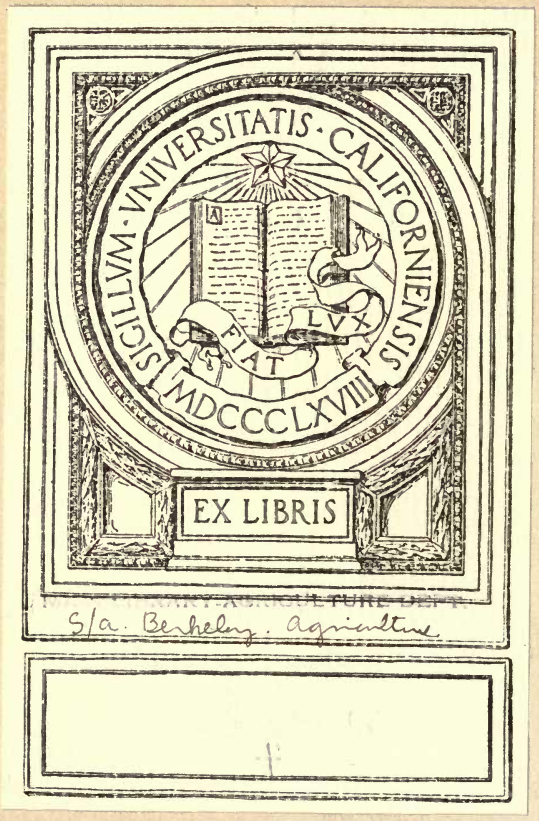
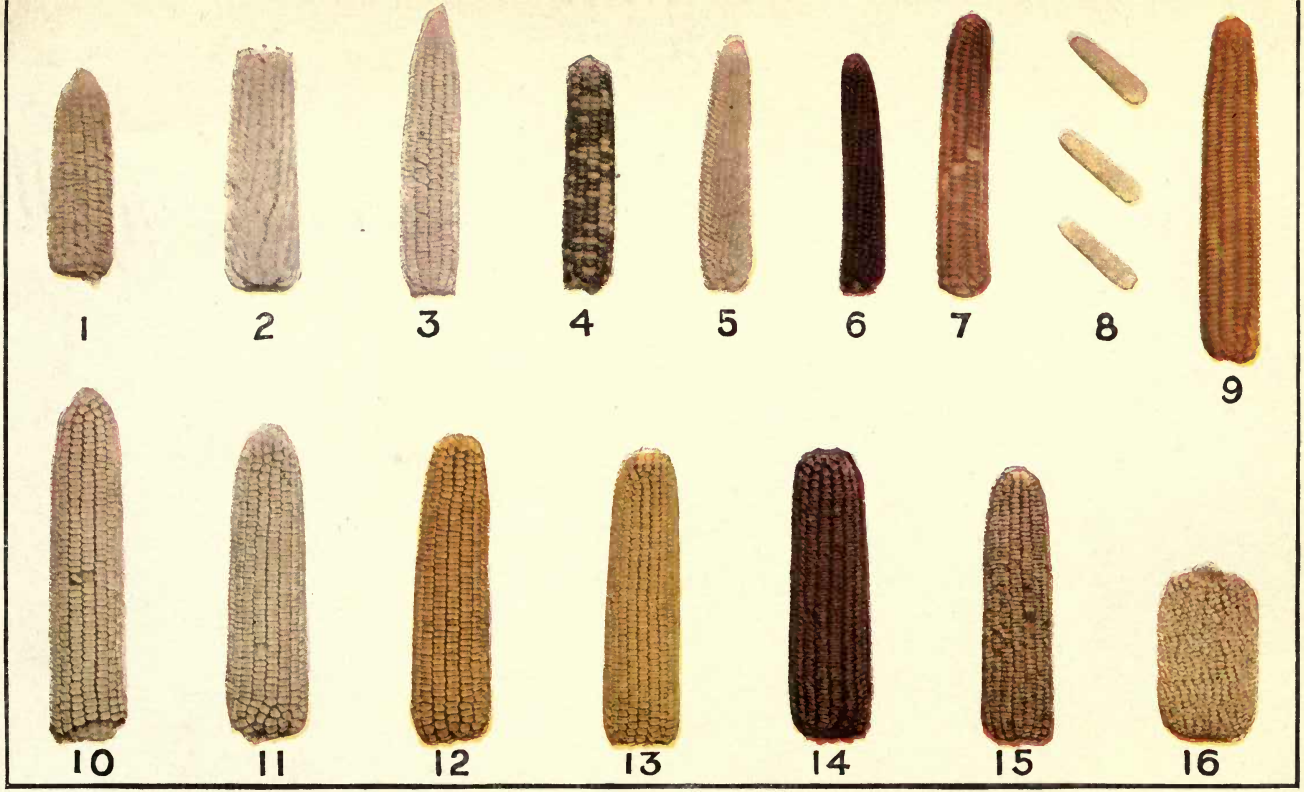
FARMING FOR PROFIT

FARM CROPS
THEIR CULTIVATION AND MANAGEMENT

FRANK D. GARDNER





TYPES AND VARIETIES OF CORN.

1—Sweet (Stowell's evergreen). 2—Pod (probably primitive type). 3—Brazilian Flour Corn. 4—Squaw Corn. 5—Pop (rice). 6—Pop (red pearl). 7—Flint (smut nose). 8—Pop (Tom Thumb). 9—Flint (golden nugget). 10—White Cap Yellow dent. 11—White dent (Boone Co. White). 12—Yellow dent (Improved Leaming). 13—Yellow dent (Reid's Yellow dent). 14—Red dent. 15—Bloody Butcher. 16—Bear Paw.

