5. Lot 5, contained 7 pigs and the feed amounted to 4,390 pounds of cornchops, and 55 pounds of alfalfa meal. Give nutritive ratio of feed, and amount of feed for each pound of gain.

6. Which of the five foregoing rations was the most profitable, basing calculations on the present market prices of feeds and hogs ready for market?

Hogging-Down Corn.

Extensive experiments in Iowa, according to investigations of the Agricultural Experiment Station of the Iowa College of Agriculture at Ames, has resulted in the following information:

1. A surprising number of Iowa, Illinois, Missouri, Nebraska, Indiana and Kansas and other mid-western farmers are "hogging-down" corn because it is a paying proposition.
2. The practice has become popular within recent years because of the comparatively low quality and the general scarcity of labor.
3. Reports show practical results in 98 of Iowa's 99 counties.

NOTE.—For particulars, write to the Experiment Station at Ames, Iowa. Ask for Bulletin No. 143.

By "hogging-down" or feeding the hogs by turning them into standing corn the saving in labor is:

(a) Husking. (b) Cribbing. (c) Handling corn and feeding in yards. (d) Handling manure. (e) Storage space in cribs, etc.

Experiment for Students of Agriculture.

EQUIPMENTS:

1. Stock scales for weighing animals.
2. Small scales for weighing feed.

APPLICATION:

1. Weigh feed for each ration.
2. Weigh the lot to be fed.
3. Find average daily gain.
4. Find average cost of pound gain each day for a period of 5 or 10 days, each month.
5. Compare cost of production with market price, daily and weekly.

Exercises.

1. Show or explain how every family outside of a city or village can keep and feed enough hogs economically to keep the family supplied with lard and pork for home use.

Experiment.

2. Turn hogs into a patch of two or three acres of standing corn — just as it is beginning to get ripe; let them run in an adjoining field of clover or alfalfa; supply them with plenty of good water; weigh the hogs at the beginning of the experiment; note the daily gains by weighing if desired; weigh at end of experiment and find gain in weight and determine the price received per acre for corn, by multiplying the pounds gained by the market price, and deducting the approximate value of pasture.

Questions.

1. To what class of mammals do hogs belong: Carnivorous, herbivorous or omnivorous?
2. Make a list of different kinds of food eaten by hogs.
3. Does a hog eat snakes? If a hog should eat a rattlesnake would it poison him? Why?
4. Why should we have meat thoroughly cooked before eating? What is Trichina in pork?
5. Where are four of the great meat packing industries located?
6. What is the freight on a carload of hogs from your locality to the nearest stock market?

6. What is the freight on a carload of corn from your home market or elevator to the nearest large grain market?
7. Name the seven leading corn producing states.
8. Name the seven leading swine producing states.
9. Compare the lists in answer to questions 7 and 8; give reasons for conclusions.
10. If corn is relatively rich in oil and starch and deficient in protein, what would you recommend as a complement to help balance the ration?
11. Why are Kansas, Nebraska and Iowa well equipped for feeding balanced rations?
12. How many hogs are fed annually on the home farm?
13. How are they fed (give methods of shelter and kind of rations)?
14. What is "Hogging-down" corn? Is this a profitable method of feeding? What kind of pasture should be accessible to the hogs fed in this way?
15. How many different feeding periods in the life of a hog? What is the chief feed for each?
16. At what age are pigs usually weaned?
17. Name some causes for stunted pigs.
18. Name five breeds, giving characteristic color of each.
19. How does hog cholera spread from one part of the country to another?
20. Describe the symptoms of hog cholera.
21. What is the serum treatment for hog cholera?
22. How long after treatment by vaccination does the hog remain immune?

In the use of the score cards let the class in agriculture have special tests in judging weights. This can be done on the farm where there are stock scales or at the stock yards when cattle, hogs, sheep and horses are being weighed and loaded for shipment.

Score Card.

HOGS

(BREEDING ANIMALS).

Institution ....

SCALE OF POINTS.	Possible Score	POINTS. Students Score	Corrected
GENERAL APPEARANCE—30 Points			
Weight, estimated..............lbs., actual..............lbs., score according to age	6	......	......
Form, deep, broad, low, medium length, symmetrical, compact, standing squarely on legs	8	......	......
Quality, clean bone, fine skin and hair, clean cut features	7	......	......
Style, energetic, active, stylish carriage	1	......	......
Temperament, male, aggressive but not vicious; female, quiet, docile	1	......	......
Condition, healthy, naturally smooth and thick fleshed	3	......	......
Sexuality	4	......	......
HEAD AND NECK—8 Points			
Snout, medium length, not coarse	1	......	......
Face, short, cheeks full	1	......	......
Eyes, large, mild, full, bright, wide apart	1	......	......
Forehead, broad	1	......	......
Ears, medium size, fine, soft	1	......	......
Jowl, neat, broad, firm	1	......	......
Neck, thick, medium length	2	......	......
FOREQUARTERS—13 Points			
Shoulder, broad, deep, full, smooth, snug and well covered on top	6	......	......
Breast, wide, prominent	2	......	......
Legs, straight, short, strong; feet sound	5	......	......
BODY—27 Points			
Chest, deep, broad; girth large	6	......	......
Sides, deep, moderate length, closely ribbed, thickly and smoothly fleshed	4	......	......
Back, broad, slightly arched, medium length, thickly and smoothly fleshed	7	......	......
Loin, wide, strong, thickly and smoothly fleshed	7	......	......
Belly, straight, proportionate width, firmly fleshed	2	......	......
Flank, even with underline, full	1	......	......
HINDQUARTERS—22 Points			
Hips, wide apart, smoothly covered	2	......	......
Rump, long, wide, evenly fleshed, rounding from loin to root of tail	4	......	......
Hams, heavily fleshed, deep, wide	8	......	......
All Organs, normally developed	3	......	......
Legs, straight, short, strong; feet medium size	5	......	......
Total	100	......	......

Animal ....*Date* ....

Student .... *Standing* ....%

Score Card.

LARD HOGS.

Scale of Points.	Perfect Score.	Student's Score.	Corrected.
General Appearance:			
1. *Weight,* score according to age	6		
2. *Form,* deep, broad, low, long, symmetrical, compact, standing squarely on legs	10		
3. *Quality,* hair silky; skin fine; bone fine; mellow covering of flesh, free from lumps and wrinkles	10		
4. *Condition,* deep, even covering of flesh, and fat over all parts of the body	10		
Head and Neck:			
5. *Snout,* medium length, not coarse	1		
6. *Eyes,* full, mild, bright	1		
7. *Face,* short, cheeks full	1		
8. *Ears,* fine, medium size, soft	1		
9. *Jowl,* strong, neat, broad	1		
10. *Neck,* thick, medium length	1		
Forequarters:			
11. *Shoulder,* broad, deep, full, compact on top	6		
12. *Legs,* straight, short, strong; bone clean, pasterns upright; feet medium size	2		
Body:			
13. *Chest,* deep, broad; large girth	4		
14. *Sides,* deep, lengthy, full; ribs close and well sprung	6		
15. *Back,* broad, straight, thickly and evenly fleshed	10		
16. *Loin,* wide, thick, straight	8		
17. *Belly,* straight, even	4		
Hindquarters:			
18. *Hips,* wide apart, smooth	2		
19. *Rump,* long, wide, evenly fleshed, straight	2		
20. *Ham,* heavily fleshed, plump, full, deep, wide	10		
21. *Thighs,* fleshed close to hocks	2		
22. *Legs,* straight, short, strong; bone clean; pasterns upright; feet medium size	2		
Total	100		

Score Card.
BACON HOGS.

SCALE OF POINTS.	Perfect Score.	Student's Score.	Corrected.
GENERAL APPEARANCE:			
1. *Weight,* 170 to 200 lbs., largely the result of thick cover of firm flesh	6		
2. *Form,* long, level, smooth, deep	10		
3. *Quality,* hair fine; skin thin; bone fine; firm, even covering of flesh without any soft bunches of fat or wrinkles	10		
4. *Condition,* deep, uniform covering of flesh, especially in regions of valuable cuts	10		
HEAD AND NECK:			
5. *Snout,* fine	1		
6. *Eyes,* full, mild, bright	1		
7. *Face,* slim	1		
8. *Ears,* trim, medium size	1		
9. *Jowl,* light, trim	1		
10. *Neck,* medium length, light	1		
FOREQUARTERS:			
11. *Shoulders,* free from roughness, smooth, compact and same width as back and hind quarters	6		
12. *Breast,* moderately wide, full	2		
13. *Legs,* straight, short, strong, bone clean; pasterns upright; feet medium size	2		
BODY:			
14. *Chest,* deep, full girth	4		
15. *Back,* medium and uniform in width, smooth	8		
16. *Sides,* long, smooth, level from beginning of shoulders to end of hind quarters. The side at all points should touch a straight edge running from fore to hind quarter	10		
17. *Ribs,* deep	2		
18. *Belly,* trim, firm, thick without any flabbiness or shrinkage at flank	10		
HINDQUARTERS:			
19. *Hips,* smooth, wide; proportionate to rest of body	2		
20. *Rump,* long, even, straight, rounded toward tail	2		
21. *Gammon,* firm, round, tapering, fleshed deep and low toward hocks	8		
22. *Legs,* straight, short, strong; feet medium size; bone clean; pasterns upright	2		
Total	100		

Animal .... Date ....
Student .... Standing ....%

Other Score Cards.

Hogs, University of Illinois, Urbana, Ill.

References.

BOOKS.

1. Swine in America—Coburn, 8-12—Webb Pub. Co., $2.50.
2. Swine Industry—Coburn, 8-12—Webb Pub. Co., $1.50.
3. Harris on the Pig—Harris, 8-12—Webb Pub. Co., $1.00.
4. The Hog Industry—Rommel, 8-12.

FARMERS' BULLETIN.

Number.
100. Hog Raising in the South.
133. Profitable Crops for Pigs.
205. Pig Management.
272. A Successful Hog and Seed-corn Farm.
329. Hogging Off Corn.
315. Supplements to Corn in Hog Feeding.
56, 84, 97, 124, 305, 331, 334. Forage Crops for Hogs.
169, 296, 315. Tankage and Bone Meal for Hogs.
22, 144, 210, 251, 329. Feeding Swine.
222. Market Classes and Grades of Swine.
147. Market Classes and Grades of Meat.
438. Hog Houses.
273. Hog Cots.
379. Hog Cholera.

CHAPTER XV.

Sheep.

Sheep raising has for many years been one of the chief animal industries of the United States.

According to reports by the government, there were on January 1, 1913, 51,482,000 sheep in the U. S. They were valued at $202,779,000. What was the average value per head?

The number of sheep of shearing age April 1, 1912, was 38,481,000 and the average weight per fleece was 6.82 pounds. What was the total production of wool?

It has been estimated by competent authority that good breeding, selection, and feeding would raise the production of wool up to 10 lbs per head. What would be the value of this increased production per head at the present market price of wool?

The advantages of the sheep industry are mainly dependent upon the following well established facts:

1. Sheep are economical producers, requiring less than the average number of pounds of feed required to produce a pound of gain, among farm animals.
2. Initial investment for beginners in sheep raising need not be great.
3. Beginning with a small flock, it will grow with the experience of the owner.
4. Returns from investment are soon realized.
5. Two crops per year; wool and lambs.
6. Income distributed: wool sold in the spring and lambs in the fall.
7. Hot-house lambs may be sold at from 10 to 14 weeks of age.
8. Spring or summer lambs are ready for market when 8 months old.
9. Keeping ewe lambs will increase a flock very rapidly.
10. Sheep will live on waste places where cultivation is unprofitable.
11. They are the natural scavengers and fertilizers of the soil.
12. They have no equal as a weed destroyer. They eat nearly all weeds and grasses.
13. They will build up run down land and restore fertility to worn our pastures.
14. They do not require expensive buildings.
15. Sheep will do well in a dry, cool, well ventilated place.

16. Lambs require a warm pen for the first few weeks.
17. Heavy growth of wool in winter and shearing in the spring adapts sheep to extremes of cold and heat.
18. The sheep industry on the western ranges must eventually result in growing very few large bands of sheep as the west becomes more thickly populated and with this will come the better price for the small farm flock that has had special care for better mutton and wool.

Types and Breeds of Sheep.

There are two distinct types of sheep: the wool type for producing wool and the mutton type for producing meat.

The breeds of sheep are very numerous. This is perhaps due largely to adaptation to a wide range of conditions, varying all the way from the lowlands to the mountains, and to differences of moisture, temperature, pasture and other variations due to climate.

The following outline shows the classification of a few of the most important and best-known breeds in America, based on the wool and mutton types:

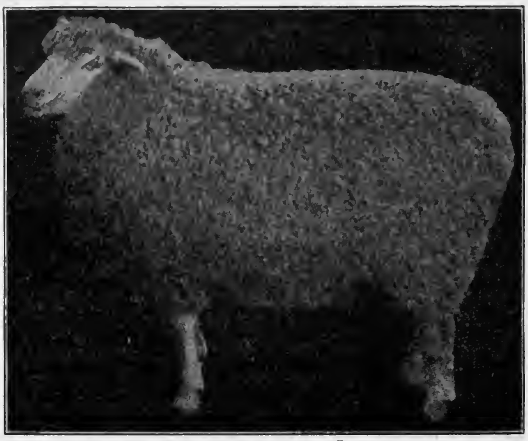


FIG. 1.— The Wool Type.

1. FINE WOOL TYPE—

   Wool Production.

      American Merino.
      Delaine Merino.
      Rambouillet.

2. MEDIUM WOOL TYPE—
Mutton Production.
Shropshire.
Southdown.
Hampshire.
Oxford.
Suffolk.
Dorset Horn.
Cheviot.
Tunis.

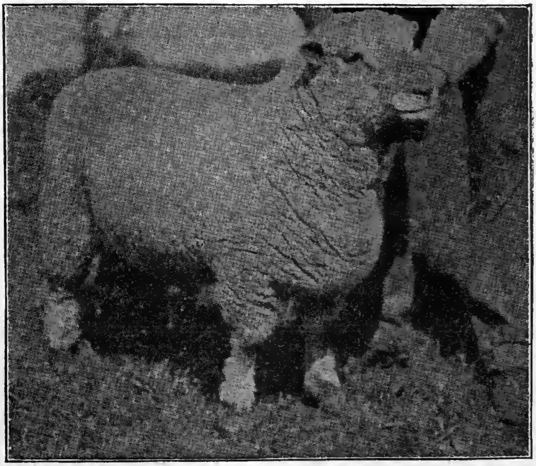


FIG. 2. — The Mutton Type.

3. LONG OR COARSE WOOL TYPE—
Mutton Production.
Lincoln.
Leicester.
Cotswold.
Kent or Romney Marsh.

The Sheep Market.

There is a demand for that which is rare or unusual in the culinary art. Lambs for the period from December 1st, to May 1st, are in good demand. They are sold in the eastern markets by the carcass instead of by the pound. They have sold for from $4 per lamb to as high as $12.50 for a prime lamb.

The term "hothouse lamb" is applied to lambs born in the late fall or early winter, probably because the lamb is grown at a time when plants can be grown only in the hothouse or greenhouse.

There is perhaps no other animal product of the farm that is subject to such great fluctuations in the market as sheep. The market price of both wool and mutton are uncertain and subject to extreme values.

The best time for the beginner to go into the sheep industry is when sheep are very low in price. When many people are selling because of falling prices, is the time to buy, because a reaction must result when the supply is no longer equal to the demand.

Standard Feeding Rations.

APPROXIMATE REQUIREMENTS OF NUTRIENTS PER DAY PER HEAD FOR FEEDING SHEEP.

	Age.	Average Live Weight per Head.	Digestible Nutrients.			Fuel Value.	Nutritive Ratio.
			Protein.	Carbo-hydrates.	Fat.		
	Months.	Lbs.	Lbs.	Lbs.	Lbs.	Calories	
Growing sheep ..	5–6	56	0.18	0.87	0.045	2,143	1:5.4
	6–8	67	0.17	0.85	0.040	2,066	1:5.4
	8–11	75	0.16	0.85	0.037	2,035	1:6.0
	11–15	82	0.14	0.89	.032	2,050	1:7.0
	15–20	85	0.12	0.88	0.025	1,956	1:8.0

The following table shows results of feeding different rations as tried out by a number of experiment stations in states that lead in feeding sheep:

Rations for Fattening Sheep.

Average Number of Pounds of Feed for Each Animal Per Day.	Number of Experiment.	Average Initial Weight.	Average Final Weight.	Average Gain Per Head.	Average Daily Gain.
1.22 shelled corn + 1.05 clover + 1.67 silage	1	62.5	92.8	30.3	.337
.61 shelled corn + .61 oats + 1.03 clover, 1.67 silage	2	62.5	90.2	27.7	.308
1.26 shelled corn + 2.11 clover	3	62.5	94.6	32.1	.357
1.11 shelled corn + 2.15 clover + .15 cotton seed meal	4	62.4	95.6	33.2	.368
1.11 shelled corn + 1.04 clover + 1.94 silage	5	62.7	94.7	32.0	.355
1.02 shelled corn + 1.04 clover + 1.94 silage, .25 cotton seed meal	6	62.5	94.9	32.4	.360
1.00 shelled corn + 2.66 silage + .15 cotton seed meal	7	62.7	87.6	24.9	.276
1.02 shelled corn + .93 Timothy hay	8	59.1	72.6	13.5	.192
1.23 shelled corn + 1.41 clover	9	59.4	82.2	22.8	.325
1.02 shelled corn + .15 cotton seed meal + .98 Timothy hay	10	59.4	78.1	18.7	.268
1.08 shelled corn + 1.44 clover + .16 cotton seed meal	11	59.3	84.0	24.7	.353
1.19 shelled corn + .90 clover + .94 silage	12	59.6	82.2	22.6	.323
1.07 shelled corn + .91 clover + .94 silage, .15 cotton seed meal	13	59.2	83.4	24.2	.346
.95 shelled corn + .95 oats + 1.71 Alfalfa	14	81.4	119.4	38.0	.560
.92 shelled corn + .92 oats + .85 native hay	15	83.6	107.9	24.3	.360
.16⅔ shelled corn + .16⅔ oats + .16 2/3 bran, 2.00 turnips, 1.50 native hay	16	101.1	123.6	22.5	.229
.16⅔ shelled corn + .16⅔ oats + 1.50 clover + .16 2/9 bran, 2.00 turnips	17	102.2	136.7	34.5	.351
Rape pasture	18	67.0	77.7	10.7	.34
.42 shelled oats + rape pasture	19	65.6	.755	10.0	.32
.75 oats + rape pasture	20	65.5	.775	12.0	.38
.54 barley + rape pasture	21	65.6	.773	11.7	.37
.92 shelled corn + .13 oats + 1.10 mixed hay + 1.12 roots	22	55.0	....	......	......
.49 bran + .37 linseed meal + .37 cotton seed meal + 1.47 hay + 1.43 roots	23	56.0	....	......	......
1.40 speltz + .10 bran + 1.80 clover hay	24	111.0	....	......	......
1.40 soy beans + .10 bran + 1.80 clover hay	25	110.0	....	......	......
.93 shelled corn + .45 gluten + .10 bran + 1.80 clover hay	26	109.0	....	......	......
1.35 shelled corn + .10 bran + 1.80 clover hay	27	109.0	....	......	......
1.49 shelled corn + 1.04 clover hay	28	82.0	....	......	......
.64 shelled corn + .64 wheat + 1.24 clover hay	29	85.0	....	......	......
1.64 oats + 1.40 clover hay + 1.00 roots	30	83.0	....	......	......
1.54 shelled corn + 1.88 corn fodder	31	76.0	....	......	......
.97 cotton seed meal + .97 cotton seed hulls	32	62.0	....	......	......
.67 shelled corn + 2.90 Alfalfa	33	89.0	....	......	......
.77 barley + pasture	34	80.0	....	......	......
.78 oats + pasture	35	81.0	....	......	......
.80 shelled corn + pasture	36	80.0	....	......	......

A careful study of the foregoing table shows different results obtained by feeding different rations.

The rations are numbered from 1 to 36 for convenience in referring to them in the following discussion:

1 and 2 show difference between a ration containing corn and one containing oats and corn.
3 and 4 show difference between using cottonseed meal in and leaving it out of the ration.
5 and 6 show effect of adding cottonseed meal to corn, clover and silage.
8 shows results of leaving out silage and cottonseed meal.
8 and 9 show effects of changing from timothy to clover.
11 and 12 show results of cottonseed in a ration of corn and clover.
12 and 13 show effects of cottonseed meal in a ration of corn, clover and silage.
16 and 17 show results with turnips.
14 and 15 show difference between use of alfalfa and native hay.
19 and 21 show results with rape pasture.

PROBLEMS.

1. In ration 1, how many pounds of each kind of feed will be required to produce one pound gain in lambs?

2. In ration 7, how many pounds of each kind of feed will produce one pound in grain?

3. In ration 23 how many pounds of each kind of feed will be required to produce one pound of weight?

Feeding Problems.

1. If 4.98 pounds of corn plus 3.83 pounds of clover hay will produce one pound of gain in lambs; what is the gain or loss in feeding corn at 70c a hundred and clover at $10 a ton at the present price of lambs?

2. What will be the cost of a ration that will produce one pound of gain in lambs, if it consists of 4.12 pounds of clover hay plus 4.47 pounds of corn and oil meal mixed (5:1), if hay is $12 per ton and corn is 50c a bushel and oil meal is $32 per ton, when lambs are selling for 8c a pound?

3. If a feed consists of:

Corn and Oil meal 5:1	5.07 pounds.
Corn stover	5.27 pounds.

Compare cost of ration at present prices with the present selling price of lambs per pound.

4. If ration number 6 in the table will produce an average daily gain of .36 of a pound, what will be the cost of a ration that will produce a pound gain if it is composed of the same foods mixed in the same ratio, when lambs are selling at the present price?

5. It has been estimated that the following ration will produce one pound of gain:

Corn and oil meal 5:1	3.88 pounds.
Alfalfa	10.383 pounds.

Estimate loss or gain at current prices.

6. Corn and oil meal in the ratio of 5:1 to the amount of 5.56 pounds were fed with 4.67 pounds of oats straw and the gain was one pound; determine results based on market prices.

7. The most extensive experiments in feeding lambs on rape have been tried out on the Ontario Experiment Station. In 1890 at this station 54 acres of rape pastured 17 head of steers and 537 head of sheep. The result showed that one acre of rape was worth $16.80. What was the income from the 54 acres?

8. In another trial on the Ontario Experiment Farm, 60 lambs were kept on 2.18 acres of rape for 25 days, during which time the increase in the weight of the lambs was 390 pounds; at that rate what would be the gain per acre at the present price of lambs?

9. At the Michigan Experiment Station, 15 acres of rape pastured 128 lambs, 7½ weeks with a total gain of 2,890. At that rate of gain what would be the income from 40 acres at the market price of lambs?

10. At the Ontario Station 6 lambs were pastured on one-sixth of an acre for one month, at this rate how many lambs could be pastured on one acre for two months?

11. The New Hampshire Experiment Station made the following experiment: 10 lambs were divided into two lots of five each. The dry fed lambs were fed one pound of grain (oats, bran and corn in equal parts by weight) and 2 pounds of clover hay each daily; the other lot was fed ¾ of a pound of the same grain mixture, 1¼ pounds of clover hay and 5 pounds of turnips each daily. They were fed 100 days. The cost of each ration was 3½ cents per lamb per day.

The five dry fed lambs gained	142.5 pounds.
The turnip fed lambs gained	185.5 pounds.

What was the cost per 100 pound gain of the dry fed lambs?
What was the cost per hundred of the turnip fed lambs?

Exercises and Experiments.

1. Show different results from experiments with cotton and woolen goods.
   - (a) — Show difference between the fading of cotton and woolen goods.
   - (b) — Show difference between the shrinking of cotton and woolen goods.
   - (c) — Show different results by burning a small strip of fiber or filling of each cotton and woolen goods.

2. Let the boy on the farm make an experiment in feeding one or two lambs on a balanced and economic ration, weighing and showing results as compared with the average weight of the lambs in the flock when sold.

How to Tell Wool.

If you want to know whether the goods you buy for wool is "all wool" or just a shoddy imitation, apply the following test:

Hold a lighted match to the material and watch it burn. Wool burns slowly, goes out quickly, leaves a gummy residue and has a very disagreeable odor.

Questions.

1. Are there any obstacles in the way of raising sheep on your farm?
2. Are there any sheep raised in your school district? What breeds are raised?
3. Could any sheep be raised on your farm without interfering with the crops now raised?
4. Into what two main classes are sheep divided? Name some leading breeds of each class.
5. Name the leading sheep-raising states of the United States. Name some goat-raising countries.
6. What products are obtained from sheep? From goats?
7. What are the products obtained from Angora goats? Give special advantages to Agriculture.
8. Why is the extensive raising of sheep and goats generally confined to rough and rugged regions?
9. From what kinds of fleeces do we get cashmere shawls and other genuine cashmere goods?
10. Describe ideal winter quarters for sheep. Why should they be well ventilated?
11. What may be the weight of a full-grown sheep. Weight of an average fleece?
12. Compare the foot of a sheep with that of a horse, that of a cow.
13. Which makes better clothing, coarse or fine wool?
14. Does cold weather trouble sheep? Wet weather?
15. Is there enough feed wasted on an ordinary farm to keep a small flock of sheep?
16. Do sheep require as much grain as other animals?
17. How does the length, evenness and density of the fleece effect its value?
18. How does sheep shearing effect sheep? When should they be sheared?
19. What are the results of over-feeding with a grain ration?

20. For what distinct advantages are each of the following breeds noted:

(a) American Merino; Rambouillet or French Merino; Delaine Merino?

(b) Shropshire; Oxford Down.

(c) Cotswold; Cheviot.

21. Would it pay to pasture sheep on $200 land?

Score Card.

MUTTON SHEEP.

(UNVERSITY OF MISSOURI, DEPARTMENT OF ANIMAL HUSBANDRY)

	Fat Wethers.	Breeding Animals.
GENERAL APPEARANCE		
Weight, estimated........lbs.; actual........lbs., score according to age	6	5
Form, straight, top line and underline, deep, broad, low, medium length, symmetrical, compact, standing squarely on legs	8	7
Quality, bone of firm texture, fine skin, silky hair, clearly defined features and joints, mellow touch, fleece soft, fine, pure	6	6
Condition, thick, even, covering of firm flesh, especially in regions of valuable cuts, indicating finish; light in offal.	6	3
HEAD AND NECK		
Muzzle, good size, lips thin; nostrils large and well apart, jaws wide	1	2
Face, short, broad, profile straight	1	1
Eyes, large, full, clear, bright	1	1
Forehead, broad	1	1
Ears, well carried, fine, medium size	1	1
Neck, thick, short; throat clean	3	3
FOREQUARTERS		
Shoulder Vein, smooth, full	2	1
Shoulders, smoothly covered with firm flesh; compact	4	4
Brisket, broad, full; breast wide	2	2
Legs, straight, short, strong, wide apart; forearm full; shank fine; feet sound	2	3
BODY		
Chest, deep, broad; girth large; foreflank full	4	5
Back, broad, straight, medium length, thickly, evenly and firmly fleshed	7	5
Ribs, deep, well sprung, closely set, thickly, evenly and firmly fleshed	6	5
Loin, broad, straight, thickly, evenly and firmly fleshed	6	5
Flanks, full, low	2	2
HINDQUARTERS		
Hips, smoothly covered, proportionate width	3	2
Rump, long, level, width well carried back; thickly, evenly and firmly fleshed	5	4
Thighs, deep, wide, well fleshed	4	3
Twist, deep, broad, well filled	6	4
Legs, straight, short, strong; shank smooth, strong	2	3
FLEECE AND SKIN		
Quantity of Wool, long, dense, even, well distributed over body.	3	4
Quality of Wool, fine, soft, pure, even, crimp close and uniform.	3	4
Condition of Wool, bright, strong, clean, yolk abundant	2	3
Skin, pink color, clear	3	4
Style, active, graceful carriage	....	1
Temperament, male: aggressive but not vicious; female: quiet, docile	....	1
Sexuality	....	5
Total	100	100

Other Score Cards.

Fine Wool Sheep, (Delaine and Rambouillet), New York State College of Agriculture, Ithaca, N. Y.

Books.

1.	Sheep Farming—Craig and Marshall, 8-12—Macmillan Co......	$1 50
2.	Shepherd's Manual—Stewart, 8-12—Webb Pub. Co............	1 00
3.	The American Merino—Powers, 8-12—Webb Pub. Co..........	1 50
4.	Manual of Angora Goat Raising—Thompson, 8-12.............	....

BULLETINS FROM THE U. S. DEPT. OF AGRICULTURE.

FARMERS' BULLETINS.

Number.

96. Sheep Raising for Mutton.
119. Establishing a Flock of Mutton Sheep.
49. Sheep Feeding.
457. Early Spring Lambs.
360. Market Classes and Grades of Sheep.
159. Scab in Sheep.
137. The Angora Goat.
330. Deer Farming in the United States.

BUREAU OF ANIMAL INDUSTRY.

Number.

81. The Sheep Industry of England, Scotland, Ireland and France.
94. Foot Rot of Sheep.

Circular 102. Stomach Worms in Sheep.

CHAPTER XVI.

Poultry.

The poultry problem is in many respects similar to the dairy problem. Hon. James Wilson, United States Secretary of Agriculture in his annual report dated November 22, 1905, said:

"The farmer's hen is becoming a worthy companion to his cow."

Still more recently, in 1911, Secretary Wilson said: "We can hardly employ ordinary arithmetic in keeping track of the growth of the poultry industry. It has developed more rapidly within the last decade than any other of the big and wonderful agricultural industries of this big and wonderful country of ours."

PROBLEMS.

In ten years the annual production of poultry and eggs increased from a valuation of $280,686,429 in 1900, as per United States census report to more than $850,000,000 for the year which ended June 30, 1910. What was the per cent gain?

A Billion Dollar Industry.

The poultry business has become one of the leading agricultural industries of the country. The following figures will show how rapid has been the growth in recent years:—

Year.	*Value of poultry products.*
1889	$282,000,000
1904	500,000,000
1907	600,000,000
1909	700,000,000
1914	1,000,000,000

It is now undoubtedly one of our billion dollar industries.

Thought, study, observation, investigation and experimentation will undoubtedly double this production within a remarkably short period.

The increasing growth and profit of this industry will be solved upon the strict observation of some of the following facts:

1. Among hens as among cows there are the "star boarders."
2. In nearly every flock there are good and poor layers.
3. On an average it takes a cash value of 100 eggs to support a hen a year.
4. It must be determined which hens are laying unprofitable eggs.
5. Kill the drones and profit-killers and keep the profit-makers.

The money making values in poultry are:

1. Quick maturity.
2. Prolific yield.
3. Attractive appearance.

A Great Economic Fact.

It must be a fact of tremendous significance to the student of agriculture when he discovers that a hen laying over 200 eggs per year at the present average price of eggs (24c per dozen) is yielding a greater profit than the average cow in the United States.

Poultry running at large on the farm will produce eggs at far greater profit than when they are kept where they must be fed regular rations at the present high cost of feed.

A small flock of hens on the farm will pay although they receive little care, but with proper care and management they can be made to yield the farmer a much greater income.

PROBLEMS.

1. Assuming that the population of New York City is now 5,000,000, how many dozen eggs would be required, so that each person could be supplied with two eggs for one meal?

2. In 1909, there were received in New York City, 4,256,320 cases of eggs, each case holding 30 dozens; what was the total number of eggs received?

3. If these eggs cost $25,000,000 on the farm, and the consumers paid on an average 50 per cent more than that amount, what did they cost the consumers?

4. The average farm price of eggs in 1899 was 11.15 cents per dozen; in 1909 it was 19.7 cents; what was the gain per cent in the market price on the farm from 1899 to 1909?

5. If a flock of hens kept in an intelligent manner, will produce on an average 120 eggs per year, per hen and if the market price is on an

average 20 cents per dozen, what is the value of a year's product from a flock of 95 hens?

6. If we estimate pay for feed, labor, interest on the investment, as given by the experiment stations, at $1 per head; what is the net profit on each hen according to figures given in problem 5? What is the per cent gain?

7. The U. S. Department of Agriculture reports that 7.8 per cent of all eggs marketed in the U. S. are rotten or unfit for use; what was the loss to consumers, if they paid $500,000,000 for eggs in 1911?

8. If eggs uniform in size and color are worth 3 cents more per dozen in the big markets, than eggs indiscriminately mixed, what was the gain of the man who kept pure bred chickens for uniformity of color of eggs, and who assorted his eggs for uniformity in size and received 23 cents per dozen for 65 crates of eggs?

9. An experiment in 1907-8 by the Agricultural College of South Australia, showed an average annual production of 255 eggs per bird for two years; at the present price of eggs, what would be the gross earnings per hen?

The Ohio Experiment Station secured reports through co-operative experiments on 31 flocks of chickens in the State of Ohio; 18 of these were farm flocks, and 13 were city-lot and surburban home flocks. The average size of the farm flocks was 121 fowls; the average size of town flocks was 46 fowls.

1. The greatest profit from a flock on the farm was $2.47 per head, while the flock yielding the least profit showed only 14.5 cents per fowl. What would be the difference in income from these two flocks, if the flock yielding the greatest profit consisted of 96 fowls and the lowest yielding flock consisted of 149 fowls?

2. If the average profit from town flocks was 32 cents per fowl, and the average profit was 83 cents per fowl from farm flocks, what was the difference in profit between a town flock and a farm flock if each contained 82 fowls?

3. One town flock of 60 fowls yielded a profit of $1.29 per head; and another flock in town yielded 56 cents, profit per head in a flock of 87 fowls; what was the income from each flock? What was the gain percent of the better flock over the one giving the poorer yield?

4. The investigation showed that the feed for the 13 town flocks cost on an average 97 cents per head; and 18 farm flocks cost 61 cents per head; how much greater is the cost per cent of the town flocks over the farm flocks? Why this difference?

5. According to reports of the station one town flock produced 145 eggs per hen in a year, and another flock produced 43 eggs per fowl per

year; if the average cost of feeding was 97 cents, cost of labor 60 cents per fowl and the average price 23 cents per dozen, what was the gain or loss in each flock per fowl?

6. A poultryman kept 96 fowls, that laid 128 eggs each per year; the feed cost 52.6 cents and the care 36.4 per fowl; he received on an average 27.7 cents per dozen. What was the profit per fowl for the year?

7. Eighty is the average number of eggs laid per year by the American hen. Is that a profitable production?

Poultry Breeds.

The following are among the best known poultry breeds:

1. The Mediterranean or Egg breeds.
   - (a) Leghorns.
   - (b) Minorcas.
   - (c) Spanish.
   - (d) Blue Andalusians.
   - (e) Anconas.

FIG. 1. A high record Plymouth Rock.

FIG. 2. A sturdy, massive male Plymouth Rock.

2. The American or General Purpose breeds.
   - (a) Plymouth Rocks.
   - (b) Wyandottes.
   - (c) Javas.
   - (d) Dominiques.
   - (e) Rhode Island Reds.
   - (f) Buckeyes.

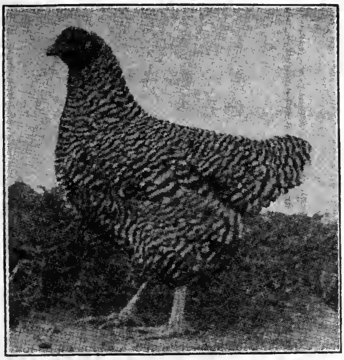


FIG. 3. Plymouth Rock Hen with high record yield.

3. The Asiatic or Meat breeds.
   - (a) Brahmas.
   - (b) Cochins.
   - (c) Langshans.
4. The English breeds.
   - (a) Dorkings.
   - (b) Orphingtons.
   - (c) Redcaps.

The Leghorns lead in the production of eggs.

The Plymouth Rocks are the best general purpose breed.

The Brahmas are the best meat producers.

In all cases whether breeding for egg production, general purposes or for meat, pure bred poultry means uniformity of products, better prices and increasing profits.

Feeds and Feeding for Poultry.

A chemical analysis of the laying hen and of a fresh egg shows the following composition:

	Water.	*Protein.*	*Fat.*	*Ash.*
Laying hen	55.8	Per cent 21.6	17	3.8
Fresh egg	65.7	.... 11.4	8.9	12.2

It has also been determined by conclusive experiments that hens in full laying should have the following digestible nutriments per day for each 100 pounds of live weight:

	Dry Matter. pounds.	*Protein.*	*Carbo-hydrates.*	*Fat.*	*Ash.*
(a) Hens of 3 to 5 pounds weight	3.3	0.65	2.25	0.2	0.2
(b) Hens of 5 to 8 pounds weight	5.5	1.00	3.75	0.35	0.3

PROBLEMS.

1. Find the nutritive ratio of the composition of the laying hen.
2. Find the nutritive ratio of a fresh egg.
3. Find the nutritive ratio of each of the feeds given above.
4. What is the average nutritive ratio of the two feeds (a) and (b) for laying hens?

A comparison of the food to be fed and of the composition of the egg and hen shows that the character of the food must be determined by the composition of the product desired.

The above figures indicate that the laying hen requires:

(a) A good supply of fresh water at all times.
(b) A large amount of water in succulent feed.
(c) A high percentage of protein in the body, egg and feed.

PROBLEMS.

1. Find the nutritive ratio of corn if its composition (according to Henry) is protein 7 per cent, carbohydrates 63.4, fat 3.9.

2. The analysis of meat scraps shows that they consist of the following: protein 68.4 per cent, carbohydrates 0.3 per cent, fat 13.5 per cent; what is the nutritive ratio?

3. In comparison of corn and meat scraps, which do you find to be too wide as a ration, and which too narrow?

4. How many pounds of meat scraps would be required in a mixture with 100 pounds of corn to make a balanced ration at a nutritive ratio of 1:4.3?

Requirements of a Successful Ration.

1. The ration must contain sufficient food nutrients.
2. The food nutrients must be in the right proportion.
3. The ration must be succulent and palatable.
4. The ration must have sufficient bulk.
5. The feeds must be economical but not necessarily cheap.
6. The rations must be fed regularly and intelligently.
7. There must be special feeds of grit, shells, charcoal and salt.

The prejudice that exists against the use of salt for feeding poultry is probably due to the fact that often times when poultry has been fed on meat that was kept in brine it resulted in the death of some of the members of the flock.

In a comparison of feeds or balanced rations for farm animals it is found that poultry requires a greater percentage of mineral constituents than are needed by other farm animals.

The rapid growth in comparison to the period from hatching to maturity is the real cause for the great demand of feeds containing material for growing the frame work of the body.

Between the ages of 6 and 13 weeks it has been determined that on an average it will require from 4 to $4\frac{3}{4}$ pounds of feed to produce 1 pound of gain.

From 13 to 26 weeks old it will require from $4\frac{3}{4}$ to $5\frac{3}{4}$ pounds of feed to produce 1 pound of gain.

PROBLEM.

When 5 pounds of feed will produce 1 pound of poultry, find the profit in producing 100 pounds of poultry @ 20c per pound, when feed costs 2c a pound.

A Comparative Study of Growth in Animals.

An analysis of the milk of mammals as used for feeding their young and a comparison of the rapidity of growth show the following results:

(This relationship is indicated in the following table taken from bulletin 201 of the Ohio Experiment Station:)

Species.	Time in days for the new-born animal to double its weight.	100 Parts of Milk Contain			
		Protein.	Ash.	Calcium.	Phosphorus.
Man	180	1.6	0.2	.021	.022
Horse	60	2.0	0.4	.086	.057
Cow	47	3.5	0.7	.114	.087
Goat	22	3.7	0.78	.143	.122
Sheep	15	4.9	0.84	.178	.127
Swine	14	5.2	0.80	.178	.135
Cat	9.5	7.0	1.02	......	......
Dog	9	7.4	1.33	.321	.223
Rabbit	6	10.4	2.50	.636	.437

From the above table it will be noted that the rapidity of growth is closely related to the mineral nutrients, ash, calcium and phosphorus.

PROBLEM.

If an experiment showed that 770 chicks weighed 61 pounds at hatching time, and 140 pounds at the end of two weeks, about how long does it take for chicks to double in weight?

Questions.

1. Why does the young bird in growing require food containing more phosphorus than a mature fowl?
2. Why do growing chicks require more feed in proportion to their size than growing claves?
3. How old must a colt be to double its weight? a lamb? a young rabbit?

PROBLEM.

1. If a colt will double its weight in 60 days and a chick will double its weight in 10 days, how many times greater is the process of digestion and assimilation in the chick than in the colt?

The New York Experiment Station has determined certain feeding standards for poultry, of which the following is taken for chicks:

POUNDS.

	Dry Matter.	*Ash.*	*Protein.*	*Carbo-hydrates.*	*Fat.*	*Nutritive Ratio.*
For First Two Weeks	10.1	.5	2.0	7.2	0.4	1:4.1
From 2 to 4 weeks of age	9.6	.7	2.2	6.2	0.5	1:3.4
From 4 to 6 weeks of age	8.6	.6	2.0	5.6	0.4	1:3.8
From 6 to 8 weeks of age	7.4	.5	1.6	4.9	0.4	1:3.7
From 8 to 10 weeks of age	6.4	.5	1.2	4.4	0.3	1:4.3
From 10 to 12 weeks of age	5.4	.4	1.0	3.7	0.3	1:4.4

The above are the digestible nutrients per day for each 100 pounds live weight.

Poultry Foods and Feeding the Business Hen.

The following table shows the composition and nutritive ratio of some of the common materials used as poultry foods:

(Henry's Feeds and Feeding.)

	Per Cent.				
	Ash.	*Crude Protein.*	*Carbo-hydrates.*	*Fat.*	*Nutritive Ratio.*
Corn, Dent	1.5	7.0	63.4	3.9	1:10.3
Wheat, winter	1.8	9.2	55.9	1.	1: 6.5
Barley	2.4	9.5	66.1	1.2	1: 7.2
Oats	3.0	9.1	44.7	4.1	1: 5.9
Buckwheat	2.0	7.7	49.2	1.8	1: 6.9
Peas	2.6	18.0	56.0	.9	1: 3.2
Soy Bean	...	29.6	17.7	15.9	1: 1.8
Cowpea	...	18.1	34.5	1.3	1: 2.1
Cornmeal, bolted	...	6.3	61.8	3.0	1:11.0
Wheat bran	5.8	12.6	44.1	2.9	1: 4.0
Wheat middlings	3.8	12.2	47.2	2.9	1: 4.4
Oatmeal	...	11.3	49.9	5.8	1: 5.5
Brewer's grains, dried	...	16.2	35.5	5.3	1: 2.9
Gluten meal	.8	25.0	49.4	5.6	1: 2.5
Linseed meal	5.3	27.2	31.8	2.7	1:14.0
Dried blood	4.7	59.1	....	2.3	1: 0.1
Meat scraps	4.1	68.4	.3	13.5	1: 0.4
Skimmed milk	...	2.9	5.2	.3	1: 2.0
Red clover hay	6.2	6.5	34.9	1.6	1: 5.9
Mangels	...	1.1	4.8	...	1: 4.4
Rutabagas	...	.9	7.1	...	1: 8.9

PROBLEMS.

1. Which of the above foods do you find to be too wide as a poultry ration?
2. Which of the above foods are too narrow for a poultry ration?
3. Figure out a balanced ration of the nutritive ratio of 1:4.4 for chicks 10 or 12 weeks' old.
4. Figure out a ration of the proper nutritive ratio of 1:3 which is about a proper summer ration for White Leghorns.
5. Prepare a formula from the above feeds for a scratching ration having a nutritive ratio of 1:6.6.

NOTE — Care must be taken that the ration shall have sufficient bulk — be palatable, succulent and be of the proper nutritive ratio.

A good summer ration for laying hens. (Especially White Leghorns.)

Mixture No. 1.

DRY MASH.

Kind of Food.	Amount by Weight. Pounds.	Amount by Measure. Quarts.	Dry Matter.	Ash or Mineral Matter.	Protein.	Carbohydrates Plus Fat × 2¼.	Cost.
Wheat Bran	200	380	176.0	11.6	24.2	90.6	$3 20
Wheat Middlings	200	240	176.0	7.6	25.6	121.4	3 50
Ground Oats	200	200	178.0	6.0	18.4	113.6	3 30
Corn Meal	100	95	89.0	1.5	7.9	76.4	1 65
Gluten Meal	100	80	92.0	.8	25.8	65.6	1 70
Meat Scrap..............	100	86	89.3	4.1	66.2	31.1	3 00
Short Cut Alfalfa.........	100	200	92.0	7.4	11.0	42.3	1 60
Salt	4	......	......	......	......	......	......
Total	1,004	1,381	892.3	39.0	179.1	541.0	$17 95
Average to one pound....	......	1.38	.892	.039	.179	.541	$.018

Nutritive Ratio, 1:3.02.

Alfalfa and meat scraps may be reduced in quantity or omitted entirely when birds can get a sufficient amount of green grass and insects.

Oil meal instead of gluten meal will hasten the growth of feathers.

For heavier breeds it is advisable to cut down this ration and compel laying hens to hunt and scratch for rations in the litter.

It is advised to change occasionally from feed No. 1 to the following:

Mixture No. 2.

SUMMER DRY MASH.

Kind of Food.	Amount by Weight. Pounds.	Amount by Measure. Quarts.	Dry Matter.	Ash or Mineral Matter.	Protein.	Carbohydrates Plus Fat × 2¼.	Cost.
Wheat Bran	200	380	176.0	11.6	24.2	90.6	$3 20
Wheat Middlings	100	120	88.0	3.8	12.8	60.7	1 75
Ground Oats	100	100	89.0	3.0	9.2	56.8	1 65
Gluten Meal	50	40	46.0	.4	12.9	32.8	85
Meat Scrap	25	21	22.3	1.0	16.5	8.0	75
Total	475	561	421.3	19.8	75.6	243.9	$8 20

Nutritive Ratio, 1:3.22.

Mixture No. 3.

A GOOD NIGHT-RATION.

Kind of Food.	Amount by Weight. Pounds.	Amount by Measure. Quarts.	Dry Matter.	Ash or Mineral Matter.	Protein.	Carbohydrates Plus Fat × 2¼.	Cost.
Cracked Corn	200	120	178	3.0	15.8	152.8	$3 30
Wheat	100	53	90	1.8	10.2	73.0	2 20
Clipped Oats	100	98	89	3.0	9.2	56.8	1 93
Buckwheat	100	66	87	2.0	7.7	53.3	2 00
Total	500	337	444	9.8	42.9	335.9	$9.43
Average in one pound	......	.674	.888	.019	.085	.671	$.018

Nutritive Ratio, 1:7.8.

Mixture No. 4.

SCRATCHING RATION.

Kind of Food.	Amount by Weight. Pounds.	Amount by Measure. Quarts.	Dry Matter.	Ash or Mineral Matter.	Protein.	Carbohydrates Plus Fat × 2¼.	Cost.
Wheat	100	53	90	1.8	10.2	73.0	$2 20
Clipped Oats	100	98	89	3.0	9.2	56.8	1 93
Total	200	151	179	4.8	19.4	129.8	$4 13
Average in one pound	......	.755	.839	.024	.097	.649	$.0206

Nutritive Ratio, 1:6.6.

PROBLEMS.

1. Find the cost per hundred of the different feeds used in the four different mixtures: No. 1, No. 2, No. 3, and No. 4, computed on the basis of given cost in last column.

2. Find the cost of these mixtures at the present cost of the foods used in the four given rations.

Feeding Sprouted Oats.

The object of feeding sprouted oats in winter is to furnish a fresh succulent, green feed.

Sprouted oats is not fed for the value of its food constituents but because it is a tonic and has a stimulative effect on the digestive organs.

Methods of Sprouting.

Clean, sound oats are soaked in water for 12 hourse; they are then placed in trays having a depth of several inches; the trays are then placed in a closet for heating artificially if necessary. The heat for sprouting should be at a temperature of at least 70 degrees. The oats will start to sprout at once. The oats in the trays should be stirred two or three times a day until the roots and sprouts are from a half to three-quarters of an inch long when they are then left to become matted and form a mass that may be taken out of the crates in cakes when it has sprouts 3 or 4 inches in length.

A piece of this matted oats 6 to 8 inches square may be broken up into small pieces and fed once a day to 100 hens. It should be scattered so that all the birds may have an opportunity to get a part of the feed.

When trays in which the oats has been sprouted become mouldy they should be thoroughly scrubbed with a 50 per cent solution of formalin (equal parts commercial formalin and water).

The three important principles to be observed in sprouting with a closet are these:

1. There must be light. This may be admitted through glass doors on the closet.

2. There must be sufficient heat which may be furnished artificially with a lamp or through a heating system from a building.

3. There must be plenty of moisture evenly distributed throughout the closet. The glass should show mosture on the surface.

Feeding Pullets for Winter Laying.

PROBLEMS.

1. The following mixture is recommended for the month of September:

Bran	300 pounds
Corn meal	100 "
Middlings	100 "
Meat scrap	100 "

Find the nutritive ratio.

2. For October, use the following combinations:

Bran	200 pounds
Corn meal	100 "
Middlings	100 "
Gluten meal	100 "
Meat scrap	100 "

What is the difference between the nutritive ratio in this ration and that in problem 1?

For November, use same ration as in problem 2, and add 50 pounds of linseed meal. What difference does that make in nutritive ratio?

NOTE.—For December use same combination as that used for October; and for January use same ration as that used for November. From the month of January on, the 50 pounds of linseed meal are added every alternate month.

With the above methods of feeding, the following results were obtained by the Maine Experiment Station, with 300 Barred Plymouth Rock Pullets:

	Total No. of eggs laid.	*Average per bird.*
September	139	.46
October	725	2.42
November	984	3.28
December	2,926	9.75

PROBLEM.

1. Reckoning the average net return on eggs for the four months up to January 1, at 40c per dozen, which was the price received by the station, for eggs from these 300 pedigreed birds, what was the income per pullet for four months if they laid 4,774 eggs?

Problems Worth Considering.

Standard bred poultry have proven the following results.

1. More reliability in breeding.
2. Larger egg production from egg breeds.
3. Improved quality of meat in meat breeds.
4. Uniformity in size, shape and color of eggs.
5. Better appearance and attractiveness of a flock.
6. Cost of keeping no greater than that for mongrels.
7. More uniformity and efficiency in food consumed.
8. Better prices for stock and eggs.

The Size of Eggs.

The eggs of the different breeds in order of their weight are as follows: Black Minorca, Light Brahma, Barred Rock, White Leghorn, White Wyandotte, Rhode Island Red, White Crested Polish, Buff Cochin.

STANDARD SIZE EGGS.

The problem is not merely to get the record-hen to lay the greatest number of eggs possible in 365 days, or in any other given length of time, but mankind (and the owner of the hen) is interested in having her lay uniformly large eggs—as many pounds and ounces of this form of unexcelled human food as it is possible for her to produce.

BELOW STANDARD SIZE.

To be "Select" and bring top prices in markets that are particular, new-laid hen eggs should average to weigh not less than 25 ounces to the dozen. If White Leghorn eggs per dozen weighed only 19 ounces, in the New York City market, such eggs would "Grade" about 20 per cent lower in price than the larger eggs.

A Study of the Composition, Care and Handling of Eggs.

"Analysis tells us that an egg contains the same constituents, practically as corn and wheat but has a larger proportion of protein. To the chemist, the egg is simply water, protein, fat, ash, etc., the same as wheat and corn. The only difference between a bushel of wheat and a bushel of eggs is that the eggs are more palatable and nutritious. They are also more valuable when placed upon the market.

Without the shells, one dozen eggs contain 13.57 oz. water, 2.32 ozs. protein, 2.26 ozs. fat and 0.22 ozs. ash. A pound of eggs is worth from ten to fifty cents, depending on the time of year and the markets; a pound of wheat being worth from one to two cents. By giving the wheat to the hen to market, it is converted by a delicate process of manufacture into a form of food so palatable and wholesome that it commands ten times as much as when it was in the bin or grain sack. In selling eggs at 40c per dozen the poultry man is receiving 25c for water.

Observing some of the following important facts will result in mutual profit to both producer and consumer:

Good Eggs.

1. An egg is considered suitable for food when it shows no signs of incubation, or decomposition.
2. An egg is fresh, when it is newly laid, of normal size, clean, with a small air cell, contents free from discoloration.

Bad Eggs.

1. Blood rings that can be quickly recognized before the candle, shows that the embryo chick has developed to a sufficient size to render the egg unfit for use.
2. Black rot in an egg shows a dark appearance before the candle, hydrogen-sulphide gas causes this change of color, and causes the rotten-egg-smell and sometimes causes the egg to explode.
3. White rot or mixed-rot causes the egg to become offensive to both sight and smell. The yolk and white are mixed and the contents become watery.

Eggs may be damaged and rendered worthless or of an inferior grade by some of the following reasons:

1. By being washed, which opens up the pores of the shell, leaving in bacteria and causing decomposition.
2. By being kept in a warm room.
3. By being kept in a damp cellar causing them to mold and sour.
4. Bad flavors caused by unsuitable feed, and by being placed so near that they will absorb odors from onions, oils, vegetables, etc.

The successful poultryman must base his success in handling and marketing eggs upon his observation of certain well established facts:

1. Eggs for the market should be infertile.
2. Fertile eggs or those that have a germ or embryo, will incubate wherever they are exposed to a temperature of 70° to 103° Fahr.
3. Eggs should be gathered once a day in cool weather and twice a day during hot or rainy weather.
4. They should be carefully sorted and packed in crates, each to have eggs of uniform size, color and cleanliness.
5. They should be kept in a dry, cool place having uniform temperature.
6. They should be sold when fresh.
7. They should be marketed at least twice a week.
8. They should be sold on a quality basis.
9. They should command the highest price.
10. There should be a demand for your eggs.
11. There should be special customers for the product.

Preserved Eggs.

There are various methods of preserving eggs:

1. By keeping eggs in cold storage where the temperature is at 29° to 30° Fahr.
2. By dipping in boiling water for a few seconds.
3. By applying grease to the shell of the egg.

Breeding.

Eggs selected for hatching purposes or for artificial incubation should be laid by hens of the following characteristics:

1. Pure bred mature fowls.
2. Early producers as pullets.
3. Vigorous and healthy.
4. Largest specimens of the breed.
5. Late moulters with bright and lustrous eyes.
6. Best records in egg production.
7. Bright red comb and wattles.
8. Long body and neck.
9. First off and last on the roost.
10. Singers that are active in working and hunting for food.
11. A well spread tail.
12. V shaped in three ways:
    (a) On sides from front to rear.
    (b) Top and bottom from front to rear.
    (c) From base of tail downward.

To establish a prolific egg-yielding flock.

1. Find out which are the best layers in your flock—"best by test".
2. Find the best producers by the trap-nest record or by careful watching.
3. The best producers are the ones from which to hatch eggs.
4. Select a male bird that is a descendant of a high egg-record hen.
5. Be sure that the prolific egg-yield blood lines are well established by high egg records of ancestors for several generations back.