FARMING FOR PROFIT

FARM CROPS

THEIR CULTIVATION AND MANAGEMENT

A NON-TECHNICAL MANUAL FOR THE CULTIVATION, MANAGEMENT AND IMPROVEMENT OF FARM CROPS

BY

FRANK D. GARDNER

PROFESSOR OF AGRONOMY, PENNSYLVANIA STATE COLLEGE AND EXPERIMENT STATION

ASSISTED BY

C. F. NOLL
Assistant Professor of Agronomy, Pennsylvania State College

ALVA AGEE
Director, Agricultural Extension, Rutgers College

W. H. DARST
Assistant Professor of Agronomy, Pennsylvania State College

PROF. E. F. CAUTHEN
Associate in Agriculture, Alabama Agricultural Experiment Station

GEORGE T. McNESS
Tobacco Expert, Texas Experiment Station

ILLUSTRATED

THE JOHN C. WINSTON COMPANY

PHILADELPHIA CHICAGO

PREFACE

This book makes a popular appeal to all men engaged in farming, whether amateurs or professionals. It is designed to be a handy reference work on the cultivation and management of farm crops. Technical terms and lengthy discussions have been avoided.

Ages of farm experience and a few generations of agricultural research have given us a vast store of practical knowledge on tilling the soil and raising crops. This knowledge is scattered through many different volumes on different phases of the subject, in experiment station bulletins, agricultural journals and encyclopedias. The important facts on which the most successful farming is based are here brought together in readable form.

The subject-matter is arranged in three parts, the first dealing with the various farm crops, their selection and cultivation; the second with the diseases of farm crops and their remedies, insect pests and their control, and insecticides and fungicides; and the third includes valuable tables of agricultural statistics showing the cost per acre of producing farm crops, the fertility of farm produce, percentage composition of agricultural products and so forth.

Each department has been prepared by a specialist in the subject presented, and his name appears at the beginning of each chapter. Those unacknowledged have been prepared by myself. References are given here and there to books and pamphlets that may be helpful to the farmer who wishes to have more exhaustive information on specific subjects.

The illustrations have been secured from many sources. Due credit has been given these.

Special acknowledgment is due the publishers of this volume and the other volumes in the series for their conception and for many helpful suggestions in the presentation of the subject-matter.

Acknowledgment is also due Professor E. L. Worthen and Professor R. S. Smith, both of the Pennsylvania State College, for helpful suggestions and criticisms on crop rotations. I wish also to especially acknowledge the valuable editorial assistance of my wife in the preparation of the manuscript.

FRANK D. GARDNER.

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Crop Improvement

By C. F. Noll
Assistant Professor of Agronomy, Pennsylvania State College

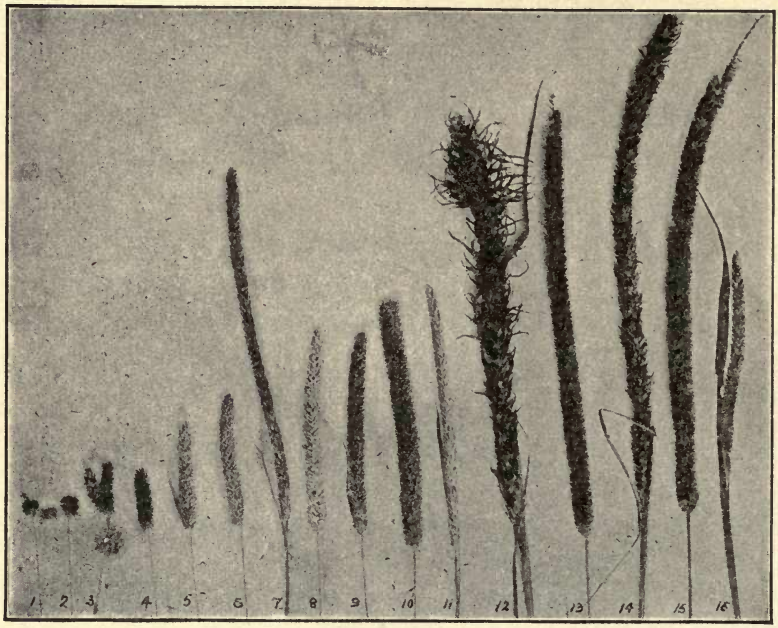
The development of varieties and strains of our farm crops which have great productiveness or superior merit in other respects is a matter of great interest to all agriculturists. Increase in yield due to natural productiveness of a variety results in a gain which is maintained year after year without additional cost of fertilizer or expense in culture. Such gains are of much economic importance, as shown by the differences secured in many variety tests. At the Pennsylvania State College Experiment Station, where varieties of various crops are tested under the same conditions, there are some which outyield others by as much as fifty per cent. Here the good yielding varieties are grown with just the same expense as the poor ones, except for the slight additional cost of handling the increase in crop. Similar results have been secured at experiment stations in nearly every state.

Plant Selection.—Crop improvement or plant breeding is often looked upon as a new thing, but ever since man has been growing plants, they have gradually been modified by seed selection. All of our cultivated plants come from wild forms, but some of them have been so changed that they could not now perpetuate their race if left to shift for themselves. Within the memory of men now living, the fruits of tomatoes have been developed from the size of a walnut to several times as large, and other changes have been effected which have made them more desirable for table use. Though plant improvement has been thus going on for ages, only within the past few decades has there been great general interest in this work, and only of late have some of the fundamental principles been understood.