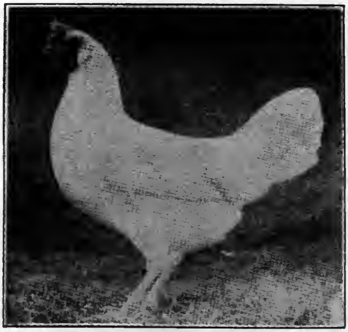


FIG. 4. White Leghorn.

6. By proper selection and cross breeding for a number of years, observing closely the laws of heredity, it is possible to build up a strain of layers that will produce 100 per cent more eggs than the average flock of hens.

FIG. 5. A 288 Egg Record.

FIG. 6. Male White Leghorn.

Eggs for Hatching.

Early hatched pullets lay better in winter than old hens.

Old hens should be kept for breeding purposes.

Eggs laid by old and mature fowls are larger, and the chicks are stronger, healthier, more thrifty, and more vigorous than chicks hatched from pullet's eggs.

This fact was demonstrated by The West Virginia Experiment Station in 8 experiments that were carried out with the following results:

	Old hens.	*Pullets.*
Total No. of eggs incubated................	1,094	871
Average weight of eggs per hd.	12.96 lbs	11.19 lbs
Total number of chicks......................	840	591
Average weight of chicks when hatched per hundred	8.28 lbs	7.12 lbs
Average weight of chicks per hundred at second weighing	29.56 lbs	23.07 lbs
Total number of recorded deaths............	42	85

PROBLEM.

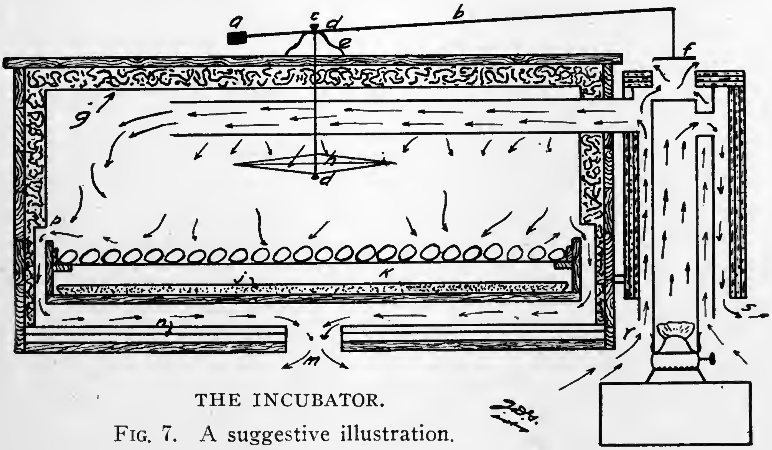
1. Find the per cent of eggs that were hatched and the per cent of deaths that occurred from both the hens and pullets used as breeders in the preceding experiment given by the West Virginia Station.

Facts about Incubation.

Eggs set or put in the incubator about April 1, produce the highest per cent. of chicks.

Early hatched chicks grow faster than the late hatched; April is considered the most favorable month for growth.

The weight of chickens when hatched does not seem to be in direct proportion to the weight of the eggs.



THE INCUBATOR.

FIG. 7. A suggestive illustration.

Cross-section of a hot air heated incubator showing the method of regulating the temperature, the ventilation system, and the general construction.

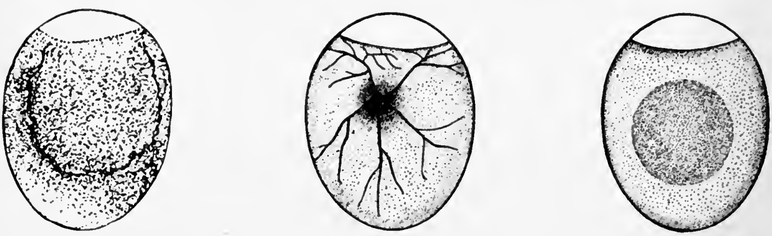
(*a*) Counterpoise weight. (*b*) Regulator arm. (*c*) Connecting rod. (*d*) Thumb nut. (*e*) Pivot casting. (*f*) Heater disc. (*g*) Cotton batting filling between inside and outside cases. (*h*) Thermostat. (*i*) Egg chamber. (*j*) Moisture pan filled with sand kept wet. (*k*) Nursery. (*m*) Bottom ventilator for escape of air from egg chamber. (*n*) Insulation in bottom of incubator. (*p*) One of four pipes to discharge air from above level of eggs into false bottom beneath egg chamber. (*r*) Fresh air intake. (*s*) Outlet for escape of lamp fumes. No fumes can get into machine.

There should be an incubator and incubation in every school building.

Principles of Incubation.

1. The average time for hatching is 21 days.
2. The average heat required for hatching is 103 degrees Fahr.
3. The eggs should be turned once each day.
4. The eggs should be removed and aired each day for a few minutes.
5. The heat must be uniform.
6. Heat may be supplied by oil, gas, electricity, or hot water.
7. Incubator to be in a dry, cool, unheated room.
8. Incubator must be perfectly level to heat evenly.
9. The first test of eggs should be made on the sixth or seventh day.
10. The second test is made on the 17th or 18th day.
11. Just as the eggs begin to hatch the temperature may be allowed to run up to 103.5 degrees.
12. When the chicks are coming out rapidly it is advisable to keep up the heat to 104 or 105 degrees.
13. The natural heat from the chicks when hatching will require less artificial heat.
14. Eggs of different species of birds will require different periods of time for incubation.

FIG. 8.



Dead germ, 7th day — Fertile egg, 7th day — Infertile egg

The success of the incubator hatch will depend upon a thorough understanding of its operation and the care with which it is operated. Most failures come from lack of information and from mismanagement.

Poultry Problems.

1. Four hundred eggs were placed in an incubator; the cost of the eggs was 20c per dozen; the cost of kerosene for operating incubator was 50c; there was 75 per cent of a hatch; the chicks were sold at 9c apiece; what did the operator receive for his trouble?

2. A 400 egg incubator was set on March 10, and the hatch on April 1, showed 90 per cent of a hatch; 5 per cent of the chicks were unsalable; what was the amount received for the balance at 7c apiece?

3. The experiment station of Cornell University began an experiment with 7 flocks of 110 chicks each; the total weight of the chicks was 61.06 pounds; what was the average weight per chick?

4. At the end of the second week of the experiment in problem 3, there were 763 chicks and the weight was 138.09 pounds; at the end of the fourth week there were 743 chicks and the weight was 220.59 pounds; at the end of the sixth week there were 684 chicks, and the weight was 296.07 pounds; what was the average gain per chick, and what was the average weight at the end of each of the three periods?

The Poultry House.

1. There should be at least 2 sq. ft. of floor space per bird.
2. There must be sufficient sunlight and ventilation to insure sanitary conditions.
3. Roosts should be on a level and at least 2 feet from the floor.
4. Roosts may be made of 2 by 2 inch material, with the upper side rounded.
5. A good hen-house should have separate apartments for roosting, feeding, and laying.
6. The foundation should reach below the surface from 12 inches in sand and gravel to 30 inches in ordinary soils.
7. The wall should be built at least 6 inches above the surface that the sills may be above the ground.
8. There must be a scratching room. All floors must be dry and so constructed as to keep out rats and other vermin.

The Poultry Yard.

The best kind of soil for a poultry farm is a light sandy loam.

The location should be on dry well drained land.

A permanent sod poultry yard is unsanitary.

Soil about a poultry house should be turned over frequently and reseeded with forage crops.

An ideal location for a poultry house is on a piece of ground sloping south or southeast.

There must be an abundance of sunlight for coops and there should be shade for poultry in hot weather.

For wholesome conditions in a poultry yard, there should be at least 150 square feet per bird.

The essentials for poultry may be summed up as:

(a) Dryness.
(b) Sunlight.
(c) Warmth.
(d) Ventilation.
(e) Room.
(f) Sanitation.

Divisions of the Poultry Yard.

Poultry should be supplied with suitable forage crops; there should be different enclosures, each with different crops, such as alfalfa, buckwheat, rape, timothy, junegrass, rye, oats, wheat, each sowed at different times so that there may be green feed summer and fall.

Yards or fields with small lots should be located on different sides of the poultry buildings.

Poultry Questions.

1. Give three reasons why we should keep pure bred poultry stock.
2. Give three reasons why eggs should be kept clean.
3. Why should eggs be kept in a cold place of uniform temperature?
4. Why should we produce infertile eggs for the consumer?
5. Show the advantages of co-operation in marketing eggs among farmers who keep small flocks.
6. Draw plans and explain the principles of a model up-to-date poultry house.
7. At what degree Fahr. will eggs hatch well and what is the length of time required? Hen eggs? Duck eggs? Turkey eggs?
8. Will 110 degrees Fahr. destroy the eggs?
9. Why should the eggs in the incubator be cooled and turned every day?
10. Does a hen turn and cool her eggs while hatching?
11. How many days after the eggs are placed in the incubator can we detect the fertile and infertile eggs?
12. Why does the young bird in growing require food containing more phosphorus than a mature fowl?
13. Why do growing chicks require more feed in proportion to their size than growing calves?
14. How old must each of the following be to double its weight: a colt, a dog, a pig, a chick?

Score Card.

Poultry, New York State College of Agriculture, Ithaca, N. Y.

Some Good Poultry Books.

1. Our Domestic Birds — Robinson, 8-10 — Ginn & Co., $1.35.
2. Making Poultry Pay — Powell, 8-12 — Webb Pub. Co., $1.00.
3. How to Keep Hens for Profit — Valentine, 7-12—Macmillan Co., $1.50.
4. Poultry Culture — Robinson, 7-8 — Ginn & Co., $2.50.
5. Farm Poultry — Watson, 8-12 — Macmillan Co., $1.25.
6. Poultry Laboratory Guide — Lewis, 7-10 — Macmillan Co., $0.65.
7. The Beginner in Poultry — Valentine, 7–8 — Macmillan Co., $1.50.
8. Profitable Poultry Production — Kains, 8-12 — Orange Judd Co.
9. The New Egg Farm — Stoddard, 8-12 — Webb Pub Co., $1.00.
10. Poultry Feeding and Fattening — Fiske, 8-12 — Webb Pub. Co., $0.50.
11. Squabs for Profit — Cox, 7-10 — Webb Pub. Co., $0.50.
12. Poultry Architecture — Fiske, 7-10 — Webb Pub. Co., $0.50.
13. Poultry Appliances and Handicraft — Fiske, 7-10; Webb Pub. Co., $0.50.
14. Progressive Poultry Culture — Brigham — Torch Press Pub. Co., Cedar Rapids, Iowa.

SUPPLEMENTARY READING.

Write to the United States Department of Agriculture for such bulletins as may be desired in the following list:

Farmers' Bulletin, No. 528. Hints to Poultry Raisers.
F. B. No. 287. Poultry Management.
F. B. No. 236. Incubation and Incubators.
F. B. No. 51. Standard Varieties of Chickens.
F. B. No. 128. Eggs and Their Use as Food.
F. B. No. 182. Poultry as Food.
Circular 140. The Egg Trade of the United States.
Circular 141. The Improvement of the Farm Egg.
Circular 176. A System of Poultry Accounting.
Circular 92. Mites and Lice on Poultry.
Circular 64. A New Nematode Parasite in the Crop of Chickens.
Circular 128. White Diarrhoea of Chicks.
Circular 100. A Secondary Course in Animal Production.
Circular 61. How to Kill and Bleed Market Poultry.
Farmers' Bulletin No. 530. Important Poultry Diseases.
F. B. No. 140. Fattening Poultry.
F. B. No. 452. Capons and Caponizing.
F. B. No. 445. Marketing Eggs.

F. B. No. 355. A Successful Poultry and Dairy Farm.
F. B. No. 64. Ducks and Geese; Standard Varieties and Management.
F. B. No. 177. Squab Raising.
F. B. No. 200. Turkeys: Standard Varieties and Management.
F. B. No. 234. The Guinea Fowl.

In addition to the many good bulletins furnished by the national government, nearly all the state experiment stations have issued important bulletins on poultry, and these can be secured by writting your state experiment station.

Every poultryman should subscribe for some good poultry and farm journal.

When writing to the U. S. Government, read the instructions carefully, contained on page xi in the introduction.

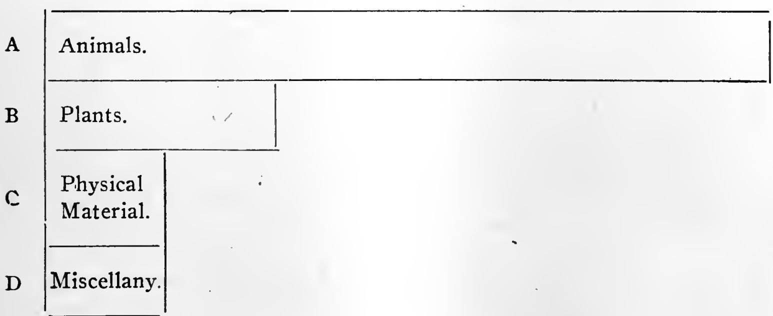
CHAPTER XVII.

Birds and Insects.

"Nature study is learning those things in nature which are best worth knowing, to the end of doing those things that make life most worth living." —*Hodge.*

THE CHILD'S INTEREST IN NATURE.

A careful analysis of information gained by studying the nature of the questions asked by children of 11 to 12 years of age, who wrote to the nature and science deartment of certain publications, has revealed the facts as graphically represented in the following table:



This graph of children's interests show that the percentage of interest in nature is distributed about as follows:

Animals	About	60	per	cent.
Plant Material	"	20	"	"
Physical Material	"	10	"	"
Miscellany	"	10	"	"

While it is no doubt true that no two tabulations for the determination of the child's interests and inclinations might be alike when taken in different parts of the country, yet it is very evident that animals surpass all other departments of Natural Science in attractiveness for children.

The Study of Birds.

As a class birds are one of the most interesting divisions of the animal kingdom, for the student of zoology.

They serve certain well defined purposes which may be briefly stated as follows:

1. Destruction of insect pests.
2. Consumption of noxious weed seeds.
3. Distribution of plants.
4. Food value.
5. Objects of beauty and song.

How to Love Birds.

A BORN BIRD-LOVER.

The birds have always meant much to me. As a farm boy they were like a golden thread that knit the seasons together. In early manhood I turned to them with the fondness of youth, re-enforced with an impetus obtained from literature. Books, especially the poets, may do this for a man. They may consecrate a subject, give it the atmosphere of the ideal and lift it up in the field of universal interest. They seem to have done something like that for me in relation to birds. I did not go to books for my knowledge of the birds, except for some technical knowledge, but I think literature helped to endow them with a human interest to me and relate them to the deeper and purer currents of my life. What joy they have brought me! How they have given me wings to escape the tedious and the deadening! I have not studied them so much as I have loved them; at least, my studies have been inspired by love.

FIG. 1. A Pair of Red-Winged Blackbirds.

How much easier and surer knowledge comes through sympathy than through the mere knowing faculties! It seems as if I had imbibed my knowledge of the birds through the pores of my skin, through the air I have breathed, through the soles of my feet, through the twinkle of the leaves and the glint of the waters. I have gone a-fishing and read their secrets out of the corners of my eyes. I have lounged under a tree, and the book of their lives has been opened to me. I have hoed in my garden, and read the histories they write in the air. Studied the birds? No. I have played with them, camped with them, gone berrying with them, summered and wintered with them, and my knowledge of them has filtered into my mind almost unconsciously.—*John Burroughs.*

Birds are one of the four classes of that branch of the animal kingdom known as vertebrates.

Birds are divided into several groups or orders, by reason of certain well known characteristics of each order.

- Birds of prey (Accipiters).
  - Divided into the following groups:
    - Vulture (Vultur) as the Condor.
    - Falcons (Falco) as, Falcons and Eagles, and Hawks.
    - Owls (Strix) as, Barn Owl, Great Horned Owl.
    - Shrike (Lanius) as, Northern Shrike, Loggerhead Shrike.
- Sparrows (Passeres) divided into the following groups:
  - The Thrush Family, Robin, Bluebird, Wood Thrush, Hermit Thrush, Catbird, etc.
- Climbers (Scansores)
  - Parrots (Psittacus).
  - Woodpeckers (Picus). Red-Headed Woodpecker, Flicker.
  - Cuckoo (Cuculidae), Yellow-Billed, and Black-Billed Cuckoo.
  - Toucan.
- Gallinaceous (Gallinaceae).
  - Peacock (Pavonidae).
  - Turkey — Wild and Domesticated.
  - Chicken (Common breeds). See Poultry.
  - Pheasant, as the Golden Pheasant and Silver Pheasant.
  - Partridge. Many different varieties.
  - Quail. Bob White and California Quail.
  - Pigeon. Passenger Pigeon. (now extinct.)
- Waders (Grallae).
  - Ostrich.
  - Cassowary.
  - Flamingo.
  - Heron.
  - Spoonbill.
  - Plover.
  - Rail.
  - Woodcock.

Web-Footed (Anseres)

Pelican.
Petrel.
Cormorant.
Albatross.
Swan.
Goose (wild and tame)
Duck (wild and tame).

Economic Value of Birds.

There is a practical as well as an artistic side to the study of birds. The true lover of nature who has the poetic and artistic temperament, and the practical agriculturist may look at bird study from different points of view. It is our aim in school agriculture to introduce bird study for a two-fold purpose; to cultivate a love of the beautiful in this most interesting division of the animal kingdom, and to also teach the economic value of these interesting inhabitants of the orchard, field and forest.

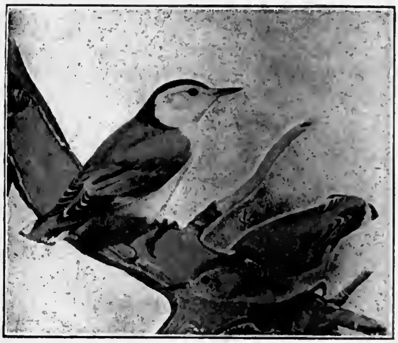


FIG. 2. A Pair of White-Breasted Nuthatches.

The material prosperity of this nation depends largely upon the agricultural interests of the country, and any agency that serves to increase and insure crop production, is of direct interest and importance to our whole population. It has been thoroughly demonstrated that birds are one of the most potent factors that contribute to our success in farming.

It has been estimated by entomologists that the loss to our agricultural interests, caused by insect pests, is upwards of $900,000,000 annually. Ornithologists have determined by a scientific study of birds that if it were not for our birds that this loss would be much greater, and that if we had given better protection to our bird friends this loss would have been much smaller. There are those who even believe that successful agriculture would be impossible if it were not for the assistance of birds.

Each kind seems to have a certain work to do. The fare of some consists almost wholly of noxious weed seeds, some feed on seeds and insects, and others subsist almost wholly on insects.

It has been estimated that in an agricultural state like Iowa, that tree sparrows eat approximately 875 tons of weed seeds annually.

The U. S. Department of Agriculture has estimated that the total consumption of weed seed by the combined members of the sparrow family would result in a saving of 1 per cent in our crops, annually.

The Biological survey of the United States has examined the crops and stomachs of upward of 50,000 birds, during the last 25 years. This has been done to obtain data upon which to base legislation for their protection.

To quote the report from the U. S. Department of Agriculture:

"A tree swallow's stomach was found to contain 40 entire chinch bugs, and fragments of many others, besides 10 other species of insects. A bank swallow in Texas devoured 68 cotton-boll weevils, one of the worst insect pests that ever invaded the United States; and 35 cliff swallows had taken an average of 18 boll weevils each. Two stomachs of pine siskins from Haywards, Cal., contained 1,900 black olive scales and 300 plant lice. A killdeer's stomach taken in November in Texas, contained over 300 misquito larvae. A flicker's stomach held 28 white grubs. A nighthawk's stomach collected in Kentucky contained 34 May beetles; the adult form of white grubs. Another nighthawk from New York had eaten 24 clover-leaf weevils and 375 ants. Still another nighthawk had eaten 340 grasshoppers, 52 bugs, 3 beetles, 2 wasps and a spider. A bobtailed grackle from Texas had eaten at one meal about 100 cotton bollworms, besides a few other insects. A ring-necked pheasant's crop from Washington contained 8,000 seeds of chickweed, and a dandelion head. More than 72,000 seeds have been found in a single duck stomach taken in Louisiana in February.

"As many as 1,000 grasshoppers have been found in the stomach of a Swainson's hawk, representing a single meal; and in the retreat of a pair of barn owls have been found more than 3,000 skulls, 97 per cent of which were of mammals, the bulk consisting of field mice, house mice, and common rats. Nearly half a bushel of the remains of pocket gophers — animals which are very destructive in certain parts of the U. S. was found near a nest of this species."

It has been estimated that a family of Bob-whites consisting of two adult birds and ten young, would consume 780,915 insects and 59,707,888 weed seeds in a year in addition to their other food.

A Bob-white in captivity has been known to consume at one meal 100 chinch bugs, 12 squash bugs, 2,326 plant-lice, 39 grasshoppers, 12 cut worms, 12 army worms, 568 mosquitos, 101 potato beetles, and 8 white grubs.

The following record is taken from another list given in the National Audubon Societies' leaflets: 5,000 chrysanthemum black flies, 1,350 flies, 1,286 rose-slugs, 1,300 grasshoppers, 932 miscellaneous insects, eaten by a Bob-white in one day.

PROBLEMS.

1. It has been estimated that there are approximately 2000 birds per sq. mi. in the U. S.; at that rate what would be the total number in the U. S.?

2. At the rate of 2000 birds per sq. mi., how many would this be per 80-acre farm?

3. If the average number of large insects killed per bird is estimated at 50 per day, how many insects does the average bird kill per year (365 days)?

4. Estimating that on an average the quantity of insects killed annually by each bird will fill a peck measure, how many bushels of insects are destroyed annually by birds in the U. S.?

5. How does the number of bushels of insects destroyed compare with the total number of bushels of corn, wheat, oats and clover seed produced in 1914?

6. If each bushel of insects destroyed would have damaged crops to the extent of 50c, what did the birds save to agriculture in one year in the U. S.?

Some of the Farmer's Friends.

Name.	*Per Cent Insect Food.*	*Per Cent Vegetable Food.*	*Where Found.*
Robin	42	58	Orchard and dooryard
Bluebird	68	32	Orchard and dooryard
Chickadee	70	30	Orchard, garden and forest
Meadowlark	76	24	Field
Brown Thrasher	60	40	Thickets
Myrtle Warbler	78	22	Woodlands
Barn Swallow	100	00	Barn rafters
Purple Martin	100	00	Trees and dooryard
Chipping Sparrow	42	58	Gardens, orchards, shrubbery
Night Hawk	100	00	
White-Breasted Nuthatch	50	50	Trees
Brown Creeper	100	00	Park trees and woodlands
Baltimore Oriole	83.4	16.6	Orchards and woodlands
Kingbird	85	15	Orchards
Yellow-Billed Cuckoo	75	25	Forests and park trees
Red-Headed Woodpecker	..	..	Open woodlands, orchards, park
Downy Woodpecker	76	24	Open woodlands, orchards, park
The Cardinal	..	..	Woods, shrubbery, vines
Rose-Breasted Grosbeak	52	48	Woodlands near dwellings
Whip-poor-will	..	..	Forests
Red-Winged Blackbird	27	73	Prairies, ponds, sloughs
Catbird	..	..	Dooryard berry patches
Song Sparrow	25	75	Hedges and garden shrubbery
Blue Jay	25	75	Woodlands, orchards
Cardinal	45	55	Shade trees, shrubbery
Bobolink	86	14	(North) Fields
Canary (Goldfinch)	..	..	Garden
Cedarbird	..	..	
Vireos	..	..	

Beneficial Destroyers of Rodents and Noxious Animals.

NOCTURNAL BIRDS OF PREY.

Owls.	*Place of Abode.*
Screech Owl	Orchards, groves and thickets
Barn Owl	Barns and other buildings
Long-eared Owl	Woods
Short-eared Owl	Meadows and swampland

DIURNAL BIRDS OF PREY.

HAWKS.	
Marsh Hawk	Meadows and swampland
Red-Tailed Hawk	Sparsely wooded areas, or prairies
Sparrow Hawk	Open country
Red-Shouldered Hawk	Woods.

BIRDS OF PREY NOT BENEFICIAL.

Great Horned Owl	Densely wooded lowlands
Sharp-Skinned Hawk	Woods
Cooper's Hawk	Forest
Goshawk	

BIRDS OF QUESTIONABLE VALUE AT CERTAIN SEASONS.

American Crow	Woods and fields
Cowbird	Fields and meadows
Blackbird	Groves, parks, woods
Bobolink	Fields

A BIBD PEST.

English Sparrow	Streets, yards and fields

Foods of Game Birds.

PRAIRIE CHICKEN.

15% insects.
85% vegetable food consisting of 15% noxious weeds, the balance is browse and grain mostly from stubble.

CALIFORNIA QUAIL.

3% insects.
62% noxious and troublesome seeds.
35% fruits-grain, etc.

RUFFED GROUSE—"PARTRIDGE" OR PHEASANT.

10% insects.
90% wild fruits, berries, nuts, weed seeds.

UPLAND PLOVER.

97% animal matter, chiefly injurious and neutral forms.
3% weed seed pests chiefly.

KILLDEER.

3% vegetable matter chiefly noxious weed seeds.
97% insect pests.

HORNED GREBE.

72.2% insect pests.
27.8% fish.

FRANKLIN'S GULL.

94.46% animal matter mostly grasshopper.
5.54% vegetable matter.

PROBLEMS.

1. If insects caused a loss of $1,000,000,000 to the crops in 1912, what per cent was that loss of the total crop of the same year? (See Year Book—Dept. of Ag.)
2. It has been estimated that the average cat in Massachusetts will kill 10 useful birds per year; if Ohio's rural cat census is 276,719 cats, at that rate what would be the number of birds sacrificed annually in Ohio?
3. It has been estimated that a bluebird will destroy on an average 30 insects a day; how many insects would 100 bluebirds destroy in 8 months?
4. It has been stated in a U. S. Government report that the estimated consumption of weed seeds by the combined members of the sparrow family results in a saving of 1 per cent of the total crop production of the United States. What was the amount of money saved to the farmers based on the value of farm products in the U. S. in 1912?
5. It is estimated by the government that tree sparrows annually eat approximately 875 tons of weed seeds in the state of Iowa. What was the number of pounds of weed seeds consumed per acre in that state?
6. The University of California estimates that there is 1 meadowlark for each 4 acres of the 11,000,000 acres in the Sacramento and San Joaquin valleys, and that each pair raises an average of 4

young at the time when insects are most numerous, and that the average consumption of weed seeds and insects in 3¼ pounds. Find the approximate number of meadowlarks and the number ot pounds of weed seeds and insects eaten?

7. If there are on an average 20 Bob-whites per square mile in Ohio and their value to agriculture is 25c per head, what is their total value to the farmers of Ohio?

8. If there were one Bob-white per acre in your state, what would be the total number, and what would be their total value to agriculture, estimated at the very low sum of 10c per bird?

Migratory Movements of Birds.

The following list gives dates of the extreme time limits for the occurrence of the species that are found in the vicinity of Wooster, Ohio.

This will serve as an index for those who wish to note the appearance and time of leaving of birds for a long distance East and West of Wooster on this parallel, North Latitude.

SOME OHIO BIRDS.

1.	Green Heron	April 18-Oct. 1
2.	Solitary Sandpiper	Aug. 13-Oct. 10
3.	Yellow-billed Cuckoo	May 7-Oct. 13
4.	Black-billed Cuckoo	Sept. 15 and 24
5.	Whip-poor-will	April 24-Aug. 27
6.	Nighthawk	May 3-Sept. 26
7.	Chimney Swift	April-Oct. 14
8.	Hummingbird	May 7-Oct. 6
9.	Phoebe	Mar. 12-Oct. 9
10.	Wood Pewee	May 4-Sept. 26
11.	Least Flycatcher	May 1-Sept. 13
12.	Cowbird	Mar. 12-Nov. 1
13.	Baltimore Oriole	April 24-Sept. 10
14.	Purple Finch	Apr. 28-May 8 and Oct. 11-Nov. 16
15.	Grasshopper Sparrow	Apr. 14-Aug. 13
16.	White-crowned Sparrow	Apr. 30-June 7 and Oct. 7-14
17.	White-throated Sparrow	Apr. 14-May 23 and Sept. 24-Nov. 5
18.	Chipping Sparrow	Mar. 19-Oct. 23
19.	Field Sparrow	Mar. 14-Oct. 22
20.	Junco	Sept. 24-May 1
21.	Swamp Sparrow	April 28 and Feb. 15

22.	Towhee	Mar. 8-Nov. 18
23.	Dickcissel	May 21-Sept. 16
24.	Scarlet Tanager	April 27-Sept. 25
25.	Purple Martin	Mar. 24-Sept. 8
26.	Cliff Swallow	Apr. 24-Sept. 2
27.	Barn Swallow	Apr. 10-Sept. 2
28.	Tree Swallow	Mar. 26-May 14
29.	Red-eyed Vireo	Apr. 28-Sept. 17
30.	Warbling Vireo	Apr. 22-Oct. 3
31.	Yellow-throated Vireo	Apr. 28-Sept. 9
32.	Black and White Warbler	Apr. 28-Sept. 17
33.	Blue-winged Warbler	Apr. 29-Sept. 1
34.	Cape May Warbler	May 4-16 and Sept. 27
35.	Yellow Warbler	Apr. 21-Oct. 10
36.	Black-throated Blue Warbler	Sept. 16 and Oct. 6
37.	Myrtle Warbler	Apr. 14-May 20, Sept. 13-Nov. 5
38.	Magnolia Warbler	May 1-31 and Aug. 31-Sept. 14
39.	Chestnut-sided Warbler	May 3-26 and Oct. 13
40.	Bay-breasted Warbler	May 7-23
41.	Black-poll Warbler	May 7-June 9 and Sept. 28-Oct. 2
42.	Blackburnian Warbler	May 1-29
43.	Black-throated Green Warbler	Apr. 29-May 26 and Sept. 10-18
44.	Oven-bird	Apr. 18-Oct. 7
45.	Louisiana Water-Thrush	Apr. 3-July 31
46.	Connecticut Warbler	May 21 and 29
47.	Mourning Warbler	May 15
48.	Yellow-breasted Chat	Apr. 29-July 26
49.	Wilson's Warbler	May 12-June 6
50.	Redstart	May 11-Sept. 17
51.	Catbird	Apr. 24-Oct. 10
52.	Brown Thrasher	Apr. 10-Sept. 19
53.	House Wren	Apr. 13-Sept. 16
54.	Brown Creeper	Oct. 2-May 4
55.	Red-breasted Nuthatch	Mar. 9-May 10
56.	Golden-crowned Kinglet	Sept. 24-May 6
57.	Ruby-crowned Kinglet	Apr. 27-May 16, Sept. 28-Oct. 23
58.	Blue-gray Gnatcatcher	Apr. 14-Sept. 26
59.	Wood Thrush	Apr. 28-Oct. 4
60.	Veery	May 4-29 and Sept. 24
61.	Olive-backed Thrush	May 7-20 and Sept. 19-Oct. 8
62.	Gray-cheeked Thrush	Sept. 12
63.	Hermit Thrush	Apr. 10-May 20 and Sept. 9-Oct. 7

How to Protect Birds.

1. Organize Audubon Societies.
2. Build houses for the birds.
3. Plan shelter for those that stay in winter.
4. Provide food in bad winter weather.
5. Provide drinking fountains and baths.
6. Protect them from enemies.
7. Urge the enactment of Bird Legislation, and enforcement of Laws.
8. Discourage the use of bird plumage for ornaments.

They will repay you a thousand fold for your labor in their behalf, in their songs and in the protection of your crops.

FIG. 3. A School Exhibit showing bird-houses, birds and other school studies, at Harpster, O.

Exercises.

1. Organize an Audubon class in the school.
2. Write for leaflets to the National Audubon Society.
3. Make a list of birds on the home farm.
4. Make a list of birds that you know by sight.
5. Make a list of birds that you can recognize by their song.
6. Make a list of birds that you have seen searching the trunk, branches and bark of trees in the orchard or woods. Make a list of tree-insects eaten.
7. Make a list of birds that build their nests on the ground in pastures and meadows. Make a list of insects they eat.

8. Make a list of weed seeds eaten by birds.
9. Have book in which to make drawings of birds.
10. Make a collection of bird pictures.
11. Make a list of famous bird-poems.
12. Collect some good bird-books for the library.
13. Read at least one good book on birds.
14. Write a description of the nest and eggs of each of the following: robin, oriole, swallow, woodpecker, killdeer, quail, wren, and bluebird.
15. Write a story on "Birds in Our Orchard."
16. Write a story on "My Favorite Bird."
17. Let pupils bring lists of domestic and wild birds on the home farm.
18. Let some tract of land, or some grove, woodlot or park be visited for the study of birds and the insects they eat.

NOTE.—This work should be commenced at the beginning of the school year and continued in the spring, when the birds return.

Questions.

1. What is ornithology?
2. What are the chief distinctions between birds and mammals?
3. To what order do each of the following belong: eagle, robin, woodpecker, quail, ostrich, goose?
4. Explain cause and manner of the migratory movement of birds.
5. Name some non-migratory birds that are adapted to climatic changes.
6. How do the habits of robins and bobolinks in the north differ from their habits in the south?
7. Name some species of birds that have become extinct.
8. Is the bat a mammal or a bird?
9. What difference have you observed between the walk of a robin and a crow?
10. What difference is there in the arrangement of the claws of a woodpecker and a quail?
11. What is a roost? What difference is there between a quail roost and a black-bird roost?
12. Do the eggs of different orders and species of birds require the same length of time for hatching?
13. Name some species that are gregarious and some that live in pairs.
14. What difference have you observed in the number of eggs in a pigeon's nest and the number of eggs in a quail nest?
15. What difference is there in the feeding of young between a hen and an oriole?

16. Why do each of the orders of birds have the following striking characteristics:

(a) Birds of prey — hooked beaks and strong sharp talons,
(b) Sparrows — straight pointed bills and rapid flight,
(c) Climbers — large, strong beaks and claws on each foot arranged in pairs,
(d) Gallanacious and domesticated — short wings, rapid motion,
(e) Waders — long neck and bill and long legs,
(f) Web-Footed — web-feet, short neck — wide bill.

17. How does the color of birds aid in protection from enemies?

Book References.

BIRDS.

1st. and 2nd. Grades.

1. Bird World — Stickney — Ginn & Company.
2. Our Feathered Friends — Grinnell — D. C. Heath & Co.
3. Everyday Birds — Torrey — Houghton, Mifflin Co.
4. True Stories of Bird Life — Miller — Houghton, Mifflin Co.
5. Oriole Stories — Lane — Ginn & Co.
6. Birdlife Stories — Weed — Rand McNally & Co.
7. The History of the Robins — Trimmer — D. C. Heath & Co.

3rd and 4th Grades.

1. First Book of Birds — Miller — Houghton, Mifflin Co.
2. Our Birds and Their Nestlings — Walker — American Book Co.
3. Home Life of Wild Birds — Herrick — Putnams.
4. The Woodpeckers — Eckstrom — Houghton, Mifflin Co.
5. Birds of Village and Field — Merriam — Houghton Mifflin Co.
6. Birds Through an Opera Glass — Merriam — Houghton Mifflin Co.
7. Bird Neighbors — Blanchan — Doubleday Page & Co.

5th and 6th Grades.

1. Story of the Birds — Baskett — Appletons.
2. Birds Through the Year — Gilmore — American Book Co.
3. Bird Homes — Dugmore — Doubleday, Page & Co.
4. Bird Ways — Miller — Houghton, Mifflin Co.
5. Bird Stories — Burroughs — Houghton, Mifflin Co.
6. My Saturday Bird Class — Miller — D. C. Heath & Co
7. The Bird Book — Eckstrom — D. C. Heath & Co.

7th and 8th Grades.

1. The Bird — Beebe — Henry Holt & Co.
2. Birds of the United States — Apgar — American Book Co.

3. Birds of Western United States — Bailey — Houghton, Mifflin Co.
4. North American Birds — Baird, Brewer, Ridgeway — Little, Brown & Co.
5. North American Birds' Eggs — Reed — Doubleday, Page & Co.
6. Our Common Birds and How to Know Them — Grant — Scribners.
7. Protection of Our Native Birds — Lange — Macmillan Co.
8. Bird Life Stories, (book 2) — Weed — Rand McNally.

Bird Literature.

One of the most valuable bulletins on this subject has been prepared by the United States Government, entitled, "Fifty Common Birds of Farm and Orchard". The number of this bulletin is 513. It was prepared in the Bureau of Biological Survey, United States Department of Agriculture.

Teachers and others interested in Bird life should write to the National Audubon Society, New York City. Through the help and with the instructions of this society children may be induced to form Audubon Classes and become interested in the study and protection of the birds.

Teachers may find the following books of value in their work:

"First Book of Birds," by Olive Thorne Miller.
"Stories of Bird Life," by T. Gilbert Pearson.
"Bird Guide," by Charles K. Reed.

Bulletin No. 250, "Some Ohio Birds," by Ohio Experiment Station, Wooster, O. This bulletin is one of the most valuable that can be secured for bird study in Ohio and neighboring states. It was prepared at the suggestion of the author of this book, and the following list of books are taken from this bulletin:

Every farmer, and every school boy and girl should read a good book on birds.

List of Useful Books on Birds.

For those wishing more complete knowledge concerning our native birds, the following books and publications will be helpful.

1. Bird Life — Chapman. D. Appleton & Co., N. Y. $2.00 net.
2. Bird Neighbors — Blanchan. Doubleday, Page & Co., N. Y. $2.00.
3. Birds Every Child Should Know — Blanchan. Doubleday, Page & Co., N. Y. $1.20 net; $1.30 postpaid.

4. Birds in Their Relation to Man — Weed & Dearborn. L. B. Lippincott Co., Philadelphia, Pa. $2.50.
5. Birds of Eastern North America, Hand-book of — Chapman. D. Appleton & Co., N. Y. $3.00 (pocket edition, flexible covers $3.50).
6. Birds of Ohio — Dawson. Wheaton Publishing Co., Columbus, Ohio (out of print).
7. Birds of Ohio, Catalogue of The — Jones. Published by The Ohio State Academy of Science.
8. Birds of Ohio, Report of The — Wheaton, Geological Survey of Ohio, Vol. 4 (out of print).
9. Bird Studies with a Camera — Chapman. D. Appleton & Co., N. Y. $1.75.
10. Birds That Hunt and Are Hunted — Blanchan. Doubleday, Page & Co., N. Y. $2.00.
11. Bulletins of The Bureau of Biological Survey, Washington, D. C.
12. Camera Studies of Wild Birds in Their Homes — Reed. Doubleday, Page & Co. $0.60 net; $0.70 postpaid.
13. Camps and Cruises of an Ornithologist — Chapman. D. Appleton & Co., N. Y. $3.00 net.
14. Check List of North American Birds. Published by The American Ornithologists' Union, N. Y. Obtained through the Secretary, J. Dwight, Jr. $2.75.
15. Color Key to North American Birds — Chapman. Doubleday, Page & Co. $2.50 net; $2.75 postpaid.
16. How to Attract the Birds — Blanchan. Doubleday, Page & Co., N. Y. $1.35 net; $1.50 postpaid.
17. Life Histories of North American Birds — Bendire. Smithsonian Institution, special bulletin (out of print).
18. Useful Birds and Their Protection — Forbush. Published by The Massachusetts Board of Agriculture, Boston. $1.36 postpaid.
19. Warblers of North America, The — Chapman. Doubleday, Page & Co., N. Y. $3.00 net.
20. Water-Fowl, Among The — Job. Doubleday, Page & Co., N. Y. $1.35 net; $1.50.

BIRD AND NATURE MAGAZINES.

Wilson Bulletin, The. Published by The Wilson Ornithological Club, Oberlin, Ohio, $1.00 per year.

Bird-Lore. Published bi-monthly by the National Association of Audubon Societies, Harrisburg, Pa. $1.00 per year.

Blue Bird, Junior Audubon Monthly, 50c. Dr. Eugene Swope, Cincinnati, Ohio.

The Guide to Nature — $1.00 per year. Edward F. Bigelow, Arcadia Sound Beach, Conn.

Insects.

"The more I think of it, I find this conclusion more impressed upon me, that the greatest thing a human soul ever does in this world is to *see* something.

Hundreds of people can talk for one who can think, but thousands can think for one who can see. To see clearly is poetry, prophecy and religion — all in one." — *John Ruskin.*

Insects constitute one of the most interesting branches in the animal world. The number of distinct species is probably greater than the total number of all the other species of animals combined.

Among insects are found some of the most remarkable exemplifications of the guidance of instinct—as in the ant, the bee, and other species.

Among insects as among other branches of animals, there are the foes and friends of man. The real purpose of every species, will probably never be revealed. An estimate of the sum total of benefits derived cannot even be conjectured.

The further we go into the study of insects the more we learn of their uses in the great plan of nature.

The early botanists believed that insects were useful to flowers. Sprengel discovered that insects fertilize flowers. The great Darwin discovered the uses of insects in cross-fertilization of flowers.

Everything in nature is undergoing a process of change. It is evolution. For millions of years the flower has been adapting itself to insect life and insect life has been adapting itself to inflorescence.

The form, the hue, the fragrance, the nectar of the flower have all become adapted to the wooing of some specie or species of insect guests. The great Angraecum orchid of Madagascar with its slender nectar eleven inches in length was found to have its insect visitor — a huge sphinx-moth with a tongue eleven inches long. When the attention of Darwin was called to this orchid with a long nectary, he said it was conclusive evidence of the existence of a moth with a tongue as long as the nectary "even though no such moth is known." The discovery of the moth later, proved the truth of his claim.

Thus by sipping the nectar, and getting pollen upon its body and carrying it to other flowers, cross-fertilization is carried on, the competitive struggle for existence goes on; natural selection is eternal and the survival of the fittest endures.

The strong plant gains more vigor, the strong crowd aside the weak — and the insect has been the powerful agent in evolution of plants, and plants have been dominating factors in the evolution of higher forms of animal life and the higher spiritual, intellectual and physical existence of man.

William Hamilton Gibson has truthfully said: "With Darwin as our guide, and the insect as our Key — an open sesame — the hidden treasure is revealed."

The Butterfly

There is a great order to which butterflies and moths belong.

The order is called Lepidoptera, meaning scale-winged.

The transformation or metamorphosis is complete.

The four characteristic stages are: the egg, the larvae, the chrysalis, the adult butterfly.

In writing or telling the life story of a butterfly let the pupil outline the story under the following divisions:

1. The laying of the egg.
2. The hatching of the larva.
3. The growth of the larvae.
4. The change to the chrysalis.
5. The change to the butterfly.
6. The habits of the butterfly.

Some Injurious Butterflies and Moths.

The Adult State.	*The Larvae State.*
Common White Butterfly.....	Cabbage Worm.
Black Swallow-tail Butterfly..	Celery, carrot and parsnip worms.
Cresphontes Butterfly	Orange-dog Caterpillar.
Sphinx Moth	Sphinx Caterpillar (tomato, potato and tobacco worms).
Bobbycinae Moths	Silk Worm and Tent Caterpillar, etc.
Gypsy Moth	Leaf Caterpillar.

The Adult State.	*The Larvae State.*
Brown-tail Moth	Leaf Caterpillar.
Owlet Moths	Army Worm, Cutworm, etc.
Codling Moth	Apple Worm.
Leaf Roller Moth	Leaf Roller Caterpillar.
Peach-twig Moth	Peach Worm.

The order of straight-winged insects is called Orthoptera.

This order includes some of the common or well known insects such as

The Grasshopper.	The Cockroach.	The Short-Horned Locust.
The Cricket.	The Walking Stick.	The Manteids.

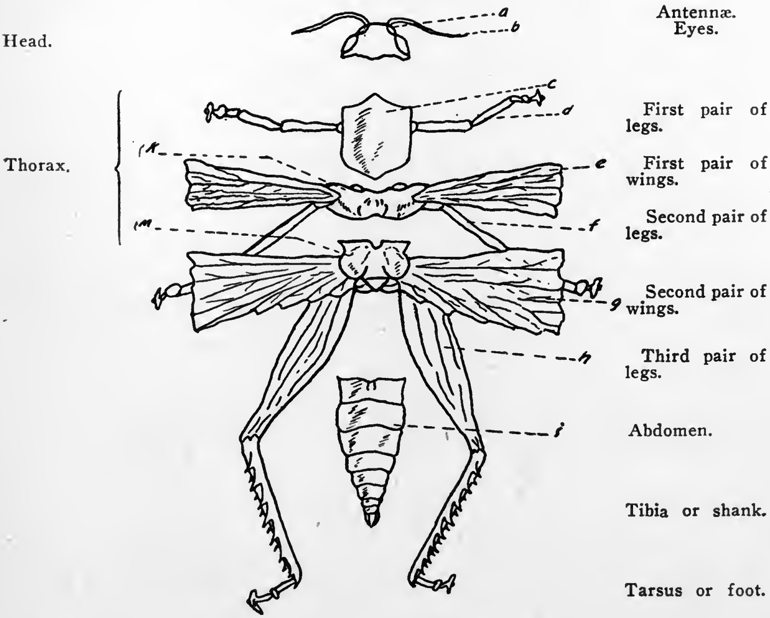


FIG. 4. Anatomy of Insects.

Write or tell the Life Story of a Grasshopper.

Use the following outline:

1. Where and when the eggs were laid.
2. Description of the eggs.
3. Date of hatching.

4. Description of the young.
5. Growth, habits, and food.
6. What becomes of adults.

Illustrate stories with drawings.

Name and describe different parts of the grasshopper.

Make collection of different kinds.

The Hemiotera or Half-winged insects are also called The True Bugs. Among the most obnoxious are:

The Squash Bug.	The Leaf Hooper.	Ants.
The Chinch Bug.	The Jumping Plant Lice.	Periodical Cicada. (17 year locusts).
The Harlequin Cabbage Bug.	The Aphides or plant Lice.	The San Jose Scale.
The Harvest Fly.		The Oyster-shell Scale.

Secure bulletins if possible treating of these insects and study methods of exterminating these pests. (See spray calendar).

The Diptera or Two-winged Flies are the most abundant of all insects. A short list of some of the most important are given for observation and study.

The transformation is complete but they differ from butterflies in that the larvae are commonly known as footless maggots.

Among the most troublesome and destructive to cultivated crops are:

The Hessian Fly.	Crane Flies.	Orange Fruit Fly.
The Wheat Midge.		Root Maggot Fly.

The Beetles.

The order Coleoptera or sheath-winged insects have a hardened outer surface of the whole body. The larvae are grubs. These grubs vary greatly in form and habits.

Beetles feed upon plant tissues or upon animals alive or dead.

Among the plant feeding group are some very troublesome and injurious varieties.

Among the animal-feeding forms are some very beneficial insects.

Adults.	*Larvae.*
May Beetle or June Bug	White Grub.
Rose Chafer or Rose Bug	Grubs.
Click Beetles or Snapping Beetles	Wireworms.
Leaf Beetle (various kinds)	Worms.
Flea Beetles	Worms.
Apple Tree Borer	Worms.
Curculio	Worms.
Cotton Boll Weevil	Grubs.

Some Predaceous Insects.

By predaceous insects is meant those insects that devour the bodies or suck the life blood of their victims, or live as parasites and destroy the host.

Among these predaceous insects are many valuable friends to agriculture.

They destroy many injurious insects according to their various habits of life. According to their mode of life they may be classified as follows:

1. Some devour their victims bodily with wide open jaws.
2. Some pierce the body with pointed beaks and suck the lifeblood.
3. Some insert lancelike ovipositors into the body of the victim and deposit eggs that develop into parasites that attack the body.

PREDACEOUS BEETLES.

Tiger Beetles. Ground Beetles. Ladybird Beetles.

PREDACEOUS BUGS.

Soldier Bug. The Ambush Bug. The Wheel Bug.

PREDACEOUS FLIES. (TWO-WINGED.)

Robber Flies. Syrphus Fly.

PREDACEOUS FOUR-WINGED FLIES.

Ants. The Social Wasps. The White-Faced Hornet. Mud Wasps.
The Dragon Fly.

The Aphis Lion, which is the larvae of the Golden-eyed, Lace-winged Fly.

The Ichneumon Fly.
The Plant-louse Parasite.

The Chalcid Flies.
The Proctotrypid Flies.

THE TWO-WINGED PARASITES.

Tachina Flies.

Insects and Their Insect Enemies.

	Name of Injurious Insect.	*Kind of Crops Injured.*	*Its Natural Enemy. Name of Predaceous Insect.*	*How it destroys the Farmer's Enemies.*
1.	Grasshopper	Field Crops...	Blister Beetle.......	Destroys eggs.
2.	Cutworms	Field Crops...	Ground Beetles.....	Eat body.
3.	Potato Beetle...	Potato	Soldier Bug........	Suck blood.
4.	Caterpillar	Trees	Ichneumon Fly.....	Deposits egg.
5.	Butterfly	Crops	Ambush Bug.......	Eats body.
6.	Plant Lice......	Crops	Ladybird Beetle.....	Devour victim.
7.	Plant Lice......	Crops	Aphis Lion.........	Sucks blood.
8.	Soldier bug	....	Mud Wasp.........	Eats body.
9.	Grain Aphis.....	Crops	Plant - louse Parasite	Lays egg.
10.	Gypsy Moth.....	Trees	Chalcid Fly.........	Lays egg.
11.	Cabbage Worm..	Cabbage	Chalcid Fly.........	Lays egg.
12.	Army-worm	Oats	Tachina Flies.......	Deposits eggs.
13.	White Grub.....	Crops	Pelecinus Fly........	Deposits eggs.
14.	Cotton Boll Weevil	Cotton	Ants and Parasites.	Eat Larvae.
15.	House Fly......	....	White-faced Hornet.	Eats body.
16.	Various Insects..	....	Dragon-Fly	Eats body.
17.	Various Insects..	....	Damsel-Fly	Eats body.
18.	Plant - feeding Caterpillars.	....	Ichneumon Fly......	Oviposits eggs

PROBLEMS.

1. If the cotton crop in the U. S. amounts to 15,000,000 bales and the loss of cotton caused by the Boll Weevil amounts to 400,000 bales annually, what per cent of the crop is lost?

2. If a bale of cotton weighs 500 pounds gross weight, and cotton is worth 12c per pound, what is the value of the annual crop and what is the annual loss on account of the boll weevil?

3. It has been estimated that should the cotton boll weevil become generally distributed in the south it would cause an annual loss of $225,-000,000. If our total production from the farms of the U. S. amounts to 9 billion dollars annually, what will be the per cent of loss to the U. S. if the Boll Weevil damage reaches the loss of 225 millions annually?

There are over 50 species of insects that are injurious to stored grains. Ten of these species are very injurious and for that reason are named in the following list:

1. The Angoumois grain moth.
2. The Mediterranean flour-moth.
3. The Indian meal moth.
4. The meal snout moth.
5. The confused flour-beetle.
6. The granary weevil.
7. The rice weevil.
8. The saw-toothed grain weevil.
9. The yellow meal worm.
10. The dark meal worm.

For measures of prevention, you should consult your state Experiment Station. Most of these pests may be eradicated by simple methods.

The list of injurious insects given is for the purpose of calling attention to the insects that should be studied if any time can be given to entomology in the class room.

Pupils should be required to make a collection of these injurious insects that they may be studied at least to the extent that they may be identified in the collection and recognized in their natural places of habitation.

Equipment.

1. Two Booklets — one on Insect Enemies and one on Insect Friends, upon which to make drawings and reports.

2. Vivariums, constructed by covering glass jars or boxes with fine wire netting. Prepare the artificial place as near as possible in conformity to the natural state of the insect's home.

3. Alcohol to kill insects and to preserve animals and insects in glass bottles or jars.

4. Riker mounts for insects.

5. Frames with glass covers, for keeping butterflies and other insects after they have been killed and treated for preservation.

6. Breeding cages for experiments with insects. Should be so arranged that pupils may observe complete metamorphosis.

Exercises.

1. Make list of insects you can recognize by their song.
2. Make a list of butterflies that you know by sight.
3. Make a collection of insects and place in case, arranged to show name.
4. Make collection of butterflies and arrange in case for reference in nature study.
5. Place bodies of small animals, including lizards, snakes, etc., in sealed air-tight glass jars, filled with alcohol.
6. Keep cocoons in cages, so made that it will be convenient to watch changes.
7. Keep caterpillars in vivarium and watch changes.
8. Make collections of eggs, larvae, chrysalis and butterflies.
9. Make a collection to represent the different stages or changes in the complete metamorphosis of the insect to be studied, as follows: Egg, larva, pupae or chrysalis, and adult.
10. Make collections to show the incomplete transformation in life history of insects.
11. Make a drawing to illustrate parts of an insect. How do spiders differ from insects? Is the spider an insect? Why?

Exercises.

1. Watch an ant's nest to discover if any insects are carried to it.
2. Watch hornets, wasps and spiders and observe how they catch flies and other insects.
3. Examine inside of Mud Wasp's nest for remains of insects.
4. Place some Predaceous Ground Beetles in a vivarium. Feed them cutworms, cabbage worms and other caterpillars.
5. Make collections of beetles and bugs. Keep in a vivarium and referring to the table page 322, feed them the kind of insects they attack for food.
6. Collect Tent Caterpillars early in the spring, and web-worms early in autumn. Keep these in vivaria and note how many are killed by parasites.
7. Examine cocoons for parasites preying on the larvae.
8. Look on tomato vines, grapevines, and other plants for sphinx caterpillars. See if you can find on the caterpillars and cocoons, eggs of microgaster flies.

Entomology.

QUESTIONS.

1. What relation does zoology bear to agriculture?
2. Explain how wind, water, birds and insects become agents in cross-fertilization of flowers?
3. How do insects pollinate flowers?
4. How does the bee carry pollen, and what purpose does it serve in the hive?
5. How does the Humble bee affect the clover crop?
6. How does the honey bee aid the fruit crop?
7. By what two senses are insects lured to the blossom?
8. Is the fragrance of the flower adapted to any particular kind of insects?
9. Explain why some flowers bearing all the organs of fertilization can not pollinate themselves.
10. Is there any technical distinction between "pollination" and "fertilization" of the flower?
11. Is there any evidence to show that flowers adapt themselves to their insect friends?
12. What relation have you observed between the color of plants and the color of some of their insect guests?
13. Do flowers ever serve as a protection to insects? How?
14. If cross-fertilization is the result of natural selection or of the law of the survival of the fittest, what can you say of the importance of insect life in its relation to evolution in the vegetable kingdom?
15. How could the increase of insects of a certain species result disastrously to agriculture? How has nature provided for a well balanced production to maintain an equilibrium between farm friends and farm foes among plants and animals?
16. Why must we know the life history of an insect before we can combat it successfully?
17. With respect to spraying, insects are divided into what two forms?

Book References for Nature Study.

INSECTS.

1ST AND 2ND GRADES.

1. Fanciful Flower Tales — Bigham — Little, Brown & Co., 50c.
2. Stories of Insects — Chase — March Bros., 25c.
3. Wings and Stings — Doulton — Rand-McNally.
4. Story of Insects — Mulets — (Phyllis Books) — Page.
5. Butterflies and Bees — Morley — Ginn & Co.

3RD AND 4TH GRADES.

1. The Honey Makers — Morley — McClurg & Co., 60c.
2. Insect Folk — Morley — Ginn & Co., 40c.
3. The Insect Book — Howard — Doubleday, Page & Co.
4. Autobiography of a Butterfly — Doulton — Rand-McNally.
5. The Spinner Family — Patterson — McClurg & Co.
6. Butterfly Book — Holland — Doubleday, Page & Co.

5TH AND 6TH GRADES.

1. Insect Stories — Kellogg — Henry Holt & Co., $1.50.
2. Stories of Insect Life — Weed — Ginn & Co., 60c.
3. Common Spiders — Emerton — Ginn & Co.
4. Our Insect Friends and Foes — Gragin — Putnam's Sons.
5. The Bee People — Morley — McClurg & Co.
6. Caterpillars and Their Moths — Soule and Elliott — Century Co.
7. Wasps and Their Ways — Morley — McClurg & Co.
8. Buzz — Noel — Henry Holt & Co.

7TH AND 8TH GRADES.

1. Elementary Studies in Insect Life — Hunter — Crane & Co.
2. Butterfly and Moth Book — Miller — Scribner's Sons.
3. Farm Friends and Farm Foes — Weed — D. C. Heath & Co.
4. Blossom Hosts and Insect Guests — Gibson — Newson & Co.
5. Flowers and Their Friends — Morley — Ginn & Co.
6. Birds and Bees, Sharp Eyes — Burroughs — Houghton, Mifflin Co.
7. Nature Study — Holtz — Scribner's Sons.
8. Nature Study and Life — Hodge — Ginn & Co.
9. Economic Entomology — Smith — Lippincott.
10. Economic Entomology — Folsom — P. Blakitson & Co.
11. Manual of Insects — Comstock — Comstock Pub. Co.

Bulletins for Supplementary Reading.

Bulletins can be secured from your state and from the national governments treating of these insects in such a way that the work is both interesting and practical.

Send for Circular 76. List of Publications of the Bureau of Entomology. This list contains the titles of nearly 300 bulletins and circulars on insects.

A limited list such as the following will give an idea as to what can be secured and as to the nature of the bulletins that should be kept on file in the school library for reference.

F. B. No. 155. How Insects Affect Health in Rural Districts.
F. B. No. 459. House Flies.
F. B. No. 196. Usefulness of the American Toad.
F. B. No. 447. Bees.
F. B. No. 442. The Treatment of Bee Diseases.
F. B. No. 127. Important Insecticides.
F. B. No. 145. Carbon Bisulphide as an Insecticide.

CIRCULARS FROM THE BUREAU OF ENTOMOLOGY.

Circular No. 171. The Control of the Codling Moth.
Circular No. 146. Insecticides and Fungicides.
Circular No. 45. Some insects injurious to stored grains.
Circular No. 38. Spraying for Fruit Diseases.
Circular No. 75. The Grain Smuts.
Circular No. 369. How to Destroy Rats.

Write to your state Experiment Station. Have your name placed on the free mailing list.

Ask for whatever available information you need from the Department of Agriculture.

Write to your congressman for help in getting help from the government.

CHAPTER XVIII.

Feeds and Feeding.

Food is that which is taken into the body of animals and is transformed into tissues, heat and energy.

Composition.

Food as usually purchased consists of the edible portion and the refuse. The edible portion consists of water and the nutrients-protein, fats, carbohydrates and mineral matter or ash.

The refuse consists of shells, bones, entrails and other parts not used for food.

The chief use of water in its relation to foods is to act as a solvent and to aid in the digestion of foods.

Water constitutes about 75 per cent of the weight of animal bodies and growing plants.

Chief Functions of Principal Foods.

Protein builds and repairs tissue.

Fats are stored for the production of energy.

Carbohydrates furnish fat and energy.

Mineral matter or ash helps to form bone.

Composition of Foods.

Protein consists of the white of eggs, casein of milk, lean meat, gluten of wheat.

Fats are derived from meat, butter, olive oil, oil of corn.

Carbohydrates consist of crude fiber, starch, sugar, gum, resin.

Mineral matter consists of potash, soda, and other minerals.

The composition of different samples of the same kind of food is not uniform in amount.

The same kind of plant will vary in composition in different localities, according to soil, maturity and characteristics.

Experiments have demonstrated the fact that the protein content of corn varies greatly in the same type and even in the same field.

The Illinois Experiment Station has conclusively proven that by proper selection we can increase the protein content.

The Ohio Experiment Station has shown by chemical analysis that the kernels from one ear of corn tested 8.34 per cent protein, while the kernels from another ear from the same variety and crib, tested 13.14 per cent protein.

This accounts for the variation in the different tables that have been prepared by chemists showing the composition of food materials; hence in the preparation of a table for feeding purposes we must get the average composition. In the crib above mentioned the average run of corn tested 9.97 per cent protein.

Composition of Food and Digestive Nutrients Compared.

A chemical analysis of 100 pounds of corn according to certain authorities is 10.6 pounds of water, 10.3 pounds of protein, 72.6 pounds of carbohydrates, 5.0 pounds of fat, 1.5 pounds of ash.

These food materials are not all taken up by the body. The amount of the same kind of food digested and assimilated varies in different kinds of animals, and even among animals of the same kind.

It has been demonstrated that the per cent of digestible nutrients in corn is as follows: 76 per cent of the protein, 66.7 per cent of the carbohydrates, 86 per cent of the fat. The number expressing the percentage digestible is called the digestion coefficient.

PROBLEMS.

1. How many pounds of each of the following digestible nutrients are there in 100 pounds of corn; digestible protein, digestible carbohydrates, digestible fat?
2. How many pounds of water and how many pounds of dry matter in 100 pounds of corn?

In some tables showing the digestible nutrients in 100 pounds of feed, the per cent of fat and carbohydrates are added together.

Fats serve the same purpose as carbohydrates in animal nutrition. But fat produces 2.25 times as much energy as carbohydrates when they are burned in equal amounts.

3. Find the combined per cent of digestible nutrients of carbohydrates and fat in corn.

4. How many pounds of these two digestible nutrients are there in 500 pounds of corn?

For the solution of problems to find the amount of digestible nutrients, see Henry's Feeds and Feeding.

The substances that are found in the bodies of animals are very closely related in chemical composition to the plants from which they came.

Balanced Rations.

A ration is the amount of feed required for an animal for one day.

A balanced ration is a ration containing the digestive nutrients, protein, carbohydrates and fat in the proper ratio for supplying the requirements of the animal for a certain purpose.

A young animal must have a well balanced ration for normal growth and development.

There may be various reasons for lack of proper gains in animal growth, although food be supplied in sufficient quantities. It may be deficient in ash or protein or carbohydrates and be unsuited to the production of growth.

In accepting certain standards for balanced rations, it is necessary to mix feeds according to a fixed nutritive ratio.

When there is not enough protein in a ration to form the proper nutritive ratio with carbohydrates and fat, the ration is said to be too wide. When there is too much protein for the amount of carbohydrates and fat, the ration is said to be too narrow.

Protein from different sources will have different effects. Protein as found in meat, blood, casein, or eggs, has been prepared in the animal body and is completely utilized in producing growth in other animal bodies. Corn is deficient in ash and protein and unsuited to the production of maximum growth. The ash and protein is only partly utilized.

A large portion of the vegetable proteins derived from beans, oil meal, peas, clover and alfalfa are very suitable for producing growth.

An experiment at the Kansas Agricultural College shows that out of several lots of weanlings at the Kansas Station, pigs put on a dry feed of corn did not seem to thrive; but pigs of the same lots and weight fed on corn and alfalfa hay were thrifty and were soon fat and ready for market.

When ash alone was added to the corn, the results were not perceptibly better, but when a complete protein was added in the form of tankage, or alfalfa, the grain was very rapid.

The bones of pigs fed on rations rich in protein and ash, were double the size of the bones of corn-fed animals and the breaking strain of the bones of corn-fed pigs was 500 pounds while the breaking strain of the bones of pigs fed on corn and alfalfa was 1,370 pounds.

This demonstrates why so many corn-fed hogs go down on their pasterns before they are fit for the market.

In a trial at the Illinois Experiment Station, 6 cows on a balanced ration with a nutritive ratio of 1:6, produced nearly as much as 9 cows on a ration with a nutritive ratio of 1:11.

Because of lack of sufficient protein in the ration with a nutritive ratio of 1:11 the other nutrients were not used to the best advantage. This shows that an excess of carbohydrates cannot take the place of a deficiency of protein.

Calculating Feeding Rations.

In order that the individual may be able to intelligently calculate a well balanced ration for any of the various kinds and classes of live stock, he must be familiar with at least one of the various feeding standards now in more or less general use among progressive stockmen. He must also have access to a set of tables showing the amount of dry matter and digestible nutrients in different kinds of feeds.

The Wolff-Lehman feeding standards and Henry's feeding tables are perhaps more popular than any others because they have been used longer and because of their greater simplicity and ease of application.

Terms Commonly Used in Connection with Feeding Standards.

Dry Matter — The dry matter of a food refers to the food material after all water has been removed by drying at a temperature of not less than 212° F.

Crude Protein—This name is applied to a large group of substances, all characterized by the fact that they contain the element nitrogen; hence they are also called nitrogenous substances.

Crude Fiber—The framework, or hard woody portion of plants, including the cell walls, is composed mainly of fiber; sometimes called cellulose. It is most abundant in coarse fodders, such as hay, straw and stover, and is the most indigestible constituent of feeding stuffs.

Nitrogen-free extract — Includes such substances as starch, sugar, gum, resin, etc., and forms an important part of all feeding stuffs, especially grain.

Carbohydrates — This is a general term applied to the materials in the nitrogen-free extract and crude fiber taken together.

Ether extract of crude fat — In the chemical analysis of feeding stuffs, the oils, fats and wax are dissolved out by means of ether, and are usually designated as ether extract or crude fat.

Digestible nutrient—Is that part of a food stuff which is capable of being digested by an animal, and of being assimilated and built up in the animal structure, the indigestible portion being voided in the excrement.

Nutritive ratio — Signifies the relation between the protein and the carbohydrates and fat taken together. It has been found that fat will yield about 2.25 times more heat than carbohydrates. Hence a nutritive ratio is determined by multiplying the digestible fat in a food or ration by 2.25, adding the product to the amount of digestible carbohydrates, and dividing the sum by the digestible protein. The quotient will be the second factor of the ratio.

EXAMPLE: — Corn contains 6.3% digestible protein, 64.8% digestible carbohydrates and 5.0% digestible fat.

$$5 \times 2.25 + 64.8 \div 6.3 = 12$$

Nutritive ratio 1:12

The purpose of any feeding standard is to show the amounts of digestible protein, carbohydrates and fat supposed to be best adapted to different animals when kept for different purposes. In selecting feeds from which to compound a ration that shall contain the right amount of digestible nutrients it is necessary to observe also that the total amount of organic or dry matter is maintained approximately within the limits of the standard; otherwise although the proper amounts of digestible nutrients might be secured the total bulk of the ration would be so great as to preclude its consumption by the animal.

In calculating a feeding ration it will usually be necessary to formulate several trial rations before we get just the ration desired, because one cannot determine merely from observation just how much of one or more feeds will be required to furnish the amount of dry matter and digestible materials which we want the ration to contain.

The following ration, made up of 40 lbs. of corn stover, 15 lbs. clover hay, 3 lbs. ground corn and 1 lb. cottonseed meal will serve, however, to indicate the method:

CORN SILAGE.

	In 100 Pounds	*In 40 Pounds*
Dry matter	26.4 ÷ 100 × 40 =	10.56
Crude protein	0.9 ÷ 100 × 40 =	0.56
Carbohydrates	14.2 ÷ 100 × 40 =	5.68
Fat	0.7 ÷ 100 × 40 =	0.28

CLOVER HAY.

	In 100 Pounds	*In 15 Pounds*
Dry matter	84.0 ÷ 100 × 15 =	12.6
Crude protein	7.1 ÷ 100 × 15 =	1.06
Carbohydrates	38.8 ÷ 100 × 15 =	0.27

GROUND CORN.

	In 100 Pounds	*In 3 Pounds*
Dry matter	85.0 ÷ 100 × 3 =	2.55
Crude protein	6.7 ÷ 100 × 3 =	0.20
Carbohydrates	64.3 ÷ 100 × 3 =	1.93
Fat	3.5 ÷ 100 × 3 =	0.10

COTTONSEED MEAL.

	In 100 Pounds	In 1 Pound
Dry matter	$93.0 \div 100 \times 1 =$	0.93
Crude protein	$37.6 \div 100 \times 1 =$	0.38
Carbohydrates	$21.4 \div 100 \times 1 =$	0.21
Fat	$9.6 \div 100 \times 1 =$	0.10

Tabulating these results we have the following:

Material.	Dry Matter.	Digestible nutrients.			Nutritive ratio.
		Crude protein.	Carbohydrates.	Fat.	
Corn silage 40 lbs............	10.56	0.56	5.68	0.28	....
Clover hay 15 lbs..........	12.60	1.06	5.67	0.27	....
Corn meal 3 lbs.............	2.55	0.20	1.93	0.10	....
Cottonseed meal	0.93	0.38	0.21	0.10	....
Total ration	26.64	2.20	13.49	0.75	1:6.8

Exercises.

1. Heat a small piece of fresh lean meat in a long test tube. Observe the water as it rises and collects on the cooler parts of the vessel. Weigh before and after heating. What does this experiment prove?

2. Perform the same experiment as in exercise 1, except that wood is to be used instead of meat.

3. To find protein in wheat. Make stiff dough of wheat flour. Wash the dough in cold water; this will remove the starch. The remainder will be very elastic; this is chiefly protein called gluten.

4. Chew grains of wheat until the starch has been dissolved and the "gum" which is left is chiefly gluten.

5. Examine other forms of protein, as white of egg, both raw and cooked.

6. Make wet paper balls of different kinds of paper. Remove the starch with water. What remains is fiber or cellulose.

7. Examine small grains, as corn, wheat, etc. Cut open the kernels. The white powder is nearly pure starch.

8. Boil maple syrup, or sap, cane sap, sugar-beet sap, grape juice, apple cider until they form sugar.

9. Take seeds of flax, cotton, sunflower or castor bean. Crush them and rub between the fingers. You will detect the oil.

10. Burn some alfalfa, charcoal or wood. The part remaining after they are burned is mineral matter, called ash.

11. Burn bone. What is left? Why do we sometimes feed charcoal to hogs?

NOTE TO TEACHERS: — Get from local dealers a collection of samples of concentrated feeds. Place these in bottles and label each.

Write to manufacturers for samples of oil, cottonseed, corn, linseed and other products.

Feeding — Questions and Problems.

1. What do you understand by "digestible nutrient"? Nutritive ratio. Digestion co-efficient?

2. What are the principal classes of nutrients in plants?

3. What are the principal constituent compounds of bones? Of muscles?

4. Considered with reference to feeding stuffs, define *concentrates, roughage, balanced ration, carbohydrates, protein, ether extract, nitrogen-free extract, crude fiber.*

5. What do you understand by "condimental" foods?

6. Why should animals be fed a balanced ration?

7. Should a horse that is idle receive the same kind and amount of food as one at hard work? Give reasons for your answer.

8. Why is it usually advisable to combine concentrates and roughage in a feeding ration?

9. Should a dairy cow in full flow of milk, and a steer being fattened for beef be fed the same ration? Give reasons.

10. Determine the amount of dry matter, and digestible nutrients in the following feeds and calculate the nutritive ratio:

Clover hay	12	pounds
Corn silage	20	"
Cornmeal	4	"
Wheat bran	4	"
Gluten feed	4	"

11. Prepare a ration for fattening steers weighing 1500 pounds, making your own selection of feeding stuff.

12. Prepare a similar ration for a dairy cow weighing 900 pounds.

Books.

Feeding Standards, — Wolf - Lehman.
Feeds and Feeding, — W. A. Henry.
The Feeding of Animals, — W. H. Jordan.

CHAPTER XIX.

Meat Products.

ECONOMY, COMPOSITION AND NUTRITIVE VALUE OF CUTS.

In order to be able to place meat products upon the market at the most profit and upon the most exact basis, the producer should have a precise knowledge of the final market products into which the slaughtered animals of the farm are to be converted.

The great mass of consumers as well as producers do not understand the relative economy, composition, and nutritive value of the different cuts of beef and other animal carcasses.

The following facts are presented for the dissemination of this needed information. The cuts used herewith represent the various cuts of beef as made for the University of Illinois Experiment Station by an expert from the packing-house market of Swift and Company, Chicago.

A careful study of the cuts will be of distinct advantage to the buyer of meats. It is of decided economic importance to know the location and nutritive value as well as the price of different cuts.

Every farmer who does considerable meat cutting on his farm can save by cutting to prevent waste. Figure 1 shows the wholesale cuts of beef and how to cut up the wholesale cuts. These should be studied carefully and kept where they can be had for ready reference.

WHOLESALE AND RETAIL CUTS.

Wholesale cuts marked by heavy black line. Retail cuts marked by light black lines.

TABLE 3—PERCENTAGES OF LEAN, VISIBLE FAT, AND BONE IN THE STRAIGHT WHOLESALE CUTS.

Straight Wholesale Cuts.	Lean.	Fat.	Bone.	Total.
Loin	58.53	31.75	8.89	99.17
Rib	55.21	30.17	14.18	99.56
Round	64.61	18.03	16.63	99.27
Chuck	69.47	18.63	11.26	99.36
Plate	50.61	40.73	8.47	99.81
Flank	36.30	63.18	.25	99.73
Fore shank	47.61	11.63	40.20	99.44
Kidney suet	7.01	92.99	0	100.00
Entire side	56.90	30.29	12.34	99.53

PROBLEMS.

1. If an entire side of beef weighs 357 lbs., and 10% is rib; and 14% of rib is bone; what is the number of pounds of bone?

2. A hind quarter of beef weighs 200 lbs., which is 48% of the whole side; the round meat is 22% of the side; if the round is 16.5 per cent bone, what is the number of pounds of bone?

TABLE 4—COST OF LEAN AND OF TOTAL MEAT IN THE STRAIGHT WHOLESALE CUTS AT MARKET PRICES.

Straight Wholesale Cuts.	Wholesale price per pound of cut, cents.	Cost per pound of lean in cut, cents.	Cost per pound of total meat in cut, cents.
Loin	18.5	31.6	20.5
Rib	15.0	27.1	17.5
Round	11.5	17.8	13.9
Chuck	9.5	13.7	10.8
Plate	8.0	15.8	8.7
Flank	8.0	22.0	8.0
Fore shank	5.0	10.5	8.4

PROBLEMS.

From the proportions of lean, fat and bone in the different cuts, their relative economy at retail market prices may be determined.

The net cost of lean meat will give a fair idea of the relative economy of roasts and steaks.

In comparing the prices of steaks and roasts with boiling and stewing meats there must be a consideration of the fact that both fat and lean are more completely utilized in boiling and stewing as in the preparation of meat loaf, as hamburger and corned beef.

PROBLEMS.

NOTE. — The relative cost of lean meat in a given cut consists of the price per pound paid for the cut divided by the percentage of lean it contains; the cost per pound of gross meat is the market price of the cut divided by its total percentage of lean and fat meat. For example, if a steak cost 20c per pound and is composed of 80 per cent lean, the net cost per pound of lean is $20 \div .80 = 25$, or 25c.

1. If a pound of loin costs 20c and contains 10% bone and 10% visible fat, what is the cost per pound of the lean meat in the cut?

2. If a pound of loin costs, as given in the foregoing table, 18.5c and the cost per pound of total meat in the cut is 20.5c what is the percentage of bone?

3. If a pound of fore shank costs 5c and the cost of lean per pound in the shank is 10.5c and the cost per pound of total meat is 8.4c what is the per cent bone and what is the per cent fat?

4. A pound of flank costs 8c and the cost per pound of lean in the cut is 22c; what is the number of ounces of fat in the pound?

5. If the wholesale price of round is 10c, what should be the price of loin according to prices given in table 4?

6. According to table 4, when ribs are 16c per pound, what should be the price of plate?

Cuts of Beef.

The straight cuts are loins, ribs, rounds, chucks, plates, flanks, and shanks.

The grades of beef cuts are No. 1, No. 2, No. 3 and strippers.

The grade of cut depends upon its weight, thickness, covering and quality.

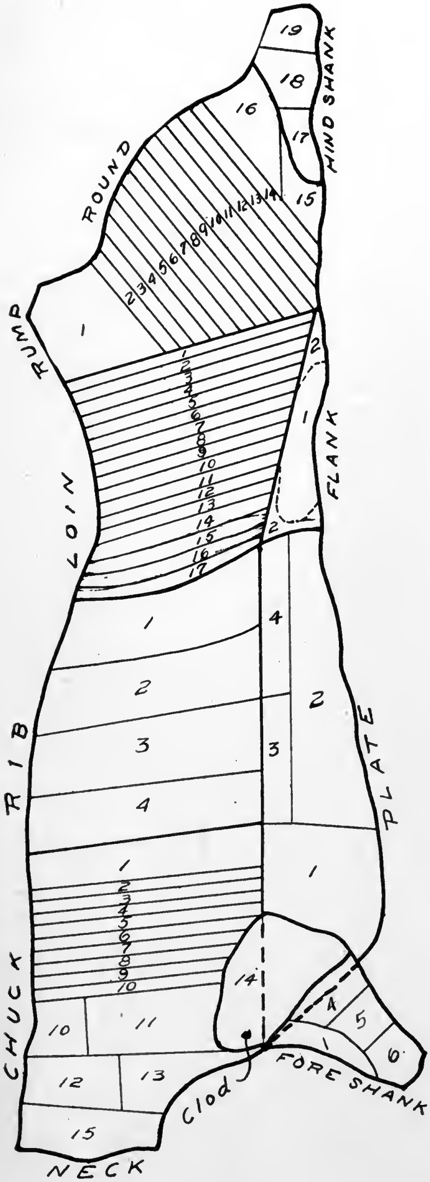


FIG. 1.

Retail Cuts of Beef.

HIND QUARTERS.

ROUND—

Rump—

1. Rump.

Round: rump and shank off.

- 2. Round steak, first cut.
- 3–13. Round steak.
- 14. Round steak, last cut.
- 15. Knuckle soup bone.
- 16. Pot roast.

Hind Shank—

- 17, 18. Soup bones.
- 19. Hock soup bones.

LOIN—

- 1. Butt-ends sirloin steak.
- 2. Wedge-bone sirloin steak.
- 3–4. Round-bone sirloin steak.
- 5–6. Double-bone sirloin steak.
- 7. Hip-bone sirloin steak.
- 8. Hip-bone porterhouse steak.
- 9–15. Regular porterhouse steak.
- 16–17. Club steaks.

FLANK—

- 1. Flank steak.
- 2. Stew.

FORE QUARTERS.

RIB—

- 1. 11th and 12th rib roast.
- 2. 9th and 10th rib roast.
- 3. 7th and 8th rib roast.
- 4. 6th rib roast.

CHUCK—

- 1. 5th rib roast.
- 2–10. Chuck steaks.
- 10–13. Pot roasts.
- 14. Clod.
- 15. Neck.

PLATE—

- 1. Brisket.
- 2. Navel.
- 3–4. Rib ends.

FORE SHANK—

- 1. Stew.
- 2–4. Soup bones.

The following table shows the percentage of straight beef cuts to the carcass weight:

PERCENTAGE OF "STRAIGHT" BEEF CUTS TO CARCASS WEIGHT.

Cuts.	Loins.	Ribs.	Round.	Chucks.	Plates.	Flanks.	Shanks.	Suet.
Extreme	15–19	8–11	20–26	21–27	12–16	2–5	3–7	2–7
Conventional	17	9	23	26	13	4	4	4

In the solution of the following problems, the figures representing the conventional weight of "straight" cuts are used. The weight of a fore quarter being 52 lbs., and the weight of a hind quarter 44 lbs. and suet 4 lbs.

PROBLEMS.

1. A prime steer weighed 1,250 pounds and dressed 60 per cent (cold weight); according to the above table, what would be the weight of the round steak in this beef?

2. The hind quarter of a beef weighed 100 pounds; what was the weight of the whole carcass?

3. The loin in a beef weighed 167.6 pounds; what was the weight of the whole beef?

4. The entire side of a beef weighs 225 pounds; what is the weight of a fore quarter?

5. How many pounds of flank in a beef that weighs 1,000 pounds?

6. What will be the cost of the rib of a beef weighing 800 lbs. @ 17.5c a pound?

The University of Illinois made tests upon the carcasses of three steers of the following description and weight:

		Weight.
No. 1.	A choice grade Hereford................	902 lbs.
No. 2.	A choice grade Aberdeen-Angus..........	1,190 lbs.
No. 3.	A prime pure-bred Shorthorn............	1,360 lbs.
	Average weight	$1,150\frac{2}{3}$ lbs.

The slaughter tests showed the average weight of each part and its per cent of the average live weight of the three steers.

	Per cent of live weight.
Dressed beef, warm	62.31
Dressed beef, cold	61.73
Shrinkage	.57+

The weight of parts removed from dressed beef show the following results:

Parts.	*Per cent of live weight.*
Hide	6.80
Tongue	.45
Heart	.40
Liver	1.20
Sweet breads	.07
Lungs	.53
Trachea	.23
Tail	.14
Stomach with contents	9.83
Intestines	3.21
Spleen	.23
Head	2.30
Fore feet	.70
Hind feet	.70
Blood	3.13
Other parts	5.54
Loss in dressing	2.24
Total percentage removed from dressed beef plus	.57
Shrinkage	38.27
Dressed beef — cold	61.73
Total	100.00

Exercises and Questions.

1. Make a drawing of retail cuts of beef according to diagram. Number and name cuts.
2. According to cost of retail cuts at price per pound, which are the highest and which are the lowest priced cuts?

3. According to cost per pound of lean meat in cuts, which are the most expensive and which are the cheapest cuts?
4. When buying lean meat for its protein content, which cuts are the cheapest and which are most expensive?
5. Which are the cuts of highest percentage of fat, of fuel value, of protein content?
6. When the food value is about the same, why are some cuts of meat so much higher in price than others?
7. Considering relative food values, which cuts are the most economical?

Analysis shows that some of the cheaper cuts are more valuable in protein content and energy produced than some of the high priced cuts. Boiling, stewing and roasts, hash, meat loaf, corned beef and hamburger are economical and palatable ways of utilizing both the fat and lean of the cheap cuts of beef.

Bones contain rich flavoring matter and nutritive substances and are used for making various soups.

TABLE 5—PERCENTAGES OF WATER, SOLUBLE AND INSOLUBLE DRY SUBSTANCE, AND FAT IN THE BONELESS MEAT OF THE WHOLESALE CUTS.

Wholesale cut.	Water.	Dry substance.				
		Other than fat.				
		Soluble.	Insoluble.	Total.	Fat.	Total.
Flank	32.26	1.73	8.88	10.61	57.16	67.77
Plate	39.42	2.29	9.89	12.16	48.57	60.75
Rib	45.15	3.06	11.23	14.29	40.62	54.91
Rump	46.25	3.33	11.42	14.75	38.95	53.70
Loin	47.42	3.48	11.69	15.17	37.71	52.88
Chuck	55.47	3.82	13.53	17.35	27.54	44.89
Neck	56.32	3.80	14.07	17.87	26.12	43.99
Fore shank	60.95	3.80	15.75	19.55	19.98	39.53
Hind shank	61.02	3.90	14.84	18.74	20.77	39.51
Round	60.86	4.89	14.55	19.44	19.65	39.09
Clod	63.04	4.48	15.02	19.50	17.96	37.46

TABLE 6—COST OF LEAN AND OF TOTAL MEAT IN THE VARIOUS RETAIL CUTS AT MARKET PRICES.

Retail cuts.	Diagram number Figure 1.	Retail price per pound of cut, cents.	Cost per pound of lean meat in cut, cents.	Cost per pound of lean and fat meat in cut, cents.
STEAKS—				
Porterhouse, hip bone	8	25	38.6	28.9
Porterhouse, regular	10	25	40.2	27.2
Club steak	17	20	32.1	22.6
Sirloin, butt-end	1	20	25.3	20.6
Sirloin, round-bone	3	20	28.3	21.1
Sirloin, double bone	5	20	28.7	22.7
Sirloin, hip bone	7	20	32.3	24.2
Flank steak	1	16	19.3	16.0
Round, first cut	2	15	17.0	15.3
Round, middle cut	6	15	17.3	15.6
Round, last cut	14	15	19.3	16.0
Chuck, first cut	2	12	18.3	14.1
Chuck, last cut	9	12	15.7	13.1
ROASTS—				
Prime ribs, first cut	1	20	40.5	22.9
Prime ribs, last cut	4	16	26.1	18.8
Chuck, 5th rib	1	15	22.8	17.3
Rump	1	12	19.4	12.8
BOILING AND STEWING PIECES—				
Round pot roast	16	10	11.6	10.1
Shoulder clod	14	10	12.3	10.5
Shoulder pot roast	11	10	14.3	11.6
Rib ends	3	8	16.2	9.2
Brisket	1	8	15.0	8.7
Navel	2	7	12.8	7.7
Flank stew	2	7	10.9	7.1
Fore shank stew	1	7	8.5	7.0
Neck	15	6	8.5	7.0
SOUP BONES—				
Round, knuckle	2	5	26.3	12.5
Hink shank, middle cut	18	5	7.5	6.3
Hind shank, hock	19	5	62.5	26.6
Fore shank, knuckle	2	5	17.2	12.5
Fore shank, middle cut	4	5	12.5	9.4
Fore shank, end	6	5	28.8	20.9

TABLE 7 — RELATIVE FUEL VALUE OF THE BONELESS MEAT OF THE WHOLESALE CUTS.

Wholesale cuts.	Percentage of distribution of calories.		Pounds of boneless meat required to furnish 1000 calories.
	In fat.	In protein.	
Flank	92.7	7.3	.40
Plate	90.5	9.5	.46
Rib	87.1	12.9	.52
Rump	86.4	13.6	.54
Loin	85.5	14.5	.56
Chuck	79.0	21.0	.70
Neck	77.6	22.4	.73
Hind shank	72.5	27.5	.86
Fore shank	70.9	29.1	.87
Round	70.6	29.4	.88
Clod	68.7	31.3	.94

A calorie is the amount of heat required to raise the temperature of one kilogram of water one degree Centigrade.

95 per cent of the energy of fat and 92 per cent of the energy of protein are available in use by man.

The high fuel value depends upon the high percentage of fat.

The percentage of calories depends upon the percentage of fat and percentage of protein.

TABLE 8 — COST OF MEAT REQUIRED TO FURNISH ONE POUND OF PROTEIN AND 1000 CALORIES FROM WHOLESALE CUTS AT MARKET PRICES.

Wholesale cuts.	Retail price per pound, cents.	Boneless meat in the cut, percent.	Cost of pound boneless meat in cut, cents.	Cost of pound protein in cut, cents.	Cost of 1,000 calories in cut, cents.
Fore shank	5	59.56	8.4	50	7
Hind shank	5	48.84	10.2	63	9
Neck	6	84.31	7.1	46	5
Flank	8	99.44	8.0	85	3
Plate	8	91.23	8.7	82	4
Clod	10	95.18	10.5	63	10
Chuck	11	87.99	12.5	84	9
Rump	12	79.85	15.0	119	8
Round	15	90.39	16.6	101	15
Rib	18	85.56	21.0	171	11
Loin	22	90.23	24.4	188	14

Average prices calculated from the retail prices given in Table

PROBLEMS.

1. Which are the three cheapest cuts for protein content?
2. Compare the cost of a pound of protein in the flank with the cost of a pound of protein in the loin.
3. Which three cuts are the cheapest per 1,000 calorie? Which two are the highest in price per 1,000 calories?

Market Classification and Grades of Meat.

The following descriptions are based on data secured in an investigation at wholesale markets at the Union Stock Yards, Chicago, and in other cities.

These classifications are based on the wholesale meat trade and not on the live stock market. The weights refer to dressed carcasses.

Carcass beef includes both sides and quarters.

Carcasses are classified as to:

1. Kind, steers, heifers, cows, bulls, stags.
2. Form, thickness, finish, quality, soundness, weight.
3. Grade, prime, choice, good, medium, common, canners.

Carcasses are further classified as follows:

"Native"—
Beef, grain fed, compact, thick, mature, from medium to prime steers, heifers, cows of heavy weight.

"Westerns"—
Rangy in form, "grassy" in color, coarse in quality; common to good cows and steers inferior to natives.

"Yearlings"—
Beef carcasses of young steers and heifers 400 to 700 pounds dressed weight for retailing on the block.

"Kosher" beef—
Medium to choice carcasses of steers, cows, and heifers slaughtered, inspected, cleaned and labeled in accordance to Jewish rites.

"Distillers"—
Carcasses of steers, bulls, and stags of soft washy flesh and high color and characteristics of cattle fattened on distillery slops.

"Shippers"—
Carcasses of steers, heifers, and cows of medium to prime grades for shipping to eastern cities.

"Export beefs"—
Carcasses of medium to choice steers, good choice heifers, heavy cows, bulls and stags.

Cured beef products are:

1. Barreled beef packed in brine.
2. Smoked beef cured in sweet pickle, dried and smoked.
3. Canned beef sealed in tins or glass jars after curing and cooking.

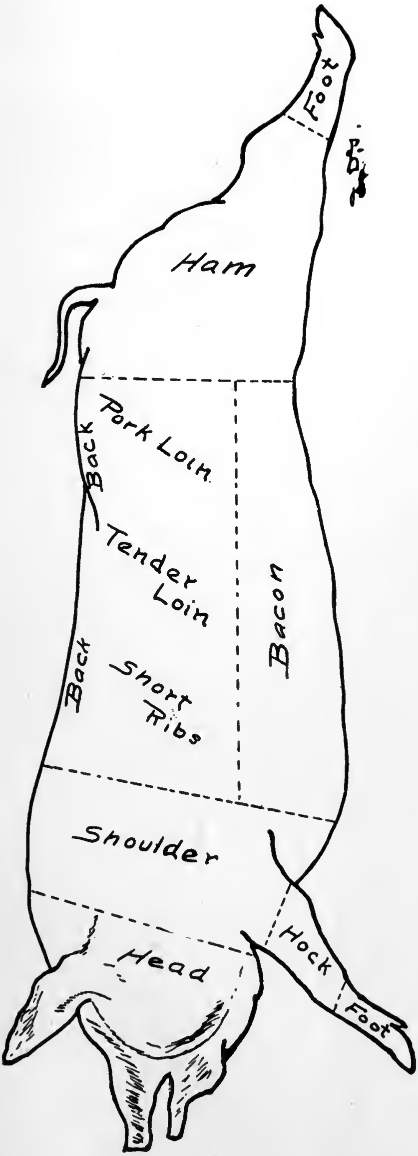
Pork.

Dressed hogs are classified as follows:

(1) smooth heavy, (2) butcher, (3) packing, (4) bacon, (5) shippers, (6) pigs.

Packing hogs are selected for weight.

Bacon hogs are selected chiefly for quality and finish.



The following figures show the comparative values of the different cuts of pork as used by the retail butchers of Chicago:

Foot	1c.
Ham Trimmings........	4c.
Ham	$7\frac{3}{4}$c.
Pork Loin	$6\frac{1}{2}$c.
Tenderloin	8c.
Side	6c.
Short Ribs	$6\frac{1}{4}$c.
Bacon	7c.
Shoulder	6c.
Shoulder Trimmings....	4c.
Head	3c.
Hock	3c.

PROBLEMS.

1. When hams are 12c. a pound what should be the comparative value of all other parts of pork according to comparisons of Chicago retail butchers?

2. When bacon is 10c., fix a table of prices for all other cuts.

FIG. 2.

Pork cuts are quoted as fresh pork, dry salt, and bacon meats, barreled or plain-pickled pork, sweet pickled meats, smoked meats, English meats, and boiled meats.

Lard is graded as follows: Kettle-rendered leaf, kettle-rendered, neutral, prime steam, refined, and compound lard. The grading being based on the method of rendering, color, flavor, grain and kind of fat.

Pork to have the best flavor must come from healthy hogs that have had plenty of range and exercise.

The best meat comes from a variety of food such as berries, nuts, roots and grass, and plenty of good clean water.

The muscular tissues must be developed to get good lean meat.

Meat is better from a hog fattened in the field than from a hog fattened in a pen.

To secure sound meat a hog must be killed in cool frosty weather.

The meat must hang up until it is thoroughly drained and cooled.

Hams, shoulders, ribs, sides, etc., must be carefully cut, prepared, cured and kept, or they will spoil.

And last but not least, a hog may be raised right, fattened properly, killed at the right time, and cured scientifically, and the meat be in an almost perfect condition and yet if it is not properly cooked it may not be fit to eat. Thus agricultural science is intimately connected with and interwoven with domestic science.

Veal.

Carcass Veal.—This usually consists of whole carcass with skin on.

Grades.—Choice, good, medium, light and heavy. Grade determined by its form, quality, finish and weight.

Native calves have white, fine-grained flesh and long, soft hair.

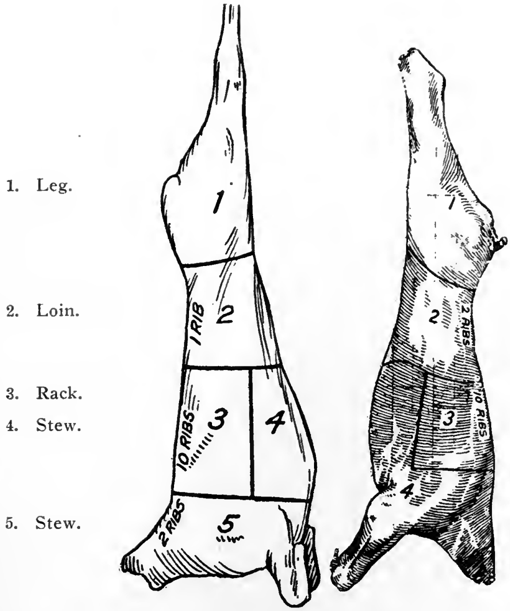
Westerns calves have coarse dark colored flesh, rangy form and short straight hair.

The following represents the cuts of veal:

The regular cuts are saddles and racks. Each is about one-half by weight of the whole carcass (skinned.

Veal legs and stews each contain about one-third the carcass weight.

Ribs and loin contain about one-sixth the carcass weight.



Mutton and lamb cuts Cuts of veal

FIG. 3 and 4.

Facts About Meat.

MUTTON, BEEF AND OTHER MEATS COMPARED.

1. Meat differs in composition according to the age of the animal.
2. There is a larger percentage of fat, protein, and extractives or flavoring substances and a smaller percentage of water in mature animals, than in young animals of the same kind.
3. Meats are very digestible foods; 97 per cent of the meat protein and 95 per cent of the fat are retained in the body, and 87 per cent of the energy is available for body uses.
4. In medium fat beef, 20 per cent of the edible portion is fat, and in medium fat mutton, the edible portion contains 30 per cent fat.
5. The edible portion of beef is about 18 per cent protein and in mutton it is about 16 per cent.
6. So far as nutritive value is concerned, mutton is usually classed with beef. Analysis shows that they have approximately the same composition.
7. A comparison of beef with veal, mutton with lamb, and of fowl with chicken shows that there is a difference in composition and nutritive ratio.

8. The term "mutton" applies to the flesh of sheep one or more years old.
9. The percentage of waste is a little less than 20 per cent in each mutton and beef.
10. The tenderest portion of flesh in all animals is that which lies under the backbone. This part is known as the tenderloin in the front and hind quarters.
11. Chops are cut from the true loin or from the small bones of the spine; a thick chop is called an English chop.
12. If the tough meat lying parallel to the bone on the rib is trimmed away from the chop, leaving only the tenderloin it is called a French chop.

The results of a large number of experimental tests made and recorded at different abattoirs and packing houses show the relation of dressed to live weight. The following table shows the average dressed weight of (cold) carcasses:

Dressed.	*Per Cent of Live Weight.*
Beef	60
Pork	80
Mutton	55
Veal	60
Poultry	60
Fish	60

NOTE TO TEACHERS: State problems, giving live weight of animals to find dressed weight.

Whenever it is possible the class in agriculture should have an opportunity to visit an abattoir and study the methods of doing certain parts of the work, such as,

Killing,
Dressing,
Cooling,
Cutting.
Packing,
Preparing cured and manufactured products.

Study the daily market reports.

Advise the pupils to visit the stock yards, the slaughtering and packing houses of some extensive concern like Armour, Swift and Company or some similar place.

A visit to some great manufacturing plant like the H. J. Heinz Pickle Factory at Pittsburg, where there are manufactured some 57 varieties of products, of meat and other farm products, will help to give the pupil a broader view of the importance of agriculture in America.

Exercises and Experiments.

1. Devise an experiment to show the effect of salt upon a piece of meat, before and after the meat is cooked.
2. Explain how meats may be cooked so as to retain juices.
3. Explain process whereby juices may be extracted; partly retained and partly extracted.
4. Make a list of herbs, vegetables, spices, and acids used in flavoring meats.
5. Make a list of the cuts of beef, mutton, lamb, pork, etc., with the best methods of cooking each.
6. Explain the principle of soup making. Name cuts well adapted to making soups.
7. Explain process of making lard, sausage, souse, head cheese, pickled heart, tongue and feet, bologna, wienerwurst, liverwurst, pressed ham, dried beef.
8. Name meats from different animals on sight. Tell from what part of carcass piece is taken.
9. Practice dressing, beef, pork, veal, lamb, fish, chicken, etc.
10. Make demonstrations of cutting, salting, curing, smoking, pickling, packing, preserving, storing; use of coolers, refrigerators, etc.

Questionns.

1. What is an abattoir?
2. Why should there be enforcement of strict laws against slaughtering diseased animals for food?
3. At what age do steers generally produce the best flavored meat?
4. What is the average age at which hogs are butchered in the U. S.?
5. What should be the age of a calf before it is fit for veal?
6. What is the difference between lamb and mutton?
7. Explain difference between fat and lean meat.
8. Is the lean meat of an animal poor in flesh properly flavored? Why?
9. How can you detect tainted, sour, or decayed meats?
10. Explain how different kinds of feeds effect the color of meats.
11. What difference is there between a corn-fed and a grass-fed steer?
12. Make a list of domesticated and wild animals used for food.
13. Explain different ways in which meat is used for food.
14. Explain different methods of preserving meats.
15. What is sugar-cured meat?

16. What is smoked meat? Does the kind of wood used in smoking effect the taste of meat?
17. What precautions should be taken to prevent danger from parasites, poisons and bacteria in meat?
18. Of what advantage is government inspection of meats?
19. What makes the difference between tough and tender meat?
20. Why is the neck of beef tough and the porterhouse steak tender?
21. Should meat be cooked until well done?
22. What should be the color of meats of the following kinds, from animals in good condition: beef, veal, mutton, lamb, pork?
23. What is ripened meat?
24. Should meat be placed in the refrigerator while it still retains animal heat?
25. What are some of the dangers of using canned meats?
26. Define: Boiling, steaming, stewing, broiling, braising, pudding, sauteing, stuffing, frying, roasting, puree, stew, consomme, bouillon, soup, hash, giblets, squab, bisque, gravy, chowder, fillet, roast, souse, omelet, escalloped, sweet bread, croquettes, cutlet, sandwich, oleomargerine, pot-pie, quenelles, au gratin, rechauffes, gelatin pudding, suet, mayonnaise.
27. Explain each of the following menu terms often used where meals are served *"a la carte"*: Eggs au gratin, chicken fricassee, porterhouse steak, sirloin steak, beef omelet, pork chop, poached eggs, fish croquettes, quail on toast, smothered grouse, lamb stew, veal cutlets, tortue verte claire, bouillon en tasse, clam chowder, egg nog, Julienne soup, chicken pot-pie, hamburg steak, venison steak, fillet of beef, cheese fondue, braised beef, fillets of grouse, scrambled eggs, boiled ham, schmier-käse or cottage cheese, cream puffs, Welsh rarebit, orange jelly, farina soup, Scotch roll, broiled squab, scallop broth, plain omelet, breakfast bacon, rib roast, stuffed turkey, baked fish, fried oysters, lyonnaise.

Household Science and Arts Library.

Laboratory Handbook for Dietetics—Mary S. Rose.
Chemistry of Food and Nutrition—Sherman.
Food Products—Sherman.
Science of Nutrition—Lusk.
The World's Commercial Products—Freeman and Chandler.
Elementary Household Chemistry—Snell.
Nutritional Physiology—Stiles.
Household Bacteriology—Buchanan.
Bacteria, Yeasts, and molds in the Home—Conn.
Microbiology—Marshall.
Household Physics—Lynde.
Selection and Preparation of Food—Bevier and Van Meter.

Principles of Cookery—Anna M. Barrows.
Technique of Cookery—M. B. Van Arsdale.
Foods and Household Management—Kinne and Cooley
Pure Foods—Olsen.
Domestic Science—Austin.
Household Science and Arts—Morris.
Bacteria in Relation to Country Life—Lipman
Home and School Sewing—Patton.
Nutrition and Diet—Conley.
Cost of Living—Ellen H. Richards.
Cost of Food—Ellen H. Richards.
Cost of Shelter—Ellen H. Richards.
Cost of Cleanness—Ellen H. Richards.
Standards of Living—Chapin.
The New Housekeeping—Frederick.
Increasing Home Efficiency—Martha B. and Robert W. Bruere.
Household Hygiene—S. Maria Elliott.
Household Management—Bertha E. Terrill.
The Expert Waitress—Larned.
Laundry Manual—Balderston and Limerick.
Bulletins of the U. S. Department of Agriculture.
Bulletins from State Experiment Station.

PART IV.

FARM MANAGEMENT.

CHAPTER XX.

Production and Consumption.

"Population must increase rapidly, more rapidly than in former times, and ere long the most valuable of all arts will be the art of deriving a comfortable subsistence from the smallest area of soil. No community whose every member possesses this art can ever be the victim of oppression in any of its forms. Such a community will be alike independent of crowned kings, money kings, and land kings."—Abraham Lincoln.

The wealth and power of nations springs chiefly from the soil. A hundred cottage homes and gardens owned by a hundred different individuals is greater evidence of national prosperity and greatness than a hundred homes owned by a single individual, when in those homes there are housed the families of a hundred miserable, subservient, cringing tools of landlordism and monopoly.

The high cost of living cannot be wholly charged to under-production by the farmer. It is a problem that must be solved partly by the consumer. The price received by the farmer is one thing, while the price paid by the consumer under the usual method of distribution is quite a different thing.

There may be overproduction of some farm crops in a certain locality, while in another locality there may be underconsumption of the same product. For instance in 1909 potatoes were sold in certain parts of the country for from 10 to 20 cts. per bushel, yet at the same time consumers in the East were paying 50 to 75 cents per bushel.

One of the most successful solutions that has been proposed outside of legislative action has been the organization of co-operative societies. Cooperative selling and cooperative buying associations will go far toward relieving conditions, effecting inequality in distribution and prices.

The problem of cooperative distribution is so simple that it requires no extended discussion here. It is simply a process of elimination of a long chain of middlemen, standing between producer and consumer, who keep prices down for the producer and make prices high for the consumer.

"One of the most vital subjects before the country today is the efficient and economical handling and marketing of the products of the farm. Upon its correct solution hinges in great part the reduction of the high cost of living."—Charles J. Brand. Year Book U. S. Dept. of Agriculture. 1912.

It has been estimated by competent authorities that fully 25 per cent of the cotton crop and a still greater per cent in fruits are wasted by slipshod methods of scattering these crops on the way to market.

Cooperative organizations of cotton growers have demonstrated what can be accomplished through social efforts at Montgomery, Alabama; Glendora, Mississippi; Purcell, Oklahoma; and in the Imperial Valley, California.

These farm organizations have their own ginneries, warehouses, elevators, exchanges, systems of credits, and other advantages.

In California the citrus-fruit organizations are handling about 50,000 carloads of fruit per annum. They have packing houses, cold-storage and precooling plants, and they have their own selling agencies throughout the United States and foreign countries. They have revolutionized their business and are now able to market 50,000 carloads of fruit with less difficulty than they marketed 15,000 carloads when they had no organization.

The farmers of the northwestern states are now handling possibly $250,000,000 worth of grain annually. A farmers' elevator in South Dak. handled over a million bushels of wheat in 1910.

NOTE — Read, "Cotton Improvement on a Community Basis," by O. F. Cook, Yearbook of the Dept. of Agriculture for 1911.

Read, "Co-operation in the Handling and Marketing of Fruit," by G. Harold Powell, in the Yearbook of the Dept. of Agriculture, for 1910.

According to investigations made in June, 1910, by the U. S. Dept. of Agriculture, and published in the year book by order of the Secretary of Agriculture, James Wilson:

Investigation established the fact that in 78 cities the consumers paid for milk 100.8 per cent above the price received by dairymen.

Consumers paid 15.8% above the factory price of creamery prints.
Consumers paid 15.6% above the factory price of tub.
Consumers paid 13.3% above the factory price of renovated butter.

The industrial commission found some extreme cases where,

Consumers paid 135.3% above the producers price on cabbage.
Consumers paid 100% above the producers price per melon per lb.
Consumers paid 260% above the producers price on onions by the peck.
Consumers paid 400.4% above the producers price on oranges by the dozen.
Consumers paid 111.1% above the producers price on strawberries by the quart.
Consumers paid 200% above the producers price on watermelon sold singly.

Consumers and Producers.

According to the International Institute of Agriculture:

It has been estimated that in 1912, that the producers of the farm received $6,000,000,000 for their products and these same products cost the consumers $13,000,000,000.

It has been estimated that in New York City the prices received by farmers and the prices paid by consumers were as follows:

1. *Eggs.*
   (a) Farmers received 17 million dollars.
   (b) Consumers paid 28 million dollars.
2. *Milk.*
   (a) Farmers received 23 million dollars.
   (b) Consumers paid 49 millions dollars.
3. *Cabbage.*
   (a) Farmers received $1,800,000.
   (b) Consumers paid $9,000,000.
4. *Potatoes.*
   (a) Farmers received $8,500,000.
   (b) Consumers paid $60,000,000.
5. *Onions.*
   (a) Farmers received $821,000.
   (b) Consumers paid $8,000,000.

PROBLEM.

1. What was the per cent profit made by middlemen on each of the following products in New York:

(a) On eggs?
(b) On milk?
(c) On cabbage?
(d) On onions?
(e) On potatoes?
(f) On the total amount of business transacted?

There is no longer any excuses for this unreasonable difference between the cost of production and consumption that now goes into the pockets of non-producers.

The farmers and consumers must demand a preference freight service that will afford the speediest form of transportation of perishable products. The milk train, the peach train, the strawberry train, of loaded refrigerator cars will help to solve the problem.

Within the circle of figure 1 is the greatest fruit eating section in the world. Within a radius of fifty miles of the City Hall, New York, there is a population of 5,000,000 people. Less than 3 per cent of these people ever produce any fruit.

To supply a great city with milk, butter, eggs, fruit and other products in a fresh condition is one of the great problems of transportation.

With special freight service, the motor truck and the parcels post and a city market there is no reason why the producers of eggs, dressed poultry, butter, fruit, vegetables and flowers can not market a large part of their products direct to the consumer.

In ages past nations have started out in their careers of military conquest to gain more territory, to enhance their agricultural and commercial resources. Today a nation than can double its agricultural production, its commerce, its manufacturing and its transportation has accomplished far more for its populace than if it had acquired by militay conquest an area equal to its own.

The great problem for agricultural science to solve is not to increase the number of acres to be tilled. It is a problem of increasing the yield and profits on the land that we are already tilling. It is a problem of saving and of economical and profitable distribution of what we are already producing.

The problem of production and consumption is both a country and a city problem. In the solution of these problems to the greatest good to the greatest number, the city and the country must exercise a reciprocal relationship.

The success of the farmer depends upon cheaper methods of production and better means of distribution, a better and more stable price for his products. The welfare of the consumer in the city will depend to a great extent upon cooperative methods with the producer to keep down the exorbitant toll of middlemens' profits.

Five miles has been estimated as the average limit for supplying green goods for the city supply when drawn in wagons over soft roads.

With good roads and mechanical transportation with the motor truck, the whole country within 30 miles of the city can be made available for truck gardens.

Fruit and vegetables can be profitably produced, and marketed with the motor truck at a minimum cost over a territory many times greater than when hauled by horses. This method will cut down the average cost of hauling at least 50 per cent .

Figure 1 represents a part of our country containing a population of 35,000,000 people. Within the above circle with New Jersey as a center there are 85 of the principal cities of the United States.

PROBLEMS.

1. Find the approximate area of the above map if the diameter of circle is 1,000 miles.
2. What is the land area of the map given above?
3. What is the average population per square mile?
4. What part of the land area of the United States does this land constitute?

The dotted line in figure No. (1) shows a long narrow belt which extends from the vicinity of Atlanta, Ga., to the southern portion of New Jersey, along the Aatlantic Coast, and is known as the great winter garden which supplies the cities of

FIG. 1.

THE MOST POPULOUS PART OF NORTH AMERICA.

the northeastern states with fresh vegetables demanded for consumption.

To the student who has a desire to study this region further and acquaint himself wtih the climatic conditions, the transportation facilities, the growth of the trucking industry of this region, the trucking soils, the topography of the region, it is advised that he should read "Truck Soils of the Atlantic Coast Region" by Jay A. Bonsteel, in the year book of the United States Department of Agriculture, 1912.

EXERCISE.

Secure a map of the United States.

Draw a line from the 80th meridian at Pittsburgh, Pennsylvania, to the middle boundary of North Dakota at the 100th meridian.

Draw another line from Pittsburgh to the southwest corner of Oklahoma and then draw a line from this point in Oklahoma north on the 100th meridian to the point where it will intersect the line from Pittsburgh to the northern boundary of North Dakota.

PROBLEMS.

1. Find the length of each of the three sides of this triangle. This may be found approximately by using the scale on the map.
2. How many sq. miles of land are included within this boundary?
3. What part is this of the land area of the United States?
4. What part is this of the land area of the globe?

The population of this region is about 30,000,000.

The Banner Region in Agriculture.

Within this area is produced one-half of all the corn in the world.

This region also produces one-third of the hogs, one-fifth of the cattle, one-fourth of the meat, one-fifth of the oats, one-eighth of the wheat, and one-tenth of the horses of the world.

This is the region of greatest opportunity in the world, because we can more than double the production per acre, within a very short term of years.