Man originates to a very limited extent desirable changes in the plants with which he works. He is dependent chiefly upon changes which occur naturally, and all that he does is to take advantage of these changes and perpetuate the forms which are the most suitable for his purpose. He cannot, for example, make the pole lima beans over into the dwarf form, but when dwarf plants are found in a field of lima beans, he can save seed of these plants and perpetuate and multiply a race of dwarf lima beans.

Kinds of Variation.—No two plants are exactly alike, but most of the variations are of no significance to the plant breeder. They may be

due to differences of environment, and in this case will not be inherited. If a hill of corn is heavily manured, the stalks and ears will be larger than where manure is withheld, but seed from these favored hills is not necessarily any better than seed from plants not so well fertilized. However, variations may arise which are hereditary and which may be the beginning of new varieties. When the variations are in the yield or size of plant, usually one cannot distinguish the difference between the variations which are hereditary and those which are not, except by a study of the progeny of the plants. When the variations are in color or form,



VARIATIONS IN TIMOTHY.[1]

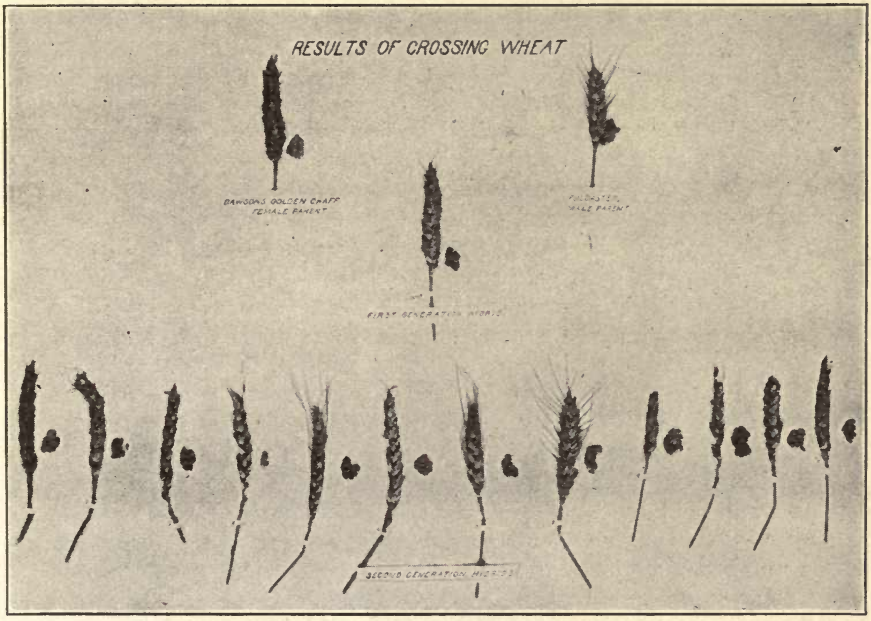
one may have less difficulty in picking out those which could be used to develop new strains or varieties.

Hybridization.—Hybridization means the crossing of plants of different species or different varieties. It is accomplished by taking the pollen from a flower of one of the plants to be crossed and placing it on the pistil of a flower of the other. Care must always be exercised to prevent the plant-producing seed from being fertilized with its own pollen or with foreign pollen carried by the wind or by insects.

While there has been a good deal of mystery to many in regard to the crossing of plants and a disposition to regard hybrids as of superior

[1] Courtesy of The Macmillan Company, N. Y. From "Plant Breeding," by Bailey.

merit, the cross-fertilization is usually easily accomplished, and, on the other hand, the varieties produced by crossing are not necessarily of superior merit. Crossing of plants for the most part results in new combinations of parental characters. By crossing a yellow pear tomato and a large red one, one could produce a red pear tomato and a large yellow one. If a variety of wheat with bearded heads and white grains is crossed with a variety with smooth heads and red grains, there could be produced a bearded wheat with red grains and a smooth wheat with white grains. By selection and propagation the characters become fixed and give new varieties.



NOTE THE VARIATION IN THE SECOND GENERATION HYBRIDS.[1]

Choice of Varieties.—In attempting to improve a crop one should first endeavor to secure a first-class variety. Because of the great difference in varieties, if the poorer yielding ones were chosen and an attempt were made to improve them in productiveness, it is not likely that they could be made better than varieties already in existence.

Variety testing is a rather simple matter, but some precautions must be observed if the results are to be dependable. The main considerations are as follows:

1. The varieties should be tested on as uniform soil as possible of the kind on which the field crops are to be grown.

[1] Courtesy of Pennsylvania Agricultural Experiment Station.

2. The plats should be long and narrow rather than short and broad, and should extend across inequalities in the land rather than parallel with them.
3. A known standard variety should be planted in every third or fourth plat for comparison.
4. Trials should be conducted for a number of years and the choice of a variety based upon the average performance rather than upon the results of only one year.

Suggestions are given in this chapter for the improvement of a few crops. The methods of procedure with others would be similar, depending chiefly upon how the blossoms are fertilized and upon methods of propagation.

CORN

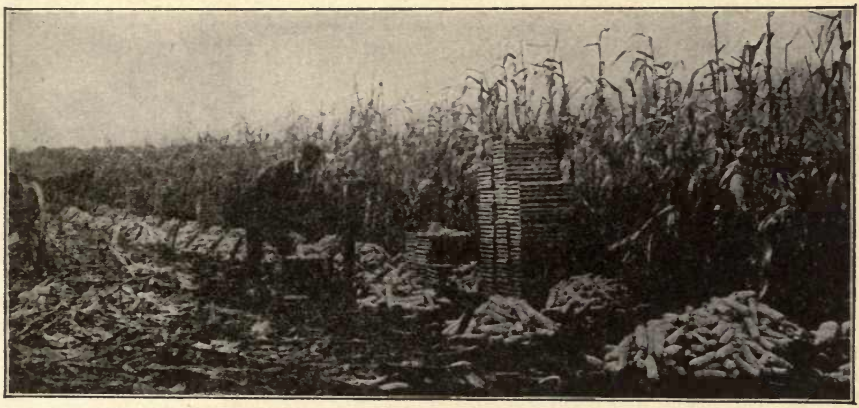
Special care must be exercised in the purchase of seed-corn. This crop tends to become adapted to local conditions and may not do well when removed to different localities. Especially is there likely to be a failure to mature when seed from a locality having a longer season is bought. On the other hand, a wise selection of seed should enable a farmer to adapt his corn better to his own conditions.

Most of our best known varieties have thus been developed by consistent selection of seed for a number of years on the same farm. The well-known Leaming variety was developed by J. S. Leaming in Clinton County, Ohio, by continuous selection, from a variety bought in Hamilton County, Ohio, in 1855. By selection along the same line, this variety was made very uniform. Reid's Yellow Dent, a very popular variety of a well-defined type, originated with a cross between two varieties planted in the same field by Robert Reid in 1846. The type was fixed in this case also by continuous selection. Most farmers could not do better than test a number of varieties to find a good one and then by careful selection of seed try to make it better.

The Ear-Row Method.—The most rapid improvement of corn is accomplished by some ear-row (or ear-to-row) method of breeding. There are a number of methods in use which vary in detail. By ear-row planting is meant the planting of each ear to be tested in a row by itself to determine its productiveness and other desirable qualities. The rows should be of such a length that not over half of the seed on an ear need be planted. If the rows are three and one-half feet apart and the hills three feet apart, forty-two hills will comprise approximately one one-hundredth of an acre. Five or six grains should be planted in a hill and when the corn is up, it should be thinned to three stalks per hill. Mixed seed of the variety should be planted for a check every sixth row. During the growing season the rows should be observed and desirable or undesirable characteristics noted.

Each row should be harvested separately. Since the yield of stover

is of only minor importance, it does not matter whether the plants are cut or not, but they must be husked separately and the corn ears weighed. After the yields of the ear-rows have been obtained, any one of a number of methods for continuing the work may be followed. The simplest way is to take the remnants of the best ears as shown by the ear-row test, shell these together and plant in an isolated seed plat the next year. From this plat the diseased and weak stalks should be removed before the pollen is shed. Seed should be saved from the best rows in the ear-row plat for field planting the next year. The third year there should be an ear-row plat like that of the first year and the ears for this should come from the multiplying plat grown the second year. The seed of the main crop the third year should come from the multiplying plat and from the part of the field in which the seed from the ear-rows was planted. This



THE EAR-TO-ROW TEST PLAT WITH CORN HUSKED, SHOWING A METHOD USED IN ASCERTAINING WHICH SEED EARS HAVE YIELDED BEST.[1]

method provides for an ear-row plat and a multiplying plat on alternate years.

Ideals in Selection of Corn.—Besides attempting to secure greater productiveness in a variety of corn, one who would improve the crop should seek to adapt the variety in length of growing season to the locality in which it is grown. In a general way the best varieties are those which require about all of the season for development and yet can be depended upon to mature before frost.

The stalks should be of medium size and able to stand up well. The ears should be of medium height from the ground, with a rather short shank, and should droop somewhat rather than stand erect. By continuous selection for high and low ears for five years at the Ohio Experiment Station, two strains were developed from one variety with a

[1] From Year-Book, U. S. Dept. of Agriculture.

difference in height of ear of over two feet. Here the low-eared strain was the earlier and gave the greatest average yield.*

The ears should be of good size, should have medium size cobs, should be fairly uniform in color and type of kernel and should be attractive in appearance. The so-called show points of the ears are of less economic importance than was at one time thought, but corn that looks good finds the best market when sold for seed.

In the above discussion it has been assumed that the corn is grown primarily for grain. Ensilage varieties should have a rather large, leafy stalk besides a good ear, and may be somewhat later in maturing than varieties for grain.

WHEAT, OATS AND BARLEY

In the case of wheat, oats and barley, variations frequently occur within a variety which make it worth while to search for those which are better than the parent variety and to multiply them as new strains.

First Year.—Go through the field and select choice heads, taking as many as can be planted separately, remembering that really good strains are more likely to be found in a large number than in a small number.

Second Year.—Plant the seed of these heads each in a separate row. Make the rows a foot apart and plant the grains four inches apart in the row. The same number of grains should be planted from each head, which may be twenty-five or thirty.

When ripe, the number of plants in each row should be determined, the rows should be cut separately and the yield of each gotten.

Third Year.—A number of ounces of seed of each strain should now be available. If 100 head-rows has been planted the year before, about twenty of the best should be sown this year. These should be sown under field conditions and the parent variety should be sown for a check and put into every third plat. A good size of plat is sixteen feet long and two rows wide, the rows being eight inches apart and the plats ten inches apart. These grains can be planted thus side by side, for they do not readily cross-fertilize.