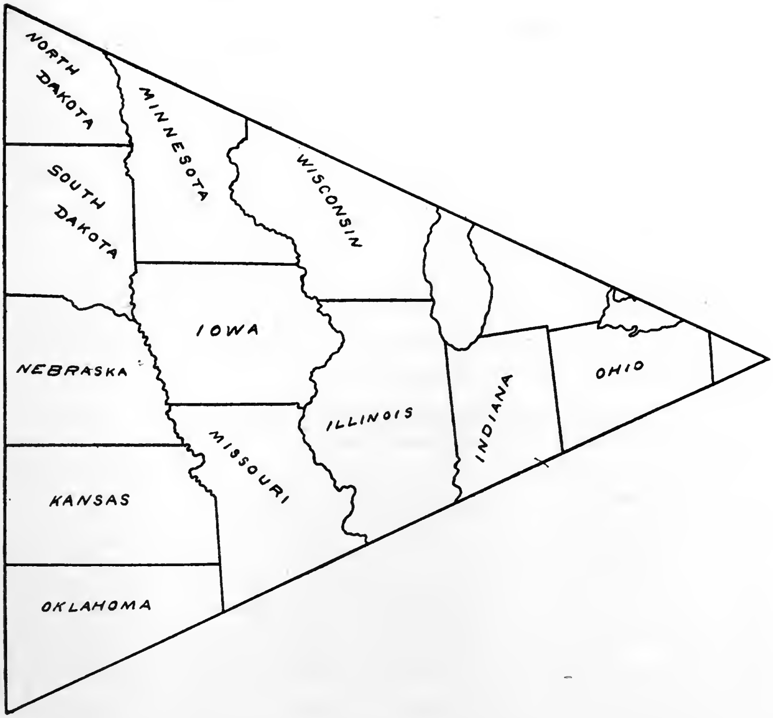


FIG. 2.—The banner agricultural region of the United States.

PROBLEMS.

1. Find the area of the map of the above agricultural region.

2. How does it compare in size with the area of the United States and with the land surface of the globe?

3. If the annual production of corn within this area is 2,000,000,000 bushels what is the average production per acre?

4. Find the approximate average production of oats, wheat, clover, timothy and alfalfa per acre, basing calculations on the government reports for the last decade.

NOTE.—The school should be supplied with a copy of the annual report of the Secretary of Agriculture of the United States each year.

Questions.

1. If the population within the area of the map given in Fig. 2 is about 30 millions, what is the population of the states of the Union in the territory outside according to the 1910 census?

2. Compare the principal occupation of each of the three regions in the United States lying parallel to the sides of the triangular map, with the principal occupation in the triangular area.

3. Is it possible for the area of the arable lands of the United States to be increased to any considerable extent?

4. At the rate at which our population has been increasing, about how long will it take for our present population to double?

5. Is it possible for the production per acre in the states of the corn belt to be doubled? Give reasons for your opinion.

6. What is the ratio between the increase in number of laborers on the farm and the increase in population from 1870 to 1910?

NOTE. — The census of 1870 shows a population of about 40,000,000, people; in 1910 — 93,000,000.

Our Progress and Productive Power.

Year.	Farm Laborers.	Value of Farm Products.	Value of Farm Property.
1870	5,992,000	$1,958,000,000	$8,900,000,000
1880	7,713,000	2,212,000,000	12,180,000,000
1890	8,565,000	2,466,000,000	16,082,000,000
1900	10,433,000	4,717,000,000	20,439,000,000
1910	12,000,000	8,926,000,000	32,000,000,000

It will be observed in this table that while the number of farm laborers has only doubled in the last forty years, yet the value of farm products and farm property has been quadrupled.

Twelve million laborers in 1910 are farming four times as many acres as six million laborers farmed in 1870, or in other words the farmer of today tills twice as many acres as he tilled in 1870. This is convincing proof of the steadily increasing productive power of labor saving machinery.

Results of Inventions and the Diversification of Labor Resulting From Improved Machinery.

1. Today a western farmer uses a machine driven by a 100 horsepower engine, which plows, sows, and harrows at the same time a strip 30 feet wide, at the rate of 4 miles an hour; how many acres can he seed in 1 day of 10 hours?
2. If one man with a team of horses can plow, seed and harrow $1\frac{1}{2}$ acres per day; how many men with teams will be required to do

an amount of work equal to that performed in 10 hours by a machine described in problem 1.

The time was when 90% of the people had to engage in agricultural pursuits; this was because nearly all the work of producing or raising food had to be done by hand or with crude and simple mechanical appliances.

Now it is estimated that from five to ten men on a great western farm with the latest improved modern machinery can raise enough food to maintain a village of one thousand population.

The result now is that instead of many laborers being engaged on the farm to do the work now done by machinery operated by a few men, these men are engaged in mining coal and iron, in transportation of manufacturing and food materials; in manufacturing this improved machinery, so that indirectly the energy and labor of the factory is transferred to the fields in the form of powerful machines that do the work of seeding and harvesting, hauling, transporting and milling.

The cotton gin now does the work of hundreds; machinery now enables a man to cut and cure a ton of hay in one and one-half instead of eleven hours. The reaper does the work of a dozen men. The steam thresher does the work of a hundrd flails. The amount of labor required to raise a bushel of wheat has been shortened from three hours to ten minutes. The amount of labor required to raise a bushel of corn has been shortened from four and one-half hours to thirty minutes.

PROBLEMS.

1. According to competent authority, in 1855 it took four and one-half hours to produce one bushel of corn; now it only requires about 30 minutes to produce the same amount. Our corn productive power is therefore how many times greater now than in 1855?

2. In 1855 it took 3 hours to produce a bushel of wheat; now it does not require to exceed 10 minutes to produce the same results. How many times greater is the power of producing wheat now, than in 1855?

According to the reports of the International Institute of Agriculture:

Italy cultivates 92 per cent of her geographical area.
Austria cultivates 93 per cent of her geographical area.
Hungary cultivates 94.5 per cent of her geographical area.
France cultivates 95.5 per cent of her geographical area.

PROBLEMS.

1. The census of 1910 shows that there were 878,798,000 acres of arable land divided up into farms in the U. S.; if 54 per cent of this land was utilized for growing crops, what was the number of acres cultivated?

2. If the area of the United States is approximately 3 million square miles, and 54 per cent of the arable land (878,798,000 acres) is under cultivation, what per cent of the geographical area of the United States do we use for growing crops?

3. If we take into consideration the coming problems of equal opportunities, the conservation of energy, and the economic production of an abundant supply that will satisfy the demands of the consumers of the United States the great problem of agriculture is not to increase the number of acres to be tilled but rather to increase the quality as well as the quantity of that which is in demand from the acreage that is already tilled.

If we will study carefully Fig. (2) showing a map of the corn belt, it is easily apparent that the boundary of this great agricultural region conforms to the trend of the Appalachian mountains on the southeast, the Great Lakes' region on the northwest and the great arid plains and Cordilleras on the west; beyond these boundaries in the United States it will never be possible to compete with this great grain producing region of the Mississippi Valley, until ages hence when our mountain systems have been worn by the elements into alluvial plains.

This rich region is located in an ideal climatic, geographical and commercial region, and its problem is the problem of increasing its production steadily, doubling its production every time our nation's population doubles.

The trend of modern agricultural education is in the direction of a better knowledge of the two great fundamental principles of successful farming.

1. Prevention of waste and loss.
2. Increasing the quantity and improving the quality of products.

Waste and Loss in Agriculture.

The greatest farm waste of the American farm comes from the loss of fertilizers, careless feeding, and improper care, breeding and shelter of animals.

The greatest losses to agriculture in the United States are caused by insect pests and animal diseases and inferior methods of farming.

The following figures is a conservative estimate based on reports made by government experts to show the magnitude of the tremendous losses sustained annually by the agricultural and business interests of the country:

We are losing $2,000,000,000 annually on account of loss in manures.
We are losing $1,000,000,000 annually on account of insect pests.
We are losing $1,000,000,000 annually on account of poor drainage.
We are losing $1,000,000,000 annually on account of improper rotation.
We are losing $400,000,000 annually on account of poor dairy cows.
We are losing $300,000,000 annually on account of animal diseases.
We are losing $200,000,000 annually on account of poor seed.
We are losing $100,000,000 annually on account of rodents.
We are losing $45,000,000 annually on account of improper care of eggs.
We are losing $500,000,000 annually on account of weeds.
We are losing $1,000,000,000 annually on account of bad roads.
We are losing $50,000,000 annually on account of forest fires.
We are losing $400,000,000 annually on account of poor shelter and improper feeding.

1. According to the foregoing statement what is the sum total of the losses sustained by the farm interests of the nation?
2. What per cent is the above loss of the total production of the United States, which is valued at nine billions of dollars annually?

This estimated loss to the agriculture of the United States is not overdrawn when considered in the light of the estimate made by Dr. Seaman A. Knapp when he summed up the possible increase in productive power of the Southern States. He estimated it was possible to increase the production of the South fully 800 per cent as follows:

300 per cent to the use of more and better mules and farm machinery.
200 per cent to the production of more and better stock.

150 per cent to the rotation of crops and better tillage.
50 per cent to better drainage.
50 per cent to better seed.
50 per cent to better use of legumes and better feeding.

Problems in Production.

If we are now producing annually crops on the farms valued at nine billions of dollars when our population is about 100 millions; what should be the value of our agricultural products in 1950, if our population reaches 200 millions?

2. There are now employed on the farms of the United States 12 million laborers. If the present number of laborers, by better methods of farming, could increase our production 50 per cent; how many laborers would be required to raise the production 100 per cent?

4. If we could double our production and prevent half of the amount of our annual wastes, what would be the value of our annual production of crops with prices remaining the same?

5. The national and state governments of the United States are spending $40,000,000 annually to maintain the National Department of Agriculture, state experiment stations, state boards of agriculture, agricultural colleges, and for other purposes of agricultural education to prevent wastes and losses to agriculture and to improve the welfare of the country generally; what per cent is this amount expended of the losses sustained by agriculture as shown by the table?

6. Various estimates have been made of the losses occasioned by bad roads, it would not be out of the way to estimate this loss at least at a billion dollars annually; if there are 100,000,000 people in the United States; what is the average loss per capita?

7. According to experiments conducted in the feeding value of corn in the form of ensilage, 65 per cent is in the kernel, and 35 per cent is in the stalk and leaves; when the value of the corn in the U. S. was one and one-half billions as estimated in the value of shelled corn, what would have been the value of the rest of the corn crop in the form of ensilage.

8. It has been estimated by agricultural experts that at least 90 per cent of the corn stalks of the country under the present system of farm management are lost; what would be the gain to agriculature if the full value of the stalks could be saved when the grain value of the crop is valued at about the average value of the corn crop for the last ten years which was 1.4 billions of dollars?

Years ago the first settlers had before them millions of acres of virgin soil. As fast as they cleared away the forest they added new fertile fields to their domain, but when the forests were gone the addition of virgin soil ceased and the old fields began to wane in fertility and those who have followed the pioneers have been confronted with new and perplexing problems in agriculture. We are now applying ourselves to the solution of these great questions in the light of agricultural science.

We can already see clearly the results of scientific instruction in the United States. Take for example the statistics of New York, Pennsylvania, Ohio, Indiana, and Illinois, for the last forty years and the crops of corn for the four ten-year periods show the following remarkable results:

Average Production by Ten Year Periods.

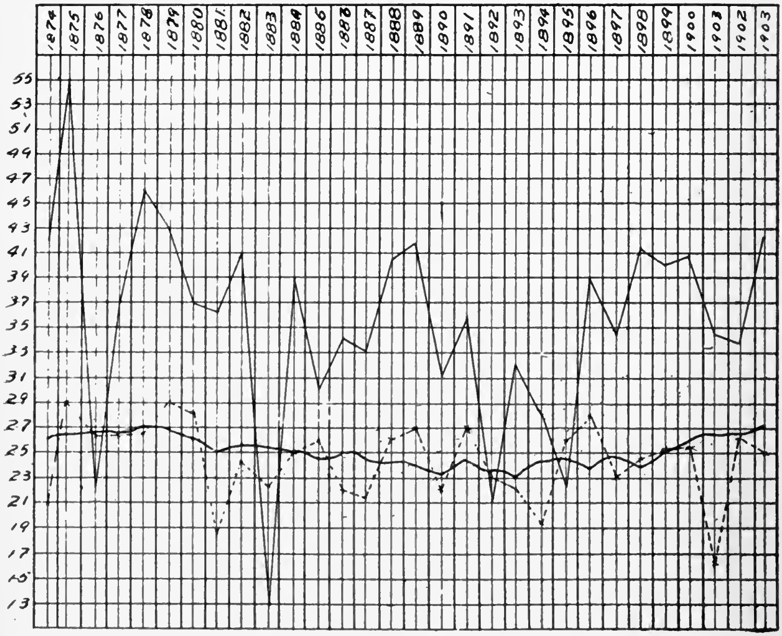
	'66 to '75	'75 to '85	'85 to '95	'95 to '05	'05 to '10
New York	31.6	30.4	31.1	30.3	35
Pennsylvania	35.1	32.8	30.9	34.3	37.2
Ohio	35.3	32.6	28.8	34	38.3
Indiana	32.8	29.9	28.9	34	37
Illinois	29.9	27.2	29	34.5	35.7

The following table shows the fall and rise of production of four staple crops in the United States for the period from 1870 to 1910:

TEN-YEAR PERIODS.

	'70 to '80	'80 to '90	'90 to '00	'00 to '10
Corn, bushels	27	23.4	24.5	26
Wheat, bushels	12.4	11.84	13.27	14.28
Oats, bushels	28.42	26.52	26.21	38.87
Hay, tons	1.23	1.19	1.28	1.45

A close study of these statistics will show that there was a gradual decline in production per acre of the staple crops from 1870 to 1890, and that from the end of that twenty-year period there was a gradual rise in production for the period from 1890 to 1910.



THE CORN CROP.

FIG. 3. The light black line shows the crop yield of Ohio from 1874 to 1903. The dotted line shows the crop yield of the U. S. The heavy black line shows the general tendency in crop yields from 1870 to 1890 and from 1890 to 1903.

TENDENCY OF CROP YIELDS PER ACRE.

In the above chart the downward tendency until about 1890, and since then an upward trend, is strikingly shown. The recent tendency toward enlarged production per acre is general throughout the United States; it is not due to a shifting of production from one section to another. "For the United States as a whole, and for most States, it can not properly be said that yields are diminishing. In most civilized countries of the world the yield per acre of crops has been tending upward in recent years."—*The Crop Reporter.*

But there is another significant fact that stands out clearly in relation to the history of this last period from 1890 to 1910, and it is this: that our Experiment Stations, Agricultural Colleges, and Agricultural Schools in the United States date principally from 1890 to 1910.

The Lessons of the Experiment Stations.

The average production of corn in the corn belt is only 30 bushels, yet the boy corn growers and the experiment stations have shown that we can grow 100 bushels of shelled corn per acre.

The average production of wheat in the United States is only 14 bushels per acre, but the experiment stations have demonstrated that we can raise more than 40 bushels per acre.

The average production of potatoes in 1911 was but 80 bushels per acre, but the agricultural colleges and experiment stations have shown the student of agriculture that we can raise from three to four hundred bushels per acre.

The average production of lint cotton in 1910 was 170 pounds per acre, but the government experiment stations of the south have raised from 700 to 1,500 pounds per acre.

The average production of butterfat per cow in the United States is but 160 pounds per year and yet there are herds of cows reported by the government as producing 400 pounds of butterfat per year.

The experiment stations of the United States have obtained similar results in nearly all their attempts to increase the production of the leading farm products of the country.

On the whole it is very apparent from the scientific demonstrations of agriculture that we can increase the average production of our great staple products from two to three hundred per cent.

Exercises.

The Community.

This work should begin with a study of community life. The child should know the people of his community, and how they live; how the community supports itself, and its relation to the neighboring communities; how churches, schools, roads, telephones, telegraphs, mail routes and many other modern conveniences came to be here; pupils should be taken on trips to visit shops, mines, and factories where they can have an opportunity to see different classes of the leading trades of the country; let them see the working of levers, pulleys, derricks, cranes and steam shovels; examples of water power, steam, electricity and gas. Let them see the traffic of the city and the different occupations represented; transportation, commerce and manufacturing; methods of transportation on lakes, rivers and canals; on railroads and public highways.

Discuss.

Methods by which our mails are carried; distribution; different kinds of roads; effects of good and bad roads; on our mail delivery, business, schools, health, transportation and civilization.

Study the relation between location and value of farms; between fertility and value; between fruit, grain and stock farms; points that determine the value of land; why some farms are neglected or deserted; study the laws of supply and demand; location of the best markets; cost of production, transportation and marketing; study crop reports; study the shortage of crops and find the probable demand.

Discuss plans whereby a boy could produce the greatest income from an acre of ground; a farmer on ten acres; on twenty acres; on forty acres; on eighty acres.

Geography.

Study the map and learn the location of the region producing each of our leading agricultural products; study the states that lead in the production of each; explain causes for difference in products; construct relief maps and product maps; arrange a corn map, a map showing location of other staple products and also an animal map; send to Washington to the department of agriculture and ask for Crop Reports published by the Secretary of Agriculture which will show distribution of products and give valuable statistics; this will furnish supplementary work correlated with Geography.

Books.

THE RURAL LIFE SERIES.

1. Country Life and the Country School — Carney, 8-12 — Row, Peterson & Co.
2. Rural Wealth and Welfare — Fairchild, 8-12 — Macmillan Co., $1.25.
3. The Outlook to Nature — Bailey, 8-12 — Macmillan Co., $1.25.
4. The State and the Farmer — Bailey, 8-12 — Macmillan Co., $1.25.

5. Introduction to Agricultural Economics — Taylor, 8-12 — Macmillan Co., $1.25.
6. The Conservation of Natural Resources in the United States — Van Hise, 8-12 — Macmillan Co., $2.00.
7. Co-operation in Agriculture — Powell, 8-12 — Macmillan Co., $1.50.
8. The Social Spirit in America — Henderson, 8-12 — Scott, Foresman Co.
9. How to Co-operate — Myrick, 8-12 — Webb Pub. Co., $1.00.

INDUSTRY AND LIFE.

1. Industrial Studies (United States) — 5-7 — Ginn and Co., 65c.
2. Industrial Studies (Europe) — Allen, 6-8 — Ginn and Co., 80c.
3. The World's Commercial Products — Freeman & Chandler, 8-12 — Ginn & Co., $3.00.
4. How the World is Fed — Carpenter, 6-8 — American Book Co., 60c.
5. How the World Is Clothed — Carpenter, 6-8 — American Book Co., 60c.
6. How the World is Housed — Carpenter, 6-8 — American Book Co., 60c.
7. Geographical Readers — Carpenter, 6-8 — American Book Co. (per vol.), 60c.
8. Great American Industries:
   Minerals — Rocheleau, 7-8 — A. Flanagan Co., 50c.
   Products of the Soil — Rocheleau, 7-8 — A. Flanagan Co., 50c.
   Manufactures — Rocheleau, 7-8 — A. Flanagan Co., 50c.
   Transportation — Rocheleau, 7-8 — A Flanagan Co., 60c.
9. Commercial and Industrial Geography — Keller and Bishop, 7-8 — Ginn & Co.

BULLETINS OF THE U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF STATISTICS.

Number.	*Title.*
2.	Cooperative Credit Association.
25.	Milk Transportation.
26.	Wages of Farm Labor.
43.	Changes in Farm Values.
44.	Local Conditions as Effecting Farm Values.
48.	The Cost of Producing Farm Products.
49.	The Cost of Hauling Crops from Farms to Shipping Points.
78.	Agricultural Graphics.

SOME GOOD STATE BULLETINS.

241. County Experiment Farms in Ohio. Ohio Experiment Station.
139. Soil and Crop and their Relation to State Building. South Dakota Ex. Station.
173. The Municipal Abattoir. Kentucky Ex. Station.

CHAPTER XXI.

Climate.

A knowledge of the climate of a country is of great importance, for upon the general weather conditions prevailing throughout the year and particularly during the growing season depend the kinds and in a large measure the quality and quantity of the crops.

The agricultural prosperity of a section depends more upon the climate than upon the soil itself. Infertile soils may be made productive, with our present scientific knowledge, but we cannot change climatic conditions very materially. Consequently the farmer who contemplates farming in a new territory with which he is unfamiliar, should first make a careful study of climatology and second, make a careful examination of the soil.

Rainfall, humidity, sunshine, average temperature, range of temperature, altitude, proximity of lakes and mountains and other similar points should be carefully noted and studied before selecting a location for farming. Nor should the kind of farming be overlooked, for if alfalfa is to be the leading crop it will not need the same climate as that required by corn. The same kind of crop will not always grow in different latitudes, although the soil may be the same. A good wheat country may be a poor corn country.

It is very evident that there are many reasons why we should study climate as well as soil.

The Weather Bureau, the Farm and the School.

Since 1870 the Federal Government has maintained a service for the forecasting of weather conditions throughout the United States.

This work was originally designed for the benefit of navigation, but it has been broadened in the scope of its work until it has become one of the most practical and essential utilities of commerce and agriculture.

It is to the benefit of agriculture that this discussion of the weather bureau is directed.

It is hereby desired to place the farm and school into a closer acquaintance and relationship with the workings of the weather bureau.

Since 1890 the chief of the weather bureau has been under the direction of the Secretary of Agriculture.

The observations and forecasts are made in such a way that it is important the public should know some of the following facts:

1. There are 200 observation stations in the United States.
2. Each station represents 21,000 square miles.
3. Each station is operated by one or more trained observers.
4. Observations are made twice daily.
5. Results are immediately telegraphed to the central office at Washington.
6. Weather forecasts are made for 36 to 48 hours in advance.
7. Forecasts are telegraphed to more than 2,000 cities.
8. Forecasts are sent to 135,000 addresses daily.
9. Forecasts are received by 3,500,000 telephone subscribers daily.

Special Benefits Derived from Reports and Warnings of the Weather Bureau.

1. Railroads regulate shipments of perishable products of the farm according to forecasts of the weather bureau.
2. It helps to regulate the temperature during extremes of weather, in greenhouses, heating and lighting plants.
3. It has a bearing on the advertisements of merchants.
4. It helps the fruit grower to protect his fruit.
5. It assists in harvesting, haying and saving of crops.
6. It warns against storms and floods.
7. It assists in the lake and ocean trade.
8. It assists the manufacturer in regulating production.

In short the whole business of the country is affected by the reports of the weather bureau and millions of dollars are saved to the great industries often by a single warning of a cold wave or of a cyclone or some unusual weather disturbance that is on the way.

The following references are given to assist the teacher in getting such information as may be desirable to assist in the study of climatology in its relation to agriculture and the general business interests of the country.

Among the publications of the weather bureau, the following are worthy of special mention:

1. The Monthly Weather Review.
2. Bulletin of the Mount Weather Research Observatory.
3. Climatological Data.
4. Bulletins by experts of the service.
5. Library of the Weather Bureau, numbering about 28,000 books.
6. Annual Report of the Chief of the Weather Bureau.
7. Snow and ice bulletins during winter.

Every teacher should write to the U. S. Department of Agriculture Weather Bureau and ask for the List of Publications of the Weather Bureau that are available for distribution.

Need of Moisture.

According to observations made by scientists in England, Germany and America, it has been determined that a plant in growing will transpire and evaporate from 200 to 500 pounds of water for each pound of dry matter produced.

The leading crops are named in the following table in the order of the amount of water required to produce one pound of dry matter.

Barley	estimated	at	from	310	pounds	to	774	pounds	of	water.
Oats	"	"	"	402	"	"	665	"	"	"
Buckwheat	"	"	"	371	"	"	664	"	"	"
Red Clover	"	"	"	249	"	"	453	"	"	"
Wheat	"	"	"	225	"	"	359	"	"	"
Corn	"	"	"	233	"	"	272	"	"	"

A study of this table will enable us to determine from a study of the annual rainfall map of a region, together with other weather conditions, what are the crops best adapted to that region.

It is very apparent that the evaporation of water from the tissue of plants will vary in amount in different climates and in different soils. More water is required in an arid than in a humid region; more water is required in a warm than in a cold region. Winds are also a determining factor.

PROBLEMS.

1. Observations made in Illinois showed that in one week in July, the growth of corn amounted to 1,300 pounds of dry matter per acre; if the water required to produce 1 pound of dry matter was determined to be 233 pounds, that amount of water was equivalent to how many inches of rainfall?

2. In an experiment in Wisconsin it was determined that the amount of water necessary to produce each pound of dry matter in corn was 272 pounds per acre in a certain experiment; this was equivalent to how many inches rainfall?

3. If in producing a ton of clover hay, which is 85 per cent dry matter, 470 pounds of water were required to produce each pound of dry matter, how many inches of rainfall would be required to furnish sufficient water to produce two tons of clover hay per acre?

4. Assuming that the average production of dry matter in the crops of the average farm is two tons per acre, what is the amount of water in pounds required to produce a yield of one pound of dry matter, if the total amount required to produce two tons of dry matter is equivalent to a rainfall of 15 inches?

5. It has been observed that a single corn plant during the first week of August, when it was coming into tassel and when the ear was forming, used water at the rate of one and one-half quarts per day. At that rate how much would that plant use in two weeks?

6. It was estimated that the amount of water that fell during the few days that produced the great floods in Ohio, in March, 1913, was on an average equal to about 10 inches of rainfall; if the area of Ohio is 43,000 sq. mi. how large a cube of water would represent this amount of rainfall?

7. How large a lake would the Ohio flood rains of March 1913, have filled to an average depth of 50 feet, if the length of the lake is to the width as 3 is to 5?

The principles upon which dry farming are dependent for success are as follows:

1. Deep plowing and pulverizing to absorb all the moisture from rain and snow.
2. Compacting subsoil to enable water to rise to the roots of growing crops.
3. Stirring upper few inches of soil to act as a mulch or blanket to prevent moisture evaporation.

4. Prevention of weeds that would use up moisture through transpiration.
5. Tilling the land one season and raising a crop the next.
6. Two seasons collection of moisture for growing one crop.
7. Addition of vegetable moisture to the soil to hold water and food for plants.

EXPERIMENT.

During the dry season examine the difference in moisture between a plat of ground growing a heavy crop of weeds and a plat that is growing no vegetation.

EXERCISES.

Learn the weather signals used by the weather bureau.

1. White flag indicates fair weather.
2. White and blue flag foretells local showers.
3. Blue flag indicates rain or snow.
4. White flag with black center foretells a cold wave.
5. A blue triangular flag placed above the weather pennant indicates rising temperature. If placed below pennant it means falling temperature.

Ask or petition your mail carrier to carry the weather signals.

Have some pupil draw upon the blackboard each day the flag showing the weather report.

Construct a small convenient place for holding and protecting weather instruments.

Some of the important instruments that should be owned by the school are the following:

List of Instruments.

1. Mercurial Barometer.
2. Thermometers.
3. Wind vanes.
4. Rain and Snow Gauges.
5. Anemometers, with sunshine records.
6. Barographs, thermographs, with devices making automatic records.
7. Kites, meteorographs, self registering instruments.

The U. S. Weather Bureau will furnish addresses of manufacturers of the above named instruments.

Send for the reprint from the Yearbook of the Department of Agriculture, entitled "The Weather Bureau and the Public Schools."

This circular will give you a course of study of this branch of nature study for the first seven grades.

The Farmer and the Weather Bureau.

Every up-to-date farmer ought to have a table of the meteorological and phrenological data of his own county.

The data should be arranged and kept where it is handy for references.

The following outline will present a plan for such an arrangement:

1. State..........
2. County.........
3. County Seat..........
4. North longitude..........
5. West longitude..........
6. Topography of the county.
7. Average above level of nearest large lake.
8. Average level above the sea.
9. Description of the variety and variableness of the soils.
10. What variation can be found in certain localities within a radius of 100 rds? A radius of one mile?
11. Mean monthly and annual temperature for the last one or two decades.
12. Warmest month with its mean temperature.
13. Coldest month with its mean temperature.
14. Warmest year in last decade or in last two decades. Mean temperature.
15. Coldest year in last decade or in last two decades. Mean temperature.
16. Highest monthly mean.
17. Lowest monthly mean.
18. Coldest winter. Mean temperature.
19. Warmest summer and mean temperature.
20. Year of lowest mean temperature.
21. Year of highest mean temperature.
22. Highest temperature recorded.
23. Lowest temperature recorded.
24. Greatest number of days between frosts.
25. Average date of last frosts in spring.

26. Average date of earliest frosts in fall.
27. The average annual rainfall for past decade.
28. Average rainfall for each month.
29. The average date of blossoming for peaches, cherries, pears and apples.
30. The average time for seeding crops.
31. The average time for maturing and harvesting.
32. The average yield of each of the staple crops.
33. The year of highest yield of each.
34. The year of lowest yield of each crop.
    (Get these data at least for the wheat, corn, oats, hay and potato crop.)
35. Study the relation of yields in any given year.
36. Draw diagrams to show production of ten or more leading crops for studying relative production.

NOTE — Schools should be equipped with Bulletin — Frost Data of the United States.

This bulletin contains:

Chart I. The Average Date of Last Killing Frost in Spring.
Chart II. The Average Date of First Killing Frost in Autumn.
Chart III. The Latest Date on which Killing Frost Has Occurred in Spring.
Chart IV. The Earliest Date on which a Killing Frost has Occurred in Autumn.
Chart V. The Average Length of the Crop Growing Season.

The following diagram will illustrate the methods used by the various departments of the government to show the relative yield and prices of crops for a given number of years

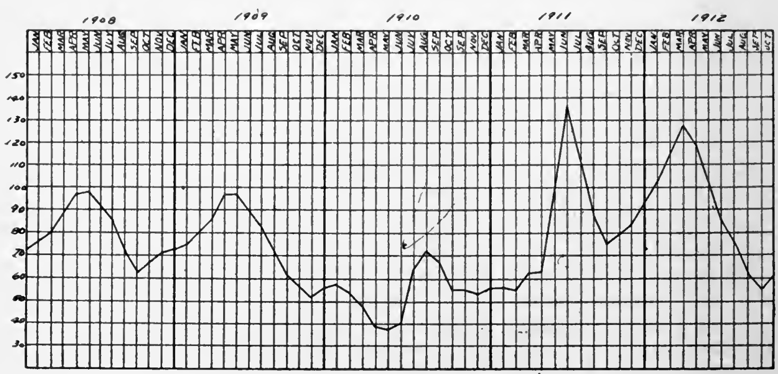


FIG. 1 — Yield of potatoes in bushels per acre to be indicated by a dotted line placed in the graph by pupil. The dark line given in graph indicates price of potatoes each month for years given.

An excellent method of indicating the monthly rainfall by a precipitation chart is seen in the following figure, showing the rainfall in one of the counties of Wyoming for a period of twelve years:

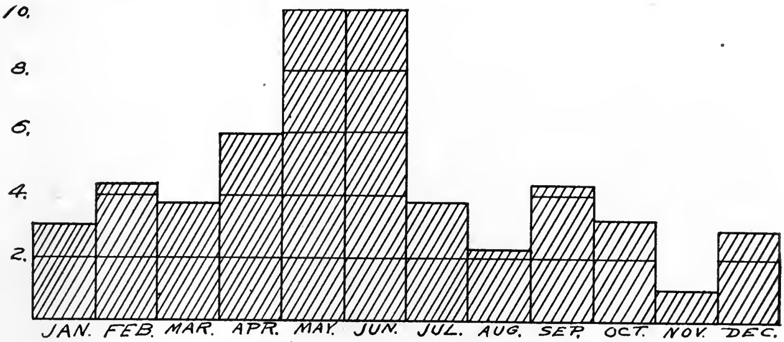


FIG. 2.—Basin, Big Horn County. Monthly precipitation in inches. Records for 12 years.

Table Showing Some Climatic Factors of the United States.

TAKEN FROM THE RECORDS OF THE STATIONS OF THE UNITED STATES WEATHER BUREAU.

(For a Long Term of Years.)

Station.	Average January Temperature.	Average July Temperature.	Average Annual Temperature.	Annual Rainfall.
Abilene, Tex.	43	82	63	25
Albany, N. Y.	23	72	48	36
Alpena, Mich.	19	66	42	33
Amarillo, Tex.	34	76	55	23
Atlanta, Ga.	42	78	61	49
Atlantic City, N. J	32	72	52	41
Augusta, Ga.	46	80	64	48
Baker City, Ore	24	65	45	13
Baltimore, Md.	33	77	55	43
Bismarck, N. D	7	70	40	18
Block Island, R. I	31	68	50	44
Boise, Idaho	29	73	51	13
Boston, Mass.	27	71	49	43
Buffalo, N. Y	25	70	47	37

CLIMATIC FACTORS OF THE UNITED STATES — Continued.

Station.	Average January Temperature.	Average July Temperature.	Average Annual Temperature.	Annual Rainfall.
Cairo, Ill.	35	79	58	42
Cape May, N. J.	34	73	54	41
Carson City, Nev.	33	68	49	11
Charleston, S. C.	49	81	66	52
Charlotte, N. C.	40	79	60	49
Chattanooga, Tenn.	41	78	60	51
Cheyenne, Wyo.	26	67	45	14
Chicago, Ill.	24	72	48	33
Cincinnati, O.	32	78	55	38
Cleveland, O.	26	72	49	35
Columbia, Mo.	27	77	54	37
Columbus, O.	29	75	52	37
Concordia, Kan.	24	78	53	27
Corpus Christi, Tex.	54	83	70	27
Davenport, Iowa	21	75	49	33
Denver, Colo.	29	72	50	14
Des Moines, Ia.	20	76	49	32
Detroit, Mich.	24	72	48	32
Dodge City, Kan.	27	78	53	21
Dubuque, Iowa	18	75	48	34
Duluth, Minn.	10	66	39	30
Eastport, Maine	20	60	41	43
El Paso, Texas	44	81	63	10
Erie, Pa.	27	72	49	39
Escanaba, Mich.	14	67	41	32
Eureka, Cal.	47	55	51	46
Fort Smith, Ark.	38	81	61	41
Fresno, Cal.	45	82	63	10
Galveston, Tex.	53	83	69	47
Grand Haven, Mich.	25	70	47	31
Green Bay, Wis.	5	70	43	31
Hannibal, Mo.	27	77	53	34
Harrisburg, Pa.	29	75	52	37
Hatteras, N. C.	46	79	62	61
Havre, Mont.	14	68	42	14
Helena, Mont.	20	67	43	13
Huron, S. Dak.	10	72	42	21
Indianapolis, Ind.	28	76	53	41
Jacksonville, Fla.	54	81	68	53
Jupiter, Fla.	64	81	74	60
Kansas City, Mo.	26	78	53	37
Key West, Fla.	69	84	77	39
Knoxville, Tenn.	38	76	57	49
La Crosse, Wis.	15	73	46	31
Lander, Wyo.	17	68	42	14
Lewiston, Idaho	35	74	53	13

CLIMATIC FACTORS OF THE UNITED STATES — Continued.

Station.	Average January Temperature.	Average July Temperature.	Average Annual Temperature.	Annual Rainfall.
Lincoln, Neb.	21	76	50	28
Little Rock, Ark	41	81	62	50
Los Angeles, Cal	54	70	62	16
Louisville, Ky.	34	79	57	44
Lynchburg, Va.	36	77	56	43
Marquette, Mich.	16	65	41	33
Memphis, Tenn.	40	81	61	50
Miles City, Mont	15	73	44	13
Milwaukee, Wis.	20	70	45	31
Mobile, Ala.	50	81	66	62
Montgomery, Ala.	48	81	65	51
Moorhead, Minn.	3	69	38	25
New Haven, Conn	27	72	50	47
New Orleans, La	53	81	68	57
New York, N. Y	30	74	52	45
Norfolk, Va.	40	78	59	50
Northfield, Vt.	15	67	41	34
North Platte, Neb	21	74	48	19
Oklahoma City, Okla	35	80	59	32
Omaha, Neb.	21	77	50	31
Oswego, N. Y	24	70	47	36
Pensacola, Fla.	52	81	68	56
Philadelphia, Pa.	32	76	54	41
Phoenix, Ariz.	50	90	69	8
Pierre, So. Dak	18	75	46	17
Pittsburgh, Pa.	31	75	53	36
Port Huron, Mich	22	69	45	31
Portland, Me.	22	68	45	43
Portland, Ore.	39	66	52	45
Pueblo, Colo.	29	74	51	12
Rapid City, So. Dak	22	70	45	19
Red Bluff, Cal	45	82	63	25
Roseburg, Ore.	41	66	53	34
St. Louis, Mo	31	79	56	37
St. Paul, Minn	12	72	44	29
Salt Lake City, Utah	29	76	52	16
San Antonio, Tex	51	82	68	27
San Diego, Cal	54	67	61	10
San Francisco, Cal	50	57	55	22
Santa Fe, N. M	29	69	49	14
Sault Ste. Marie, Mich	13	62	38	31
Savannah, Ga.	50	81	66	50
Seattle, Wash.	39	63	51	37
Shreveport, La.	46	82	65	46
Sioux City, Ia.	16	74	47	26
Spokane, Wash.	27	69	48	19

CLIMATIC FACTORS OF THE UNITED STATES — Concluded.

Station.	Average January Temperature.	Average July Temperature.	Average Annual Temperature.	Annual Rainfall.
Springfield, Ill.	26	76	52	37
Springfield, Mo.	31	76	55	45
Toledo, Ohio	26	74	50	31
Valentine, Neb.	8	73	46	22
Vicksburg, Miss.	47	80	65	54
Walla Walla, Wash.	33	74	53	18
Washington, D. C.	33	77	55	44
Wichita, Kan.	30	79	56	31
Williston, N. D.	7	69	39	15
Wilmington, N. C.	46	79	62	51
Winnemucca, Nev.	29	72	49	8
Yankton, S. D.	16	75	47	25
Yuma, Ariz.	55	91	72	3

A careful study of the corn and rainfall graph page 383 shows that the total yield of corn for the corn belt may be predicted from the rainfall during the month of July.

An inch of rainfall may mean an increase of millions of dollars in the value of the corn crop.

A close observation of the rainfall will enable us to determine the amount of tillage and cultivation that may be necessary to conserve moisture.

After the class in agriculture has made a thorough study of the weather statistics of the county, the following conclusions should be tabulated:

1. What were the years of best and poorest yields in certain crops? Give cause in your opinion.
2. What was the precipitation in July in the year producing the highest yield of corn? Was it above or below normal?
3. In the year of greatest yield of oats, what was the precipitation and temperature in June and July?
4. What was the observation relative to temperature and precipitation in the months of June and July, when there was the largest yield in potatoes? Was it below or above normal?

5. How was clover affected by the previous winter? What was the relation of precipitation in April, May and June to the hay crop in the year of greatest yield?
6. Study the relation of snowfall to the preservation of crops.
7. What relation do you observe between weather conditions and the production of clover seed?
8. Make similar comparisons in the study of weather conditions and the production of other crops.
9. In what state do you find the greatest variety of crop productions? Give reasons.
10. Of what importance are these facts of climate and production in the selection of a farm? How has it affected the migratory movement of the people?

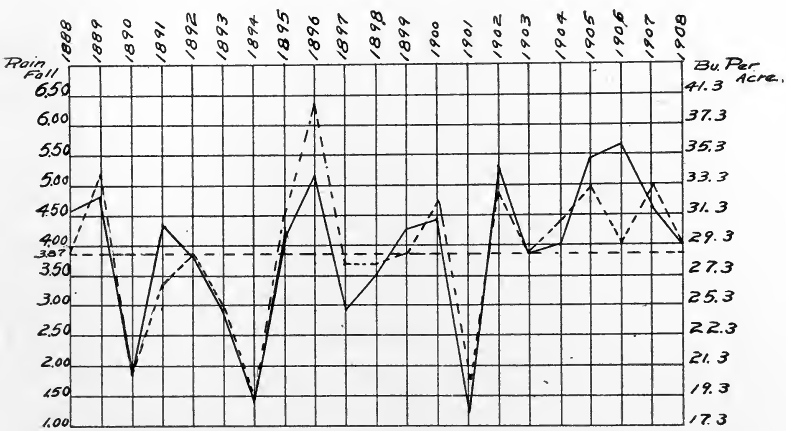


FIG. 3—Average Ohio, Indiana, Illinois, Iowa, Kansas, Nebraska, Missouri and Kentucky.

Relation of corn yield to July rainfall. The light dotted line represents the variation in inches of rainfall, while the solid line shows the corn production for the corresponding years. It will be noted that a high yield accompanies an abundant rainfall. The heavy straight dotted line shows average rainfall and production.

Experiments and Demonstrations.

Invert a glass jar over a live plant. The inner surface of the jar will be covered with moisture in a very short time. This is caused by the transpiration of the live plant.

Examine the stomata or openings on the under side of the leaf with a microscope. These are the pores through which the water is exhaled.

Get wilted or drooping plants during dry hot weather and show that water is not furnished by the roots of the plant with sufficient rapidity to replace the loss caused by evaporation from the leaves.

Make a demonstration of the expansive force of freezing water.

Show its effect in the disintegration of rocks.

Place a small hollow glass tube in water to show effects of attraction and the capillary effect of water. Note that the water rises in the hollow part of the tube above the level of the water on the outside.

Pour a little ink into a saucer. Place a lump of loaf sugar in the ink in such a way that but a small part of the loaf is in the ink. Observe that the whole loaf will become colored.

Pulverize a lump of loaf sugar into a fine powdered form and try the experiment as that with the solid loaf sugar and the ink and it will be observed that the ink does not pass into the powdered sugar above the level of the ink.

Make a demonstration of the effect of a soil mulch by the side of a plat of soil that is not mulched and note the effect on the conservation of moisture.

Plant ten rows of corn; try an experiment by treating part of these rows with a soil mulch and leaving part without mulching. Note the results in the growth and yield of the crop on each of the two different plats.

Questions.

1. What do you understand by conservation of moisture?
2. Do tile drains help to conserve moisture? How?
3. What is a soil mulch?
4. Does the depth of the mulch have any bearing on the amount of evaporation?
5. Why does poor soil dry out more rapidly than rich soil?
6. Why does sand dry out more rapidly than peat?
7. Why does alfalfa look green and continue to grow while other plants die during a dry season?
8. Name some trees that grow in wet or swampy places; some that are found chiefly on high dry places.
9. What is irrigation? Explain different methods of irrigation.
10. Are there any advantages in irrigation outside of arid regions?
11. What is dry farming? Where is it practiced?
12. What is the average number of days in the growing season in your locality?
13. What is the average number of days in the growing season between spring and autumn frosts?
14. Explain how plant breeding has served to adapt crop growing to the length of the season between killing frosts.
15. Describe an ideal growing day for corn.
16. Describe an ideal day for cutting and making hay.

17. Describe ideal weather conditions for seed formation in clover heads.

18. How are blossoms on fruit trees sometimes protected from late frosts in the spring? Describe various methods.

19. How do cultivation, crops and forest conditions effect rainfall in a region?

20. Are there any large bodies of water or mountains in your part of the country? How do they effect your climate? What is your altitude and latitude and how do they effect your climate?

21. What is the difference between weather and climate?

22. Name some drouth resisting crops. Some crops that are non-drouth-resisting.

23. Name some of the plants that require the greatest amount of moisture. Name some that require the least amount of moisture.

24. Is there any relation between the power of a plant to resist drouth and the amount of water that it requires for transpiration?

25. How did the drouth affect the corn crop last year?

Did it affect the wheat crop? Why?

26. Compare the potato and oat crop with that of other years and give reasons for difference in production.

Discuss the fruit crop; how was it effected by the weather?

How was pasture in your locality effected by the weather?

What effect did the pasture conditions have on the stock market?

Information.

Study weather bulletins by the State Experiment Stations.

Study U. S. Weather Bureau Reports.

CHAPTER XXII.

Farm Records and Accounts.

"I have brought with me to show you, young men, a little book—a book which may interest you. It is the first ledger I kept. I was trained in business affairs and I was taught how to keep a ledger.

"This little book shows largely what I received and what I paid out during my first years of business.

"I paid my own bills, and always had a little something to give away and the happiness of saving some. It is true I could not secure the most fashionable cut of clothing. I did not make any obligations I could not meet. I lived within my means, and my advice to you young men is to do just the same.

"Now let me leave this little word of counsel for you. Keep a little ledger as I did. Write down in it what you received, and do not be ashamed to write down what you pay away. See that your pay is always in such a manner that your father or mother may look over your book and see just what you did with your money. It will help you to make money, and that you ought to do."—John D. Rockefeller.

Big business depends more upon its methods of accounting, for its success than upon any other one department in its organization.

Agriculture with its investment of over $32,000,000,000 and its annual production of $9,000,000,000 is conducted almost wholly without any system of accounts. In fact bookkeeping is almost unknown to the average farmer of the United States.

There is no doubt but that a strict accounting of the transactions of the farm would result in almost a revolutionizing of the whole system of agriculture and bring about a saving of hundreds of millions to the farm interests of the country if faithfully put into operation on the majority of our farms.

Every farmer who can read and write can keep a record of receipts and disbursements, without a very extensive knowledge of bookkeeping.

He should begin this work with at least one inventory at the beginning of the year.

The following inventory will serve to illustrate a very simple method for keeping an account of assets and liabilities.

INVENTORY, JANUARY 1, 1914.

100 acres with improvements @ $100 per acre	$10,000
6 head of horses	1,000
8 cows and 4 head of young cattle	475
5 sows and 34 shoats	390
20 head of sheep	150
900 bushels of corn	540
300 bushels of wheat	270
30 tons of hay	360
550 bushels of oats	220
Tools and machinery	850

What are the total assets?

LIABILITIES.

Liabilities are what a man owes on notes, accounts, mortgages and other forms of indebtedness. This must be subtracted from his total assets to determine what he is worth.

An inventory shows a farmer to have indebtedness as follows:

Mortgages on land	3,500
Mortgages on stock	450
Notes	876
Accounts	1,324

What are the total liabilities?

PROBLEM.

If a farmer's assets are $14,255, and his liabilities are $6,150 what would he be worth after all debts are paid?

A number of books may be provided for keeping accounts.

A separate book may be kept for each, live stock, dairying, poultry, etc

A few accounts such as the following will show the method to be employed:

ACCOUNT SHOWING TRANSACTIONS.

POTATO GROWING.

Rental value of 2 acres	$12 00
Value of manure applied	11 00
Cost of fertilizer applied	26 00
Plowing and harrowing	10 00
Cost of seed, spraying, etc	9 00
Cultivation, digging, and marketing	17 50

The yield of potatoes was 125 bushels per acre, and they were sold for 60c per bushel. What was the net profit?

POULTRY ACCOUNT.

1915. EXPENSES.

Interest on investment of $350	$21 00
Cost of feed	175 00
Cost of labor	80 00
Miscellaneous expenses	23 00
	$299 00

RECEIPTS.

1,800 dozen eggs	$360 00
475 broilers	190 00
Other poultry	110 00
	$660 00
	$299 00
Net profit	$361 00

The following will indicate a method of keeping the account with wheat.

1914.		Dr.	Cr.
	Rent or interest on investment in land......	$50 00	
Sept. 5	To man and team plowing 10 acres.........	20 00	
Sept. 20	Labor preparing land......................	12 00	
Sept. 28	20 bushels of seed wheat..................	20 00	
Oct. 1	Rolling	4 00	
Oct. 2	Drilling	4 50	
1915.			
July 5	Cutting and shocking......................	12 00	
July 29	Threshing and labor.......................	18 00	
Aug. 31	Delivering to market......................	12 00	
Sept. 10	Received for 350 bushels of wheat.........	....	$280 00
	Totals	$152 00	$280 00
	Net profit	....	$128 00

Financial Statement.

FEEDING STEERS.

LOT 4.—TEN STEERS FED SHELLED CORN, COTTONSEED MEAL, CLOVER HAY, AND CORN SILAGE, 1914-1915.

Nov. 21,	To 10 steers, weight 8,322 lbs. @ $6.65 per cwt........	$553 41
Nov. 21–Dec. 21,	To 2,780 lbs. shelled corn @ 38.9 cts. per bu.	19 31
Dec. 21–Jan. 20,	To 4,100 lbs. shelled corn @ 40.1 cts. per bu.	29 36
Jan. 20–Feb. 19,	To 4,465 lbs. shelled corn @ 42.2 cts. per bu.	33 65
Feb. 19–Mar. 21,	To 4,440 lbs. shelled corn @ 42.4 cts. per bu.	33 62
Mar. 21–Apr. 20,	To 4,380 lbs. shelled corn @ 45.3 cts. per bu.	35 43
Apr. 20–May 20,	To 4,275 lbs. shelled corn @ 49.7 cts. per bu.	37 94
Nov. 21–May 20,	To 4,673 lbs. cottonseed meal @ $30.00 per ton	70 10
Nov. 21–May 20,	To 4,400 lbs. clover hay @ $12.00 per ton....	26 40
Nov. 21–May 20,	To 46,175 lbs. corn silage @ $3.00 per ton....	69 26
	Total expenditures	$908 48
May 20,	By 10 steers, weight 12,675 lbs. @ $7.85 per cwt........	994 99
	Total profit	$86 51
Profit per steer	....	8 65

A Convenient Form of Milk Sheet.

The weight of each milking may be recorded daily and summarized at the end of each month.

DAILY RECORD OF EACH INDIVIDUAL COW.

May 1915.		No. 1 Bess.		No. 2 Rose.		No. 3 May.		Daisy.							
1.......	A. M.	26	8			11	8								
	P. M.	15		32	5	11	6								
2.......	A. M.	28	1	40	2	12									
	P. M.	16	5	31	9	12	4								

(Showing first and last part of monthly record sheet.)

30......	A. M.	22	4	28		13	4	20	3						
	P. M.	13	6	36	4	11	3	18	2						
31......	A. M.	23	1	25	1	13		21							
	P. M.	14	2	21		11	9	17	4						
Total..		1292.7		1651.8		743.0		76.9							

BREEDING RECORD.

Date When Bred.	Name and Description.	Registry No.	Due to.	Days.	Date.
May 31, 1913......	Bell C., Bay Mare...	29642	Foal	340	May 5, 1914.
March 4, 1911.....	Irene, Holstein-Friesian Cow	138678	Fresh	283	Dec. 11, 1911.
January 6, 1912...	Lady Grace, Poland-China Sow	106543	Farrow ...	112	April 27, 1912.
November 22, 1910	Oxford Ewe	....	Lamb	150	April 21, 1911.

INSURANCE RECORD.

Date.	Name of Company.	No. of Policy.	Things Insured.	Amt. of Insurance.	Amt. of Premium.	Date When Paid.	Date When Premium Expires.
Aug. 4, 1915......	....	25680	Barn	$1,000 00	$12 50	Sept. 4, 1915..	Aug. 4, 1920.

EMPLOYEES RECORD 1914.

Date.	Name of Employee.	By Day, Wk. or Mo.	Wages.	Time Worked.	Amt. Due.	Date.	Amt. Paid.	Receipt.
June 1, 1914......	John Smith	Month	$30 00	3 months	$90 00	Sept. 1, 1914.....	$35 00	Receipt.

RECEIPTS—MONTHLY ACCOUNT FOR SEPTEMBER, 1908.

Date.	Sold To.	Article.	Weight, Measure or Number.	Price.	Amount.	Cash, Check or Note.
Sept. 6, 1908......	A. B. Walker & Co.................	Wheat	120 bu.	$0 89	$106 80	Check.
Sept. 9, 1908......	S. M. Johnson......................	Horses	2	$180 00	360 00	Cash.

EXPENDITURES—MONTHLY ACCOUNT FOR SEPTEMBER, 1908.

Date.	Paid To.	For.	Number, Weight or Measure.	Price.	Amt. Paid.	Cash, Check or Note.
Sept. 6, 1908......	G. E. Queen........................	Corn	165 bushels	$0 40	$66 00	Check.
Sept. 9, 1908......	C. R. Thornton....................	Lumber	2000 feet	$20 00	$40 00	Note.

YEARLY INVENTORY.

ASSETS.

Date.	Article.	Quantity.	Price.	Amount.
Jan. 1, 1903.......	Horses	4 head	$200 00	$800 00
Jan. 1, 1903.......	Cows	9 head	80 00	720 00
Jan. 1, 1903.......	Corn	1,200 bushels	50	600 00
Jan. 1, 1903.......	Machinery	All kinds	....	560 00
Jan. 1, 1903.......	Buildings and Land.......	200 acres	100 00	20,000 00

LIABILITIES.

Date.	Form of Indebtedness.	When Due.	Amount.	Accrued Interest.
Jan. 1, 1903.......	Mortgage on land.........	Nov. 15, 1919..	$1,500 00	$10 25
Jan. 1, 1903.......	Mortgage on horse........	March 20, 1915.	75 00	3 37
Jan. 1, 1903.......	Note	July 16, 1916...	340 00	9 35
Jan. 1, 1903.......	Hardware bill	Sept. 1, 1915...	180 00	....

Find difference between assets and liabilities.

Questions and Exercises.

1. Define "record." Define "bookkeeping."
2. What is meant by an account?
3. Define a ledger?
4. What is meant by "Dr." and "Cr." in an acct.?
5. Define a loss; a gain; depreciation.
6. Define "resource;" "income."
7. What is an "asset"? A "liability"?
8. What is a resource inventory? A liability inventory?
9. Define "gross receipts;" "net profit."
10. Define terms, "on credit;" "on account."
11. What is meant by "cash."
12. What is meant by "merchandise"?
13. What special kinds of records are important in farming?
14. Name the important elements in a poultry acct.
15. What is an expense account?
16. What is an itemized statement?
17. What is the distinction between saving and economy?
18. What is the distinction between farm economy and rural economics?
19. What is a promissory note? Write one.

20. What are the principal parties to a note?
21. What is interest? What is usury?
22. What is the legal rate in your state?
23. What is discount?
24. Explain advantages of depositing money in banks?
25. Explain advantages of paying by checks or drafts.
26. What is a bank account? How opened?
27. Explain use of signatures and endorsements in dealing with banks.
28. What is a "draft;" a "deposit"?
29. What is a bank book?
30. How often should it be balanced? Why?
31. Should a farm have a name and be registered?
32. Do you have a letterhead for correspondence?
33. Arrange proper parts for a farm letterhead for a business letter.
34. Give directions for a letter accompanied with a remittance.
35. Where can you get proper postal information?
36. In what different ways can you send a remittance?
37. Is it safe to send currency through the mails?
38. What is a P. O. money order?

Book References.

1. Principles of Bookkeeping and Farm Accounts, Bexell and Nichols, 7-8, American Book Co.
2. The Farmer's Business Hand Book, Roberts, 7-8, Macmillan Co.
3. Crop Improvement Farm Record Book—Crop Improvement Committee, Council of Grain Exchanges, 64-65 Board of Trade Bldg., Chicago, Ill.
4. Farm Accounts—Smith & Thomas; The Laurel Book Co., Chicago, Ill.

The fundamental principles of farm management are dependent upon facts which must be obtained from a careful system of accounts which cover practically the whole field of farm management. They may be briefly summed up as follows:

1. Kind and number of operations required by each enterprise of the farm.
2. Men, horses and machinery required for each operation.
3. Time required between certain dates for work to be performed.
4. Amount of work performed per day.
5. Percentage of time required between certain dates to perform a stipulated amount of work.