Fourth Year.—By the fourth year there will be enough seed for a larger plat which may be sown with a grain drill. A good plan is to shut off the middle hoe, put in a partition and sow at one time two plats of four or five drill rows each, depending upon whether the drill used has nine hoes or eleven. As before, the parent variety should be sown in every third plat. Only the most promising strains should be continued.

Fifth and Succeeding Years.—If desired, the plats may be made larger than the fourth year, but the arrangement of plats should be the same. Only those which are a decided improvement on the parent variety should be retained.

* Ohio Experiment Station Bulletin No. 282, Corn Experiments, by C. G. Williams and F. A. Welton.

Crossing of Varieties in Small Grain Breeding.—Different varieties may be crossed for new combinations of characters as discussed before. The first generation from the cross will look like one parent in respect to some characters and like the other parent in others. The seed of each plant should be kept separate and planted like the head-rows in selection work. Usually it will be found that the progeny of these parent plants are not uniform. In that case the grain from each plant must be kept separate and planted again in separate rows as before and this must be kept up until all the plants from a parent are alike in all of their visible characters. Those that are uniform should be considered pure strains, and after this the testing may proceed as with selections from the third year on.

Varieties of these crops should be improved in production first of all, but also in resistance to disease and stiffness of straw. In the case of wheat, the milling quality of the grain is important, and in oats, from the market point of view, the color of grain, white being the preferred color.

Many of the older varieties of these crops owe their origin to selections made by farmers and some to crosses. Of the varieties of wheat, Fultz was originated by Abraham Fultz in 1862 from a selection from Lancaster; Gold Coin, which was an accidental seedling variation, was selected from Deihl Mediterranean; Fulcaster, the well-known red-bearded variety, resulted from a cross between Fultz and Lancaster, made by S. M. Schindel, Hagerstown, Md.

POTATOES

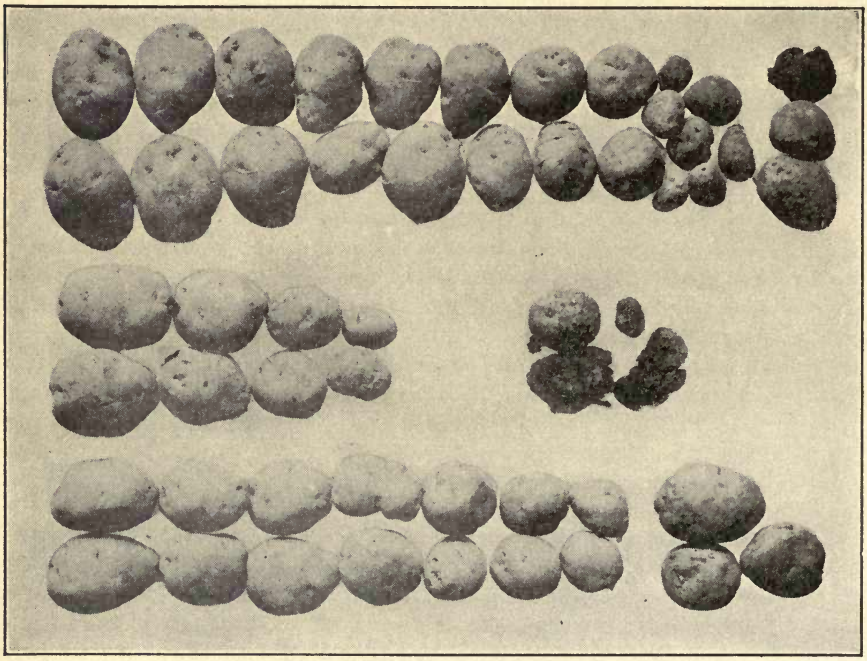
Production of Seedlings.—New varieties of potatoes originate from seedlings. The seeds are produced in the true fruits, which come after the blossoms and look like little green tomatoes. These fruits or balls, as they are commonly called, are produced very sparingly and in some seasons none are seen. The seed should be sown indoors early in the spring and the young potato plants handled like tomatoes until they are set out in the field. Transplanting to pots increases their vigor. The first year few reach full development and most do not for two or more years. The seedlings, as a rule, are quite variable and few if any look just like the parents. Each should be regarded as a new variety and given a number and kept separate as long as grown.

The work is very interesting and may give varieties better than those already on the market, but most seedlings are of inferior merit.

Hill and Tuber Selection.—Potatoes vary in the hill and it is possible to improve a variety by selection of the best hills or the best tubers. It is a good practice to dig by hand a great many hills and save seed of some of the best for a seed plat the next year. This seed plat should be gone over and weak and diseased hills removed and the remainder saved for

the field planting. Greater progress will be made by keeping the tubers from selected hills separate and testing these as new strains. Each should have a number by which it will always be known. The first year ten hills of each might be planted in rows side by side with the parent variety every third place. The best only should be saved and the next and succeeding years the plats may be made larger.

Tuber unit selection should start with selected tubers of the same size which are desirable in appearance and free from disease. These are each cut into four pieces, which are planted in succession, one tuber after



Variation in Yield of Potatoes from Selected Tubers.[1]

the other, with some space between the hills from the different tubers. When mature, the four hills from a tuber are dug together and the future selection based upon the yield of tubers and their appearance. These must be designated by numbers as in other selection work. The next year single row plats of ten or more hills each of the most promising may be planted, with the parent variety in every third plat as before.