6. Holidays, rain, repairs for machinery, and other probable causes of delays computed.
7. Cost of production and income including all general farm expenses or "overhead charges."
8. The income per hour and day for all labor performed.
9. The acre cost of production as the unit.
10. Depreciation in value of farm equipment.
11. Average life of farm implements, doing a certain amount of work.
12. Time required for chores based on arrangement of buildings and distribution of work.
13. Relation of size of farm to profit on investment.
14. Cost of man labor, horse labor and machine labor.
15. Relation of market value of feeds and animals fed, including value of manures.
16. Profits from crop rotations.
17. Profits from use of commercial fertilizers.
18. Profits from drainage.
19. Cost of marketing.
20. Cost of feeding and housing animals.
21. Relation of organization to profit.
22. The cost of living.
23. The rate of income on investment.

Problems.

TIME REQUIRED FOR I ACRE IN VARIOUS FARM OPERATIONS.

Operation.	Day's Work.	Time for 1 Acre.
	Acres.	*Part of day.*
Plowing	1.75	0.571
Harrowing (3 times)	10	.300
Drilling	8	.125
Total	....	.996

1. What per cent. of the time during August and September will be required for one man and two horses, on an average, to plow, harrow three times and drill 40 acres of wheat?

Solution: Referring to the foregoing table, it would require $40 \times 0.996 = 39.8$ actual days of work to put in this crop. Since there are 61 days in August and September, the available time is $39.8 \div 61 = 0.653$, or 65.3 per cent.—practically 2 days in 3 on an average. The available time at any other season may be found in a similar manner if the area that one man can manage during that season is known. The amount of work he can do in a day must also be known.

Practical problems of this kind relating to the operations in the school district should be stated for solution, by both teacher and pupils.

FARMSTEAD WITH GOOD BUILDINGS.

CHAPTER XXIII.

Management and Equipment.

It is undoubtedly true as stated in the government reports that the majority of farmers have no approximate idea of the amount of money that they have invested in the major and minor items of farm equipment.

It has been determined in a survey by the government that the annual rate of depreciation in the value of the major items of the farm's equipment amounts to 7.3 per cent per year, and the depreciation in the value of minor items is much greater, owing to carelessness and negligence.

One of the ways by which this tremendous waste may be arrested to a great degree is by making inventories, at a time when farmers have time to collect and replace all missing items in their proper places. This will save time in the busy season.

It is to be hoped that in the teaching of agriculture in the schools one of the things that will be taught is the importance of an annual inventory of the articles of minor equipment, as well as major equipment.

An investigation and inventory of the minor items of farm equipment found on 33 average farms of 160 acres each well distributed throughout a Middle-Western State, showed that from 3 to 95% of these farms reported some of the following lists of articles:

General Purpose—

1 Auger,
2 Awl,
3 Axe and handle,
4 Pinch bar,
5 Bench screw,
6 Auger bit,
7 Bit brace,
8 Steel square,
9 Bevel square,
10 Try square,
11 Wood chisel,
12 Compass,
13 Level,
14 Drawing knife,
15 Scratch guage,
16 Gimlet bits,
17 Grub hoe,
18 Claw hammer,
19 Hand axe,
20 Hatchet,
21 Screw driver,
22 Log chain,
23 Wooden mallet,
24 Mattock,
25 Compass saw,
26 Hand saw,
27 Crosscut saw (large),
28 Plane,

29 Iron wedge,
30 Tape line,
31 Rasp,
32 Brush hook or scythe,
33 Cant hook,
34 Chalk line,
35 Buck saw,
36 Carpenters' pincers,
37 Anvil,
38 Vise,
39 Forge,
40 Combination drill press,
41 Drills,
42 Tinners' snips,
43 Cold chisel,
44 Whetstone,
45 Screwplate,
46 Tongs,
47 Flat file,
48 Round file,
49 Taper file,
50 Oil can,
51 Machine oil (gals.),
52 Pipe wrench,
53 Monkey wrench,
54 Tool grinder,
55 Grindstone,
56 Riveting hammer,
57 Sledge hammer,
58 Pliers,
59 Nippers,
60 Punch,
61 Hack saw,
62 Saw set,
63 Maul,
64 Post hole digger,
65 Wire splicer,
66 Wire stretcher,
67 Ditch cleaner,
68 Tile spade,
69 Brick trowel,
70 Plastering trowel,
71 Sand sieve,
72 Pick,
73 "D" handled shovel,
74 Long handled shovel,
75 Counter scale,
76 Spring balance,
77 Steelyards,
78 Platform scale,
79 Rat trap,
80 Steel trap,
81 Jackscrew,
82 Step ladder,
83 Ladder,
84 Farm bell,
85 Lantern,
86 Hoisting block,
87 Barrel,
88 Padlock,
89 Paint brush,
90 Whitewash brush,
91 Basket,

Household and farm—
92 Lard press and sausage stuffer,
93 Sausage grinder,
94 Hog scraper,
95 Hog hook,
96 Butcher knife,
97 Kettle,
98 Tree pruner,
99 Pruning shears,
100 Crates,
101 Garden rake,
102 Hoe,
103 Cultivator,
104 Trowel,
105 Cold frame,
106 Flat,
107 Spade,
108 Sprinkler,
109 Lawn mower,
110 Lawn rake,

All stock—
111 Broom,
112 Clipping machine,
113 Manure fork,
114 Pail,
115 Tie chain,
116 Tie rope,
117 Hand sprayer,
118 Wheelbarrow,

Horse and driving—
119 Bit,
120 Blanket,
121 Brush,
122 Currycomb,
123 Collar,
124 Harness oil (qts.),
125 Fly nets,
126 Halters,
127 Muzzle,
128 Nosebag,
129 Sweat pad,
130 Harness punch,
131 Riveting machine,
132 Rivets (boxes),
133 Tie rope,
134 Saddle,
135 Riding bridle,
136 Snaps,
137 Sponge,
138 Neck straps,
139 Syringe,
140 Storm apron,
141 Buggy jack,
142 Wagon jack,
143 Clevis,
144 Chamois skin,
145 Dust robe,
146 Lap robe,
147 Evener, 2-horse,
148 Evener, 3 or 4 horse,
149 Storm front,
150 Dash lantern,
151 Neck yoke,
152 Whiffle-tree,
153 Whip,
154 Whisk broom,

Cattle—
155 Cow bell,
156 Calf muzzle,
157 Crate,
158 Tie rope or chain,
159 Dehorning clipper,
160 Milk tube,

Dairy—
161 Milk can,
162 Milk crock,
163 Milk pan,
164 Milk pail,
165 Churn,
166 Butter crock,
167 Butter bowl,
168 Butter scales,
169 Strainer,
170 Skimmer,
171 Thermometer,

Sheep—
172 Bell,
173 Shears,

Swine—
174 Ring plier,
175 Rings (boxes),
176 Snout clipper,
177 Tongs,
178 Crate,
179 Portable house,

Poultry—
180 Fountain,
181 Feed hopper,
182 Trap nests,
183 Feed pan,
184 Feed sieve,
185 Hover box,
186 Egg tester,
187 Coop,
188 Leg bands,
189 Bone cutter,

Bees—
190 Foundation (lbs.),
191 Section box (100),
192 Foundation fastener,
193 Hive,
194 Super,
195 Smoker,
196 Bee escape,
197 Bee veil,
198 Honey crate,
199 Honey extractor,

Corn—
200 Shock tyer,
201 Knife,
202 Hand planter,
203 Ensilage fork,
204 Seed tester,
205 Seed rack,
206 Husking peg,
207 Husking gloves (pr.),

Hay—
208 Stack cover,
209 Carrier,
210 Hoisting fork,
211 Pulleys,
212 1-inch hay rope (ft.),
213 ½-inch trip rope (ft.),
214 Hand fork,
215 Baled hay hook,
216 Scythe and snath,
217 Hand seeder,
218 Sickle,
219 Slings,
220 Knife,

Small grain and seed—
221 Cradle,
22 Binder cover,
223 Flail,
224 Measure,
225 Straw fork,
226 Hand rake,
227 Sacks,
228 Scoop shovel,

Sugar beets—
229 Beet fork,
230 Beet hoe,
231 Beet topper,

Potatoes—
232 Scoop,
233 Fork or hook,
234 Hand planter,

Maple sugar—
235 Sap bucket,
236 Spout,
237 Cover,
238 Scoop,
239 Gathering pail,
240 Tapping bit.

Let each student in agriculture make an inventory of the major and minor items of the home farm. This will be interesting and instructive. In order to facilitate this, the tables may have extra blank columns marked "number" and "price of each". This will make the work of invoicing minor and other items very easy for the pupil. Explain use of each article.

A summary of the major and minor items of farm equipment may be made through a school survey of the school district.

The inventory may be made to show much interesting and desirable information in columns as follows:

First Column shows the number of each kind of articles on each farm.
Second Column shows figures of first cost of each article mentioned.
Third Column shows total cost of articles mentioned.
Fourth Column for pupil to suggest the number of articles he would recommend for a well organized farm.
Fifth Column, to show the total cost of articles recommended.

COLUMNS FOR SURVEY.

First Column shows percentage of farms reporting articles named.
Second Column shows the average number of each kind on farms reported.

The following list of articles represents an equipment as selected by a graduate of a College of Agriculture just before engaging in farming on his own account.

This list serves to demonstrate the advantages of studying carefully the necessary equipment for a beginner.

This plan affords many important advantages, among which may be named some of the following:

1. Selection of a minimum list of necessary articles.
2. Negotiating with large firms having big assortment.
3. An opportunity to select best grade of goods.
4. Reduction in price on a large bill.
5. A good discount by paying cash.
6. This plan can be negotiated through a local dealer.
7. Few trips in securing the goods.
8. Saving many trips when in need of articles.
9. A convenient place and orderly arrangement of tools.
10. Proper care, use and shelter of articles.

1 Leather halter.........	$1 65	1 Riveting machine......	50
1 Gallon paint...........	1 50	1 Soldering iron.........	30
1 Gallon barn paint......	85	1 Crowbar, 16 pounds....	64
1 Bottle "3 in 1" oil......	10	1 Center punch	10
1 Small oil can..........	05	1 Draw knife	60
1 Leather punch	60	1 Garden hoe	35
2 Pair gloves	20	1 Grindstone	3 75
1 Pair shucking gloves...	50	1 Buggy robe	8 00
1 Shucking peg	20	1 Blacksmith's vise, 5 inch	6 00

1 Tamper	1 00	1 Cold chisel	20
1 Pair scales, 600 pounds.	11 00	1 Chisel, ¾ inch	30
1 Oilstone	50	1 Chisel, 1 inch	35
2 Gallons of harness oil	2 00	1 Rope, ½ inch, 50 feet	55
1 Jack plane	2 00	1 Hoisting block	2 50
1 Paint brush	65	1 Tinner snips	35
1 Rachet brace	1 75	1 Road scraper	5 00
1 Bit, ¼ inch	20	1 Steel square	85
1 Bit, 5–16 inch	20	1 Nail hammer	75
1 Bit, 7–16 inch	20	1 Ball pein hammer	75
1 Bit, ½ inch	25	1 Jack screw	2 25
1 Bit, 10–16 inch	30	1 Pipe wrench	1 50
1 Bit, 12–16 inch	30	1 Currycomb	20
1 Bit, 1 inch	40	3 Clevises	24
1 Hand saw	1 75	1 Crosscut saw and handle.	2 80
1 Hand saw	90	5 Files	75
1 Hack saw	45	1 Grub hoe	45
1 Compass saw	25	1 Garden hoe	35
1 Pair of pliers	1 00	1 Horse brush	45
1 Pair of pliers	30	1 Horse brush (tail)	15
1 Post hole digger	1 25	1 Hatchet	75
1 Screw driver	35	1 Lantern	90
2 Shovels	1 20	1 Fork, 4 prong	60
1 Scoop shovel	75	1 Punch	10
1 Plastering trowel	62	1 Pick and handle	60
2 Wedges	40	2 Boxes copper rivets	20
1 Fork, 3–prong	65	2 Boxes tubular rivets	10
1 Whetstone	05	1 Spade	60
1 Mail box	1 00	1 Ditching spade	1 00
1 Wagon jack	1 00	1 Snath	75
1 Bucket	95	1 Scythe	75
1 Set ladder irons	1 35	1 Wheelbarrow	1 75
12 Bolts, 14–inch	49	1 Hay knife	75
1 Horse blanket	3 00	1 Feed basket	80
1 Whip	25	1 Pair nippers	75
1 Monkey wrench	40	1 Sledge and handle	90
1 Alligator wrench	25	3 Quarts of paint	1 15
1 Paint brush	15		
1 Carbon seed sower	4 50	Total	$106 86
1 Saw set	60	Less 10 per cent. cash discount	10 69
1 Log chain, 15 feet	1 72		
1 Axe and handle	1 00		
1 Boy axe	75	Net cost	$96 17

The following is a fair list of the major items of farm equipment as found on some of the best farms of the middle West States.

A study of the construction, use, repair and care of tools would undoubtedly mean a great saving to agriculture, through economy of time, as well as saving in unnecessary cost of repairs.

One of the important points that should be emphasized in farm economy is the construction of a well-arranged tool shed for housing of the important and costly tools of the farm.

The shed should be so arranged that tools of a certain kind for certain work could be housed and removed quickly and easily. There should be a place for every thing and everything easily accessible.

Major Items of Farm Equipment.

Double work harness,
Single work harness,
Double light harness,
Single light harness,
Truck wagon,
Light wagon,
Auto truck,
Buggy or auto,
Walking plow,
Sulky plow,
Gang plow,
Spike tooth harrow,
Spring tooth harrow,
Acme harrow,
Disc or cutaway harrow,
Roller or crusher,
Planker,
Wheelbarrow seeder,
Endgate seeder,
Broadcast seeder,
Standard single-disk drill,
Press drill,
Corn planter,
Cultivator,
Harvester,
Corn harvester,
Corn picker—husker,
Corn shredder,
Corn husker,
Ensilage cutter,
Mower,
Hay rake,
Hay tedder,
Hay loader,
Hay stacker,
Hay fork,
Hay slings,
Hay carrier,
Thresher,
Huller,
Fanning mill,
Fence stretcher,
Jack screw,
Portable elevator,
Manure spreader,
Lime spreader,
Feed mill,
Corn sheller,
Spray pump,
Gas engine,
Stem tractor,
Wind mill,
Pump.

A good shop properly equipped with tools will enable a farmer who has had a proper course in manual training to repair many of the broken parts of machinery named in the foregoing list. He can also make many of the necessary equipments of the farm, such as the following:

Troughs,
Gates,
Doors,
Windows,
Coops,
Trap nests,
Bee hives,
Boxes,
Bins,
Rollers,
Drags,
Handles,
Ladders,
Single trees,
Double trees,
Tongues,
Wagon boxes,
Hog racks,
Hay racks,
Poultry crates,
Fruit crates,
Frames,
Tanks,
Cisterns,
Silos,
Seed Testers,
Seed dryers,
Seed grader,
Seed racks,

PROBLEMS.

1. If the figures show that the average farm of 167 acres has minor items having a first cost of $190, what will be the loss annually if the depreciation amounts to 7.8 per cent. annually?

2. At the rate of the average annual depreciation of 7.3 per cent., the major items of equipment must be replaced on an average every how many years?

3. A farmer finds that an investment of $50 made judiciously in addition to the average equipment would have saved him about 50 trips to town in 10 years; allowing that the time for a man and team for these 50 trips was worth $3.00 per day, what would have been saved if these articles had been purchased in the beginning?

4. A farmer has estimated that his losses from lack of proper tools for repairs at the proper time has caused him a loss of $300 in ten years; if the extra tools needed would have cost $75, what would have been his gain, allowing a depreciation of 10 per cent. through loss and exposure of tools annually?

5. If a farmer on 200 acres can save $50 annually by having a good equipment of minor tools valued at first cost at $300, and the loss is 7.3 per cent. annually, what does he save by having the tools, if it requires an outlay of $21.90 annually to replace the loss by depreciation and allowing 6 per cent. on the investment?

Farm Management.

PROBLEMS.

1. The average size of the Ohio farm is 89 acres, and the value of land, improvement, live stock and machinery is $4,833 per farm. What is the average value per acre?

2. The average size and value of 21 farms studied by the Ohio Agricultural Experiment Station was 165.88 acres and $14,461. What was the value per acre?

3. The average value of land and buildings in Ohio in 1910 was $68.57 per acre; land alone was worth $53.33. What was the average

value of buildings per acre? What was the average value of buildings per farm?

4. The value of implements and machinery on Ohio farms in 1910 was fifty-six million dollars. What was the value per farm if there were 271,000 farms in Ohio?

5. Twenty-five million three hundred and fourteen thousand dollars was spent for labor; $4,163,000 was spent for fertilizers. What was the expenditure per acre if there are 19,210,000 acres of improved lands in the state?

1. A farmer lost $125 on a horse that became blemished by a loose barbed wire lying on the ground. If it would have taken ten minutes to have replaced the wire on the fence and nail it fast, what would his time have been worth per minute, if he had repaired the fence when he first saw its condition and had prevented the loss?

2. If a set of buildings poorly arranged cause the loss of one hour daily in doing chores, what is the total loss of time in one year? What is the loss financially if the farmer's time is worth $2.25 per day?

3. If a farmer loses $75 per year because of poor buildings and lack of shelter for his farm animals, and this amount could be saved by building a barn at a cost of $1,000, estimating money to be worth 6 per cent., what would this farmer save in ten years by building a barn?

4. If there is an investment of $500 in farm machinery, and there is an average loss of 10 per cent. annually when it is not sheltered, how long will it take for the loss to be equivalent to the cost of a $225 tool shed?

5. Which is the cheaper, a farm of 80 acres that has a set of new buildings erected at a cost of $3,000; the fields fenced with 760 rods of fence at a cost of 60c a rod; ditched at a cost of $20 an acre; if it can be purchased with these improvements at $200 per acre or to purchase a farm of the same size with identically the same kind of soil but without buildings or fences or ditches at $150 per acre?

Exercises.

Make a list of the articles and tools of the farm and classify as follows:

1. Tools of the household.
2. Barn tools.
3. Orchard tools.
4. Garden tools.
5. Field implements.
6. General purpose tools.
7. Shop tools.

(a) Name the tools of a blacksmith shop.
(b) Name the tools in a carpenter outfit.

8. Learn the uses and values of the different articles named in the lists of major and minor items of farm equipment.

Exercises.

FARM MANAGEMENT.

Water.

Study different sources for securing water; artesian wells; open wells; waterworks; filtered water; sterilized water; difference between soft and hard water; difference in the city and farm method of getting water; study types of pumps and windmills; reservoirs, tanks and cisterns; methods of heating or cooling for house use or for stock; study how water may become contaminated and contain disease germs such as typhoid; explain danger in using cups found at public drinking places; study new sanitary methods for drinking places.

Lighting and Heating.

Study systems of heating; the fan, steam, hot water, and gas systems; wood stoves and coal stoves; the fire place; study chimney construction; protection from fire; study combustion; effects of oxygen; observe movements of cold and warm air; a modern system of heating and ventilation; explain principles of ventilation; study principles of the kerosene lamp; of electric lights; gas lights; send to the Standard Oil Company for samples of the products of oil; study nature, use and dangers of gasoline, acetylene, benzine, electricity. Send to Department of Public Instruction for Guide to Safety.

Tools and Farm Mechanics.

Send to the Ohio Experiment Station for Bulletin No. 227, Farm Equipment; make a list of the tools needed on a farm of 80 acres; study cost as given in above named bulletin; study losses caused for want of care; name the tools that belong to a carpenter's outfit; name some tools every boy and girl should learn to use; study care of tools; preventing rust; name tools of a blacksmith shop.

Study principles involved in the construction and operation of farm machinery; mower, reaper, fanning mill; separator, cream separator, milk tester, pumps, wind mills, engine, electrical apparatus, water power, spraying machinery, seed drills, and other important and complex machines of the farm.

Arithmetic.

Give supplementary problems with the lesson in arithmetic; have practical agricultural problems; they should combine the facts of agriculture with mathematical training; feeding problems; balanced rations; nutritive ratio; mixing of fertilizers; mixing sprays; construction of buildings; silos; cribs; granaries; tile drains; fences, road building; ditching; problems in seeding; planting and harvesting of wheat, corn and other crops; marketing; egg production; trade problems; make all problems practical and applicable to the every day transactions of the community by consulting the daily market reports.

In figuring the depreciation of fences surrounding an area planted to a certain crop it is necessary to know their value and to estimate the length of time they will last. For example, the depreciation of a fence estimated to last ten years should be figured at 10 per cent.

Score Card.

FARMS.

(New York State College of Agriculture, Department of Farm Management.)

	Points.
Fertility —	
8. Natural	80
9. Condition	40
Physical Properties of the Soil —	
10. As affecting economy of cultivation	
11. As affecting number of days of labor	90
12. As affecting loss of soil fertility	10
13. As affecting kinds of possible crops	20
Drainage —	
14. Natural	
15. Artificial	50
Condition —	
16. Freedom from stumps, stones, weeds, waste land, etc.	50
Climate —	
17. As affecting animal and crop production	
18. As affecting number of days of labor	
Healthfulness —	
19. As an economic factor	40
Location —	
20. Distance to Market	40
21. Roadways	50
22. Local markets	30
23. Shipping facilities	20
24. Neighbors as an economic factor	40
25. Labor supply of neighborhood	10
26. R. F. D., telephone, trolleys, etc.	30
27. Churches, school, grange, etc., as economic factors	30
Taxes —	
28. Per cent. on cash value	10
Water Supply —	
29. Running water, wells	40

SCORE CARD — Concluded.

	Points.
Improvements —	
30. Site of farmstead	10
31. House as adapted to needs of farm	60
32. Other buildings	60
33. Fences; kind, condition, arrangement	30
34. Timber, orchards, vineyards, etc	20
Size —	
1. Adapted to kind of farming	20
Fields —	
2. Shape and size	30
3. Nearness to farmstead	30
Topography —	
4. As affecting ease of cultivation	30
5. As affecting production	10
6. As affecting erosion and loss of fertility	15
7. As affecting air drainage	5
Total	1,000

Suggestions.

1. This score card is only suggestive.

2. When there is an exceptional value or advantage noted in a farm the score should be higher than given in card.

3. If we are looking for a dairy farm, truck or fruit farm, distance from market should count for much in scoring.

4. The lack of water for a stock farm would disqualify it.

5. No points are assigned for climate, for this should be judged before comparing farms. See chapter on (Climate).

6. A very good way of judging a farm is to omit all figures: F (fair), P (poor) or V P (very poor).

7. In all cases of judging all of the important items named in the score card should be carefully observed.

Questions.

1. What is farm equipment?
2. What is a tool?
3. What is a machine?
4. Describe and explain the six fundamental devices that modify forces and motions of a simple machine—lever, wheel and axle, inclined plane, screw, wedge and pulley.

5. Define friction, lubrication and wear.

6. What are bearings, roller bearings, ball bearings?

7. What is cast iron, chilled cast iron, malleable iron, cast steel, Bessemer steel, wrought iron, tool steel?

8. Name some of the parts of certain tools in which some of the following varieties of timber are especially adapted: hickory, white oak, ash, maple, poplar, white and yellow pine. Give reasons.

9. Explain how feed, fuel and wind may be made sources of energy.

10. What is energy? Explain difference between energy in unburned coal and in that of wind?

11. How does paint preserve the life or durability of wood and iron?

12. What is rust? How can it be prevented?

Book References.

The Farmstead—Roberts—Macmillan Co., N. Y.
Physics of Agriculture—King, Author, Madison, Wis.
Agricultural Engineering—Davidson—Web Pub. Co., St. Paul, Minn.
Farm Structures—Ekblow—Macmillan Co., N. Y.
Grammar of Woodwork—Degerton—Macmillan Co.
Educational Woodworking—Park—Macmillan Co.
Woodwork and Carpentry—King—American Book Co., Cincinnati.

Bulletins.

Write to U. S. Department of Agriculture for bulletins on Poultry, Swine and Dairy Equipment and Buildings. Write to your State Experiment Station for same.

CHAPTER XXIV.

Trucking.

There are many truck crops that are well adapted to the intensive method of farming. It is especially profitable to produce those kinds of crops that are suitable for canning.

Tomatoes, cabbage, cucumbers, berries, and many small fruits are profitable canners' crops.

It has been shown in many instances that land under greenhouse management can be made to produce crops valued at from five to ten thousand dollars per acre per year.

As our population increases and the average size of our farms decrease we must increase the area of intensive farming. The truck garden and greenhouse must supply the city with a great part of the daily consumption of vegetables.

In this chapter particualar attention is called to the tomato for it is one of our most popular products and can be raised profitably in almost every part of the United States and is especially well adapted to the canning industry.

Attention is also called to the Potato because it is one of the most important crops in the U. S.

Canners' Crops.

TOMATOES.

Raising an acre of tomatoes.

STATISTICS.

In 1912 there were enough goods canned and packed in the United States to furnish every family with:

17 cans of tomatoes.
15 cans of sweet corn.
5 cans of peas.
110 cans of fruit, beans, kraut, pickles, etc.

PROBLEMS.

1. If the average family in the U. S. consists of five persons, find the number of cans of goods put up in 1912 based on the census of 1910.

2. In 1909 there were 18,800,000 cases of tomatoes of 12 cans each packed in the United States; if the consumers of the country paid on an average of 12c per can, what was the total amount paid for canned tomatoes?

The demand and the price paid for tomatoes makes tomato growing and canning one of the most profitable industries in the country. This has led to the organization of many girls' tomato growing and canning clubs. This work has been much encouraged by the teaching of agriculture in the schools and the organization of contests.

A few records of some of the club girls in growing and canning on a profitable basis will show something of the possibilities of this industry, and how girls at home can make use of some of the products of the farm at considerable profit.

Suggestions for Club Work.

GIRLS' GARDEN AND CANNING CLUB.

Age: 10 to 18 years, inclusive.

Acreage: 1/10 acre, chiefly tomatoes. A few other vegetables.

Club members required to can surplus products.

Basis of Award:

(1)	Quality	20
(2)	Quantity (Total pounds of vegetables harvested and used)	20
(3)	Variety of canned products	20
(4)	Profit on investment	20
(5)	Written history on "How I Made My Tomato Crop"	20
	Total Score	100

BOYS' AND GIRLS' POTATO CLUB.

Age: 10 to 12 years, inclusive.
Acreage: 1/8 acre.
Basis of Award:

(1)	Greatest yield per $\frac{1}{8}$ acre	40
(2)	Best showing of profit on investment	30
(3)	Best exhibit of one peck seed potatoes	15
(4)	Best history on "How I Made My Crop of Potatoes"	15
	Total Score	100

SEED SELECTION CONTEST.

Based upon:

(1) Largest number of bushels of hand-picked seed.
(2) Best bushel of hand-selected seed.
(3) Best ten units of hand-selected seed.
(4) Best unit mother-stalk for seed purposes.
(5) Best individual tomato for seed purposes.

PLANS FOR AN ACRE CONTEST.

5/20 acre	Potatoes
1/20 acre	Cabbage
2/20 acre	Cucumbers
2/20 acre	Sweet Corn
2/20 acre	Tomatoes
1/20 acre	Winter Onions
1/20 acre	Beans
1/20 acre	Popcorn

The balance 5/20 of an acre, may be planted to lettuce, summer radishes, spinach, celery, squash, pumpkins, melons, beets, carrots, and many other useful products.

By simple methods this acre of ground can be made to yield to exceed \$150 from the sale of agricultural products.

Cities, villages, and even rural communities can use vacant lots and waste lands to good advantage in securing such lands for the use of boys who can carry on a contest during the summer vacation.

Make report of yield — pounds — amount used for home consumption — amount sold — profit on investment — amount received for labor, etc.

State briefly what your club work or agricultural education has done for you, in interest, instruction, health, comfort and in financial benefits.

An Acre of Tomatoes.

COST OF PRODUCTION.

The following is an estimate of the cost of an acre of tomatoes:

1.	Barnyard manure — 10 tons	$10 00
2.	Plowing, disking, harrowing, and rolling	5 00
3.	Fertilizer — 600 pounds per acre	9 00
4.	Plants and planting	15 00
5.	Cultivating four times	4 00
6.	Hoeing and weeding	1 00
7.	Rent of land	6 00
	Total	$50 00

The above is a fair estimate of the average cost of one acre of tomatoes under average conditions.

The ordinary yield of tomatoes is from five to ten tons per acre, but where they are treated on the basis of the above estimate for expenses there is a possible production of from fifteen to twenty tons per acre.

There are many conditions that may serve to increase or diminish the cost of an acre of tomatoes.

PROBLEM.

1. On the basis of cost in producing one acre of tomatoes at $50, allowing $5 for gathering and $8.50 for canning outfit, cans and labels, what will be the net profit on one acre of tomatoes if the yield amounts to 18 tons, for which the price for fresh vegetables and canned products averaged $9.50 per ton?

In the canning contests in 1911, some of the results are given in the following reports:

WESSON, MISS., SIZE OF GARDEN, ONE-TENTH ACRE.

Cost of production:		*Garden receipts:*	
Rent of land	$1 00	Cash sales of fresh vegetables	$8 00
Cost of planting	50	Cash sales of canned products	25 00
Manure and fertilizing	3 00	Value of vegetables, home use	10 00
Cultivation	1 00	Total receipts	$43 00
Gathering	1 50	Less total expenses	19 77
Canning outfits, cans, labels.	8 27	Net profit	$23 23
Cost of canning work	4 50		
Total expense	$19 77		
Net cost per No. 3 can*	04		

* The net cost per can is calculated by dividing the total cost of making the crop and the expense of canning by the total output, No. 3 cans being taken as a unit.

Canning Tomatoes at Home and in Club Work.

SAMARIA, S. C., ONE-TENTH ACRE OF TOMATOES.

Cost of yield and canning	$35 33	Cost of home canner	$6 25
Canned products, 770 No. 3 cans.		Sold fresh tomatoes	47 90
Net cost per can	04	Net profit for season	78 37

MONETTA, S. C., ONE-TENTH ACRE OF TOMATOES.

Cost of yield and canning	$36 74	Cost of home canner	$6 25
Canned products, 706 No. 3 cans.		Sold fresh tomatoes	26 65
Net cost per can	04⅓	Net profit for season	60 51

BROOKHAVEN, MISS., ONE-TENTH ACRE OF TOMATOES.

Cost of yield and canning	$33 07	Net cost per can	$0 03⅓
Canned products, 1,008 No. 3 cans.		Net profit for season	67 73

BROOKHAVEN, MISS., ONE-TENTH ACRE OF TOMATOES.

Cost of yield and canning..	$41 10	Cost of home canner........	$10 00
Canned products, 950 No. 3 cans.		Sale of fresh products......	23 50
Net cost per can...........	03¼	Net profit for season.......	74 80

Essentials of Success.

The following points must be observed in raising canner's crops:

1. The crop must be seasonable.
2. The soil must be suitable.
3. There must be a balanced plant food.
4. The growth must be rapid.
5. The flavor must be good.
6. The color must be bright.
7. The crop must be marketed in good condition.
8. The market must be within driving distance.
9. The market must be suitable.
10. There must be love of work and business management.
11. Keep a strict method of accounts.

Fertilizing.

PLANT FOOD FOR INTENSIVE PLANT PRODUCTION.

One acre of a market garden must produce on an average at least ten times as much as an acre on the average farm.

Barn manure is a most valuable plant food, but its analysis shows that it is not well balanced for some of our plant foods.

Average barn manure carries the following composition per ton:

10 to 15 pounds of nitrogen.
5 to 9 pounds of phosphoric acid.
10 to 15 pounds of potash.

This would be a fertilizer with a formula that is not suitable for a crop that requires rapid growth; sweet corn, and tomatoes require a longer period for growth than many of the other garden plants and should have an available plant food of about the formula 3-4-6, applied at the rate of from 500 to 1,200 pounds per acre.

Production and Care of Tomatoes.

The ideal method of growing tomato plants is by starting the seed in a green house late in winter, but most growers have no green house facilities and must make use of the hotbed for early plants.

The manure hotbed is most commonly used. A manure hotbed may be very cheaply constructed; for information on hotbed construction see chapter on "Planning and Adorning the Farmstead and School Grounds."

Potatoes.

The potato is a modified form of the stem of the potato plant, called a tuber. Potatoes are propagated from tuber cuttings.

Some idea of the importance of the potato crop in the United States may be formed from the fact that for the last five years we have been producing over 3,600,000 acres of potatoes and the production has averaged about one hundred bushels per acre.

Statistics.

AVERAGES OF ACREAGE PRODUCTION, BUSHELS PER ACRE, AND FARM PRICE FOR POTATOES, IN FIVE-YEAR PERIODS, 1868 TO 1912 IN U. S.

Five year period.	*Number of acres.*	*Bushels produced.*	*Bushels per acre.*	*Farm price per bushel Cents.*
1868–1872	1,246,200	117,745,800	94.8	54.9
1873–1877	1,529,800	134,773,200	88.0	53.3
1878–1882	1,934,200	150,706,200	78.4	59.5
1883–1887	2,284,000	175,197,800	76.9	48.3
1888–1892	2,619,200	193,325,000	73.7	50.7
1893–1897	2,720,000	213,461,800	77.8	44.6
1898–1902	2,716,000	220,849,400	81.2	49.5
1903–1907	3,014,200	289,399,800	95.9	56.3
1908–1912	3,566,400	343,587,600	96.1	62.3

PROBLEM.

1. What is our average production per capita if our population is estimated at 100,000,000 people?

The average acre yield of potatoes in both Great Britain and Germany is 200 bushels. If the production in the United States is only half as great there must be some important causes for this difference in production.

A study of potato production in Europe has demonstrated the fact that if we are to improve and increase our production in the United States we must adopt some of the following measures:

1. More attention must be paid to quality and quantity of seed.
2. There should be a differentiation of the potato industry into seed and crop-specialists.
3. We must use pure seed from productive varieties.
4. Seed must be uniform in size and shape, firm and sound.
5. The sprouts should just begin to show at planting time.
6. Select seed tubers from strong productive plants.
7. Seed potatoes should not be over-ripe.
8. Use a liberal amount of seed.

FOR TREATMENT OF POTATO SCAB.

Use the following:

Mix one pint formalin (which can be purchased at the drug store) with 30 gallons of water. Spread the seed potatoes out about 6 inches deep and sprinkle them till they are wet with the mixture. Cover the heap with bags or old covers of any sort in order to keep the gas among the potatoes as long as possible. This penetrating gas kills the germs of the scab. Leave the heap covered over night. In the morning the potatoes are ready to cut. Treat the potatoes for scab before cutting, whether they are scabby or not. Do not take chances.

DEMONSTRATION.

If you are planting potatoes affected with scab, plant two rows side by side; one treated with formalin and one untreated and note results when the potatoes are dug.

Try growing some potatoes on a plat, using home-mixed commercial fertilizers as follows: Nitrate of Soda, 25 pounds; Acid Phosphate, 50 pounds; Sulphate of Potash, 25 pounds. Use 10 pounds of this mixture to 10 square feet of soil. Prepare the furrows for the tubers; spread the fertilizer in the furrow and work into the soil and cover lightly.

NOTE TO TEACHER. — Have the pupils learn to recognize some of the well known varieties, as, Early Rose, Early Ohio, Early Michigan, Triumph and some of the late varieties — Peerless, Peachblow, Rural New York, Green Mountain, Burbank, etc.

One of the best methods for conducting an experiment to determine the requirements of a potato soil is the following plan which is accessible to both the student and the farmer.

PLAT METHOD.

1	NITROGEN.
2	POTASSIUM.
3	PHOSPHORUS.
4	CHECK.
5	NITROGEN AND POTASSIUM.
6	NITROGEN AND PHOSPHORUS.
7	POTASSIUM AND PHOSPHORUS.
8	CHECK.
9	NITROGEN, POTASSIUM AND PHOSPHORUS.
10	BARNYARD MANURE.

The plats should be numbered. The fertilizers should be carefully weighed. The potatoes in each plat should be weighed and the rate of production per acre determined.

A large number of plats may be used so that the experiment will show the results of using different quantities of fertilizers and manures.

In all these experiments care should be taken to have uniformity in size, quality, and type of potato.

PROBLEMS.

1. A conservative estimate made by the U. S. Government experts of the increase in potato production that might be expected from the use of high grade seed has been placed at 10 per cent. If our crop is estimated at 350,000,000 bus. and the price is 50c a bushel what would be the value of this 10 per cent increase in production?

2. An investigation by the Ohio Experiment Station clearly demonstrates the superiority of selected over unselected seed. High-yielding plants were compared with low-yielding plants and unselected stock, and the average yield from 100 hills during the three years of the experiment resulted as follows:

High-yielding seed	138 pounds
Unselected seed	110 pounds
Low-yielding seed	73 pounds

What was the percent gain in yield of the high-yielding seed over each of the other kinds?

Exercises.

PLAT WORK FOR SEED POTATO DEMONSTRATION.

Plant at least twenty rows of potatoes of the same variety. Number the rows from 1 to 20. Plant the small seed potatoes in the odd numbered rows beginning with row number 1. Plant the large selected potatoes in the even numbered rows. Select the small seed from the small irregular tubers. Select the large seed potatoes from the same bin or basket containing the small ones selected for the experiment. Cut the small tubers into as many pieces as the large tubers are to be cut. A few rows may be planted to small tubers cut in two pieces, to note difference if any occasioned by the size of the cuttings.

When the potatoes are ripe each row should be dug and the tubers weighed separately. Compare the yield of rows planted with small seed with yield of rows planted with large seed.

Tabulate results as follows:

(Taken from an actual experiment.)

	Seed Used.	*Yield.*
Row 1.	Small seed, yield 127 pounds	132.3 bushels per acre
Row 2.	Large seed, yield 160 pounds	166.7 bushels per acre
Row 3.	Small seed, yield 131 pounds	136.5 bushels per acre
Row 4.	Large seed, yield 187 pounds	194.8 bushels per acre

Points to be observed:

1. Find the average yield of rows from large seed.
2. Find the average yield of rows from small seed.
3. Find the per cent of gain in favor of large seed using the yield of small seed as a base.

FERTILIZERS AND MANURES.

There is a diversity of opinion both as to methods and amount of fertilizers to use for potato soils. This is often due to a wide variation in the soils, climate, moisture, seed and fertilizers. A few important points will serve to illustrate:

1. Fertilizers are of little value for a dry season.
2. Fertilizers will not give satisfactory returns in a soil depleted of organic matter.
3. Poor soil packs easily and is not friable and therefore is rendered undesirable for potatoes.
4. When soils contain the necessary elements, fertilizers will not produce appreciable results.
5. Chemical analysis will not show the real requirements of the soil.
6. A carefully conducted experiment will give some valuable information.

THE COST OF PRODUCTION.

Plowing	1 acre	$ 2 00
Disking and Harrowing	1 acre	1 00
Preparing Seed	1 acre	1 00
Planting Potatoes	1 acre	1 50
Cost of Seed (15 bus.)	1 acre	15 00
Cost of Spraying (4 times)	1 acre	5 00
Cost of 4 Cultivations and Hoeing	1 acre	2 50
Cost of Fertilizer—800 pounds	1 acre	10 80
Cost of Digging	1 acre	10 00
Interest on Money Invested in Land	1 acre	10 00
Total Cost per acre		$58 80

THE PROFIT.

If an acre of potatoes at a total cost of $58.80 for production, yielded 200 bushels of marketable potatoes @ 60c per bushel; what is the net profit per acre?

Big Profits in Little Things.

A carload of tomatoes contains about 700 four-basket crates of 25 pounds each, and brings an average of about forty cents a crate net to the grower. The average planting each year in California for eastern shipment is about 2000 acres. The average yield per acre during the shipping season of three months, is about four tons.

Onions are among the surest and most profitable crops. They are in constant demand and the market price will insure a return of from $200 to $500 an acre. The beginner should try an experiment with from a half to an acre of ground. They are raised on black rich land.

Strawberries will yield from $200 to $400 per acre with proper soil and care.

Raspberries and Blackberries will yield upwards of $200 per acre.

Cucumbers can be made to yield as high as $200 per acre.

The following table will show about the average relative value of crops per acre as produced by the best agriculturists on the best farms; in gardens and greenhouses.

Crop.	*Gross Receipts.*	*Net Profit.*
Wheat	$20 00	$13 00
Oats	18 00	11 00
Corn	30 00	18 00
Clover	20 00	15 00
Alfalfa	45 00	30 00
Timothy	20 00	15 00
Potatoes	100 00	50 00
Sweet Potatoes	125 00	85 00
Onions	250 00	150 00
Cucumbers	150 00	100 00
Sugar Beets	80 00	50 00
Strawberries	275 00	175 00
Blackberries and Raspberries	200 00	150 00
Grapes	300 00	200 00
Melons	150 00	100 00
Cantaloupes	200 00	150 00
Greenhouse crops	10,000 00	7,500 00

Score Cards.

POTATOES.

	Points.
Uniformity	20
Symmetry	15
Trueness to type	20
Freedom from disease and insects	15
Commercial value	30
Total	100

TOMATOES.

(For Use by Girls' Tomato Clubs; Devised by U. S. Bureau of Plant Industry.)

	Points.
Yield of fruit in pounds	20
Size — medium and uniform size rather than very large	5
Color — normal for well ripened fruit	5
Uniformity of sample — smoothness, size, color and shape	10
Shape and smoothness — freedom from cracks and surface blemishes	5
Evenness of maturity	5
CANNED PRODUCT.	
Color when cooked	20
Quality of canned product — color, pulp, whole or cooked up, amount of water, etc.	20
Number of cans per bushel	5
Weight of cans and percentage of pulp	5
Total	100

Books.

1. Potato Culture — Tracy, 7-12 — Webb Pub. Co.,$0.50.
2. The Potato — Fraser, 8-12 — Webb Pub. Co., $0.75.
3. Truck Farming in the South — Cemler, 8-12 — Webb Pub. Co., $1.00.
4. Bean Culture — Sevey, 8-12 — Webb Pub. Co., $0.50.
5. Celery Culture — Beattie, 8-12 — Webb Pub. Co., $0.50.
6. Onion Culture — Greiner, 8-12 — Webb Pub. Co., $0.50.

References to Garden and Canning Crops.

FARMERS' BULLETINS FROM THE UNITED STATES DEPARTMENT OF AGRICULTURE.

No. 460. Frames as a Factor in Truck Growing.
No. 521. Canning Tomatoes at Home and in Club Work.
No. 220. Tomatoes.
No. 254. Cucumbers.
No. 176. Cranberry Culture.
No. 61. Asparagus Culture.
No. 198. Strawberries.
No. 204. The Cultivation of Mushrooms.
No. 213. Raspberries.
No. 282. Celery.
No. 324. Sweet Potatoes.
No. 354. Onion Culture. No. 434. The Home Production of Onion Seeds and Sets.
No. 433. Cabbage.
No. 407. The Potato as a Truck Crop.

CHAPTER XXV.

Planning and Adorning the Farmstead and School Grounds.

"The tree planter and teacher united in one shall be declared the best benefactor of modern times, — the chief provider for posterity."

J. Sterling Morton,
Founder of Arbor Day.

The School Garden.

After animals, plants are the objects of greatest interest to children in nature study. The average school environments make it possible to study plants to greater advantage than animals.

The facilities and conveniences for the study of plants are within reach of nearly all schools. The necessary requirements can be easily secured, in most instances, without very great expense.

The increasing interest in agricultural education is making the study of plants a matter of growing importance, and the demand is becoming urgent for definite and practical plans for the establishment of school gardens.

In rural communities where there are no consolidated or centralized schools, it is advisable to encourage the work of making experiments or tests in plats on the home farm.

In the city, village or in the rural community where there is a high school or a consolidated school with sufficient space for lawns, playgrounds, and gardens, there should be a plan for growing shrubs, trees, vines and flowers, in an artistic manner. This should be done in such a way that it will serve a useful purpose in instruction. The school grounds should be an object of beauty, study and inspiration. The following points should be observed:

1. The primary object of the school is instruction.
2. The work of adorning should be planned and carried out with the two-fold purpose of securing beauty and utility. Trees and shrubbery attract birds and insects and facilitate the study of economic zoology.

3. The school garden may serve a number of purposes, as study, beauty, recreation, practical utility.
4. The school ground should be planned, and the work of planting and beautifying so executed, and the grounds so kept that they will serve as a model for study by the residents of the community.
5. The grounds should be the pride of the school and they should be the outward manifestation of the inner spirit of the school.
6. Artistic beauty will help to win a better school spirit and a closer sympathy among teachers, pupils, parents, and taxpayers.

From the above points we should therefore easily reach the conclusion that this work should not be planned in a haphazard way by inexperienced and untrained minds. Every school board should be impressed with the fact that in selecting a school site and planning buildings and grounds, they are dealing with that which may be far-reaching in its consequences. It is to become a familiar scene; it will become a landmark; it will form lasting impressions and the pictures of memory. The work of beautifying the grounds should have a plan.

There should be as much care in the selection of the landscape artist and in the execution of his plans as in the selection of an architect and competent workmen for the construction of a school building. No building should ever be placed where there is no room for large and commodious grounds. The grounds are a part of the complete school. A school without grounds is a lame school, and it will make crippled minds.

Location of Buildings.

School buildings should not be located near the street, nor on busy, noisy thoroughfares. They should be away from smoke and the noise of factories and railroads, as far as possible and practicable.

The primary consideration in the organization of new schools should be location of grounds. Second, the location of the building. The proper order for this work should be:

1. Selection of a proper site.
2. Selection of an area of sufficient size.
3. Planning the school grounds.
4. Plans and location of building.

It is very evident from the many undesirable conditions that nay be seen in visiting schools, that the order above given has not een heeded. Too often the reverse plan has been followed.

Often the so-called economy of some former school board ias added heavy burdens of taxation on those who must abandon ndesirable buildings and locations.

Walks and drives of over one hundred feet in length should have curves, so that trees and shrubs along the borders will show better naturalistic effects.

A view from the doors and windows of the school buildings will help to decide the location of the trees. Sights in the distance or in the environment of the building can be reained or obstructed as desired.

FIG. 1.

There should be a wide variety of the most useful trees hat grow in the locality of the school and as many varieties from ther parts of the country or other countries as can be grown.

The following list is made up of trees that are found in the ublic parks and grounds of Ohio:

Deciduous Trees.

White Oak,	Japan Catalpa,	Hickory
Red Oak,	White Elm,	Buckeye,
Pin Oak,	Red Elm,	Box Alder
Golden Oak,	Cottonwood,	Locust,
Chestnut Oak,	Poplar,	Black Cherry,
Willow Oak,	Lombardy Poplar,	Cornelian Cherry,
White Ash,	Sycamore,	Purple Birch,
Black Ash,	European Sycamore,	Silver Birch,
Prickly Ash,	Purple Sycamore,	Red Birch,
Mountain Ash,	Catalpa,	Paper Birch,

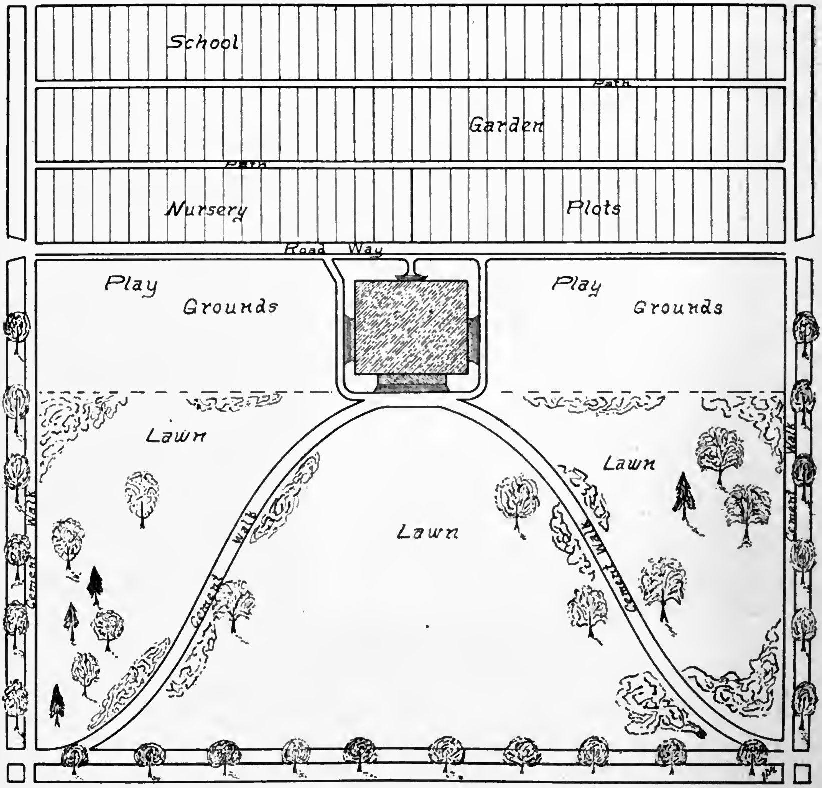


FIG. 2 — Represents a school ground containing 10 acres. It is in the form of a square and shows an ideal arrangement for trees, shrubs, flowers, lawns, playgrounds and school gardens.

Mulberry,
Kentucky Coffee Tree,
Ginkgo Tree (Japan),
Tree of Heaven (China),
Japan Varnish Tree,
Beech,
Purple Beech,
Weeping Beech,
European Linden,
Sassafras,
Horse Chestnut,
Walnut (black),
Japanese Walnut,
White Walnut,
Am. Linden (basswood),
Willow,
Persimmon,
Larch,
Liquid Amber Tree,
Sugar Maple,
Norway Maple,
Silver Maple,
Aspen,
Osage Orange,
Magnolia,
Tulip.

Evergreen Trees.

Austrian Pine,	Norway Spruce,	White Fir (Concolor),
White Pine,	Holly (American),	Douglas Fir,
American Hemlock,	Juniper,	Blue-tinted Red Cedar,
Colorado Blue Spruce,	Arborvitae,	Cypress.
White Spruce,	Oriental Spruce,	

Where there is plenty of space for trees the list of trees may include many other well-known varieties. A school ground with a great variety of trees will afford great advantages for teacher and pupil. They will afford an opportunity to study the characteristics of all the trees with which children ought to be familiar.

Among the groups of flowers, vines, shrubs, and trees, there should be some fruit bearing varieties for the attraction of birds.

There is nothing that adds more beauty and charm to the scene than cardinals, jays, robins, woodpeckers, and humming birds flitting about among the gorgeous hues of the landscape.

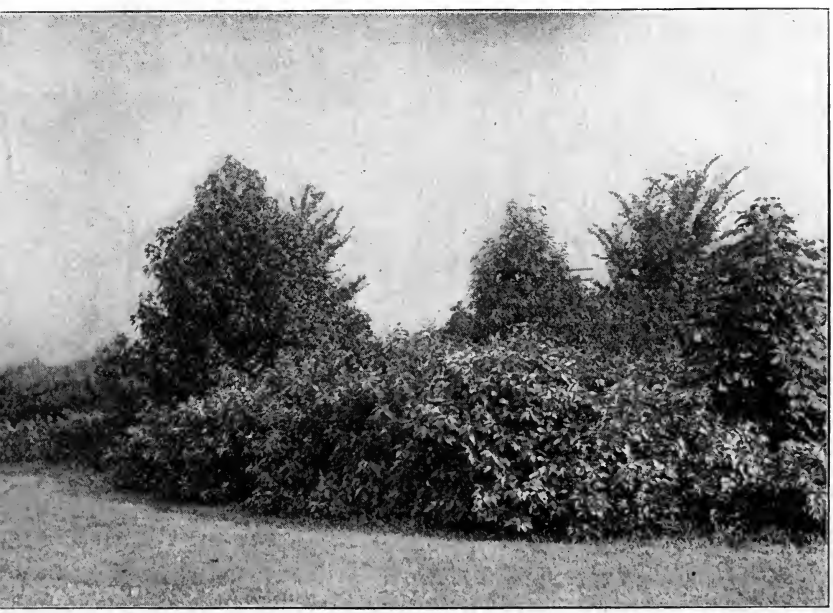


FIG. 3—A home for the birds.

The Nursery.

A plat of ground of a fourth of an acre should be reserved in a suitable locality for the nursery. The trees are to be transplanted and may therefore be planted in the plats in rows. The seedlings should be about one foot apart in the row and the rows about two feet apart, running crosswise of the plat.

By this method of planting there may be at least five thousand trees started. The care of these trees can be given to the children in the first three grades. In three years most of these trees can be removed by the children for transplanting on the home grounds.

The following figure will show the arrangement of seedlings in the plat:

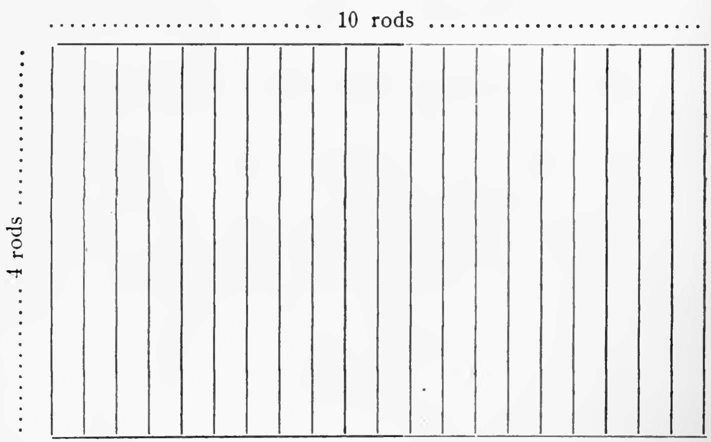


FIG. 4.

This plat may be made four rods wide so that the length of the rows will be 66 feet; and by planting the seedlings 12 inches apart, each row will provide room for 66 trees. If the plat is ten rods long and the rows are placed 2 feet apart, there will be room for 82 rows. The size of the plat may be increased to suit the size of the schools.

Each row of trees should contain fruit trees of the following numbers and kinds:

1. 10 Apple.
2. 10 Cherry.
3. 10 Peach.
4. 10 Plum.
5. 5 Pear.
6. 5 Quince.
7. 2 Mulberry.
8. 2 Crabapple.
9. 2 Sweet Cherry.
10. 10 trees for shade (forest trees).

Of course, this list is only suggestive and only such trees hould be started as are adapted to the region.

The school gardens that have been established, have for the nost part been devoted to the growing of common vegetables and lowering plants.

It is already evident that a school garden that is planned for he only purpose of growing a few annual plants for the im-nediate use of the home will encounter certain difficulties, that vill make the work unsatisfactory, for the following reasons:

1. Most plants of the vegetable type for table use mature or reach the most interesting stage of their career at a time when schools are closed.
2. After the plants have been removed there is nothing left in tangible form for study.
3. The instruction given and the knowledge of plant life will be limited to about the same routine of work and study from year to year.

There is one study however which may be added to the study of the kitchen garden plants that will present an entirely different ispect for a guide to the true lover of nature, and that is the ree for forestry or for fruit.

The advantages afforded by tree study are:

1. Permanency.
2. Different stages of growth covering a long period of years.
3. Seed, germination, seedlings, budded or grafted stalk, the flowering stage, the fruit bearing trees.
4. A different stage for study for each year of the child in school.
5. A contemporaneous development of child and tree life.
6. The trees in the lawns and parks and yards are living monuments and lasting tributes to philanthropy, to science, to the school and to the individual boy or girl.