Potatoes may be improved in productiveness, disease resistance and quality of tubers. There is a difference in susceptibility, especially to

[1] Courtesy of Pennsylvania Agricultural Experiment Station.

early and late blight, and perhaps to other serious diseases. Only strains of high market quality should be perpetuated. The tubers should be of medium size, smooth in outline, flat oval or flat oblong in shape and have shallow eyes.

Where carefully conducted, these methods of selection have resulted in the improvement of the variety.

Opportunities in Crop Improvement.—There is need in every community that at least one farmer make a specialty of producing and selling improved farm seeds. Such work is usually very remunerative, besides being of value to the whole neighborhood.

Testing of varieties and the improvement of certain crops may be made a matter of community interest, especially where there is some farmers' organization. There is also the opportunity of forming clubs or associations for crop improvement, which may be quite local or statewide, as in the case of many state crop improvement associations now in existence.

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CHAPTER 2

The Rotation of Crops

In all of the older agricultural districts the rotation of crops is recognized as an essential to successful farming. With the prevailing price of corn, farmers on the best lands in the corn-growing belt have found it profitable to grow corn after corn for a number of years. In like manner, on the best wheat land in Minnesota, the Dakotas and Canada, wheat grown continuously has proven a profitable enterprise. In that region farmers find no good argument in favor of fencing their farms, constructing farm buildings, feeding cattle and milking cows, when they can make as much money or more by a system of farming that occupies their time for a little more than one-half the year and allows them leisure during the remainder of the year. A single crop system, while successful for a time, however, will not prove successful in the long run.

Successful farming calls not only for the best possible utilization of the soil and the maintenance of its fertility, but also demands the fullest possible utilization of the labor that is to be employed. The efficiency of the labor of men and teams on farms is measured largely by the proportion of time for which they are profitably employed. In nearly all other enterprises labor is fully and continuously employed. In order that farming may compete with other enterprises for labor, it must be likewise employed on the farm.

Rotations Defined.—A crop rotation is a succession of crops grown on the same land. A good crop rotation is a systematic succession of the three general classes of farm crops, namely, cultivated crops, grain crops and grass crops, in such a way as to give large yields and provide pasture and forage on the farm at the least expense of labor and soil fertility.

The rotation is definite when the crops recur in a fixed order, and it is a fixed rotation when they not only recur in a fixed order, but also at regular intervals. A rotation consisting of corn, oats, wheat and clover and timothy is a definite one, regardless of whether the clover and timothy remain for one, two or three years, but it becomes a fixed rotation when not only the order of the crops is named, but the length of time of each crop is also specified.

Purpose of Rotations.—A rotation of crops (1) provides for maintaining the soil in good tilth; (2) supplies organic matter and nitrogen; (3) prevents destructive outbreaks of insect pests; (4) reduces plant diseases; (5) provides for the economical destruction of weeds; (6) maintains crop yields; (7) distributes the labor of men and horses; (8) saves labor in cultivation of land; (9) keeps the soil occupied; (10) provides for a

balanced removal of plant food; (11) systematizes farming; and (12) may control toxic substances.

Maintain Good Physical Condition of Soil.—Deep-rooted plants, such as alfalfa and the clovers, improve the physical condition of the subsoil as a result of root penetration. The cultivation given to inter-tilled crops, such as corn, potatoes, beets and the truck crops, improves the physical condition of the surface soil. Such frequent cultivation may tend to reduce the organic matter of the soil, but this will be largely overcome by the stubble and roots of the grasses and clovers that follow the grain crops.

Conserve Organic Matter and Nitrogen.—Extensive rotation experiments at the Minnesota Experiment Station show that standard rotations,

DANGERS OF CONTINUOUS CROPPING.[1]

On the left is corn growing on land that has grown corn continuously for 19 years. On the right is corn in a five-year rotation. Both fields were planted on the same day to the same kind of corn. The yield on the field to the left is 27.5 bushels to the acre. The field on the right gives 61.3 bushels an acre. These are the average yields for ten years.

which include an inter-tilled crop, small grains and grasses with clover, all gave net profits. A four-years' rotation of millet, barley, corn and oats was no better than four years of continuous growing of wheat. All of these are classified as exhaustive crops. They cause a reduction in both the organic matter and nitrogen supply of the soil. Land cropped continuously to wheat, corn, potatoes or mangels for a period of ten years, showed a loss of 1100 pounds of nitrogen and 20,000 pounds of carbon per acre. In twelve standard rotations covering the same period of time, there was a gain of 300 pounds of nitrogen per acre, while the carbon and humus in the soil was maintained and in some cases increased. In the standard rotations eight tons of manure per acre were applied once during the rotation.

Provide for Extermination of Weeds.—Noxious weeds often cause a serious loss in farming. Weeds not only rob the crops of plant food and

[1] From "Farm Management" by Boss. Courtesy of Lyons and Carnahan, Chicago.

moisture, thus reducing the yield and sometimes causing absolute failure, but they entail additional labor in the process of cultivation. Many weeds grow best in certain kinds of crops. For example, mustard is a common weed in the small grain crops in the prairie states. The seeds ripen a little earlier than the grain, and in the process of harvesting are freely shattered and seed the land for the succeeding year. Where small grain is grown continuously this weed becomes a serious pest. Its extermination calls for an inter-tilled crop following the small grain. Pigweed, bindweed, foxtail and crab-grass are common in corn and potato fields, but they seldom become serious in small grain fields or in grass land; consequently, cultivated crops followed by grasses and small grains make for extermination of these weeds. Daisies, wild carrot and buckhorn are common weeds in hay fields, and generally grow worse the longer the land remains in hay. Such weeds, however, give no trouble in cultivated fields devoted to corn, potatoes, etc., and the cultivation helps to exterminate them.

Lessen Insect Depredations.—Most insect pests live upon some particular crop or a few closely related crops. A crop or related crops, grown continuously on the same land, affords an opportunity for the associated insects to multiply and become very numerous. The remedy is to plant the infested fields with a crop which will not be injured by the pest in question. Unless these insects have the power of migration they will perish for the want of suitable food or for lack of conditions suitable for multiplication.

However efficient the rotation of crops may be in the extermination of insects, some rotations may prove not only ineffective but actually disastrous. For example, land that has been long in grass sometimes becomes so infested with wire-worms as to cause a practical failure when devoted to corn. Grass affords conditions favorable to the multiplication of wire-worms, and they may live in the soil sufficiently long after the grass is plowed up to destroy a crop of corn which follows. Under such conditions fall plowing or bare fallow should precede the planting of the corn. The bill bug breeds freely in the bulbous roots of timothy, and when timothy sod is plowed late in the spring and planted to corn, this insect transfers its attention to the corn with disastrous results. Such trouble may be avoided by destroying the existing vegetation some time in advance of planting the corn. The insect under such conditions will either be starved or forced to leave the field before it is planted to corn.

Cutworms are a great menace to newly planted tobacco and many other crops, but their presence depends largely on the preceding crop. Cutworms multiply extensively only in grass land where the eggs are laid by the moths. Many similar examples could be cited, and success in preventing insect depredation by crop rotation calls for a knowledge of the life history and habits of the insect pest concerned. (See Chapter 76: "Insect Pests and Their Control.")

Reduce Plant Diseases.—Plant diseases, like insect pests, are generally restricted to a particular crop or small group of closely related crops. The potato scab, so far as is known, is confined solely to potatoes. Its presence in the soil prevents the continuous growing of potatoes, and calls for a rotation in which the interval between successive potato crops is sufficiently long to provide for the disappearance of the disease. In a similar manner flax wilt or cotton wilt demands a rotation of crops in order to prevent the disease becoming disastrous. Bacterial diseases of tomatoes, potatoes, eggplants, cabbage and numerous other vegetables, the rusts and smuts of small grains, and many other diseases accumulate in the soil under the one-crop system. These troubles can be largely avoided and the crop-producing power of the soil maintained by intelligent systems of rotation. The most profitable system for any locality or type of farming can generally be ascertained from the state experiment station.

Improve Environment of Crop.—Aside from insect pest, plant diseases and weeds which flourish under the one-crop system to the disadvantage of the crop, there is another factor inimical to best plant growth. This consists of excreta given off by the roots of plants that accumulate in the soil to their detriment. As a rule, such excreta are not equally injurious to a different class of crops, and a rotation, therefore, lessens the injury. The excreted substances are organic in nature and are either changed in character or entirely disappear with time, so that the crop giving rise to them may be returned to the land after a year or more without injury.

Rotations Insure Returns.—The old adage, "Don't place all your eggs in one basket," applies with equal force in the production of crops. Unfavorable conditions in any locality are seldom such as to cause a failure of all kinds of crops, although a complete failure of a particular crop in a certain locality is not uncommon. A rotation of crops which includes a variety of crops, therefore, avoids complete failure.

Prevent Reduced Crop Yields.—The tillage given to a cultivated crop, such as corn or potatoes, increases the yield of the crop that follows by providing a better physical condition of the soil. In like manner legumes leave organic matter and nitrogen in the soil which is utilized to the advantage of corn or potatoes which may follow. The cultivation given crops destroys weeds to the advantage of crops which follow, and which do not receive cultivation.

Rotations Systematize Farming.—A well-planned rotation of crops enables the farmer to know definitely what is to be done each year, and makes possible an estimation of the general expenses and returns that may be expected. It also enables him to plan his work and secure his materials, such as seed, fertilizers, etc., in advance of the time they are needed.

Rotations Distribute Labor.—A good rotation of crops will enable the farmer to do a larger proportion of his own work than would be possible

if the land were devoted to one crop. This enables him to utilize his own labor to the fullest possible advantage, and to reduce the expense necessary for hired labor. It is important, therefore, in selecting crops for a rotation, to select those that will compete with each other for the labor of men and teams as little as possible. The common rotation of corn, oats, wheat and hay fulfils these requirements fairly well. To illustrate, the preparation of land and seeding of oats take place in the early spring. Between the seeding time of oats and the time for planting corn there is sufficient time to prepare the land for the latter crop. The cultivation of corn will precede the harvest of hay and oats. The preparation of land for winter wheat will take place after the harvest period and prior to the harvest of corn. This fully occupies the time of the farmer during the growing season. There will sometimes be conflict between the harvest of wheat and hay, and the cultivation of corn, necessitating a little extra labor at that time.

Essentials of a Good Rotation.—A good crop rotation should contain (1) an inter-tilled crop, (2) a cash crop, (3) crops to feed, and (4) a crop to supply humus and nitrogen. All crops may be roughly classified under three heads, namely: exhaustive, intermediate and restorative. All crops, when harvested, remove from the land more or less plant food, and in this sense they are exhaustive. No crop restores to the soil any considerable amount of plant food unless it is plowed under or allowed to decay on the surface of the soil. Notwithstanding these facts, certain crops leave land in poorer condition for subsequent crops than it was before. These are designated as exhaustive crops, and include wheat, oats, rye, barley and millet. Their ill effect upon subsequent crops may be due to any one or a combination of a number of factors, among which are physical condition of the soil, injurious insects, plant diseases, reduction of soil moisture and a failure to supply either organic matter or nitrogen in any appreciable quantity.