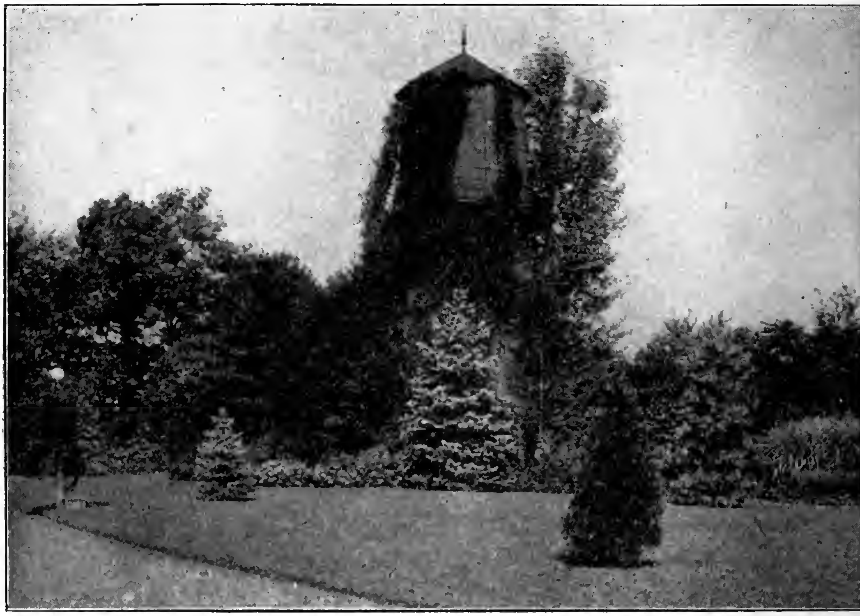


FIG 5 — A good illustration of what can be accomplished in a few years.

Detailed Work.

The details of the work of starting the school nursery must be left largely to the judgment of the teacher.

According to the plans suggested, the nursery will not require any more if as much attention as the vegetable garden.

Beginning the Work.

1. Begin in Autumn.
2. Plow, prepare and fertilize the plat of ground.
3. Collect the seeds of fruit and forest trees and store them through the winter.
4. Co-operate with other schools in exchange of seeds.
5. Most tree seeds mature in the fall.
6. Gather seeds as soon as they are ripe.
7. Some seeds should be picked from the trees; others can be collected after they have fallen.
8. Most tree seeds should be dried a few weeks before storing.

9. Do not allow them to become too dry nor to become moldy.
10. Seeds of mulberry, catalpa, osage orange, and a few others may be kept in sacks hung in a dry, cool place.
11. Seeds with thick hulls like walnuts, hickory nuts, peach seeds, plum seeds, and some others may be buried in the yard or garden or in sand pits during winter.
12. The ground should be well drained. Ordinary freezing will help to open the shells and facilitate germination.
13. Test seeds before planting in the spring. (Class Study.)
14. Keep all kernels that are plump and firm and discard those that are withered or diseased or wormy.
15. Use more seeds in the germination test than are required for the plats.
16. When seeds are sprouted by the different methods, blotters, sand, etc., the pupils may take the seeds and plant them at home in a small plat, and care for them until they are large enough to transplant to the nursery bed.

A few of the trees named in the nursery table may be selected for shading purposes, but the best results will undoubtedly come from the raising of fruit trees. (See table page 429).

Apple, pear, peach, cherry and plum seeds can be easily started at home, and very often young trees may be secured from fruit orchards.

FIG. 6 — School Garden.

When the trees have arrived at the proper age and growth they should be grafted by the pupils. This should be done in connection with a careful study of the text.

Study the childhood of farm trees. Let it be the history of their propagation and development in the nursery from the planting of the seed, through the various operations of building, grafting, sprouting, trimming, and fertilizing until the trees are ready to transplant and begin their new cycle of life amid the surroundings of the orchard.

It must be remembered that this study will also involve the study of the insect enemies and fungus diseases which are incident to forestry and fruit tree life.

The study of trees is to be continued after they are transplanted to the home orchard, lawn or garden. Thus the work commenced in the school and transferred to the home, will bring about more of the spirit of co-operation between home and school. This will aid to develop a love of study of nature. It will help to bring up the child in harmony with nature instead of out of joint with the world.

FIG. 7 — Trucking.

It is not wise to attempt to teach scientific forestry and fruit growing in any of the elementary grades.

In the primary grades tree study with an occasional glimpse of the forest should form the basis of the work.

In the grammar grades there should be a study of trees as correlated with geography and agriculture.

In the high school tree study becomes a part of botany and the high school course in agriculture.

Suggestive outlines will be found in Forest Service Circular 130 "Forestry in the Public Schools," U. S. Dept. of Agriculture.

A course of study for the first three or Primary grades, and a course of study for the three intermediate grades can be found in Farmers' Bulletin No. 488 "Forestry in Nature Study," U. S. Dept. of Agriculture.

The Vegetable Garden.

The following plans are offered as suggestions:

The following figure represents a plat of ground eight feet, ree inches wide, and sixteen feet, six inches long, or half a uare rod.

The first twelve rows of vegetables are twelve inches apart.

Rows 13, 14, 15 are 20 inches apart.

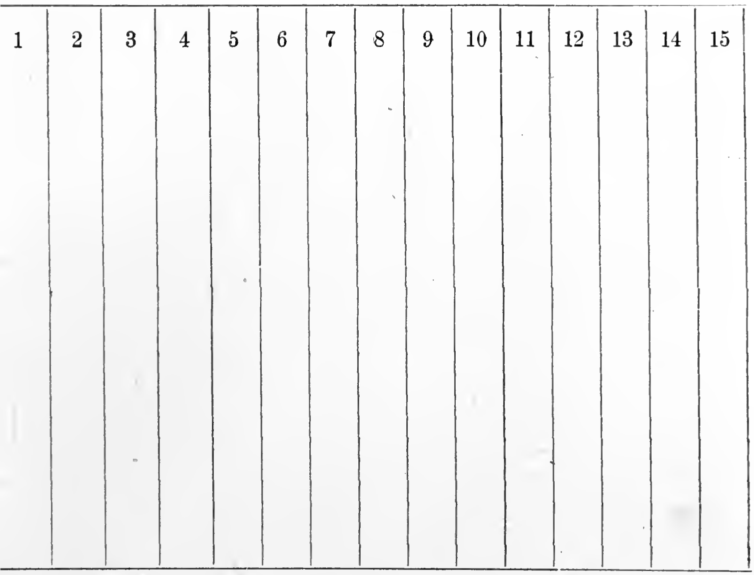


FIG. 8.

The rows in the above plat are planted as follows:

Rows 1 and 2 are planted to radishes 2 inches apart.
Rows 3 and 4 are planted to lettuce 6 inches apart.
Rows 5, 6, 7, 8 are planted to beans 6 inches apart.
Rows 9, 10, 11, 12 are planted to beets 4 inches apart.
Rows 13, 14, 15 are planted to tomatoes 20 inches apart.
Rows 1, 2, 3, 4 may be followed by beans.
Rows 5, 6, 7, 8, 9, 10, 11, 12 may be followed by spinach, turnips, nd winter radishes.

This figure represents a combination vegetable and flower garden.

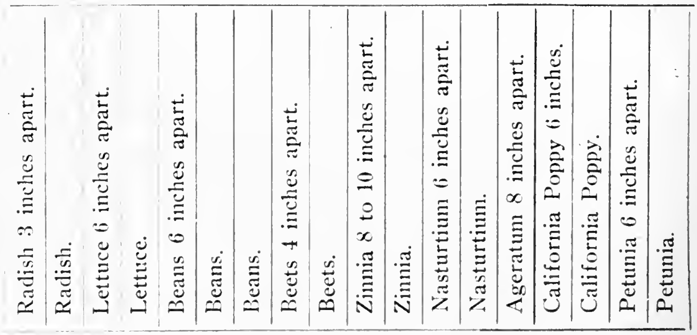


FIG. 9.

The radish and lettuce rows are to be followed by tomatoes.

The beans are to be followed by turnips.

The plants are grouped according to height of growth.

The tall growing plants are in the centre of the garden.

The low growing and decumbent plants are at the ends.

These plats are only suggestive and may be made much larger so as to include a much greater variety of products.

Each pupil should have an individual garden of the above size or larger, even, up to 1x4 rods.

Flower Beds.

The school grounds with shade trees, shrubbery, and a beautiful lawn can be made still more beautiful with the right kind of flowers artistically arranged.

Flower beds may be in the form of crescents, stars, letters and names, or in beds of irregular shapes, but the shapes of these adornments should not be the leading features of the place.

The curved pathway is made especially attractive by being bordered at intervals with clusters of flowers.

In arranging a round or star shaped bed it may be made attractive by having rings of various colors.

HARDY PERENNIAL PLANTS.

The list of perennial flowering plants is so long that it is only possible to give a very limited list in this chapter. But from the vast realm of excellent hardy perennials it is possible to select a list that will be in bloom from early spring till late in the fall. It is possibe to obtain a stock of hardy plants that will continue to beautify the lawn for many years.

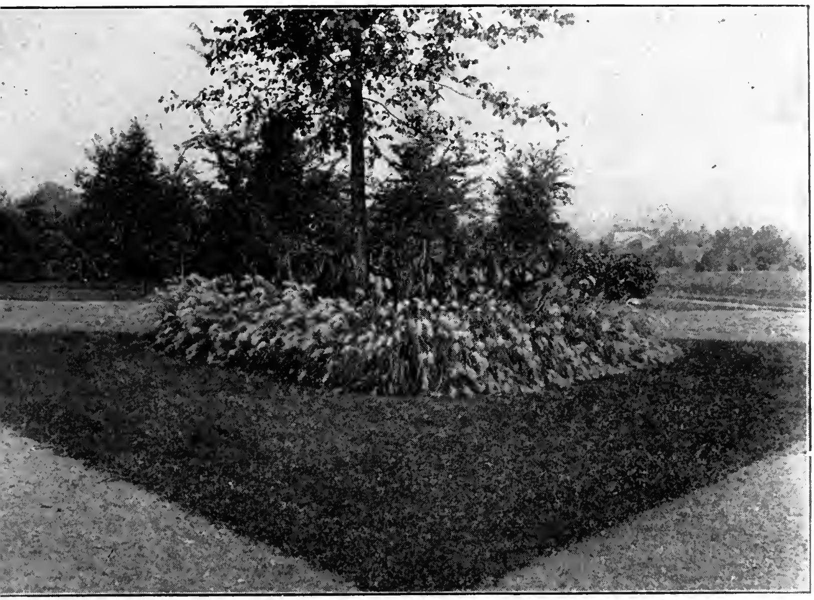


FIG. 10 — Flowers for ornamental beds in front of shrubbery.

Space forbids that anything but general directions be given for the use of the plants named in the list. A few general suggestions are given as follows:

1. The most appropriate place for these flowers is on village lots. country lawns or in public parks.
2. They may be banked along the boundaries of the lawn, at the base of buildings, along garden fences, drives and walks.
3. The beds should not be too wide.

4. They may be grown in front of masses of shrubbery, in nooks, or in front of evergreen or deciduous hedges.
5. Placed in irregular clumps, or beds at the base of a thicket of evergreens for a background, the flowers will produce an ideal effect.
6. Do not plant flowers as a rule in formal plats of ground such as squares, circles and similar geometrical shapes in the center of an open piece of ground.
7. Do not plant large areas of a single kind of plants except in instances where there are large tracts to be devoted to flowers, shrubbery and trees.
8. Let there be an aggregation of many species, that there may be new pictures unfolding from time to time.

FIG. 11 — Flowers along the borders of walks and buildings.

A LIST OF PERENNIALS.

Name.	*Colors.*	*Height.*	*Time of Flowering.*
Hardy Feverfew	White, pink and red	27 in.	May 20 to July 1.
Foxglove	White, pink and red	43 "	June 5 to Aug. 11.
Gas Plant	White and pink	24 "	May 29 to June 18.
Iris	Variegated	30 "	June 11 to July 1.
Hardy Larkspur	Variegated	60 "	June 5 to Aug. 18.
Upright Virgin's Bower	White and purple	18 "	June 9 to June 27.
Young's Evening Primrose	Golden Yellow	30 "	June 11 to July 1.
Baby's Breath		48 "	June 25 to July 22.
Hollyhock	Variegated	8 ft.	June 25 to Aug. 1.
Chinese Bell-flower	Dark blue and white	51 in.	June 27 to Aug. 11.
Butterfly Weed	Orange yellow		
Plume Poppy	White	6 to 8 ft.	

Among the common perennials are the following:

The Peony,
The Columbine,
American Senna,
False Indigo,
Perennial Peas,
Leadwort,
Japan Anemone,
Purple Cone-flower.

USES OF SOME OF THE POPULAR FLOWERS.

Among the most beautiful and popular flowers are the following:

The Ageratum for strengthening the garden's color forces in blue.
The Alyssum for borders, edgings, baskets, pots, etc.
The Aster for tall growing, herbaceous borders, late bloom and careless effect.
The Balsam used at the margin of groups to crown a terrace.
The Pot Marigold for use in mass or in borders.
California Poppy, most effective when grown in beds of considerable size.
Calliopsis for bouquets, the living room, the greenhouse and hotbed.
Campanula for the decoration of a house, or for growing in large quantities.
Candytufts for edging beds in white, for massing or for belts.
The Castor Bean for a central object in a group, for striking effect with cannas, caladiums, doelus, etc.
Chrysanthemums, for gorgeous shows.
The Clarkia for hanging baskets, vases, and edging plants, and low massing, or borders.

Cobea Scandens for rapid growth and climbing.
The Cockscomb for the odd and picturesque decorative feature of the garden.
The Columbine for a border plant.
The Cone flower for a border to a bed of delphiniums.
Corn flowers for planting in the open.
Cosmos for tall broad masses in background bordering against evergreens or fences.
Evening primrose for solid beds, border lines, for pots, and for shrubbery borders.
Forget-me-nots for close border.
Four O'clock used as a screen.
The Foxglove for among shrubbery or along walks and drives.
Gaillardia for mixed borders.
The Hollyhock for growing against evergreen hedges or shrubbery, or as a background for other flowers of lower growth.
Morning Glory for climbing.
The Larkspur for among shrubbery or as a background.
Lobelia for beds, edgings, baskets and pots.
Marigold for beds and shrubbery borders..
Mignonette for every garden.
Nasturtiums for beds.
Nemophila for borders and beds.
Pansy for beds.
Petunia for beds, and borders, and masses and window boxes.
Phlox for masses and ribbon beds of contrasting colors.
Pinks for borders, bouquets, and table decorations.
Poppy for beds and borders with a background of green.
Portulaca Beds, edgings, rockwork, for filling up irregular places in flower beds.
Scarlet Sage for hedge, border, boxes, pots, etc.
The Snapdragon for borders.
Stocks Bedding, edgings, pot culture, house or conservatory use, for cutting for bouquets and for floral work.
Sweet Peas for bouquets and table decoration.

Score Card.

Flowering Plants. Society of American Florists, John Young, Secretary, New York, N. Y.

Vines.

Vines properly grown on the school grounds will also help to make the entourage beautiful and attractive. Walls, arbors, trellises, verandas and porticos covered with vines may be made useful and artistic. A few vines such as the following will serve well for purposes of ornamentation:

FIG. 12 — A beautiful effect in the arrangement of flowers, shrubbery, vines and trees.

Hardy Vines.	*Hardy Vines.*	*Annuals.*
Boston Ivy,	Moonseed,	Scarlet Runner Bean,
Bitter Sweet,	Clematis Jackmanii,	Wild Cucumber,
Honeysuckle,	Clematis Paniculata,	Morning Glory,
Dutchman's Pipe Vine,	Wisteria,	Moon Flower,
Virginia Creeper or American Ivy,	Crimson Rambler,	Sweet Peas,
Cinnamon Vine (Chinese),	Bitter Sweet,	Climbing Nasturtium,
Japanese Ivy,	Trumpet Creeper,	Gourds,
	Common Wild Grapes,	Hop Vine,
	Grapes,	Yam.

Shrubbery.

Shrubs should be arranged in groups.

Shrubs that bloom about the same time should not all be placed together in same part of the group; they should be distributed in different parts among shrubs blooming at different times.

Highest shrubs should be placed near the center of the group.

The lowest or decumbent plants should be in the outer row.

To assist in the arrangement of shrubs according to height and time of flowering, the following list is given:

Name.	*Time of Blooming.*	*Height.*
Althea	August and September.	
California Privet		Any height, 1 to 15 ft.
Lilac	May	5 to 10 feet.
Japanese Tree Lilac	July	Full growth, 30 feet.
Flowering Tree Lilac	Flowers in early spring	2 to 4 feet.
Japanese Quince	Flowers in early spring	5 to 6 feet.
Spirea (Van Houtte)	July	Dwarf shrub.
Viburnum (Snowball)	May and June	10 to 15 feet.
Berberis Thumbergi	Fall	3 to 4 feet.
Rhododendron (Rose Bay)	May and June	5 to 6 feet.
Syringa (Mock orange)	May and June	5 to 7 feet.
Hydrangea Paniculata	July	3 to 4 feet.
Wolfberry	White berries last till winter	Low branching.
Weigelias	July	Dwarf shrub.
Flowering Currant	May	4 to 5 feet.
Japanese Rose, Etc.		

SHRUBS AND THEIR ARRANGEMENT.

The arrangement of shrubs should be made according to effects desired. If the group is to be viewed from all sides the arrangement should be different than if it is to be seen only from one side.

GOOD SCREENING.

The following plan is for a group to be seen from different parts of a large lawn:

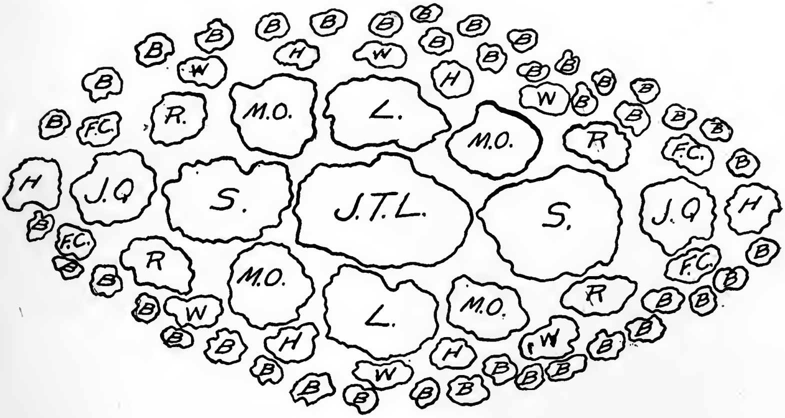


FIG. 13 — Detail of Shrubbery Group.

J. T. L.—Japan Tree Lilac.
S.—Snowball.
L.—Lilac.
M. O.—Mock Orange.
R.—Rhododendron.
J. Q.—Japan Quince.
H.—Hydrangea.
F. C.—Flowering Currant.
W.—Weigelas.
B.—Barberry.

Shrubbery with a background of large trees may begin with low branching or dwarf shrubs in the foreground and be increased in size to the higher shrubs; for instance in the following order: berberis, currant, quince, lilac, viburnum, Cornelian cherry, Japanese lilac, Fir, evergreen.

This arrangement will present an ideal scene in winter as well as in summer. If the landscape is extensive, in front of this scene there may be a large bed of flowers of striking type to give the effect of gorgeous sheets of color in the distance.

The Hotbed.

It will probably be of considerable advantage to every school having a school garden to have a number of hotbeds.

These will enable the school to get an early start in growing certain plants. This is of especial importance to those schools that close early for the summer vacation.

FIG. 14 — A windbrake laden with frost and snow.

With the gardener it is an important matter of business and for that reason it is practical instruction that ought to be within the reach of all.

A permanent hotbed may be made so that it may be heated either by radiating pipes from the heating plant or by fermenting manure. A hotbed may be made as shown in the following figure.

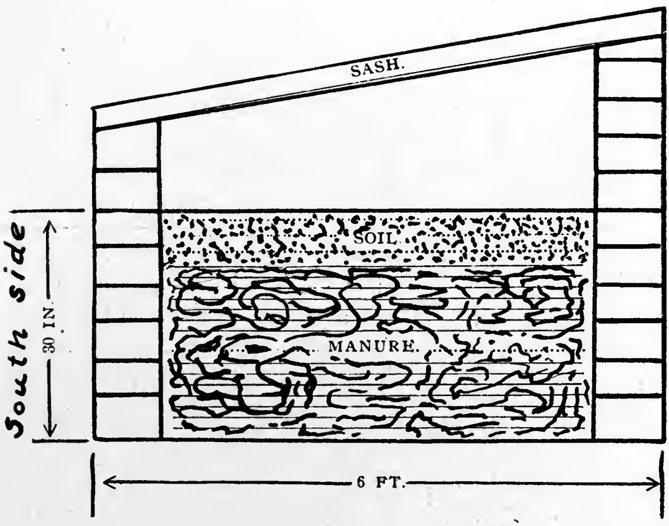


FIG. 15 — Cross section of a permanent hotbed or pit.

A pit should be dug from 2 to 2½ feet in depth, according to the climate. The pit should have plank, brick or cement walls on all sides. Standard hotbed sash are 3 by 6 feet. The pit should therefore be built in the proper proportion so that the frames may be used.

The pit should be filled with manure to within 4/5 of the depth and then covered with about 6 inches of soil.

The following table is given by the U. S. Department of Agriculture:

NURSERY PLANTING TABLE FOR FOREST TREES.

No.	Species.	When to collect seeds.	How to store seeds.	Per cent which should germinate.	When to plant seeds.	Depth to plant seeds.	Spacing of seeds in rows.	Height of 1-year old seedlings.	Forest Service publication for reference.
						Inches.		*Inches.*	
1	Ash, Green	October	Bury in sand	35–50	Spring	½	Scatter thickly	6–9	Circular 92.
2	Ash, White	do	do	35–50	do	½	do	6–10	Circular 84.
3	Basswood	September or October	Sow at once	5–60	Fall	½	do	6–12	Circular 63.
4	Beech	Fall	Bury in sand	70–80	Early Spring	¾	2 inches apart	3–6	
5	Butternut *a*	September or October	do	75–80	do	1	3 to 6 inches apart	10–18	
6	Boxelder	do	do	46–60	Spring	½	Touching in rows	10–14	Circular 86.
7	Catalpa, Hardy	October or November	Cool, dry place	40–75	do	1	½ inch apart	14–30	Circular 82.
8	Cherry, Black	August or September	Bury in sand	75–80	do	1	2 to 3 inches apart	4–6	Circular 94.
9	Coffeetree, Kentucky	September or October	Cool, dry place, or bury in sand	70–75	do	1	do	3–6	Circular 91.
10	Cottonwood *b*	June or July	Sow at once	75–95	Summer	½	1 inch apart	20–30	Circular 77.
11	Elm, Slippery	May or June	do	50–75	Late Spring	⅛	Scatter thickly	15–18	Circular 85.
12	Elm, White	do	do	50–75	do	⅛	do	5–10	Circular 66.
13	Hackberry	October	Bury in sand	70–80	Spring	½	1 to 2 inches apart	6–12	Circular 75.
14	Hickory, Pignut *a*	September or October	do	50–75	do	1–2	3 to 6 inches apart	2–6	Silvical leaflet 48.
15	Hickory, Shagbark *a*	do	do	50–75	do	1–2	do	2–6	Circular 62.
16	Hickory, Shellbark *a*	do	do	50–75	do	1–2	do	2–6	Silvical leaflet 50.
17	Locust, Black	October	Cool, dry place, or bury in sand	50–75	do	1	2 to 3 inches apart	18–20	Circular 64.
18	Locust, Honey	do	do	50–75	Fall or spring	½	do	6–14	Circular 74.
19	Maple, Red	May or June	Sow at once	25–60	Late spring	1	½ inch apart	6–10	
20	Maple, Silver	do	do	25–50	do	1	do	12–20	Circular 76.
21	Maple, Sugar	October	Sow at once or bury in sand	30–50	Fall or spring	1	do	6–12	Circular 95.
22	Mulberry, Russian	July or August	Cool, dry place	75–95	Spring	½	Scatter thickly	8–10	Circular 85.

NURSERY TABLE FOR PLANTING TREES—Concluded.

No.	Species.	When to collect seeds.	How to store seeds.	Per cent which should germinate.	When to plant seeds.	Depth to plant seeds.	Spacing of seeds in rows.	Height of 1-year old seedlings.	Forest Service publication for reference.
						Inches.		*Inches.*	
23	Oak, Bur *a*	September or October	Sow at once or bury in sand	75–95	Fall or spring	1½	3 to 6 inches apart	5–9	Circular 56.
24	Oak, Red *a*	do	do	75–95	do	1½	do	6–20	Circular 58.
25	Oak, White *a*	do	do	75–95	do	1½	do	5–9	Circular 106.
26	Osage Orange	do	Cool, dry place	60–95	Spring	½	1 inch apart	10–15	Circular 90.
27	Poplar, Yellow	do	Sow at once	5–10	Fall	¼	Scatter thickly	4–6	Circular 93.
28	Walnut, Black *a*	do	Bury in sand	75–80	Spring	1½	3 to 6 inches apart	10–18	Circular 88.

a Difficult to transplant on account of tap root. Advisable to sow seeds in permanent sites in field whenever possible.
b Easily grown from cuttings. Not necessary or advisable to attempt growing from seed.

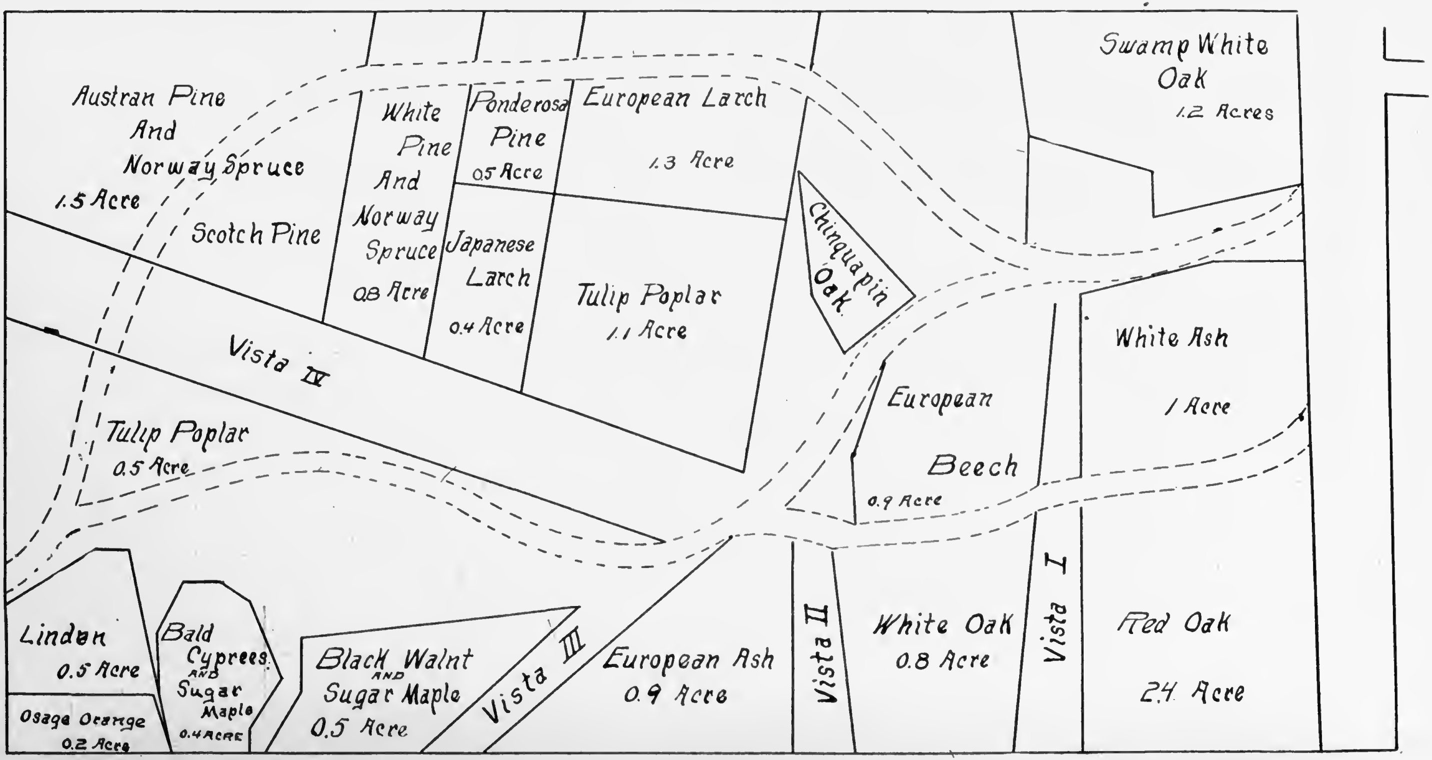


FIG. 16 — Plans for reforestation of grounds for The Lima, O., State Hospital. — Ohio Experiment Station.

In many states there are state foresters or forestry commissions, who may be able to advise and aid the schools. You may be able to secure seedlings from your state experiment station. Some of the stations are offering such help to schools. You can also make application direct to the Forest Service of the U. S. Dept. of Ag., Washington, D. C. They will put schools desiring to exchange supplies of tree seeds into communication with each other.

Planning and Adorning the Farmstead.

The Farmstead is the general area occupied by the farm buildings, the yards, lawns and walks; the entrances and driveways; the trees, vines and flowers, and shrubs.

As the farmstead is the center of activity on the farm and the place where the farmer must spend the best part of his life, the consideration of this subject ought to be full of interest and concern.

Home-making should be carried into effect systematically in conformity to some well-defined plan, looking not only to the present but also to future needs and comforts. This is an important agricultural problem, because:

1. It will help in the appearance and value of the farm.
2. It will add to the comfort and happiness of the occupants.
3. It will facilitate changes and improvements.
4. It will help to keep people on the farms.

In making plans for new buildings, there is no general plan suited to all localities; in readjusting arrangements where there has been want of definite plans; and in the location and grouping of buildings, each farm presents its own peculiar conditions and difficulties.

There are a few general rules that apply to certain conditions. Some of these rules are given here to assist the young farmer, in selecting a site and making plans:

1. Select a site with the best possible drainage.
2. Give the house the greatest prominence.
3. A dwelling on a south or east slope is better than on a north slope.

4. The house should be built to front the public highway.
5. All other buildings should be back of the house.
6. There should be a lawn of good stretch in front of dwelling.
7. Buildings should not be separated by a public highway.

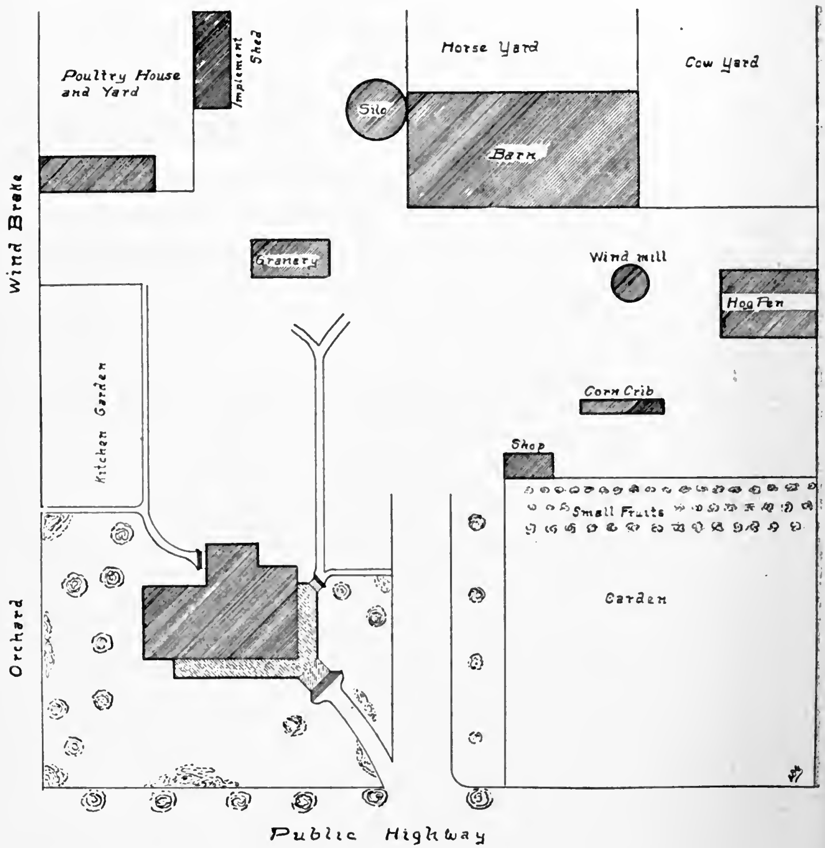


FIG. 17 — An ideal plan for the farmstead.

Figure 11 represents a farmstead 20 rods square. The distance from the dwelling to the barn is 200 feet. The distance from the dwelling to the pig pen is 250 feet. This figure shows a plan for the north side of the public highway.

In planning the farmstead it is of the greatest importance to consider the factors of economy and convenience. The important points are:

1. To save time in traveling to and from chores.
2. To save time in convenient arrangement for handling stock and feed.
3. The corn crib should be near the place to feed the corn.
4. The silo should be near the place to feed the cattle.
5. The watering place should be near the stables, or centrally located.
6. A stable should have a convenient yard for stock.

The buildings and their arrangement on a farm will depend upon the particular kind of farming to be pursued.

If it is to be general farming it will require some if not all of the following:

1. A farmhouse.
2. A barn.
3. A henhouse.
4. A hog pen.
5. A corn crib.
6. A silo.
7. A milk house.
8. A tool shed.
9. A granary.
10. A wood or coal shed.
11. A smoke house.
12. Stables for stock.
13. Tanks and windmill.
14. A shop.
15. Garage.
16. A colony house for bees.
17. Farm scale.
18. Ice house.

Any special industry of the farm such as dairying, trucking, fruit growing, poultry raising, etc., will of course demand an arrangement of buildings suited to the special line of work done.

The landscape should be so planned as to show the orderly arrangement of the buildings.

The order of arrangement should be to have all buildings within view of the dwelling and public highway and all front sides to the front and all back sides to the rear.

Locate buildings so as to avoid unpleasant odors being carried by the usual direction of the winds blowing toward the house in your locality.

Stables and manure should be at least 200 feet away from dwellings.

Every state should have a law permitting the registration of farm names. A farm named and registered should have legal protection.

No farmer should permit his buildings to be painted for advertising purposes except his own. Patent medicine, tobacco, and similar signs on buildings are in bad taste and cheapening in effect.

A bulletin board may serve a useful purpose. Some name such as the following adds dignity and gives reputation to the farm:

Cloverdale Farm. Rocky Ridge Farm. Oak Shade Farm. Fair View Farm. Evergreen Farm. Elm Grove Farm. River Side Farm. Lake View Farm. Glendale Farm. Woodland Farm. Maple Grove Stock Farm. Scioto Valley Dairy Farm. Glen Hill Poultry Farm.

FIG. 18 — Arborvitaes, Japan Cypress and Irish Juniper grouped against deciduous shrubs and trees.

To encourage interest in this work, prizes may be offered for the best plans in adorning parks, school yards and other public grounds.

If this work is taken up by the schools its effects on homes of the future and the country in general will be wonderful and far-reaching in its results.

There are hundreds of deserted homesteads, that, if property adorned would become inviting places for people to live.

The Ornamental, Practical and Useful Adornment of the Farm.

There is nothing that adds so much to the beauty of the landscape as the proper arrangement and variety of trees and other plants about the farmstead. This will depend to a very great extent upon the following points:

1. The number and location of the trees.
2. The kinds and sizes of trees at maturity.
3. Trees in clumps or groups as in nature's plan.
4. Tall trees at rear of house.
5. A well kept stretch of open lawn.
6. Trees in curved rather than in straight lines.
7. Shrubs about the borders and in front of back yard.
8. Shrubs at base and corners of porches and walls.
9. Tallest shrubs at the back with lower kinds in front.
10. Flowers for ornamental beds in front of shrubbery.
11. Flowers along the borders of walks and buildings.
12. Flowers in beds of star, oval or crescent shapes.
13. Vines that climb the walls or porches.
14. Vines on arbors or trellis work.
15. Vines on trees and walls.

Trees to Pant for Shade.

Deciduous.	*Deciduous.*	*Evergreen.*
White Elm,	Wild Cherry,	White Pine,
Hard Maple,	Chestnut,	Norway Spruce,
Soft Maple,	Poplar,	The best tree for a windbrake is Austrian pine.
Catalpa,	Golden Willow,	
Buckeye,		
Black Walnut,		

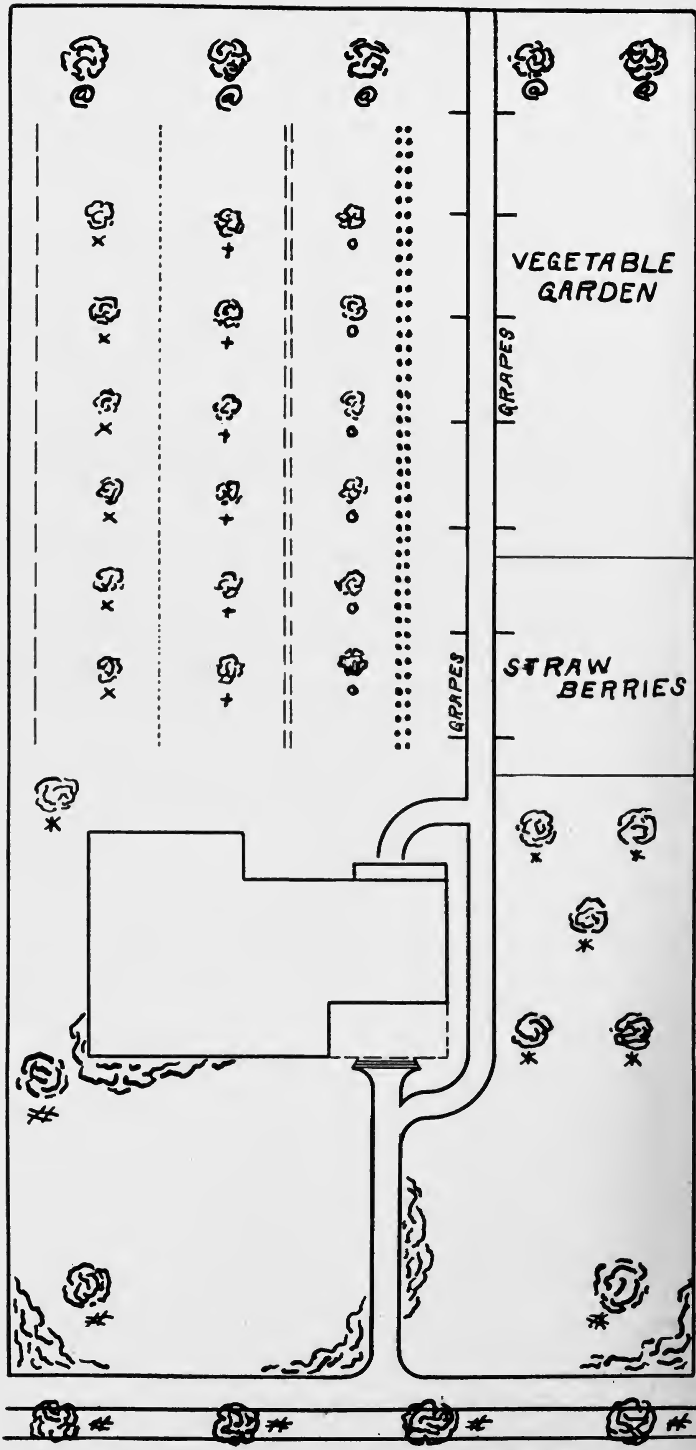


FIG. 19 — An ideal plan for a suburban place.

In the diagram the signs used signify the following:

: : : : : Currants.
= = = = = Gooseberries.
.. .. Raspberries.
— — — — — Blackberries.
° Dwarf Pears.
+ Plums.
× Peaches.
* Cherries.
@ Apples.
— Grapes. Good natural screening.
Maple trees.

The grapes are arranged on each side of the gravel, brick, or cement walk for the purpose of constructing a grape arbor over the walk. Varieties, 10 Concord, 10 Brighton, 10 Niagara.

One row of currants, 60 feet long will furnish space for 20 bushes planted 3 feet apart. If a variety is desired, plant 5 Victoria, 5 White Grape, 5 Cherry and 5 Black Champion.

One row of gooseberries, bushes 3 feet apart in a row 60 feet long will require 20 bushes. A good variety would be 5 Downing, 5 Industry, 5 Columbus, and 5 Red Jacket.

One row of raspberries of 20 bushes 3 feet apart may consist of the following varieties: 5 Gregg, 5 Marlboro, 5 King, 5 Golden Queen.

One row of blackberries, 20 bushes, of a good variety, may consist of 5 Taylor's Prolific, 5 Agawam, 5 Early King, and 5 Rathburn.

One row of six dwarf pears, 2 Bartlett, 2 Duchess, 2 Kieffer.

One row of six plums, 2 Wilder, 2 Lombard, and 2 Burbank.

One row of six peach, 2 Early Crawford, 2 Elberta, 2 Late Crawford.

Eight cherry trees, 3 Early Richmond, 3 Montmorency, 2 Allen.

Five apple trees, as follows: 1 Red Astrachan, 1 Golden Sweet, 1 Baldwin, 1 Grimes Golden, 1 Rhode Island Greening.

Four Maple for shade in front of premises on the terrace.

Supplementary Reading Books.

Classic Stories for Little Ones — McMurray.
Nature Myths — Cooke.
Books of Nature Myths — Holbrook.
Classic Myths — Judd.
The Sandman and His Farm Stories — Hopkins.
Buds, Stems and Roots — Chase.
Kindergarten Stories and Morning Talks — Wiltse.
In the Child's World — Poulsson.
Nature's Byways — Ford.
Trees in Poetry and Prose — Stone and Fickett.
Ten Common Trees — Stokes.
Nature in Verse — Lovejoy.
Days and Deeds — Stevenson.
In God's Out of Doors — Quayle.
Little Flower Folk — Pratt.
Plants and Their Children — Dana.
Stories of Country Life — Bradish.
The Lovers of the Woods — Boardman.
Arbor Day — Schauffler.
A Little Book of Profitable Tales — Field.
The Land We Live In — Price.

REFERENCE BOOKS FOR NATURE STUDY TEACHERS.

Handbook of Nature Study for Teachers and Parents — Comstock.
Practical Nature Study — Coulter and Patterson.
Nature Study for Primary Grades — Cummings.
Nature Study for Lower Grammar Grades — Cummings.
Nature Study — Holtz.
Nature Study and Life — Hodge.
Real Things in Nature — Holden.
Nature Study for Grammar Grades — Jackman.
Special Method in Elementary Science — McMurray.
Nature Study — Overton and Hill.
Nature Study and the Child — Scott.

SUPPLEMENTARY READING.

Write to the United States Department of Agriculture for the following bulletins:

Circular 19. Publications of the Department of Agriculture classified for the use of teachers.

Circular 18. Publications of the Bureau of Plant Industry.

Farmers' Bulletin,	No.	218.	The School Garden.
"	"	"	154.	The Home Fruit Garden.
"	"	"	134.	Tree Planting on Rural School Grounds.
"	"	"	408.	School Exercises in Plant Production.
"	"	"	423.	Forest Nurseries for Schools.
"	"	"	157.	The Propagation of Plants.
"	"	"	468.	Forestry in Nature Study.
"	"	"	428.	Testing Farm Seeds in the Home and in the Rural School.
"	"	"	460.	Frames as a Factor in Truck Growing.
"	"	"	185.	Beautifying the Home Grounds.
"	"	"	195.	Annual Flowering Plants.
"	"	"	248.	The Lawn.
"	"	"	255.	The Home Vegetable Garden.
"	"	"	242.	An Example of Model Farming.

The following Bulletins should be secured from the Ohio Agricultural Experiment Station, Wooster, Ohio.

No. 214. Handbook of Diseases of Cultivated Plants.
No. 190. Evergreens; Their Uses and Culture.
No. 240. The Rejuvenation of Orchards.
No. 189. Forestry Suggestions.
No. 175. The Wood Manual.

Fruit Culture.

PERIODICALS.

The Western Fruit Grower (Monthly Magazine) per year, $1.00.

Vegetable Culture.

BOOKS.

A B C of Potato Culture, Terry	$0 45
Asparagus Culture, Hexamer	50
Cabbage, Cauliflower and Allied Vegetables, Allen	50
Celery Culture, Beattie	1 50
Gardening for Profit, Henderson	1 50
Garden Making, Bailey	75
How to Make the Garden Pay, Greiner	1 00
Mushrooms, How to Grow, Falconer	1 00
Melon Culture, Troop	50
New Onion Culture, Greiner	50
New Rhubarb Culture, Morse and Fiske	50
Principles of Vegetable Gardening, Bailey	1 50
Tomato Culture, Tracy	50
Vegetable Gardening, Watts.	1 75
Success in Market Gardening, Rawson	1 10
Sweet Potato Culture, Fitz.	50
Insects Injurious to Vegetables, Chittenden	1 50
Vegetable Gardening, Watts.	1 75

PERIODICALS.

The Market Growers' Weekly Journal, Louisville, Ky., per year............. 1 00

The Vegetable Grower, Chicago, Ill., per year......... 1 00

The Garden Magazine, Garden City, N. Y., per year.. 1 50

Ohio Experiment Station Publications.

Cucumbers, Diseases of, Nos. 89, 105.
Melons, Diseases of, No. 105.
Onions, Smut of, Nos. 122, 131.
Peas, Blighting of, No. 173.
Potatoes, Cultural Notes on, Nos. 65, 76, 133, 174, 218.
Potato, Rosette disease of, Nos. 139, 145.
Tomato, Diseases of, Nos. 89, 105.
Cabbage, Two Diseases in Ohio of, No. 228.
Potatoes, Fusarium Blight and Dry Rot of, No. 229.

Farmers' Bulleins, U. S. Department of Agriculture.

Asparagus, No. 61.
Beans, No. 289.
Cabbage, No. 433.
Celery, No. 282.
Mushroom, Culture of, No. 204.
Onion Culture, No. 354.
Sweet Potatoes, No. 324.
Tomatoes, No. 220.
Cucumbers, No. 254.

Greenhouse Management and Floriculture.

Commercial Violet Culture, Galloway $1 50
Practical Horticulture, Henderson 1 50
Forcing Book, The, Bailey... 1 25
Greenhouse Construction, Taft 1 50
Greenhouse Management, Taft 1 50
Carnation, The American Ward 3 50
Chrysanthemum, The, Herrington 50
Rose, The, Ellwanger....... 1 25

Horticultural Information.

PERIODICALS.

The Florists Exchange, New York City, per year....... $1 00
The Florists Review, Chicago, Ill., per year........ 1 00
The American Florist, Chicago, Ill., per year........ 1 00

Ohio Experiment Station Publications.

Tomato Culture in Greenhouse, No. 153.
Soil Treatment for Forcing Houses, Circular No. 57.
Manure as a Summer Mulch in Forcing House, Circular No. 69.

Landscape Gardening.

BOOKS.

Hedges, Windbreaks, Shelters, etc. $0 50
Landscape Gardening, Parsons 3 50
Landscape Gardening, Waugh 50
Lawns and How to Make Them, Barron............ 1 17
What England Can Teach Us About Gadening, Miller 4 32

PERIODICALS.

Country Life in America, New York City, per year. $4 00
Park and Cemetery, Chicago, Ill., per year........ $1 00

Wood Structure and Woodworking.

Boulger: Wood.
Foster: Elementary Woodworking.
Hough: American Woods (containing thin sections of various species of woods.)
Snow: Principal Species of Wood.

State and Government Institutions from which Horticultural Information may be obtained:

The State University—The College of Agriculture maintains a Department of Horticulture. Four-year, two-year and special short course of instruction are provided. A monthly bulletin of general information and instruction is issued.

The State Ag. Dept. — Information regarding fertilizers sold in state, orchard inspection and general statistics can be obtained. An official Monthly Bulletin is issued.

The State Library — Horticultural books are loaned to granges, clubs and under some circumstances to individuals.

Department of Agriculture, Washington, D. C. — In the Bureau of Plant Industry are employed many experts in various horticultural lines. For bulletins and information address expert in charge of following or other investigations.

Crop Acclimatization.
Horticultural Investigations.
Diseases of Fruits.
Pomological Investigations.
Foreign Seed and Plant Introduction.

Farmers' Bulletins — These are issued by the Division of Publications and new ones containing Horticultural information are issued occasionally. The Bureau of Statistics furnishes crop reports, etc. The Office of Experiment Stations publishes a monthly record of Experiment Station work but does not control the distribution of bulletins of the various state institutions.

State Experiment Stations — Every state and territory in the Union maintains one or more Experiment Stations. Most of these will send their bulletins without charge to requests from residents of other states. Address, Experiment Station, naming state and postoffice.

SHRUBBERY MASSES.

CHAPTER XXVI.

How to Improve the Rural School.

"The hills are dearest which our childish feet
Have climbed the earliest, and the streams most sweet
Are ever those at which our young lips drank,
Stoop'd to their waters o'er the grassy bank."

The purpose of this chapter is to give some helpful suggestions to teachers and pupils who desire to take part in promoting the rural life movement in America.

The principal requisites are a clearer vision of our duties, a keener appreciation of responsibilities, a better knowledge of potential forces, and an accelerated activity in the application of all these for the betterment of the rural school and home.

This important task will consist principally in bringing about some of the following ends:

1. Making the school more attractive and interesting.
2. Equipping the school for more efficient work.
3. Bringing school and home into closer relationship.
4. Becoming a leader in social community life.
5. Inspiring broader views of life and higher ideals of citizenship by bringing about a better social community spirit.

How Can This Be Done?

There is no place in the world where there is more room and greater opportunity for improvement than in the community where there has been indifference and apathy in education for a long period of years.

The spirit of the community can often be judged by the condition of its environments.

Contrary to expectations, the wealth of a community does not always serve as an index to the improvement of roads, schools and other public institutions.

Some of the richest agricultural regions have the poorest roads and schools, while relatively poor regions have some of the best of public improvements.

It may also be said with equal truthfulness that the rate of taxation is not always a sure sign of the conditions relating to improvement, for the problem of economy, and judicious management are great and determining factors in progress and success.

It is not always the most expensive system that brings the greatest results.

It is the aim in the following suggestions to encourage that which will bring the speediest relief and greatest benefits without the burden of greatly increased cost.

During every month of the school year there should be some day set apart for observing some great interests affecting the local community.

There should be a day selected from some such list as the following:

1. Corn Field Day. (See program following.)
2. Alfalfa Day.
3. Poultry Day.
4. Good Roads Day.
5. Stock Judging Day.
6. Agriculture Day. (Exhibits.)
7. Field Day. (Athletic contests.)
8. Local History Day.
9. Arbor and Apple Day.
10. Bird Day.
11. Flag Day.
12. Rural School Day. (See program following.)
13. Birthday. (Some great American.)
14. Domestic Science Day.
15. Manual Training Day.
16. Parents' Day.
17. Public Health Day.
18. Garden and Flower Day.
19. School Improvement Day.
20. Holiday Day Exercises.
21. Country Improvement Day.
22. "Safety First" Day.
23. Reunion Day.
24. Rally Day.

Evening Entertainments.

1. Debating and Literary Society.
2. Spelling Contest.
3. A Lecture Course.
4. Musicals.
5. Moving Pictures and Lantern Slides.
6. Night Schools.
7. Box Socials.
8. Hallowe'en Exercises.
9. Gymnastic Exercises and Drills.
10. Writing School.
11. Parents' Meeting.
12. Social Gatherings.

The school may take advantage of some of the foregoing entertainments to raise funds for buying pictures, books, laboratory apparatus and other equipments needed by the school.

Moving pictures, lantern slides, geological and zoological collections may be made to serve a useful purpose in scientific instruction, and the victrola or phonograph will help to cultivate an appreciation for the best music and oratory from the great masters.

Corn-Field Day Exercises.

SUGGESTIVE PROGRAM (OHIO).

1. Song—"America," by all present.
2. Address by teacher in charge.
3. The 1914 Buckeye Corn Special Tour—By a boy or girl who was on the trip.
4. The Official Corn Song—Bogardus (Tune—Marching Through Georgia).
5. The Corn Plant (A Botanical Description)—By a pupil.
6. The Selection and Testing of Seed Corn—By a Pupil.
7. Planting, Cultivation and Care of Corn—By a Pupil.
8. Song—By the School.
9. Recitation—"The Corn Song"—Whittier.
10. Rotation, Fertilizers and Manures in Corn Production—By a Pupil.
11. The Importance of the Corn Crop in the United States—By a Pupil.
12. Song—By the School.
13. History of Corn; Its Improvement and Various Uses—By a Pupil.
14. Address by a School Official or Patron.
15. Song—The Star Spangled Banner.

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*Program carried out by over 1,000 schools in Ohio under supervision of author of this book December 19, 1914.

"Corn Is King in Ohio."

(To be sung to the tune of "Marching Thru Georgia")

BY C. H. BOGARDUS.

Prize Song 1913 Washington

Corn Boys' Trip.

1.

Don't you hear the chorus of a happy Buckeye host?
Lads of opportunity who make of life the most,
Listen to the message —and 'tis not an idle boast—
For Corn is King in Ohio!

CHORUS:

Hurrah! Hurrah! For the fields of golden hue!
Hurrah! Hurrah! For what a boy can do!
We've a favored commonwealth, and feel it thru and thru—
For Corn is King in Ohio!

2.

Millions praise her statesmanship and Presidential fame;
Others point to history and laud Ohio's name
But we sing her greatness in a new and proud refrain—
For Corn is King in Ohio!

3.

Here's to old Ohio, soil of untold wealth possessed;
'Tis the land of promise by the rain and sun caressed;
Here you'll find Old Mother Earth is always at her best—
For Corn is King in Ohio!

4.

Honor we the founders of the contest for the boys;
'Tis the sort of help-along the farmer lad enjoys;
Is it any wonder then, we're making lots of noise?
For Corn is King in Ohio!

Suggestive Program for Rural School Day.

AFTERNOON PROGRAM.

Singing of America by the School.

Four papers by children on the following subjects:

1. "Why we go to School."
2. "What we can do for the School."
3. "What can we do to improve the Schoolhouse and Grounds?"
4. "What I will do after I pass the 'Examination'."

Music.

5. "History of the schools of State," to be read.

Patriotic selections to be recited by the children.

6. What can we do to make our school better?
7. What more can our community do for the school than it is doing at present?
8. What public meetings might be held in this schoolhouse for the good of our community?
9. What benefits would visits from our parents bestow upon the school?
10. School gardens,—of what value might they be to this school?
11. Why not have a Literary Society or Debating Club?
12. Is our water supply safe and wholesome?
13. Why do we not have the publications from the State Experiment Station, since they can be had for nothing?
14. Our Schools and our Roads.
15. Talks by Parents and Visitors.

Music.

16. Remarks by the Teacher.
17. Announcement of Evening Meeting.

Music.

Dismissal.

A Corn Growing Contest.

A very valuable contest may be started which may be entered by school boys as well as older persons to test the seed corn of a whole school district or community, to determine who is producing the most valuable corn among those entering the contest.

A field or part of a field is selected in which fertility, drainage, type of soil is as nearly uniform as possible. Each contestant selects from his own seed corn. The seed bed has been prepared so that all parts have received uniform treatment. Each competitor plants 2 or 4 rows of corn; the rules may require that corn be planted with a checkrower or that the corn be drilled with the same number of kernels per hill or row, each row to receive the same amount and kind of cultivation.

An interesting record may be kept showing the following results in each plot:

1. The number of kernels that failed to germinate.
2. The number of barren stalks.
3. The number of smutted stalks.
4. The number of suckered stalks.
5. The number of two-eared stalks.
6. Average number of stalks per hill.
7. Date of maturity.
8. Date of roasting ears.
9. Dented or glazed.
10. Date of ripening.
11. Height of ears.
12. Average height of corn. (Measure 10 average plants and take the average.)
13. Find the number of leaves on 10 plants each taken from different hills.
14. What is the yield per plot.
15. What would be the yield per acre.
16. Number of bushels of ears.
17. Bushels of shelled corn.
18. Moisture content of corn.
19. Vitality of seed.
20. Difference between the highest and lowest yield.
21. The average yield per plot.
22. Plot having highest yield.
23. Plot yielding best quality.

An almost unlimited number of observations may be made. These contests and observations will lead to closer scrutiny and recognition of good and bad qualities in products that are grown.

Thus boys may meet and learn to study insect pests, fungi, plant diseases, and learn how to make improvements in growing plants.

A co-operative experiment shows the value of organized effort. It develops the social instinct. It removes much of the monotony of life in isolated districts. Have photographs made of your corn and other agricultural exhibits

Study the following important factors affecting the corn crop:

1. Elements usually deficient in our soils.
2. The natural and artificial means by which nitrogen, phosphorus and potassium are supplied for plant growth.
3. Effects of clover, alfalfa, soy-beans and other legumes in preparing available nitrogen for corn growth.
4. Effect of lime on acid soils.

   Success will depend upon:

   The resources of the teacher;
   The use of illustrative material;
   Results from a commercial as well as the aesthetic point of view.

Do not depend upon the text-book to keep up the interest in Agriculture.

Make a collection of the six different types of corn.

Begin with the study of securing a good specimen of a corn plant.

Have the pupils make a drawing of a complete plant.

Examine and study the different parts: stalk, nodes, internodes, leaves, husks, tassel, silk, ear, kernel, cob, etc

Name all parts from roots to tassel.

Examine roots and study effects of deep and shallow cultivation at different stages of growth.

Select seed from standing corn.

Study characteristics of the hill; the stalk; the ear; the field; the soil. If there are different types of soil in the same field, you should know from what part of the field each ear is selected.

Have the pupils select one bushel of hand-picked seed ears.

These can be used in a seed selection contest, and for an exhibit.

In awarding prizes in a seed selecting contest, the following basis of award can be used:

Basis of Award—Ear Corn:

(1) Trueness to breed type	25
(2) Vitality, maturity, and market condition	25
(3) Appearance of corn, such as uniformity of butts and tips, color, size, etc., applied to one ear, ten ears, or entire bushel	25
(4) Shelling percentage, shape, size, color, and quantity of individual grains. Apply this test to one ear, or entire bushel	25
Total score	100

In selecting seed corn or in preparing an exhibit, there are a few very important principles that should be kept in mind; trueness to type; uniformity of kernel; rows should be as nearly straight as possible; size, shape and length of ears as nearly equal as possible; tips and butts well filled; free from mixture; no grains missing; color uniform.

Study the score card.

Determine the proportion between weight of grains and weight of cob.

The weight of the grain should be from 85 to 90% of the weight of the ear.

The selected seed ears should be kept in a dry, cool place where the temperature is above the freezing point.

Corn dryers can be made from pieces of timber as follows:

A piece of timber one or two inches square at ends; of a convenient length for fifty ears; arranging a row of ears on each of the four sides.

Use finishing nails or bore holes and use wooden pegs—placing them at a slant of 45 degrees. Impale the ear on the nails or wooden pegs.

Number each ear, placing number up on surface of dryer just above the peg holding the ear. Suspend this dryer by a wire fastened to rafters or ceiling of room where corn is to be kept; in this way it may be kept out of reach of rats and mice.

Construct a seed tester for use next Spring.

Select six grains from different parts of each ear.

Determine the value of each ear for seed and discard all poor ears.

NOTE.—The champion ear of corn, which won the $1,000 trophy at the National Corn Show held in Columbus in 1910, was ten inches long, seven and one-half inches in circumference, had twenty rows of kernels, six to the inch in a row, five-eighths of an inch deep, five-sixteenths of an inch in width; it was a yellow dent.

Urge the boys to enter the Corn Growing Contest each year.

Begin the work now.

Assist them to select the seed.

If they do not enter the State Contest, have them get permission to plant at least one acre in one of the corn fields on the home farm—that they may make a demonstration of the value of scientific selection of seed, soil preparation and cultivation.

A Corn Judging Contest.

This contest may consist in selecting the best single-ear or the best ten-ear sample, the best bushel, the most perfect hill or the best single stalk.

One of the most popular contests at the rural school exhibits consists in judging the best ear or ears of corn. This contest may be conducted as follows: Place a variety of from 25 to 50 ears of the same type or of different types on a table. Each ear is designated by a different number. The contest may be to select the best five or the best ten ears of corn. The teacher may select one or more competent judges to take charge of the contest. They must be provided with a list of the names entered for the contest. Each contestant may be allowed to judge the corn separately, or if there is a large number competing, two or more may be allowed to judge at the same time. The number of the ear selected is recorded opposite the name of the person selecting it. Provisions should be made for at least first, second and third prizes.

The basis of award may be determined by the judges.

It is very important in connection with this work of seed selection in a corn-judging contest that only those breeds and varieties should be used that are known to have the characteristics suited to the local conditions. Therefore it may be profitable to have some corn-breed and variety naming contests, that the students may become familiar with some of our standard breeds.

Each pupil entering a corn growing contest or who wishes to make a special study of corn should study the following bulletins, which can be secured from the U. S. Department of Agriculture, Washington, D. C

Bulletins.

409 School Lessons on Corn.
415 Seed Corn.
414 Corn Cultivation.
257 Soil Fertility.
192 Barnyard Manures.
28 Weeds; and How to Kill Them.

Books.

298 Food Value of Corn and Corn Products.
The Study of Corn by V. M. Shoesmith.
Manual of Corn Judging by A. D. Shamel.
A B C of Corn Culture by Holden.

In all this work for corn improvement we should not lose sight of the importance of other points besides the greatest yield.

In the proper order the basis of award should be as follows:

Greatest yield per acre.

Best exhibit of ears.

Best Story of crop production.

Best showing of profit on investment.

Stir up an interest in Agriculture in your school district by having a contest, and if possible award premiums. You have an opportunity to be one of the first to organize an Agricultural Club. It will help to make you a leader in your community.

The ingenious teacher will find an almost unlimited field of operation in which contests may be devised, that will develop skill, accuracy, and lead to practical and scientific results.

Suggestions for District, Village and Township School Exhibits.

RULES.

1. Governing entries.
2. Time limit for entries.
3. Record cards.
4. Ribbons and premiums.

CLASS A.

WHAT TO EXHIBIT.

(*Corn.*)

5. Acre yield of corn.
6. Best 10 ears white corn.
7. Best 10 ears yellow corn.
8. Best 10 ears sweet corn.
9. Best 10 ears popcorn.
10. Best single ear of corn.
11. Largest ear of corn.
12. Longest ear of corn.

(Other crops.)

13. Best 5 potatoes.
14. Best 5 onions.
15. Best 5 sugar beets.
16. Best 5 turnips.
17. Best head of cabbage.
18. Largest squash.
19. Largest pumpkin.
20. Largest melon.

(Add any other product suitable to locality.)

CLASS B.

21. Best plate of fruit.
22. Best plate of fall apples.
23. Best plate of winter apples.
24. Best plate of peaches.
25. Best plate of grapes.

(Offer premiums on any leading fruit product of the locality.)

CLASS C.

(Canned goods in quarts.)

26. Peaches.
27. Pears.
28. Cherries.
29. Berries.
30. Jellies.
31. Preserves.
32. Any other canned fruits.

CLASS D.

33. Best loaf white bread.
34. Best pie.
35. Best cake.
36. Best plate cookies, buns or rolls. (6)
37. Best roll of butter.

CLASS E.

38. Best stand cover.
39. Best quilt block.
40. Best pillow top.
41. Best pin cushion.
42. Best dressed doll.
43. Best colored apron (plain).
44. Best handkerchief (plain or fancy).

(Add any other work desired in domestic science.)

CLASS F.

45. Best herbarium.
46. Best Agricultural drawings.
47. Best Agricultural apparatus.
48. Best corn tester.
49. Best device for drying seed corn.
50. Best seed chart.
51. Best collection of woods and leaves, etc.
52. Best collection of insects.
53. Best set of 10 arithmetic problems stated and solved.
54. Best drawing of corn—with analysis of constituent parts; showing grain, cross section and longitudinal section.
55. Best bird story.
56. Best colored picture of bird.
57. Best picture of farm animal (to be selected).
58. Best written story (How I made my crop (name).
59. Best exhibit of parent ear and 5 offspring. Parent ear to have not less than 25% of grains left on cob.

Apple Pie.

(Indiana Apple Show, 1912.)

	Points.
Flavor	25
Crust	25
Thoroughness of baking	25
Appearance	25
Total	100

NOTE.—Entries to be grouped in three classes: professional, housewife, and amateur.

Horseshoeing.

(Iowa State Fair, 1914.)

	Points.
Making shoes	35
Fitting	30
Driving	15
General Finish	10
Time	10
Total	100

Plowing.

(Pilot Rock, Iowa, Plowing Match, 1913.)

	Points.
Back furrow	25
Conformation of furrows	25
Straightness	25
Neatness	10
Covering trash	15
Total	100

Bread.

(N. Y. State College of Agriculture, Department of Home Economics.)

	Points.
Flavor, taste, odor	40
Texture of crumb	35
Texture of crust	10
Form of loaf	5
Written report	10
Total	100

RULES.—Loaves must be baked in pan about 9 x 5 in. top measurement. Materials must be: white flour, granulated sugar, firm, white lard, yeast, salt, water. Bread must be baked the day before it is sent in for exhibition. Written report must tell (*a*) brand of flour and kind of yeast used, (*b*) exact manner of making, (*c*) care after baking, (*d*) number and value of hours consumed, total cost of loaf, approximate number of loaves that could be made in the time taken in making one.

Work Dress.

(N. Y. State College of Agriculture, Department of Home Economics.)

	Points.
Choice of design: Simplicity, attractiveness, ease of making and laundering, fitness for purpose	60
Neatness in making	20
Choice of fabric	10
Choice of color	10
Total	100

Adorning the School Room.

"The artist with his paint and brush will get a little piece of canvas, and he will put upon that canvas the experience of his life, the wealth of lofty aspirations, and the recollection of his mother's smile and lo, it may be worth a fortune."

We must do more than see a picture; we must know it by name. We must know it by personal and intimate knowledge. We must study and read about it, or we can not get an honest, conscientious appreciation of it.

In studying a picture we should know:

1. The picture itself.
2. The artist's source of inspiration.
3. The time of its production.
4. The life of the painter.

We should study the impression the picture makes upon us.

1. What is this picture to me?
2. How does it effect me?
3. Does it give me pleasure?
4. What kind of pleasure do I derive from it?
5. Does it inspire me?
6. Have I formed an honest opinion of my own?

FIG. 1 — An Agricultural Exhibit.

This briefly is the source of our power to measure art, and to appreciate to some extent the works of the great masters of the art of paint and brush.

Pictures on the Walls.

One of the most popular living art critics has said with remarkable cogency and point, that a picture must be lived with, in order that its secret beauties may become apparent to the eye.

It is therefore of the highest importance that the pictures with which we furnish our homes and our school rooms and public buildings generally, should be pictures of genuine artistic merit. They should be selected from the masterpieces of the art of painting.

With a view to assisting those who may wish to make selections of good pictures the following list is given as an index to the gallery of the world's great art treasuries:

From Famous Paintings.

FOR 1ST, 2ND AND 3D GRADES.

The First Step..............Millet
The Age of Innocence....Reynolds
Feeding Birds...............Millet
Mother and Child.........LeBrun
The Cat Family.............Adan
Madonna of the Chair.....Raphael
The Drinking Trough.......Dupre
The Shepherdess...........Lerolle
Feeding the Hens.............Millet
Baby Stuart.............VanDyke
An Angel...................Bellini
The Melon Eaters..........Murillo
Shepherd and His Flock...Bonheur
Hiawatha ....Norris

FOR 4TH, 5TH AND 6TH GRADES.

Feeding Her Birds...........Millet
The Balloon..................Dupre
The Meeting...........Bashkirtseff
Queen Louise..............Richter
Jeanne D'Arc...............Lepage
The Shepherd's Chief Mourner ....Landseer
Prince Balthaser.........Velasquez
The Arrival of the Shepherds ....Lerolle
The Holy Family..........Murillo
Holy Night..............Correggio
September ....Zuber
A Helping Hand...........Renouf
Pied Piper of Hamelin....Kaulbach
The Return to the Farm....Troyon

FOR THE 7TH AND 8TH GRADES.

Reading Homer.....Alma-Tadema
Christ and the Doctors....Hofmann
Aurora ....Reni
The Mill....................Ruisdael
Mona Liza................DaVinci
June Clouds..................Hunt
Dance of the Nymphs.......Corot
The Chimes..............Blashfield
Industry ....Veronese
The Haymaker...............Adan
Pilgrim Exiles...........Boughton

The Return of the Mayflower
......................Boughton
Water Carrier...............Millet
Spring ....Corot
The Sower..................Millet
Ploughing ....Bonheur
The Gleaners................Breton
The Horse Fair...........Bonheur
At the Watering Trough
................Dagnan-Bouveret
The End of Labor..........Breton
The Angelus................Millet

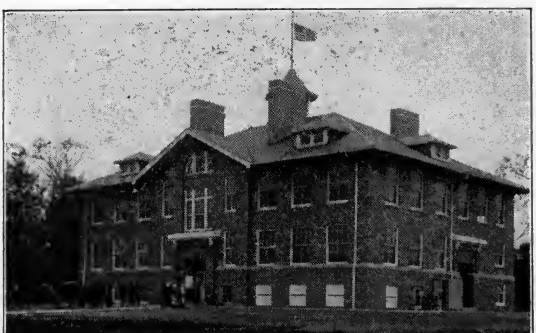
The Torrent ....Ruisdael
The Storm ....Cot
The Waterfall ....Ruisdael
Autumn Gold ....Inness
The Madonna of the Louvre................................Botticelli
The Last Supper...Da Vinci

Agricultural Subjects.

The following subjects may be used for composition work in Agriculture in the grades and in the high school:

1. Rainfall and Its Effect Upon the Farmer.
2. Agricultural Seeds.
3. Farmers' Institutes.
4. Flowers.
5. Fences.
6. Cattle.
7. Hogs.
8. Sheep.
9. Horses.
10. Good Roads.
11. Daily Markets.
12. Drainage.
15. Implements.
14. Concrete.
15. Plows.
16. Cream Separators.
17. Fruits.
18. Nurseries.
19. Hotbeds.
20. Poultry.
21. Kinds of Wood and Their Uses.
22. Farming Implements.
23. Fertilizers.
24. Crop Rotation.
25. Cotton Culture.
26. Alfalfa Culture.
27. Tobacco Culture.
28. Sweet Potato Culture.
29. Rice Culture.
30. Grape Culture.
31. Strawberry Culture.
32. Bee Culture.
33. Silkworm Culture.
34. Onion Culture.
35. Sugarbeet Culture.
36. Experiment Station.

37. County Experiment Farm.
38. Marketing Farm Produce.
39. Good Feed.
40. Bread and Principles of Bread Baking.
41. Testing Seed-Corn.
42. Meat Inspection.
43. Arbor Day.
44. Contests for School Children.
45. Country School.
46. Lawn and Lawn Making.
47. Rural Mail Delivery.
48. Agricultural Clubs for Schools.
49. Feeding Live Stock for Market.
50. Building Up Worn-Out Land.
51. Spraying Fruit Trees.
52. The Automobile.
53. Farm Wagons.
54. Wells and Cisterns.
55. Irrigation.
56. Sewing in the Public School.
57. Birds.
58. Insects.
59. Country Life.
60. Silos.
61. Canning.
62. Farmers' Organizations.
63. Centralized Schools.
64. Electricity on the Farm.
65. Model Farmer.
66. Truck Farming.
67. Modern Conveniences on the Farm.
68. Beautifying the Home.
69. Good Drainage.
70. The Future Farmer.
71. The Future Rural School.
72. Farm Credits.
73. Co-operative Societies.
74. U. S. Dept. of Agriculture.
75. The State College of Agriculture.
76. Agriculture in the Rural Schools.
77. Agriculture in the High Schools.
78. Agricultural Education.



A Recent Type of Rural School Building

Questions for Debate.

1. Resolved that Agriculture affords a broader field for the development of the intellectual powers than any other study.
2. Resolved that the farmer should not patronize the mail order house.
3. Resolved that our county should maintain a county experiment farm.
4. Resolved that the most important part of agriculture is farm management.
5. Resolved that the public schools are not keeping pace with the demands of the times.
6. Resolved that there should be a four year course in agriculture in every first grade rural high school.
7. Resolved that the schools in our township should be centralized.
8. Resolved that this state is the best agricultural state in the Union.
9. Resolved that the country is more interesting and beautiful than the city.
10. Resolved that agriculture affords greater opportunities to the average man than any other occupation.
11. Resolved that an agricultural education is a better investment than a course in law.
12. Resolved that it is possible for the farmer to enjoy the best of modern conveniences.
13. Resolved that the majority of failures on the farm are due to lack of scientific farming.
14. Resolved that landlordism and land tenantry are a menace to the progress and prosperity of the nation.

Discuss: How a school can be made the social center of the community; reviving the spirit of the old spelling school; the debating society; the literary club; make the school the home of the domestic science contest; the agricultural exhibit; the lecture course; the public forum; a place for paintings, sculpture, music, books, flowers, and happy children.

Selections Which May Be Used in Connection With the Subjects Mentioned.

Birds:

To a Waterfowl — Bryant.
The Winged Worshippers — Charles Sprague.
The Bobolink.
To a Skylark — Shelley.

The Sandpiper — Celia Thaxter.
The Skylark — James Hogg.
The Wounded Curlew — Celia Thaxter.
The Birds of Killingworth — Longfellow.
The Singing Lesson — Jean Ingelow.
Robin Redbreast — William Arlingham.
The Winter-king — Selected.

Flowers:

Daffodils — Wordsworth.
Bluebell — Selected.
The Flower — Tennyson.

Trees:

A forest Hymn — Bryant.
The Planting of the Apple Tree — Longfellow.
Woodman Spare that Tree — Morris.
Woods in Winter — Longfellow.
How the Leaves Came Down — Susan Coolidge.

Nature:

The Brook — Tennyson.
Break, Break, Break — Tennyson.
The Wanderer — Eugene Field.
The Ocean — Byron.
The Chambered Nautilus — Holmes.
Thanatopsis — Bryant.
The Stranger on the Sill — Thomas Buchanan Read.
The Cloud — Shelley.
Darkness — Byron.

The Seasons:

The Death of the Flowers — Bryant.
September — Helen Hunt Jackson.
October's Bright Blue Weather — Helen Hunt Jackson.
The First Snowfall — Lowell. The Corn Song — Whittier.
Freaks of the Frost — Hannah Gould.
Snow Bound — Whittier.
It Snows — Sarah Hale.
Midwinter — Trowbridge.
The Dying Year — Prentice.
The Snowstorm — James Thomson.
A Summer Longing — George Arnold.
Spring Again — Celia Thaxter.
March — Wordsworth.
April Day — Caroline Southey.
The Rainy Day — Longfellow.

Work — Eliza Cook.
Sowing and Reaping — Adelaide Proctor.
The Song of the Sower — Bryant.
The Summer Shower — Thomas Buchanan Read.

The Rural Life.

The Country Life — Stoddard.
The Old Oaken Bucket — Woodworth.
The Barefoot Boy — Whittier.
A True Sportsman — Foss.
That Calf — Alice Cary.
The Humblebee — Emerson.
Thoughts for the Discouraged Farmer — James Whitcomb Riley.
Evangeline — Longfellow.
The Deserted Village — Goldsmith.
Strawberries — Trowbridge.
The Fountain — Lowell.
Living on a Farm — Selected.
The Voice of the Grass — Sarah Roberts.
Good Night — Anonymous.

In Nature Study:

Read from Shakespeare.
Queen Mab's Carriage. Romeo and Juliet I., 4.
A Colony of Bees. Henry V, I., 2.
Read Eve's description of Eden, in Boox IX. Milton's Paradise Lost.

Questions.

1. Why has there been a loss of interest in the one-room rural school?

2. Why is a consolidated rural school better than a one-room school?

3. If the average number of recitations in the one-room rural is about 30 per day, what is the average length of time per recitation?

4. Is there as much interest in a class of one or two pupils as there is in a class of ten or fifteen? Why?

5. What are the chief causes for the fact that 93 per cent of the school children in the United States never enter the high school?

6. At about what age does the average pupil leave the school?

7. What effect has manual training, domestic science, and agriculture had on school attendance where they are included in the course of instruction?

8. Why should the school grounds and buildings and class rooms be among the most attractive objects in the village or rural community?

9. What are the chief causes of unequal educational opportunities in the U. S.?

10. Does the rural school need courses in manual training and domestic science as well as a course in agriculture?

11. What advantages has the rural over the city or village school in offering courses in domestic science, manual training and agriculture? What are some disadvantages?

How to Get Information.

1. Study your home state agricultural experiment station reports.
2. Read the agricultural press.
3. Write to or visit successful corn growers.
4. Correspond with your state corn growers' association.
5. Write for books and bulletins on corn.
6. Make some tests on your own farm.

Exercises.

Fall Contest—Seed-corn selection, plowing, making collections and naming seeds, mounting insects, making seed racks and dryers.

Winter Contest—Naming soil types, woods, barks, lumber, grains; making drawings of farms, barns, dwellings; rope-tying, hitching, horse-mounting, stock-judging, solving Agricultural problems.

Spring Contest—Making testers for seeds; testing germination; naming birds, buds, blossoms, flowers, leaves.

Students should be encouraged to hunt for beautiful quotations from the best authors that are applicable to the subject under consideration.

Schools should have courses in manual training; domestic science; there should be baking contests, sewing contests; instruction in household economy; learn to construct handy household articles; ironing boards, broom holders, shelves, cases, boxes, and other useful articles.

And above all things else, let the boy have his pocket knife for,

> "In the education of the lad,
> No little part that implement hath had,
> His pocket knife to the young whittler brings
> A growing knowledge of material things.
>
> Projectiles, music, and the sculptor's art,
> His chestnut whistle and his shingle dart,
> His elder pop-gun with its hickory rod,
> Its sharp explosion and rebounding wad,

His corn-stalk fiddle, and the deeper tone
That murmurs from his pumpkin-stalk trombone,
Conspire to teach the boy. To these succeed
His bow, his arrow of a feathered reed,
His windmill, raised the passing breeze to win,
His water wheel that turns upon a pin,—
Or if his father lives upon the shore,
You'll see his ship, 'beam ends upon the floor,'
Full rigged, with raking masts and timbers staunch
And waiting near the washtub for a launch."

Help the boy to construct these contrivances. Let him observe and do things. Read poems and prose selections that show great powers of observation, such as "The Barefoot Boy", and "The Brook."

Outdoor Exercises.

This study should begin with a study of community life. The child should know the people of his community, and how they live; how the community supports itself, and its relation to the neighboring communities; how churches, schools, roads, telephones, telegraphs, mail routes and many other modern conveniences come to be here; pupils should be taken on trips to visit shops, mines, and factories where they can have an opportunity to see different classes of the leading trades of the country; let them see the working of levers, pulleys, derricks, cranes and steam shovels; examples of water power, steam, electricity and gas. Let them see the traffic of the city and the different occupations represented; transportation, commerce and manufacturing; methods of transportation on lakes, rivers and canals; on railroads and public highways.

Study the subject of soils; how they were formed; the lay of the land and how it is drained; what the farms produce and why; road building methods; tools and materials used in construction; costs and benefits to be derived. Teach the important facts pertaining to the community.

Let the children go on excursions from the city to the country; let them come in touch with rural life; let them see some model farms with their well-kept and well-arranged buildings; the barns filled with grain, feed and well-kept stock.

These trips may be used to furnish material for composition and language work.

Make an agricultural survey of the school district, township and county.

Arrange statistics of your county as follows:

In Miami county, as throughout the southwestern quarter of Ohio, corn occupies a larger area than is given to the small grains combined, the areas in the cereal crops and in meadows and clover for 1909, being as follows:

Corn	60,912	acres
Oats	33,959	"
Wheat	25,376	"
Meadows	16,792	"
Clover	8,539	"

It appears that a 5-year rotation of corn, corn, oats, wheat, clover would approximate the average practice of the county.

The average yields of corn and wheat for the past 60 years are given below by 10-year periods:

MIAMI CONUTY: AVERAGE YIELD IN BUSHELS PER ACRE.

	1850–59	1860–69	1870–79	1880–89	1890–99	1900–99
Corn	33.1	34.3	38.8	40.4	37.4	43.7
Wheat	15.3	14.2	15.1	16.3	16.6	15.6

A BOOSTER.

A booster is a man who does all the good he can, in all the ways he can, to all the people he can and leaves the rest to God.

—*Hugh Chalmers.*

A KNOCKER.

A knocker is a man who does all the harm he can, in all the ways he can, to all the people he can and leaves the rest to Satan.

The Farmer's 100 Commandments.

Health, success and happiness can be found in the application of the following principles to farm life:

1. Have good buildings.
2. Have plenty of room.
3. Have convenient arrangements.
4. Keep pure bred animals.
5. Have plenty of feed.
6. Feed balanced rations.
7. Feed on time.
8. Clean the stables.
9. Kill the germs.
10. Have lightning rods.
11. Have insurance.
12. Have useful implements.
13. Oil the machinery.
14. Tighten the bolts.
15. House the tools.
16. Build good fences.
17. Pick up wires.
18. Hang the gates.
19. Close the doors.
20. Drain the soil.
21. Put in humus.
22. Plow early.
23. Prepare the seed bed.
24. Test the seed.
25. Plant carefully.
26. Cultivate scientifically.
27. Kill the weeds.
28. Beautify the yards.
29. Plant some flowers.
30. Plant some trees.
31. Raise your fruit.
32. Trim the trees.
33. Let us spray.
34. Thin the fruit.
35. Have a garden.
36. Use insecticides.
37. Visit the Experiment Station.
38. Go to the fair.
39. Attend the institute.
40. Join the Grange.
41. Educate your children.
42. Study agriculture.
43. Test your cows.
44. Sort your eggs.
45. Save your manure.
46. Rotate your crops.
47. Raise clover.
48. Feed your crops.
49. Sell your stock.
50. Insure your life.
51. Swat the fly.
52. Have sanitation.
53. Have waterworks.
54. Take a bath.
55. Have a shave.
56. Trim your hair.
57. Have good clothes.
58. Dress in style.
59. Keep warm.
60. Have some ice.
61. Keep cool.
62. Have a phone.
63. Read the dailies.
64. Read the markets.
65. Have a library.
66. Keep posted.
67. Go to elections.
68. Get better schools.
69. Get better roads.
70. Get better vehicles.
71. Get better markets.
72. Get better prices.
73. Don't be stingy.
74. Don't be narrow.
75. Don't be selfish.
76. Get in debt.
77. Get out of debt.
78. Think and work.
79. Take a vacation.
80. Take a trip.
81. Take a rest.

82. Visit the neighbors.
83. Care for the sick.
84. Let children play.
85. Make others happy.
86. Enjoy yourself.
87. Have some music.
88. Sing a little.
89. Whistle some.
90. Observe holidays.
91. Rest on Sunday.
92. Go to church.
93. Be happy.
94. Let it rain.
95. Keep sweet.
96. Keep young.
97. Live 100 years.
98. Decorate the cemetery.
99. Have a decent funeral.
100. Go to Heaven.

Apparatus for a One-Room Rural School.

	List Price.	*List Price.*
1 Standard Soil Tester		$10 00
1 Babcock Milk and Cream Tester. Cut gears with 4 cream bottles, pipette, acid measure and test bottle brush, with complete directions for use		5 50
1 Pruning Shears, 9 inches long. Hand forged, polished tool steel blade, lock nut, volute spring, malleable iron handle	$0 45	
1 Pruning Saw, flat steel back, narrow tapered point, best steel blade, 18½ inches long	1 25	
1 Tree Pruner, with pole 10 ft. long	1 35	
1 Pruning Knife. Finest quality blade	55	
1 Budding Knife. Same quality as above	25	
1 Grafting Chisel. Curved blade 3½ inches long. Chisel point ½-in. wide. Total length 10 inches	1 10	
1 Mallet, round, hardwood; 3-in. face	22	
1 Trip Scale. Capacity 2,000 grams with graduated beam, with range of 10 grams in 1/10 gram divisions	6 65	
1 Set of (5) Dry Measures, 1 qt. to ½ bu	1 50	
1 Set Weights for Trip Scale; 1,000 grams to 5 grams	1 20	
1 Microscope	44 up.	
1 Chemical Thermometer, Jena glass, double scale; -10 to 110° Centigrade; 17° to 220° Fahrenheit	80	
12 Test Tubes, 6 x ¾ inches	30	
6 Wide Mouth Bottles, flint glass, 8 oz	30	
1 Test Tube Rack, for 6 tubes	25	
1 Riker Mount, 4 x 5 inches	15	
1 Riker Mount for insects, 2½ x 3 inches	12	
1 Riker Mount, 5 x 6 inches	19	
1 Seed Corn Grader, double screen, to take out both the small grains and the large, irregular shaped grains	1 25	

The following are some of the firms dealing in agricultural apparatus and school supplies:

The Standard Soil Tester Co.—Milwaukee, Wis.
The Central Scientific Co.—Chicago, Ill.
C. H. Stoelting Co.—Chicago, Ill.
L. E. Knott Apparatus Co.—Boston, Mass.
Chicago Apparatus Co.—Chicago, Ill.
The Ohio Valley School Supply Co.—Cincinnati, O.
W. M. Welch Mfg. Co.—Chicago, Ill.
Beaver Bros.—58 Douglas Bldgs., Columbus, O.
The Columbia School Supply Co.—Indianapolis, Ind.
The Kauffman-Lattimer Co.—Columbus, O.
Dobson-Evans Co.—Columbus, O.
The Educational Supply Co.—Painesville, O.

References.

ILLUSTRATIVE MATERIAL.

Much of the following material may be secured free or at small cost by writing to:

1. Products of corn. Products of Corn Refining Co., New York City.
2. Products of silk. Cheney Bros., South Manchester, Conn.
3. Products of mines. German Kali Works, New York City.
4. Products of wheat. Washburn-Crosby Co., Minneapolis, Minn.
5. Products of wheat. Northwestern Milling Co., Minneapolis, Minn.
6. Products of cottonseed. The American Cotton Oil Co., Cincinnati, Ohio.
7. Fertilizers. Any fertilizer company.
8. Cocoa and Chocolate Products. Walter Baker & Co., Dorchester, Mass.
9. Sugar Refining Co., Brooklyn, N. Y.
10. Pictures. International Harvester Co., Chicago, Ill., Harvester Bldg.
11. Pictures. Singer Sewing Machine Co., Cincinnati, Ohio.
12. Seeds. Congressman from your district.
13. A Seed Catalogue.
14. Trees for Public School Grounds. Your Experiment Station.
15. Oil Products. Standard Oil Co., New York.
16. Audubon Leaflets. National Audubon Society, 141 Broadway, New York City.
17. Food Products. Any manufacturer.

Send to the United States Department of Agriculture, Washington, D. C., for the following:

The Crop Reporter.
Food Products Maps (Price $1.00).
Weather Charts.
Alfalfa Cultures.
Dr. Wiley's Methods of Analysis.

18. Exchange with other schools in different parts of the country and secure varieties of tree seeds, soils, rocks, fossils, plants, insects, and various farm products.
19. Ask your Congressman and U. S. Senator to help you secure free publications and other material, prepared by the government for educational purposes.

LIBRARY FOR MANUEL TRAINING ROOM.

Manual Training for Common Schools — Allen and Cotton.
Educational Wood Working—Park.
Agricultural Engineering—Davidson.
Farm Structures—Ekblaw.
The Farmstead—Roberts.
Grammar of Wood-work—Degerton.
Elemetns of Woodwork—King.
Elements of Construction—King.
Constructive Carpentry—King.
Inside Finishing—King.
Handbook for Teachers—King.
Metal Work—Leland.

CHAPTER XXVII.

Stone and Cement Construction.

SILO AND ROAD BUILDING.

Concrete is a manufactured stone formed by mixing crushed stone, stone siftings, sand or gravel with cement and water.

It is used for the following purposes:

1. Foundations for buildings.
2. Cellar walls.
3. Floors, walks, roads.
4. Pillars, posts and steps.
5. Walls for basement, barns and cow barns.
6. Watering troughs and tanks.
7. Abutments for drain tile outlets.
8. Patching stone walls.
9. Cistern walls and tops, well walls and tops.
10. Stopping holes in floors (wood).
11. Anchor posts and fence posts.
12. Tile, rollers for yards, lawns and gardens.
13. Flower pots and chimney tops.
14. Pillars for porches.
15. Filling decayed spots in trees.
16. Construction of dwellings.
17. Bridges, sewers, culverts.
18. Silos.
19. Gutters.
20. Porch floors.

Important Points About Concrete.

1. The largest part of concrete is gravel or stone.
2. For a substantial first class job the crushed stone, sand or gravel must be clean and free from dirt or vegetable matter.
3. For heavy foundations, large sized pebbles and stones may be used.
4. For reinforced concrete work only stones should be used that will pass through a 1 inch ring.
5. Sizes should be graded from the smallest, one-fourth inch in diameter to the largest not over $1\frac{1}{2}$ inch in diameter.
6. Waters should be free from strong acids and alkalis.

7. Sand constitutes about one-third to one-half of the material in making concrete.
8. Sand is the small grains that will pass through a one-fourth inch mesh.
9. Gravel and pebbles remain upon a quarter inch mesh.
10. A 40-mesh screen is a screen with 40 holes to the lineal inch.
11. Sand that will pass through a 40-mesh screen is generally unfit for concrete work.
12. In using a screen it should be placed upright at an angle of 45 degrees.

Proportions for Mixing.

Four proportions have been arbitrarily made by some authorities and are given here as a guide to the selection of materials for different classes of work. The following are given as such proportions:

1. Rich — 1:1:3 for columns, and structural parts for carrying heavy weights.
2. Standard — 1:2:4 for floors, beams, tanks, sewers and for columns requiring reinforcing.
3. Medium — 1:2½:5 for walls, piers, sidewalks.
4. Lean — 1:3:6 for heavy masses.

One part of cement, two parts of sand and four parts of gravel are known as a 1 : 2 : 4 mixture. Concrete materials are mixed in this stated proportion when used in small amounts, but in large structures it becomes necessary to determine approximately the amount of each different kind of material used in a cubic foot of concrete.

TABLE I.

QUANTITIES OF MATERIALS AND AMOUNT OF CONCRETE FORMED BY MIXING WITH A TWO-BAG BATCH OF CEMENT.

Proportion of Mixture.	Bags of Cement.	Sand.	Gravel. or Stone	Water (medium wet.)	Total Mixture of Concrete.
1:2:4	2 cu. ft.	3¾ cu. ft.	7½ cu. ft.	10 gal.	8½ cu. ft.
1:2½:5	2 cu. ft.	4¾ cu. ft.	9½ cu. ft.	12½ gal.	10 cu. ft.

PROBLEMS.

1. If 2 bags of cement, $3\frac{3}{4}$ cu. ft. of sand and $7\frac{1}{2}$ cu. ft. of stone are required to build $8\frac{1}{2}$ cu. ft. of concrete, how many cu. ft. of sand will be required to build a concrete wall 40 ft. long, 2 ft. thick, and 8 ft. high?

2. Eighty bags of cement were used in building a wall of $1:2\frac{1}{2}:5$ concrete mixture; how many cu. ft. of sand and stone each were required for the job?

NOTE — Read Table I carefully.

TABLE II.

QUANTITY OF MATERIALS IN I CU. FT. OF CONCRETE.

Mixture.	Cement by Barrels.	Sand by Cu. Yd.	Stone or Gravel by Cu. Yds.
1:2:4	0.058	0.0163	0.0326
$1:2\frac{1}{2}:5$	.048	.0176	.0352

PROBLEMS.

1. How many barrels of cement, and cubic yards each of sand and stone or gravel will be required to build a silo, of which 750 cu. ft. are to be 1:2:4 concrete, and 185 cu. ft. are to be $1:2\frac{1}{2}:5$ concrete?

2. If 1 cu. ft. of 1:1 mixture of sand and cement, will paint 15 sq. yds. of surface, and requires 0.1856 barrel of cement and 0.0263 cu. yds. of sand, what will be required (In quantities of sand and cement) to paint the silo if there are 400 sq yards of surface?

3. Make an estimate of the cost of this silo, at the present price of cement, sand, stone and labor.

Send for the following bulletins:

"Concrete in the Country", Universal Portland Cement Co., 72 W. Adams St., Chicago, Ill.

Farmers' Bulletin, No. 461, U. S. Department of Agriculture, Washington, D. C.

The Silo.

The silo has come into general use throughout the United States within the last thirty years and has reached its greatest development in those regions especially adapted to dairying.

Clover, alfalfa, soybeans and corn are all good silage crops. Corn has come into general use for ensilage and is the principal crop so used because it will produce more food material per acre than any other crop that is adapted to the silo.

The chief advantages in the use of corn for ensilage are:

1. It makes an excellent quality of ensilage.

2. There is less loss of food than with legumes on account of fermentation.

3. It is more easily harvested and put into the silo, than any other crop.

The composition of silage will vary according to the difference in crops, the degree of maturity, etc. The following table shows the percentage of digestive nutrients in 100 pounds of average ensilage:

Crop	Dry Matter.	Digestible.		
		Protein.	Carbohydrates.	Fat.
Corn	26.4	1.4	14.2	0.7
Sorghum	23.9	.1	13.5	.2
Red clover	28.0	1.5	9.2	.5
Soybean	25.8	2.7	9.6	1.3
Cowpeas	20.7	1.5	8.6	.9

PROBLEMS.

1. From the above table calculate the per cent of water in each of the crops named.

2. Which of the feeds named in the foregoing table, has the widest and which has the narrowest nutritive ratio? Which comes nearest being a balanced ration for cows?

Silo Construction.

The construction and use of the silo has become in recent years one of the most important additions to the science of agriculture.

The importance of the silo to our agricultural interests may be seen in the great number of these structures that are being built especially in the dairy regions of the country.

This being a comparatively new industry it is therefore one of the subjects of greatest importance and interest to the student of agriculture.

There have been many investigations, experiments and demonstrations that have resulted in reliable, practical and definite information.

Relation of the Size of the Silo to Length of Feeding Period and Size of Herd.

The following table is prepared on the basis of a ration of 35 pounds of ensilage for a cow weighing 1,000 pounds:

Number of Cows.	Tons Consumed in 180 Days.	Diameter of Silo.	Height of Silo.	Tons Consumed in 240 Days.	Diameter of Silo.	Height of Silo.
6	20	8	20	28	8	28
10	32	9	25	47	10	30
12	40	10	25	51	10	32
14	46	10	30	62	12	28
16	51	10	32	68	12	30
20	64	12	29	85	12	36
25	80	12	34	105	14	33
30	96	12	39	128	14	38
35	110	14	35	148	14	43
40	128	14	38	170	16	39
50	158	16	37	210	16	46

Rule for finding the capacity of a silo approximately.

Multiply the diameter of the silo by the depth and this product by one-fourth of the diameter and divide the result by 16 and this will be the capacity of a silo 30 feet deep. For silos over 30 feet deep add one per cent of weight found for each additional foot above 30 feet in depth, up to 40 ft;

EXAMPLE. — Find the capacity of a silo 12 feet in diameter and 36 feet deep.

SOLUTION.—

$12 \times 36 \times 3 = 1296.$

$1296 - 16 = 81$ tons.

This silo being 6 feet over 30 feet in depth; take 6 per cent of 81 tons which is 4.86.

$81 + 4.86 = 85.86$ tons total weight or capacity of silo.

It has been determined that the pressure of ensilage against a silo will increase with the depth and is equal to 11 pounds per square foot of each foot of depth. Thus at a depth of 20 feet the bursting pressure is 220 pounds per square foot, and at a depth of 30 feet it is 330, and at a depth of 40 feet it is 440 pounds.

By referring to the table on page 531 the tensile power of wire, or wood may be found and from this it is possible to determine the size of wires, rods or hoops that are necessary to hold together the walls of a silo, that is to be filled with ensilage.

NOTE.—Where the material is cut fine and the silo is filled slowly, the amount that can be put into a silo will be greater.

Important Facts About the Silo.

The value of the silo for the preservation of green material for feeding stock has been thoroughly tested in nearly every state and has demonstrated some of the following well established facts:

1. It prevents loss and waste of feed.
2. It is an economic way of handling food.
3. Silage is more palatable than fodder.
4. The same amount of corn in the silo will produce more milk than if fed as fodder and ears.
5. The principle used in the silo is the same as that used in canning fruit.
6. When silage is packed in the silo, it becomes heated and the air in the feed is changed to carbon dioxide.
7. When the air is exhausted the silage will stop decaying.
8. Silage will keep indefinitely if no air can get into it.
9. Silos have been built of stone, cement, brick, lumber and steel.
10. Some of the cheapest silos have been constructed of lumber.
11. It is not advisable to build a silo more than 16 feet in diameter, except for feeding large herds.
12. A layer of silage at least 2 inches in depth should be removed each day.

13. Silage keeps better in a deep silo than in a shallow one, for it must be firmly packed.
14. The height of the silo should be at least twice the diameter.
15. It may be assumed that 40 pounds per day will be required to feed each head of cattle.

Silage bears about the same relation to fresh corn that canned corn bears to fresh ears.

Silage has about the same effects on stock in winter that pasture has on animals in summer. An animal fed on silage is rarely troubled with constipation or poor digestion. The hair is noticeably sleek and soft and the skin is soft and pliable. The amount of ensilage to be fed will depend upon the mixed ration that is selected, and upon the amount of milk given by the cow as well as upon her size and physical condition.

PROBLEMS.

1. Experiences have proven that in feeding corn in the form of ensilage, 35 per cent of the value of the corn is in the stalk and leaves; if the corn stover on ten acres of corn at 3c per bundle will amount to $45, what would it have been worth as ensilage, valued at 100 per cent more than stover?

2. If the stalks and leaves of corn will take up 10 times as much space in the form of fodder as in the form of ensilage, how large a silo (in cu. ft.) will hold, as ensilage, the stalks and leaves which in the form of dry fodder compactly stored, will occupy space in a mow 15x20x40 feet?

When silage is left exposed to the air for more than a day it will spoil. It has been found by experience that it is a good practice to remove at least two inches from the surface each day.

The amount which should be fed daily should be based upon an average weight of forty pounds per cubic foot.

PROBLEMS.

1. If the weight of ensilage in a silo was found to be 40 pounds per cubic foot, how many pounds must be removed to lower the surface 3 inches in a silo that is 12 feet in diameter?

2. A dairyman wishes to construct a silo from which he expects to feed 12 cows. If the average amount of silage to be fed per cow is 36

pounds daily, what should be the diameter of the silo so that 3 inches of silage shall be removed daily?

3. How long must a hoop be to reach around a silo 16 feet in diameter?

4. On an average there is 1 ton of ensilage for every 50 cubic feet in a well-filled silo; how many tons are there in a silo 12 feet in diameter and 30 feet high, if it is filled to the top?

5. Five square feet of ensilage removed from the top layer to a depth of two inches has been proven by experience to be about the required feed for one cow; how many square feet of ensilage should be removed for each cow if a layer is removed 8 inches deep?

6. What is the diameter of a silo that provides a horizontal feeding surface of 5 feet square daily for each one of a herd of 20 cows?

7. What must be the dimensions of a silo to hold the required amount of ensilage to feed 40 pounds daily to each one in a herd of 30 cows for 180 days, if the heighth of the silo is 3 times the diameter?

Loss of Food Material in the Silo.

Fermentation is dependent upon the air in the silo. The more is present the higher the temperature and the greater the loss of food elements. Fermentation will continue until all the oxygen is used up and carbon dioxide has taken its place. Crops with hollow stems are filled with air and unless the air can be pressed out before fermentation commences there will be great loss.

The modern silo is built with greater depth and the result is greater pressure which reduces the amount of air and correspondingly reduces loss of food.

In well-built silos the loss should not exceed 10 per cent. To prevent loss from spoiling of the top layer, cover with corn stalks from which the ears have been removed. It should be tramped and wet down and seeded with oats. The heat from fermentation will help the oats to germinate quickly and form a sod which will prevent the air from spoiling the silage to a very great depth.

NOTE. — For feeding ensilage, see chapter on "Feeds and Feeding".

Experiments made by the State Experiment Station at Columbia, Mo., show that the yield of silage per acre is as follows:

Yield of Corn Bushels.	*Yield of Silage Tons.*
30	6
40	8
50	10
60	12
80	16
100	20

The experiment shows that for every five bushels' increase in the corn crop there was an increase of one ton of silage.

PROBLEMS.

1. How many tons of silage can be made from a field of ten acres that will yield an average of 45 bushels per acre?

2. How many acres of corn yielding 50 bushels per acre will be required to fill a silo 11 feet in diameter, and 32 feet high?

3. A farmer wishes to construct a silo that will hold the required amount of silage to feed 30 cows 180 days; what will be the dimensions of the silo, and how many acres of corn producing 60 bushels per acre, will be required to fill it?

4. A silo 36 feet high and 12 feet in diameter is filled with corn silage; 10 cows were fed on an average 38 pounds of silage per cow each day for 180 days; how many cows each consuming 40 pounds of silage per day, will be required to eat the remainder of the silage in 60 days?

It has been estimated that on an average, about 65 per cent of the food value of the corn crop is in the ears, and about 35 per cent remains in the fodder, when used together as silage.

It has also been determined that two and one-half tons of silage are equivalent to one ton of timothy hay in feeding value.

PROBLEMS.

1. If a field that produces 50 bushels of corn per acre will yield 10 tons of ensilage per acre, what would be the amount of timothy hay that would be equivalent in value to one acre of this corn as ensilage?

2. If corn is worth 50c a bushel, and corn stover is worth $3 per acre, what is the value of a corn crop of 10 acres, yielding 75 bushels per acre? What would be its value as silage when timothy is worth $9 per ton? Find the difference in the value of the corn plus the stover and the value of the silage

3. ,Find the capacity of a silo 10 feet in diameter, 30 feet high, and

how many acres of corn yielding 100 bushels per acre will be required to fill it.

4. If the value of corn silage is estimated at $3 per ton, what will be the difference between the value of 7 acres of corn that will yield 40 bushels of corn per acre at the present market price or if made into silage worth $3 per ton, allowing $35 for value of fodder if the corn is cut and husked?

5. A field of corn will yield 50 bushels per acre or make 10 tons of silage per acre; if the price of corn is 50c per bushel, and silage is valued at the rate of two and one-half tons of silage equal in price to one ton of timothy; what is the difference in value between the silage and grain when timothy is selling for $12 a ton?

Cost of Harvesting and Filling.

Investigations made by the government including work done upon thirty-one farms in Michigan and Wisconsin showed the following to be the average cost for filling the Silo:

Laborers, per hour	15c
A team, per hour	15c
Engine, per day	4.50
Twine, per pound	15c
Coal, per ton	5.00
Gasoline, per gallon	13c

This investigation showed that the cost per ton for filling silos varied from 46 to 86 cents.

Another investigation with 87 silos in various parts of the United States showed that the average cost of filling was 87 cents per ton.

An investigation into the cost of growing an acre of corn for ensilage for filling 87 silos showed an average cost of $1.58 per ton.

PROBLEMS.

1. According to the findings of the government, what was the average cost of ensilage per ton in the 87 cases investigated?

2. If one ton of timothy is equal in feeding value to two and one-half tons of ensilage; when timothy is selling for $10 per ton and the expense for making the hay is $1.00 per ton; which is the cheaper for feeding purposes, hay or ensilage?

An investigation of the cost of 110 silos in the states of Illinois, Michigan, Wisconsin and Minnesota shows that the average cost of concrete silos were as follows:

AVERAGE COST OF ALL SILOS PER TON CAPACITY.

Monolithic silos	$2.30
Block silos	3.10

PROBLEMS.

1. What will be the cost of a 150 ton monolithic silo at the price per ton given in the above table?

2. Find the difference in the cost of two silos of 200 tons each, one is built of cement blocks and the other is built of monolithic walls?

3. A stave silo 16x32 feet will cost about $300. According to the table on Page 490 what is the cost per ton capacity?

The deeper the silo, the cheaper it can be built, the capacity in cu. ft. remaining the same; it has been estimated that a silo 32 feet deep will hold twice as much as a silo 20 feet deep. Within 5 to 10 feet of the top ensilage will weigh about 30 pounds per cubic foot; at a depth of from 10 to 25 feet it will weigh about 35 pounds; at a depth of from 25 to 30 feet it will weigh 40 pounds and at from 30 to 35 feet the weight is 45 pounds.

Life of The Silo.

The following statement regarding the average number of years wood will remain without decay is supplied by the Bureau of Forestry, U. S. Department of Agriculture.

Specie.	*Average number of years of life untreated.*
Cypress	14
Redwood	14
Douglas Fir	10
Yellow Pine	8
White Pine	8

The Iowa Silo.

The Iowa Silos built under direct co-operation of The State Experiment Station at Ames, were built of vitrified Clay building blocks.

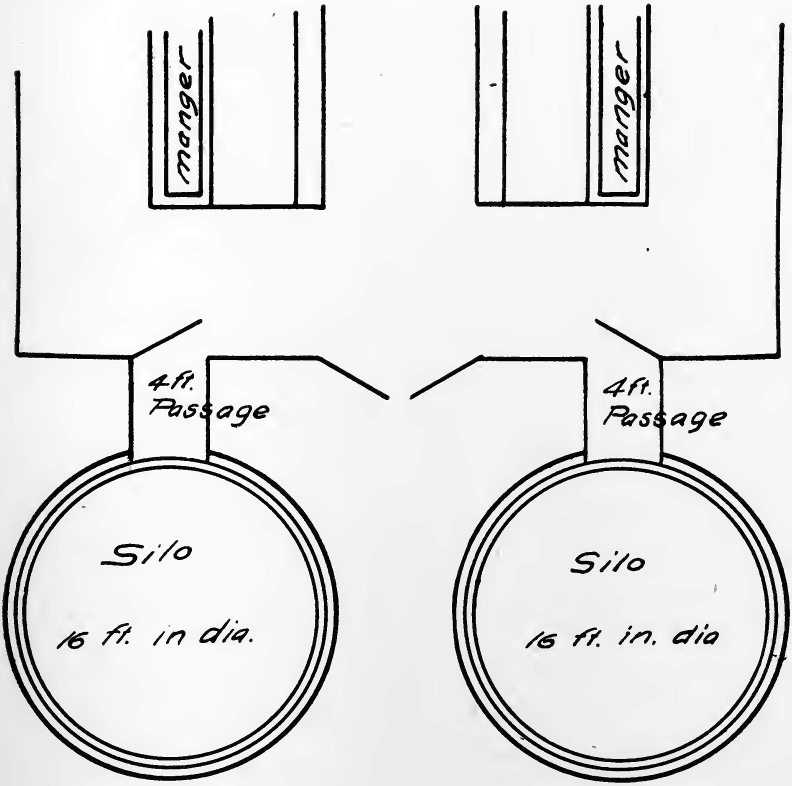


FIG. 1 — Plan of the silos showing a convenient arrangement for feeding.

Silos were built at the following places and the size and cost is given as follows in a station report of 1910:

	Size.	Cost.
Silo at Linn Grove........	16 ft. in diameter, 35 ft. high........	$308
Silo at Rock Valley.....	16 ft. in diameter, 35 ft. high........	350
Silo at Rock Valley.....	16 ft. in diameter, 37 ft. high........	282
Silo at Laurens..........	18 ft. in diameter, 36 ft. high........	285.28
Silo at Laurens..........	16 ft. in diameter, 30 ft. high........	215
Two silos at Ottumwa...	18 ft. in diameter, 35 ft. high........	750.37

PROBLEM.

Find the capacity of each of the above silos and the cost per ton capacity.

32

Reading on Silos.

BOOKS.

1. Silos and Silage — Miles.
2. Physics of Agriculture (Pages 394-427) — King, 8-12 — F. H. King, Madison, Wis.
3. Soiling Crops and the Silo — Shaw, 8-12 — Webb Pub. Co., $1.50.

FARMERS' BULLETINS U. S. DEPT. OF AGRICULTURE.

292. Cost of Filling Silos.
556. The Making and Feeding of Silage.
32. Silos and Silage.
222. Silage for Cows.

STATE BULLETINS.

193. The Silo for Missouri Farms.....Missouri Agricultural Ex. Station
141. Modern Silo Construction................Iowa Experiment Station
117. The Iowa Silo..........................Iowa Experiment Station
The Michigan Silo ....Michigan Experiment Station
112. Corn Silage for Fattening Two-Year-Old Steers, Missouri Ex. Station.
182. Silo Construction.....................Virginia Experiment Station

Roads.

SUMMARY OF BULLETIN NO. 41.

OFFICE OF PUBLIC ROADS, UNITED STATES DEPARTMENT OF AGRICULTURE.

Title: "Mileage and Cost of Public Roads in the United States in 1909."

STATISTICS ON ROAD MILEAGE.

	1904.	1909.
Total mileage of all public roads in U. S.......	2,151,379	2,199,645
Total mileage of all improved roads in U. S....	153,530	190,476
Percentage of all roads improved.............	7.14	8.66
Total mileage of stone roads in U. S..........	36,818	59,237
Total mileage of gravel roads in U. S........	109,905	102,870 (a)
Total mileage of sand-clay, brick, bituminous-macadam and other improved roads in U. S.	6,806	28,372

STATES HAVING LARGEST MILEAGE OF IMPROVED ROADS.

	1904.	1909.
Indiana	23,877 miles.	24,955 miles.
Ohio	23,460 "	24,106 "
New York	5,876 "	12,787 "
Wisconsin	10,633 "	10,167 " (a)
Kentucky	9,486 "	10.114 "
Illinois	7,924 "	8,914 "
California	8,803 "	8,587 "
Massachusetts	7,843 "	8,463 "

(a) Decrease caused by reclassification of roads.

STATES WHICH HAVE MADE THE GREATEST PROGRESS IN ROAD BUILDING IN THE FIVE-YEAR PERIOD.

MILES OF IMPROVED ROAD.

	1904.	1909.	Gain.
New York	5,876	12,787	6,911
Georgia	1,634	5,978	4,344
Washington	1,976	4,520	2.544
Missouri	2,733	4,755	2,022
South Carolina	1,878	3,534	1,656
Alabama	1,720	3,263	1,543
Pennsylvania	2,160	3,364	1,194
Tennessee	4,285	5,353	1,068
New Jersey	2,422	3,377	955
Florida	885	1,752	866
Maryland	1,570	2,142	572

The gain in New York State is due largely to the fact that the state has bonded itself for $50,000,000, and that $5,000,000 a year is being expended by the state, in addition to an equal sum by the counties, in building state highways.

The gain in Georgia is largely attributed to the use of 4,500 prisoners on the public roads of the state.

The gain in South Carolina, Alabama and Florida is due largely to the fact that sand-clay roads are being built and that this is a very cheap and satisfactory type of road building.

Photo by Thos. L. Collett

FIG. 2. A Beautiful Avenue.

STATES SHOWING THE GREATEST PERCENTAGE OF IMPROVED ROADS.

Rhode Island	49.14	Wisconsin	16.64
Massachusetts	49	New York	16.13
Indiana	36.7	Washington	13.19
Ohio	27.13	Maryland	12.77
Connecticut	24.08	Utah	12.23
New Jersey	22.76	Tennessee	11.66
Kentucky	18.82	South Carolina	11.02
Vermont	18.4	Maine	10.59
California	17.87	Michigan	10.01

The following states have between 5 and 10 per cent of roads improved: Alabama, Delaware, Florida, Georgia, Illinois, Minnesota, New Hampshire and Oregon.

There are twenty-two (22) states which have less than 5 per cent of roads improved.

AVERAGE COST PER MILE OF IMPROVED ROADS IN THE VARIOUS STATES IN 1909.*

Sand-Clay	$723 00 per mi.	Macadam	$4,989 per mi.
Gravel	2,047 00 per mi.	Bituminous Macad.	10,348 per mi.

TOTALS.

ESTIMATED COST OF IMPROVED ROADS IN THE UNITED STATES BASED ON DATA CONTAINED IN BULLETIN NO. 41.

Roads.	*Miles.*	*Cost.*	*Total.*
Stone	59,237	$4,989 00	$295,533,393 00
Gravel	102,870	2,047 00	210,574,890 00
Sand-Clay	24,601	723 00	17,786,523 00
Miscellaneous	3,771	10,000 00	37,710,000 00
(B. Mad. Brick, etc.)			
Grand Total	190,479		$561,604,806 00

* These figures are based on reports received from the officials of state highway departments and from counties, townships and other local sub-divisions of the various states.

VALUE OF RIGHTS OF WAY ON ALL PUBLIC ROADS IN THE UNITED STATES.

On a basis of 40 ft. width, there are 10,668,276 acres of rights of way included in the public roads of the United States.

Based on the average value of farm lands in the various states, the total value of these rights of way would amount to $345,652,215.00.

Cost of Improved Roads..............................	$561,604,806 00
Value of Rights-of-Way..............................	345,652,215 00
Total	$907,257,021 00

PROBLEMS.

1. The average cost of sand-clay roads for the 17 states which reported to the government was $728 per mile; the average width of surface treated was 17 feet; the average depth of material was 9 inches; what was the cost per cubic yard?

2. The average cost of gravel roads for the 31 states reporting, is $2,047 per mile. If there were 102,870 miles of gravel roads in 1909, what was the total cost of the gravel roads in the United Staes?

3. If the gravel roads were on an average 13 feet wide, 7 inches deep, what was the number of cubic yards per mile? Cost per cu. yd.?

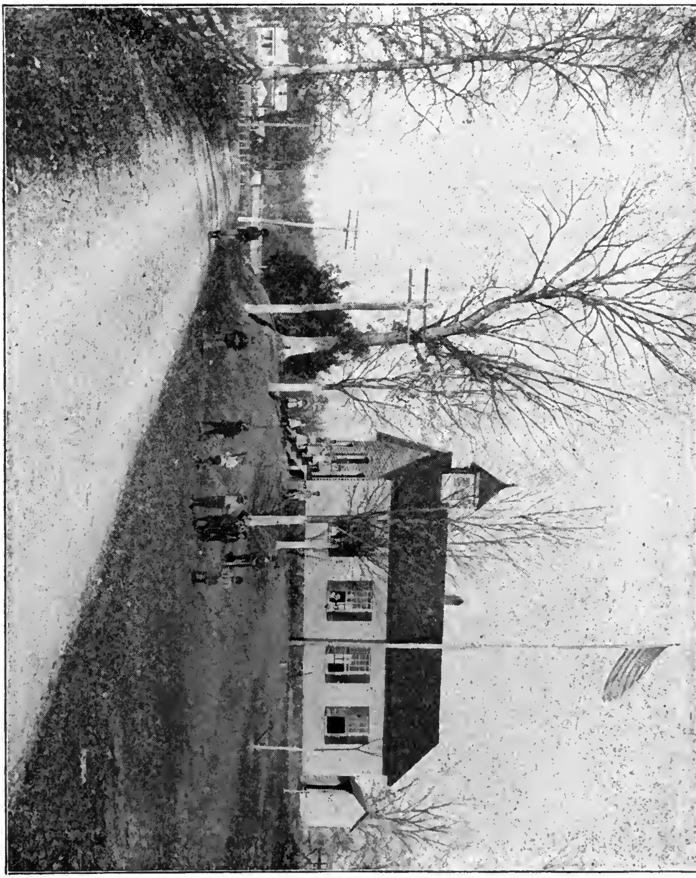
4. The average cost of macadam roads for 34 states as reported was $4,989 per mile. Macadam surface is 13 feet wide and an average depth of 6 inches. What was the cost per cubic yard?

5. Information relative to all expenditures on public roads in the United States in 1911, shows that the amount was approximately $142,000,000. What per cent is this of our accredited wealth as a nation which has been estimated at 150,000,000,000 dollars?

The Public Highway.

The public highway stands perhaps second only to the railway as one of the most important factors in determining the course of civilization and industrial progress in the United States.

The good road problem is one of the most agitated subjects before the public because upon the solution of this problem depends the welfare, comforts, and many of the conveniences of a great and progressive country.



Courtesy Ohio School Survey

FIG. 3. Improved roads, more efficient schools; more efficient schools, improved roads.

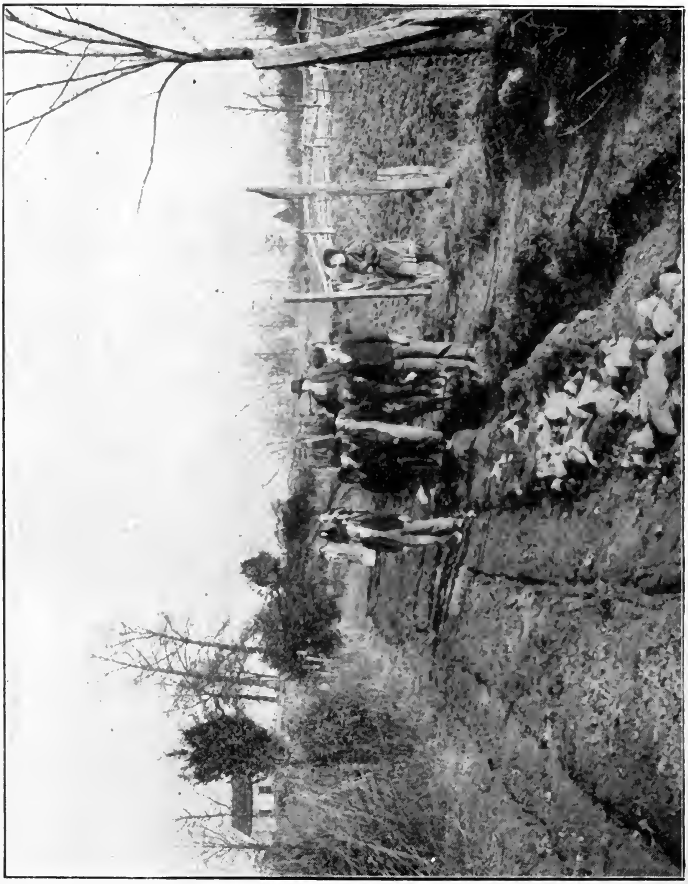


FIG. 4. Like road, like school. *Courtesy Ohio School Survey*

The growth and development of a community cannot continue unless the improvement of roads keeps pace with the demands of those who believe in the following principles:

1. Better schools and churches.
2. Better social conditions in town and country.
3. Better homes equipped with better facilities and conveniences.
4. Better transportation, values and markets.
5. Better, easier and more profitable employment.
6. Better means of communication and travel.
7. Better means of social intercourse.
8. Better distribution of labor in transportation.
9. Better economy in travel, and communication of intelligence.
10. Better prices for better marketed products.
11. Better and more equitable distribution of opportunities.
12. Better people and better government.

Transportation Problems.

The cost of transportation is usually determined by finding the cost of hauling one ton one mile over a public highway or railway or waterway.

The average freight rate in the United States is about 1 cent per ton mile. The average cost of hauling on public highways is about 25 cents per ton mile. The average cost of ocean freight from New York to Liverpool is $0.0003 per ton mile or about $1 per ton for 3,100 miles.

PROBLEM.

1. From the Bureau of Statistics, reports have been given out from which it is estimated that the cost of transportation to market of 12 of the principal farm crops in one year was $73,000,000; this was 5.2 per cent of the value of those crops; what was the value of the crops transported?

There is much complaint against socalled unjust taxes, high taxes, and inequitable distribution of taxes, but it is very evident that the most unjust and exorbitant of all taxes is the bad-road tax.

PROBLEMS.

1. A farm is located five miles from a shipping point on the railroad; the owner delivers to market on an average 50 tons per year; he must do his hauling over a road that is in poor condition; he can only haul

one ton per load and make two trips per day; if he values the time for driver and team at $3.50 per day, how much does it cost this farmer per ton per mile to deliver his products to market?

2. If the same road described in problem 1 were ditched, drained, graded, and macadamized, what would be the cost per ton per mile to haul two tons per load twice a day at $3.50 per day?

3. What is the difference in cost per ton per mile, between hauling over the bad and hauling over the good roads described in the two foregoing problems?

4. If a farmer can haul two tons per load, twice a day, a distance of 5 miles over a macadamized road, which is twice as much as he can haul over a poor road, how much does the good road save him per 100 tons per mile?

5. If the average cost of Macadamized roads in the United States is about $5,000 per mile, how many years will it require to save enough to the farmer as shown in problem 4, to more than equal the cost of the road per mile?

6. There were 125,000 automobile licenses granted in Ohio in 1914, at $5.00 per license; what was the amount of this license in Ohio? How many miles of roads could be improved at this rate annually at $5,000 per mile?

The total loss suffered by the farmers of the U. S. on account of bad roads is not alone in the extra cost of hauling. There are many other items that may be added such as bad markets, shrinkage, damage to horses, and various other losses.

PROBLEMS.

1. If investigations made by the U. S. Dept. of Agriculture show that the general average cost of hauling 23 different farm products to market is 5.22 per cent of their value, what would be the cost of marketing one-half of the total farm crop of 1914 if it is approximately valued at 10 billion dollars?

2. If the average cost of marketing corn is 9.6 per cent of its value, what would be the cost of hauling half of the corn yield of the U. S. if the average annual production is about 2,500,000,000 bushels, basing figures on the present market value?

3. The average cost for hauling on all sorts of roads in the U. S. is about 25 cents per ton mile; investigations in Europe show that the average there on good roads (dry stone roads) is 8 cents per mile; how many per cent greater is the cost on the average in the U. S. than on the European road?

4. If the cost of hauling in the U. S. is estimated at 250 millions of dollars annually and we could save 150 millions by having good roads, how many miles of Macadamized roads would that amount of money build at $5,000 per mile?

Farm Mechanics.

The following problems are to illustrate the power required to draw loads over different kinds of roads.

The Missouri Experiment Station made experiments with three sets of wheels of different height, the diameter of the axle remaining the same.

The net load in every instance was 2,000 pounds.

The tires were six inches wide.

The three sets of wheels tested were of the following description:

	Height of Front Wheels.	*Height of Rear Wheels.*
1. Standard Wheels	44 inches	55 inches
2. Medium Wheels	36 inches	40 inches
3. Low Wheels	24 inches	28 inches

The draft was determined by means of the Giddings self-recording dynamometer, and a plainmeter, so that the average draft was correctly determined.

If a load of one ton were put upon a wagon to be drawn upon a perfectly smooth hard level surface, it would be possible to get accurate mathematical results, but loads are rarely if ever drawn on such surfaces, so that it becomes necessary to make tests of practical value.

Such tests the experiment station has attempted to make.

The following summary gives the results of the experiments:

Summary.

Kind of Road.		Condition of Road.	Kind of Wheels.	Draft required for 2,000 lbs. net load.
Gravel Road....	a	Level, dry, with sand and gravel..	High	158.9 lbs.
			Medium	161.9 lbs.
			Low	185.3 lbs.
	b	Wet sand, up grade 1-44	High	231.3 lbs.
			Medium	236.5 lbs.
			Low	291.0 lbs.
Macadam Street...	c	In fair condition....	High	108.0 lbs.
			Medium	108.7 lbs.
			Low	117.4 lbs.
Cinder Track......	d	Dry and not firm...	High	113.1 lbs.
			Medium	114.0 lbs.
			Low	120.0 lbs.
Dirt Road	e	Frozen solid, sticky mud on top......	High	189.2 lbs.
			Medium	213.4 lbs.
			Low	233.8 lbs.
	f	Dry and in good condition	High	130 lbs.
			Medium	134 lbs.
			Low	132 lbs.
Timothy and Bluegrass sod.	g	Dry and firm, level.	High	248.1 lbs.
			Medium	259.9 lbs.
			Low	300.6 lbs.
	h	Wet and spongy....	High	325.2 lbs.
			Medium	362.7 lbs.
			Low	472.6 lbs.
	i	Dry and firm, up grade 1-12.7	High	480 lbs.
			Medium	495 lbs.
			Low	510 lbs.

SUMMARY — Concluded.

Kind of Road.	Condition of Road.	Kind of Wheels.	Draft required for 2,000 lbs. net load.
Plowed ground.. j	Dry across rows, small ridges	High	335.7 lbs.
		Medium	360.1 lbs.
		Low	445.6 lbs.
Plowed ground.. k	Freshly plowed, dry and cloddy	High	475 lbs.
		Medium	542 lbs.
		Low	628 lbs.

PROBLEMS.

1. The road marked (a) in the summary was a dry gravel road with sand 1 inch deep; the length of the run was 400 feet; what per cent of advantage was there in the draft of high over the medium wheels? Of the medium over the low wheels?

2. At the rate given in the table, the draft required to draw 2,000 pounds on the low wheels, would draw how many pounds on the medium wheels? On the high wheels?

3. If we consider the number of pounds gross and net weight each pound of draft pulls, as given in the table; construct a table showing what 1 pound of draft will draw under each of the several conditions.

4. The road marked (b) is one-half inch of wet sand, with ground frozen underneath; the grade is 1 in. in 44; referring to the table, what is the advantage of high over medium wheels in pounds? In per cent?

5. What is the difference in draft required to pull 2,000 pounds on a wet spongy sod, that is level, and the draft required to pull the same weight up grade 1 in 12.7 on dry firm earth using high wheels?

6. If 1 pound of draft will draw 10.6 pounds on a high wheeled wagon over a dirt road that is frozen solid but sticky on top, and the same wagon requires 1 pound of draft to draw 18.5 pounds over a macadam road in fair condition, what will be the difference in pounds of draft required to pull 2,000 pounds over the two roads given above?

7. If a low-wheeled wagon requires 233.8 pounds draft to pull 2,000 pounds over a sticky dirt road in bad condition, how many pounds will the same number of pounds draft (233.8) pull with a high wheeled wagon over a macadam road?

Road Score Card.

	Points.
Ditches	10
Garbage and Rubbish	10
Weeds and Brush	5
Protection against washing	10
Protection against standing water	10
Uniformity of width of roadbed	10
Uniformity of grading	15
Uniformity of gravelling	15
Straightness of grading	5
Straightness of gravelling	5
Care of tools	5
	100

Questions.

1. Why is concrete more economical in the long run than wood construction?

2. What is cement and how is it made?

3. Why do walls and walks built of concrete often crack and crumble?

4. Explain the difference between roads built of concrete, macadam, paving blocks (wood), paving brick, asphalt, slag and gravel.

5. What is a water-bound road? a tar-bound road?

6. What kind of soil makes the best foundation?

7. How does quick-sand affect a foundation?

8. What is reinforced concrete?

9. Explain how steel and concrete in a structure give greater strength and stability than when either steel or concrete is used alone.

10. What are some advantages of a hollow wall? of a solid wall?

11. Explain why railroads must use wood ties and why they can not have a concrete roadbed.

12. How do hard pavements affect horses and vehicles? Why?

13. Why is the automobile and motorcycle very destructive to stone roads?

14. Explain the principle of the hollow tire that saves the automobile and damages the road.

15. What is the best road to build to meet all requirements including the auto?

EXERCISES.

1. Make a list of the various uses to which concrete can be put on the farm.

2. Name some of the various parts of a basement barn, hog pen and dwelling and milk house that may be built of concrete.

3. Draw a plan showing where concrete walks should be built on your school ground.

4. Induce the school board to buy and furnish the material and let the boys build the walks.

5. Build some cement posts for fences.

Literature on Roads and Road Building.

Write to the U. S. Dept. of Agriculture and to your State Highway Department and ask for available information.

CHAPTER XXVIII.

Miscellaneous Problems.

MEASURE OF LENGTH.

12	inches	=	1 foot (ft.)
3	feet	=	1 yard (yd.)
16.5	feet	=	1 rod (rd.)
5.5	yards	=	1 rod
320	rods	=	1 mile (mi.)
1760	yards	=	1 mile
5280	feet	=	1 mile
63360	inches	=	1 mile

PROBLEMS.

1. The unit of measurement used by merchants in selling cloth is the "yard."
2. The unit of measure used by the carpenter is the "foot."
3. The unit of measure in geography is the "mile."
4. The unit of land measure is the "rod."

PROBLEMS.

1. What is the length and width of your school ground?

2. What is the exact distance from your home to the school?

3. How many miles do you walk in one school year in going to and from school?

4. If a carpet is three-fourths of a yard wide, how many strips will it take to carpet a room 15 ft. by 20 ft. if the strips are laid lengthwise of the room? If they are laid crosswise?

5. How many strips of wall paper 18 inches wide will be required to cover the walls of a room 12 ft. by 15 ft.? How many rolls will it take if the part to be papered is 10 feet high?

6. A farmer in plowing turns a 10 inch furrow, how many miles will he walk in plowing 10 acres? How far will he walk if he turns a furrow 12 inches in width?

7. If the average distance of a man's step is 30 inches, how many steps will a man take in plowing 40 acres with a plow that turns a furrow 12 inches in width?

Highways, Boundarylines.

FENCES AND FENCING.

In most states there is a law that requires a farmer to build half of the fence on the line where two farms come together.

A legal description of a farm gives the area as calculated from the middle of all highways (public) adjoining it.

COST OF FENCES.

1. What will it cost to fence a field 50 rods long, and 35 rods wide, with a woven wire fence costing 38c a rod; with posts set 20 feet apart, at a cost of 20c each; with 4 corner posts and two gate posts costing 50c each and allowing $12 to cover labor and other expenses?
2. If an 80 acre farm, 80 rods wide and 160 rods long has a frontage on a public highway 60 feet wide at one end, and a frontage on a public highway 50 feet wide on one side, what will be the number of rods of fence required to go around this farm, if we deduct the number of rods to be built by adjoining land owners, and deduct also half the area of the highways fronting this farm?

Surface or Square Measure.

144	square inches (sq. in.)	= 1 square foot (sq. ft.)
9	square feet	= 1 square yard (sq. yd.)
30.25	sq. yds.	= 1 square rod (sq. rd.)
272.25	sq. ft.	= 1 square rod
160	square rods	= 1 acre (A.)
640	acres	= 1 square mile (sq. mi.)
36	sq. mi.	= 1 township.

A Square Acre.

1 side of a square acre = 12.649 rods in length.
1 side of a square acre = 69.567 yards in length.
1 side of a square acre = 208.708 feet in length.

Figure 1 represents a farm in a hilly section. A river runs through the farm. The boundary lines are irregular on account of the course of the public highway in a hill country. The fields are laid out in various shapes on account of river, swamps, lowlands, hillsides, roads and boundarylines.

The fields are in the shapes of triangles, rectangles, trap-

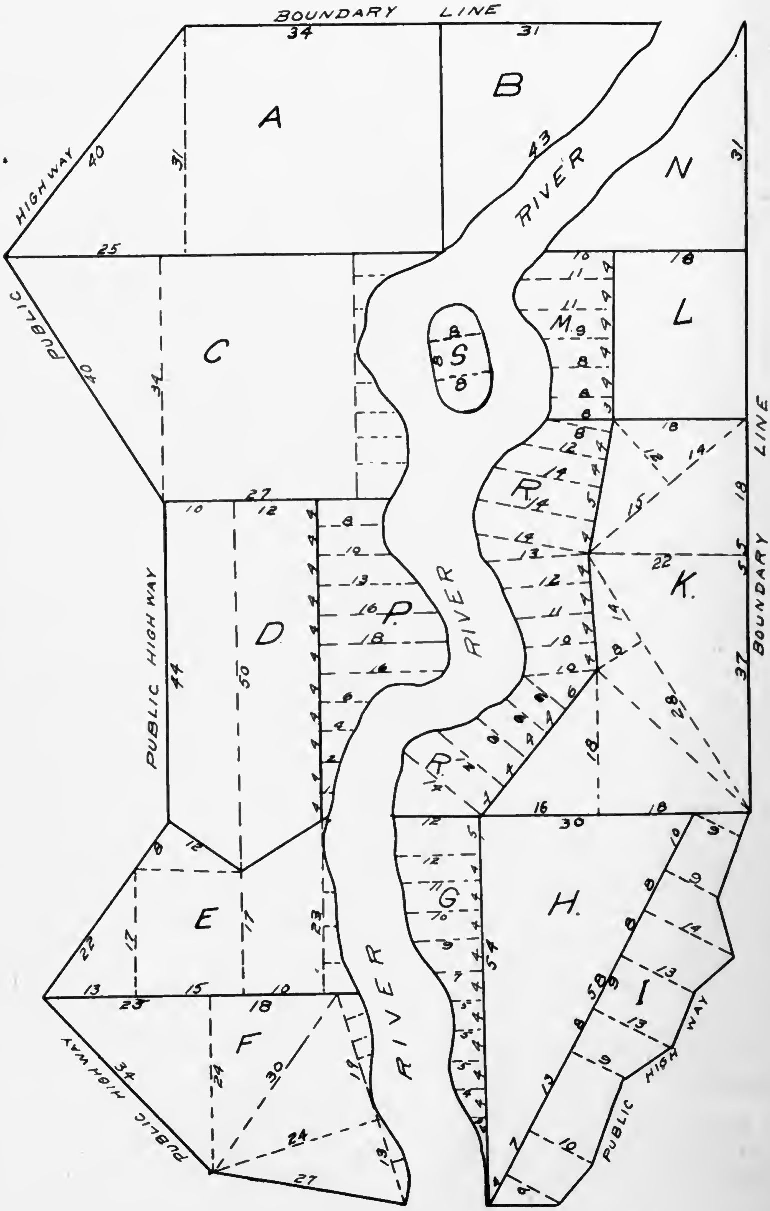

BOUNDARY LINE
A
B
C
D
E
F
G
H
I
K.
L
M
N
P.
R.
S
RIVER
HIGHWAY
PUBLIC
PUBLIC HIGHWAY
BOUNDARY LINE
PUBLIC HIGHWAY

FIG. 1.

ezoids, and other figures and are given in this connection to facilitate the study of farm mensuration.

This farm has a length of 160 rods and a width of 100 rods at the points of maximum length and width.

The different fields are designated by different letters.

The heavy dark lines show the boundaries of fields. The dotted lines are drawn to aid in finding areas of irregular fields. The figures show lengths in rods of different straight lines.

PROBLEMS.

1. Find exact number of acres in each of the following fields: A, D, H, K, and L.

2. Find the approximate area of each of the fields lettered B, C, E, F, G, I, M, P, and R, and island marked S.

3. What is the approximate area taken by the river?

4. What is the approximate area of the land on each side of the river? Give area of farm.

PROBLEMS.

1. A square field has 100 rods of fence around it; what is the cost of fencing per acre at 50c a rod?

2. A rail fence 160 rods long takes up a space 5 feet in width; how much land will be gained for cultivation if the rail fence is removed and the same number of rods in length is replaced with a woven wire fence, requiring a strip only 6 inches wide for posts and wire?

Solid Measure.

1728 cubic inches = 1 cubic foot.
27 cubic feet = 1 cubic yard.
The cord equals 128 cubic feet.
The cord is a rectangular solid, 8 feet long, 4 feet wide, and 4 feet high. ($8 \times 4 \times 4 = 128$ cu. ft.)

Firewood is usually sold by the cord, which is 8 feet long and 4 feet high; the width of the pile depending on the length of the sticks desired for the stove in which it is to be burned.

PROBLEMS.

1. A pile of wood is 32 feet long, 5 feet high, and the sticks are $4\frac{1}{2}$ feet long, or the width of the pile is $4\frac{1}{2}$ feet; how many cords are there in the pile?

DIFFERENCES IN DISTANCES AROUND FIELDS OF LIKE AREAS.

(a)

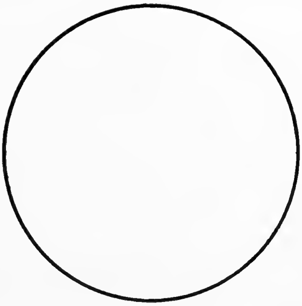


Figure (a) represents a circular field containing 10 acres. Find circumference.

(b)

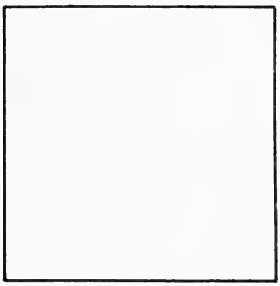


Figure (b) represents a field in the form of a square containing 10 acres. Find number of rods of fence required to enclose it.

(c

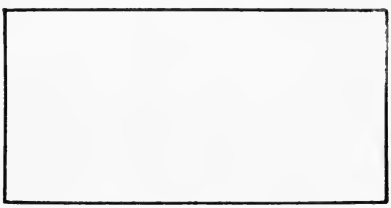


Figure (c) represents a field in the form of a rectangle, the length being twice the width, the area being 10 acres. Find number of rods around the field.

(d)

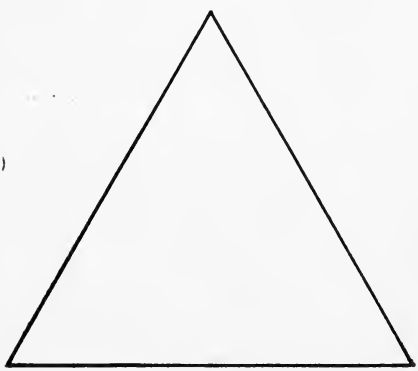


Figure (d) represents a field in the form of an equilateral triangle, containing 10 acres. Find number of rods of fence required to surround it.

2. If the sticks in the pile of wood of the dimensions stated in problem 1, are sawed into pieces 18 inches in length, how many cords of stovewood will there be?

3. If the wood sawed from the pile given in problem 1 are ranked in a rectangular pile 4 feet high, what will be the length of the pile?

4. What will be the cost of a pile of wood consisting of three ranks, of 16-inch sticks, if the 3 ranks are in the form of a rectangular solid 18 feet long, 4 feet wide and 5 feet high @ $2.25 per cord?

5. A pile of wood consists of 16 ranks each 4 feet high and 100 feet long; the cost of cutting, splitting and ranking was 55c per cord; the cost of hauling was 65c per cord; the price received was $2.25 per cord; what was net profit after paynig the above expenses?

Weight of Hay in Mows and Stacks.

The weight of hay may be determined approximately.

Mows and stacks over 10 feet high will weigh on an average about as follows:

Timothy hay 1 ton for each 500 cubic feet.
Clover hay 1 ton for each 600 cubic feet.

Piles of hay less than 10 feet in height will require 700 to 800 cubic feet per ton.

PROBLEMS.

1. A barn has a mow 40 feet by 16 feet, and is filled with timothy hay to a uniform height of 17 feet; how many tons does it contain? How many bales of hay will it make, if the average weight of the bales is 215 pounds each? What will 13 of these bales be worth at $17.40 per ton?

2. A stack of clover hay was 12 feet wide and 30 feet long; the top was removed so that the shape of the stack was that of a rectangular solid. The hay was baled and the combined weight of the bales was $8\ ^1/_{15}$ tons. What was the height of the stack?

3. How many bales of clover did this stack in problem 2 make, if the average weight of the bales was 215 pounds each?

4. If a bale of hay contains 20 cubic feet and weighs 225 pounds, how many cubic feet of bailed hay will be required to make a ton?

5. If a ton of timothy hay contains 500 cubic feet, how many cubic feet of space will this ton occupy after it is baled into bales of 20 cubic ft. each, weighing 220 pounds per bale?

6. A mow is 40 feet long, 20 feet wide, and 29 feet high; it is put into bales that weigh 11 pounds to the cubic foot; find the difference

in the number of cubic feet of the hay in the mow, and the number of cubic feet in the total number of bales.

Tanks and Cisterns.

There are 231 cubic inches in a gallon.
There are 31.5 gallons in a barrel.

PROBLEMS.

1. A watering tank of galvanized iron, is 3 feet wide, 2 feet high and 12 feet long; each end is semicircular in shape; how many barrels of water will it hold?
2. A tank is 6 feet in diameter and 20 inches deep; inside measurements; how many gallons will it hold?
3. A cement tank is built with walls 6 inches thick, and 18 inches high; how many cubic feet of cement does it contain if the part containing water is a cube?
4. A cement tank is five feet in diameter — inside measurement at the top; the walls at the top are 5 inches thick and the height of the tank outside is 3 feet; the inside surface is in the form of half a sphere; how many barrels of water will it hold and how many cu. feet of cement are there in the walls?
5. A cistern is to be 56 inches in diameter, how deep must it be to hold 100 barrels of water?
6. A tank is built of 2 inch plank, with inside measurements of 26 inches in depth and 12 feet in diameter; how many square feet of surface are there on the inside surface of the walls?

Board Measure and Lumber Problems.

The unit of lumber measure is the "board foot".

The board foot is an inch in thickness and contains 144 cubic inches.

A board 1 inch thick, 12 inches long, and 12 inches wide is a board foot.

The number of feet of lumber in a stick of timber, is therefore determined by multiplying the number of square feet on one surface by the average thickness in inches.

If a board is 1 inch or less in thickness, the number of board feet it contains is the number of square feet on one side of the board.

PROBLEMS.

1. How many board feet are there in a board 6 feet long, 8 inches wide, and 1 inch thick?

2. How many feet of board measure or lumber in a sill 10 inches square and 60 feet long?

3. How many feet of lumber in a 2 x 4 scantling 12 feet long?

4. A joist is 2 x 8 and is 20 feet long; how many feet of lumber does it contain?

5. How many feet of two inch plank lumber will be required to build a cylindrical tank, 12 feet in diameter and 26 inches deep on the inside? What will be the cost of the lumber @ $28 per thousand?

6. What will the lumber for a threshing floor cost @ $22 per M for oak plank 2½ inches thick, if the floor is 40 feet long and 25 feet wide?

7. How many feet of lumber will be required to board up the gables of a barn 40 feet wide if the roof has one-third pitch?

Lumber and Frames for Buildings.

PROBLEMS.

1. Make out a bill for framing material for a one room building, 18 ft. long, 12 ft. wide, and 16 ft. high at the gables, with a roof one-half pitch; the building to be framed with 2 by 4 studding, and rafters 2 ft. apart; ceiling joists 2 by 6, 2 ft. apart; sills 2 by 6; purlines 2 by 4.

2. Draw the plans and make out a bill for lumber required in the framing of a two room building 22 feet long, 10 ft. wide, 10 ft. from top of perline to bottom of sill; construction and dimensions of framing material to be same as given in problem 1.

Pupils should be required to make out a bill of framing material and lumber and other parts necessary for a model modern barn, crib, hen house, cow-barn and other farm buildings.

This work may be made to include drawings and even the construction of farm dwellings.

Take the class on a trip to examine a model barn. Have pupils take pencils and tablets and tape line for taking measurements. Have pupils learn names of different pieces of timber in frame and other parts.

Have pupils make suggestions as to disadvantages noted and how plans might be improved and buildings made more convenient.

This is farm management and practical agricultural arithmetic.

The time is rapidly approaching when thorough agricultural training will be based in part upon a thorough knowledge and skill in drawing.

Work for Manual Training Department.

In the agricultural course manual training should include such work as the following:

In constructing models for large buildings a scale of one or two feet per inch may be used.

For small articles for household use the work may be made practical and serviceable by requiring pupils to make furniture and tools for home use or for sale by the school.

Manual training should include models of frames, for all kinds of farm buildings, and models of buildings completed.

Problems should be given pupils for solution showing the cost or estimate of cost for a large building constructed on the plan shown in the model.

Many of the serviceable minor equipments of the farm may be made in the manual training room.

Cribs and Granaries.

A bushel contains 2,150.4 cubic inches.

Because of the two ways of measuring corn in the ear and after it is shelled, there has always been more or less confusion; this arises from the fact that in many localities it is customary to speak of a bushel measure full of ears as a bushel of corn. In all problems given in this book, a bushel of corn is taken to mean 56 pounds of shelled corn or 70 pounds of ears, because 70 pounds of ears are supposed to contain 56 pounds of grain.

It must be kept in mind that the relative weight and bulk of corn is constantly varying on account of variation in moisture content. (See Chap. on Corn). On an average, however, 70 pounds of ear corn will fill 2 bushel measures, or 2 bushel measures of ear corn will contain 1 bushel measure of grain; hence for the measurement and computation of capacity in cribs, the following facts will be of great convenience.

2 cubic feet of ear corn will produce 1 cubic foot of shelled corn.

A bushel measure contains $1\frac{1}{4}$ cubic feet (approximately.)

PROBLEMS.

1. How many bushels in a crib of corn containing a pile of ears, 4 ft. wide, 30 ft. long, with a uniform height of 9 ft.?

2. A farmer wishes to build a crib 5 ft. wide, 10 ft. high; what will be the required length so that it may hold 1,000 bushels of corn?

3. A wire crib is in the shape of a cylinder, 6 ft. in diameter, and 12 ft. high; how many bushels of corn will it hold?

4. A galvanized iron crib is in the form of a cylinder, 22 ft. in circumference, and 14 ft. high; what is its capacity in bushels?

5. If the grain in a certain crib of corn, averages 85 per cent of the weight of the ears, what will be the weight of the cobs in 14,000 pounds of ears? What is the number of cubic feet of cobs?

6. How many cu. ft. of corn in a crib that contains 350 bushels of corn?

7. If 70 pounds of ear corn will produce 1 bushel of shelled corn, what per cent of the weight of the ear is the weight of the shelled corn? What per cent of the bulk of the ears is the bulk of the cobs?

8. A car had a capacity of 1,000 cu. ft.; how many pounds of ears were required to fill it? What was the weight of the cobs?

The following table gives the legal weight of some of the chief products of the farm as established by a majority of the states:

TABLES.

Alfalfa Seed	60	Hemp	44
Apples	50	Hungarian	50
Barley	48	Kaffir Corn	56
Beans	60	Malt	34
Blue Grass Seed	44	Millet	50
Bran	20	Oats	32
Broom Corn Seed	50	Onions	57
Buckwheat	50	Peas	60
Carrots	50	Popcorn (shelled)	56
Clover Seed	60	Potatoes	60
Corn (ear)	70	Red Top	14
Corn Meal	48	Rye	56
Corn (shelled)	56	Sorghum Seed	50
Cotton Seed	32	Soybeans	60
Dried Apples	26	Sweet Potatoes	55
Dried Peaches	33	Timothy Seed	45
Field Beans	60	Turnips	55
Field Peas	60	Wheat	60
Flax Seed	56	White Beans	60

Things to Remember.

A gallon is 231 cubic inches.

A bushel is 2,150.4 cubic inches.

A barrel is 31.5 gallons.

A foot of lumber is 144 cubic inches.

A board foot is 12 inches wide, 12 inches long and one inch or less in thickness.

A cubic foot is (approximately) 9/11 of a bushel.

A bushel is (approximately) $1\frac{1}{4}$ cubic feet.

The circumference of a circle is 3 1/7 times the diameter.

The area of a circle is (approximately) $\frac{4}{5}$ of the square of the diameter.

A cubic foot of water weighs 62.5 pounds.

A cubic foot of milk weighs about 64.37 pounds.

One gallon of milk weighs about 8.6 pounds.

A cubic foot of shelled corn weighs about 45 pounds.

A cubic foot of wheat weighs about 48 pounds.

A square in roofing is 100 square feet.

There are $4\frac{1}{2}$ cubic feet in a barrel.

A cubic yard of clean sand weighs 2,970 pounds.

A cubic yard of coarse sand weighs 2,700 pounds.

Atmospheric pressure is 15 pounds to the square inch at the sea level.

A crate 10 x 11 x 20 inches inside is used for a bushel of potatoes, onions, etc.

Facts about Corn.

When corn is planted 3 ft. 6 in. each way, there are the following number of shocks per acre:

35 shocks when cut 10 hills square.
55 shocks when cut 8 hills square.
44 shocks when cut 8 by 10 hills.

The Farmer's Short Methods of Calculation.

1. To find the cost of articles sold by the hundred, thousand or ton.

PROBLEMS.

What is the cost of a 256 pound hog @ $7.50 per hundred?

Solution. The unit of weight in fixing prices on the stock market is "the hundred." Thus when we say cattle are 8.50 or hogs are 6.95, we mean that cattle are selling @ $8.50 per hundred pounds live weight, and hogs are selling @ $6.95 per hundred live weight.

As the number 256 is composed of 2 hundreds, and 56 units which is 56/100 of a hundred, therefore to find the cost in the above problem we can write the weight 2.56 hundreds. 2.56 x 7.50 = cost.

1. Find the cost of 3,543 pounds of live weight in hogs @ 9.25.
2. Find the cost of three prime steers, weighing 3,750 pounds @ 8.75.
3. What is the cost of 1,196 pounds of flour @ 2.50 per hundred?

In finding the cost of articles sold by the thousand such as tile and lumber, place the period between the thousands and hundreds, and multiply by the price per thousand.

1. What is the cost of 7,645 tile @ 13.50 per thousand?

The cost will be the product of the cost per thousand multiplied by the number of thousands, thus 7.645 x $13.50 = $103.20.

2. Find the cost of 1,675 feet of lumber @ 23.25 per thousand.
3. What will be the cost of 234,865 brick @ 12.75 per thousand?

Hay, sugar beets, coal, steel and a few similar articles are quoted by the ton. When a problem involves a weight of less than one ton, we can calculate the per thousand or hundred as the case may be. Thus 1,760 pounds of hay @ $12.50 per ton would be easily solved by stating the price @ $6.25 per thousand. Then we would have 1.760 x $6.25 = $11.00.

The Market Quotations.

Short methods of calculation:

1. Find the cost of 125,750 pounds of sugar beets @ 5.60 per ton.
2. What is the cost of 1,275 pounds of coal @ $4.65 per ton?
3. Find the cost of 2,365 pounds of hay @ $15.40 per ton.

NOTE. The price per ton is twice the price per thousand. Thousands multiplied by one-half the price per ton will be the cost, or if the number of pounds is equal to one or more tons, place the decimal point to the right of the thousands and divide price per ton by 2 and multiply by the price per thousand, thus 3,625 pounds of steel @ 40 dollars per ton = (3.625) × ($40 ÷ 2) = $72.50.

A retailer who sells hay in small quantities usually multiplies the number of pounds of hay by the price per hundred.

To find the price per hundred, we can divide the price per ton by 20, but since one twentieth of 2,000 is the same as one-tenth of two thousand divided by two, the simplest and quickest method to find the price per hundred is to remove the decimal point one place to the left in the price per ton and divide that by 2. Thus 1 ton of hay at 21 dollars is the same as $2.1 divided by 2 = $1.05 which is the price per hundred.

1. What will 2 bales of hay each weighing 215 pounds, cost @ 22.50 a ton?
2. Find the cost of 325 tile @ $9.50 per thousand, and 750 brick @ $8.40 per thousand; 1,256 feet of lumber @ 16 dollars per M. 2,345 pounds of coal @ 7.30 per ton.

Have a contest among the pupils to test their skill in the solution of the above and similar problems.

Weights of Different Materials per Cubic Foot.

For the purpose of expressing the relation in weight between different solids, water is usually taken as a standard.

Water will vary in weight according to the substances that it holds in solution, and also according to its temperature.

The standard must be invariable, therefore, the standard has been fixed as a cubic foot of distilled water at a temperature of 4° Centigrade, or 39.2° Fahr., because at this temperature it assumes its maximum density.

Pure water, at this temperature will weigh 62.421 pounds, but for all practical purposes in solving problems we shall calculate the relation of water to other solids on the basis that water weighs 62.5 pounds or 1,000 ounces per cubic foot.

Specific Gravity is a term used to express how many times as heavy a body is as an equal volume of water.

Thus if a cubic foot of lead is 11.3 times as heavy as a cubic foot of water, the specific gravity of lead is said to be 11.3.

Every object that is lighter than water will float and will only displace its own weight in water. Thus if a cubic foot of oak is placed in the water, and its specific gravity is .8, its weight will displace 8/10 of a cubic foot of water, and therefore 2/10 of the oak will be above water.

Every object that sinks will displace it own volume of water. Thus a cu. ft. of iron is 7.4 heavier than a cu. ft. of water and will displace one cubic foot of water.

The following table shows the specific gravity of various substances:

Substance.	*Specific Gravity.*
Cork	.24
Pine (dry)	.55
Oak (dry)	.73
Ice (melting)	.92
Alcohol	.84
Turpentine	.87
Milk	1.03
Sugar	1.50
Coal (bituminous)	1.25
Coal (anthracite)	1.80
Sulphuric acid	1.84
Gravel	2.00
Marble	2.80
Flint glass	3.33
Iron (cast)	7.40
Brass	8.50
Copper	8.90
Silver (cast)	10.49
Lead (cast)	11.35
Gold (forged)	19.36
Platinum	22.00

PROBLEMS.

1. A tank is 19 feet long, 4 ft. wide, and 2 ft. deep; what weight of water will it hold?
2. A cake of ice contains 4 cubic feet; if it is placed in water where it will float, how many cubic inches of ice will be above water?
3. What is the weight of a cord of dry oak?

4. What is the weight of a cubic yard of gravel?

5. Find the weight of 20 cubic ft. of oak?

6. If a cubic foot of substance weights 1,030 ounces, what is its specific gravity?

7. What is the weight of a cubic yard of Anthacite coal?

8. How many cubic inches of silver will weigh as much as 10 cubic inches of gold?

9. How many cubic inches of lead will have to be fastened to a cubic foot of cork so that the combined mass shall have the weight of a cubic foot of water?

10. A cubic foot of platinum is on the bottom of body of water, 100 feet deep; how many cubic feet of cork will be required to lift the platinum to the surface?

Specific Gravity of Soils.

PER CUBIC FOOT.

1.	Clean sand	1.76
2.	Coarse sand	1.60
3.	Medium sand	1.54
4.	Find sand	1.48
5.	Sandy loam	1.30
6.	Fine sandy loam	1.32
7.	Silt loam	1.24
8.	Clay loam	1.22
9.	Clay	1.17
10.	Gumbo clay	1.10
11.	Muck	0.33

PROBLEMS.

1. Find the weight of a cubic foot of each kind of soil named in the above list and place weight at the right of the specific gravity. (This will be a valuable table for reference in the study of soils.)

2. How many times greater is the weight of a cu. ft. of water than a cu. ft. of muck? Compare a cu. ft. of clean sand with a cu. ft. of clay. Why is coarse sand heavier than clay loam?

Abundance of Plant-food Elements in the Earth's Crust.

One of the most abundant of plant foods is nitrogen which is about 80 per cent. of the air.

Among the eighty elements that are known to chemists are those that are known to be of chief importance in the growth of plants and animals.

These essential elements and the percentage that they form of the earth's crust are given in the following table: (According to Clark.)

Oxygen	47.00
Hydrogen	.17
Carbon	.12
Phosphorus	.09
Potassium	2.32
Iron	4.64
Calcium	3.50
Magnesium	2.62
Sulphur	0.07

There are four other elements that are of less importance.

Chlorine	0.01
Sodium	2.63
Aluminum	8.16
Silicon	28.06

PROBLEM.

1. What part of the earth's crust is composed of the following food elements of importance: P. H. C. P. K. Fe. Ca. Mg. S.?

Practical Problems.

1. Have the class in agriculture get a tape line and measure the school grounds and find area.
2. Measure outside walls of school building and find area occupied by building.
3. Find the height of several of the tallest trees in the school yard.
4. Find the height of the highest point on the school building.
5. Have each pupil find distance walked each day in going to and from school.
6. Have the class lay off a rectangle 40 by 60 on the school ground, using only a tape measure.
7. Demonstrate how a board can be marked so that it can be sawed off square; do this without using carpenter's square.
8. Demonstrate how to make a mitre box.
9. Have pupils make drawings for constructing a gate 4.5 ft. by 14.5 ft. Make drawings for a barn door 4.5 ft. by 7.5 ft.
10. Draw plans for a wagon box of proper dimensions that will have a capacity of 30 bushels; how many feet of lumber will be required to build it?

11. A binder cuts a strip ⅜ of a rod wide around a square ten acre field; what part of an acre is cut in one round? In two rounds?

12. If a strip of land containing wheat is 160 rods long and 20 rods wide, how many times will a team have to turn at the ends in cutting this field of wheat if the binder cuts off 6 feet and 8 inches on an average?

13. If the same number of acres as given in problem 12 is divided into two square fields, what will be the number of turns in the two fields with a binder cutting 6 ft. 8 inches wide?

14. How many miles must a binder travel in cutting a strip 7 feet wide, to cut 5½ acres?

Farm Mechanics.

In the study of Agriculture we may regard the word *work* to mean overcoming resistance.

1. A force must produce motion to do work.
2. To calculate work by arithmetic it is necessary to weigh the object and to measure the distance it is moved.
3. To lift a pound weight one foot is called a pound of work or a foot-pound.
4. To lift a weight of 25 pounds one foot, requires 25 foot-pounds.
5. To lift a weight of 25 lbs., 4 feet requires 4x25 foot-pounds or 100 foot-pounds.

PROBLEMS.

1. If a weight of 4 lbs. is moved 25 feet, what is the required amount of work?

2. If a team hauling a load exert an average pull of 200 pounds, what will be the work done in pulling the load 10 miles? 10x5,280x 200 = 10,560,000.)

Therefore, to lift a pound 1 ft. vs. gravity or to move a body in any direction, when the force necessary to do this is equal to that required to lift 1 lb., is 1 foot-pound.

Therefore,

Work equals force multiplied by distance.

Energy is the power of doing work, and power is the rate of doing work.

If a horse can do more work than a man it is because he has more energy and power.

Measuring the power or rate of doing work.

The rate of doing work is measured by horse-power. One horse-power is the power necessary to raise 550 lbs., one foot in one second.

PROBLEMS.

1. How many foot-pounds can be moved by one horse-power in one minute?

2. If an engine can raise or move 66,000 foot pounds in a minute, how many horse power does it have?

3. What is the horse-power of an engine that can move 132,000 foot pounds in half a minute?

Draft is the force required to pull a given weight.

PROBLEMS.

1. A horse draws a load of 300 lbs. at the rate of 4 miles per hour, what horse-power is exerted?

Solution:

$4 \times 5{,}280 = 21{,}120$ feet per hour.
$21{,}120 \div 60 = 352$ feet per minute.
$352 \times 300 = 105{,}600$ foot pounds per min.
$105{,}600 \div 33{,}000 = 2.12$ horse-power.

Therefore the energy exerted by this horse is 2.12 horse-power.

2. What is the horse-power of an engine that will raise 8,250 pounds 176 ft. in 4 minutes?

3. A weight of 3 tons is lifted 50 feet. (a) How much work was required to lift it? (b) If the work was done in 30 seconds, what was the horse-power required to do the work?

4. How long will it take a two horse-power engine to raise 10 tons 100 feet?

4. The horse-power used by English and American engineers is the amount of energy which can do 550 foot-pounds of work per second or 33,000 foot-pounds per minute, which is equal to 16.5 foot-tons per minute; what is the horse-power required to raise 16.5 tons per minute to a height of 20 feet?

5. The English and American heat unit is the amount of heat energy required to raise the temperature of one pound of pure water from 32° F. to 33° F., which is 778.3 foot-pounds. How many foot-pounds would be required to raise 1 ton of water 82° above 32° F.?

NOTE — One form of energy may be converted into another.

6. The source of heat which is able to raise the temperature of a pound of water 1° in one second, will raise how many foot-pounds in the same time?

7. If the same number of heat units (778.3 ft.-lbs.) that will raise water 1° will raise a pound of sand from 32° to 37.23° what will be the difference in the amount of the sun's energy expended in heating 1 pound of water and 1 pound of sand from 32° F. to 33° F.?

(When heat is applied to ice at 32°, it will expend all its energy in changing ice to water and will not raise the temperature of the ice until it is melted.)

The temperature of ice cannot be raised.

8. If the amount of heat required to melt 1 lb. of ice is 142 units, what will be the work done expressed in ft.-pounds?

Solution: $142 \times 778.3 = 110{,}518.6$ foot-lbs.

9. What would be the time required for 1 horse-power to melt 1 lb. of ice?

$$\frac{100{,}518.6}{33{,}000} = 3.35 \text{ minutes.}$$

10. When ice and salt are mixed, the changing from the solid to the liquid form takes the heat from the cream so rapidly that the cream in the ice cream freezer is quickly frozen.

One weight of salt and two weights of snow or pounded ice will assume a temperature of —18° C., or 0 Fahr.

PROBLEM.

1. If 1 pound of water at 0° C. be mixed with 1 pound of water at 80° C, what will be the temperature of this 2 lb. mixture?

FRICTION.

When energy is transmitted to a machine there is loss of power through friction; but friction enables the belt to run a wheel and the drivers of the locomotive to haul a load.

Friction may be reduced by using wheels, oil, hard, smooth and level surfaces.

Fortunately friction retards the flow of streams.

MECHANICAL METHODS OF REDUCING FRICTION.

1. Rolling bearings as in grindstone.
2. Ball bearings as in bicycle.

Strength of Materials.

There are three ways by which solid bodies resist force.

1. Resistance to pressure.
2. Resistance to stretch.
3. Resistance to twist.

RESISTANCE TO PRESSURE.

The following rule applies to the strength of moderately seasoned white or yellow pine:

Divide the square of the length in inches by the square of the least thickness in inches; multiply the quotient by .004 and to this product add 1.; divide 5,000 by this sum and the result is the strength in pounds per square inch of the area of the end of the post; multiply this result by the area of the end of the post in inches and the result will be the strength of the post in pounds.

PROBLEMS.

1. If a post of half seasoned white pine firmly fixed and equally loaded is 8 inches square and 8 feet long, what weight in tons is it capable of carrying?

2. A rectangular pillar is 4 by 10 inches and is 12 feet long; how many tons will it carry?

3. How many tons will a post carry that is 4 by 4 inches square and 15 feet long?

4. The dimensions of a rectangular pine pillar are 6 by 8 inches, 22 feet long; what is the number of tons it will support?

5. Find the width of a pillar 12 feet long and 12 inches wide, that will carry a weight of 164 tons.

NOTE — As there is a wide variation in the strength of different kinds of timber and also a difference in the strength of different pieces of the same kind of wood, it is a good rule to estimate the load to be carried at 50 per cent of the theoretical load they are computed to carry.

RESISTANCE TO STRETCH.

According to King, the tensile strength of materials is given as follows:

Elm	6,000	per	square	inch
Poplar	7,000	"	"	"
Maple	10,000	"	"	"
Oak (white or red)	10,000	"	"	"
White pine	10,000	"	"	"
American Hickory	11,000	"	"	"

American Cast Iron	16,000 to 28,000	lbs. per sq. in.
Wrought Iron Wire (annealed)	30,000 to 60,000	lbs. per sq. in.
Wrought Iron Wire (hard)	50,000 to 110,000	lbs. per sq. in.
Wrought Iron Wire Ropes	38,000	lbs. per sq. in.
Rope (best manila)	12,000	lbs. per sq. in.
Rope (hemp)	15,000	lbs. per sq. in.
Leather Belts (1,500 to 5,000 good)	3,000	lbs. per sq. in.

Miscellaneous Practical Problems.

1. A farmer wished to place five harness hooks at equal distance apart on a board 4 ft., 2 in. long, each of the two outside hooks being one inch from the nearest end of the board. How far apart will the farmer make the holes for the hooks?

2. A certain township is exactly six miles square. Its only school house is in the exact center of the township. If all the roads run parallel to the boundaries of the township, and the school house is on a cross road, how far will the pupil who is the greatest distance possible away from the school have to drive or walk to school?

3. A man has a crop of 2,000 barrels of apples, which he sold at $3.00 per barrel. In raising and harvesting the crop, he had employed ten men ten days each, at $1.50 per day, to pick the apples; he had spent in fertilizer $350; counting his own time, he had spent in spraying and cultivating $500.00. What was the net income of his apple crop?

4. A man invests in 320 acres of land at $200 per acre. He erects buildings costing $10,000; he purchased farm equipment and machinery for $1,000. His annual net income from the farm after deducting wages for himself, was $5,000. What per cent did he receive on his investment?

5. In working the ordinary domestic pump about 20 strokes are made per minute, and these will fill a pail holding 24 pounds of water; if 20 strokes are made in 3 minutes how many pounds of water may be supplied in 2 hours?

6. If domestic animals on the farm need water at the rate of 1 cu. ft., per 1,000 lbs., of weight per day; how many pounds of stock can be supplied for 1 day by a windmill or gas engine pumping at the rate of 3 gallons per minute, for 3 hours?

7. If a four inch tile drain with a fall of 6 inches per hundred feet, will discharge .49 cu. ft. per second, how many cu. ft. will it discharge per second if the grade is doubled.

For additional problems see:

Elementary Agriculture—Hatch and Haselwood—Ross and Co., Chicago.

Farm Arithmetic—Burkett and Swartzel—Orange Judd Co., N. Y.

INDEX.