It is wise, therefore, to select as many restorative crops as possible and so arrange the crops that these will be followed by the exhaustive crops. These two classes of crops should alternate as far as possible. In conjunction with this, one should select crops that will yield well and for which there is a demand, either for feeding on the farm or as a cash crop. The best varieties of the crops entering into the rotation should always be used. These will be determined largely by local conditions.

Sequence of Crops.—It is a good plan to follow a crop with a long growing season by one having a short growing season. This is typified when corn is followed by oats. In turn oats or barley is removed from the land in ample time for seeding winter wheat, which occupies the land for a rather long period. In this connection it is wise to provide in the rotation a place where manure may be hauled directly from stables and barnyards and applied to the fields. Where there is an abundance of

manure and corn is extensively and advantageously used as feed for live-stock, corn may be grown two years in succession, especially when the soil is fertile and manure is available for both the first and second crops. It is desirable that crops be arranged in such a way that the improving effects of each crop shall be regularly received and the ill effects of the exhaustive crops be systematically neutralized by the crop that follows.

Length of Rotations.—The length of crop rotations will be determined by local conditions and the character of crops grown, together with the value of land and cost of labor. Crops that are costly to establish, such as alfalfa, should occupy the land for two or more years in order to minimize the annual cost of production. The length of time that a crop remains productive is also a factor. The annual cost of seed and the preparation of the land for the crop is one-half or one-third as much if the crop is continued for two or three years respectively, as it is if allowed to remain only one year. So long as the yield is satisfactory, it generally pays to continue the crop. This tends toward a longer crop rotation.

In many localities where general farm crops prevail, a seven-year rotation is common, such for example as corn, oats, wheat and mixed clover and timothy for four years. Such long rotations with only one legume in them do not make for increased soil fertility, unless all the crops produced are fed upon the farm and the manure returned to the fields. Where cash crops dominate the type of farming, short rotations may be better. A rotation of corn, wheat and clover or of potatoes, wheat and clover affords the maximum of cash crops, while the frequency of clover in the rotation tends to maintain the nitrogen supply of the soil. Such short rotations also maintain the soil in good tilth as a result of the frequent plowing and abundant tillage.

What Crops to Grow.—The crops to be grown in a rotation will be determined by a number of factors, as soil adaptation, length of growing season, market demands, transportation facilities, and the system of farming that prevails. Aside from these facts there is another consideration that must not be overlooked. Usually it is unwise to follow a crop like tobacco, which is considered a gross feeder, with another crop such as corn having similar feeding habits. Such a practice is permissible only on very fertile soil or where the quality of the following crops is to be influenced through reduction in organic matter or available plant food. For example, coarseness in tobacco might be reduced by having it preceded by corn.

When to Apply Manure and Fertilizers.—It is generally advisable to apply barnyard manure to those crops in the rotation that have a long growing season or a high money value, or to those that are considered gross feeders, such as corn. In the absence of manure, the same rule will apply in the applications of commercial fertilizers. When manure is supplemented with fertilizers, the fertilizers are best adapted to crops of

short growing season or to those influenced in quality by the character or form of a particular fertilizer ingredient. In this connection it should be borne in mind that the legumes require only mineral fertilizers and that crops that demand much nitrogen should follow the legumes.

Some Suggested Rotations.—Crops should naturally follow each other in such a way that each crop paves the way for the one that is to follow. Best results will be secured when plants are not compelled to do their part at a disadvantage. Wherever feasible, a large proportion of the product of a rotation should be food for livestock. This provides for the maintenance of soil fertility.

In the northeastern part of the United States a rotation of corn, oats, wheat and hay with various modifications dominates most of the general and livestock types of farming. By omitting oats a three-crop rotation results, which, if restricted to three years in length, makes for soil fertility, provides a cash crop and at the same time furnished an abundance of livestock food and bedding. This may be supplemented with alfalfa, thus increasing the protein supply. On soils poorly adapted to wheat this crop may be omitted and oats will take its place. In the northernmost latitudes and at higher elevations the acreage of corn will be reduced and that of oats and hay increased. Where markets are favorable and the soil is adapted to potatoes, this crop may be substituted for a portion of the corn, thus increasing the cash crops at the expense of forage.

Wheat generally proves a better crop in which to seed clover and the grasses than does oats. In most parts of this section of the country the grasses are seeded in the autumn and the clover seeded early in the spring. Further south, both clover and the grasses may be seeded in the autumn. The four staple crops above mentioned may be arranged into several rotations with manure and fertilizers applied as suggested in the following tabulation.

METHOD OF FERTILIZING CROP ROTATIONS.*

3 Years.	4 Years.	5 Years.	7 Years.	Per Acre.
..	..	..	1	Corn: 6 to 10 loads of manure and 25 lbs. of phosphoric acid.
1	1	1	2	Corn: 6 to 10 loads of manure and 25 lbs. of phosphoric acid.
..	2	2	3	Oats: no fertilizer.
2	3	3	4	Wheat: 50 lbs. each of phosphoric acid and potash.
3	4	4	5	Clover and timothy: no fertilizer.
..	..	5	6	Timothy: 25 lbs. each of nitrogen, phosphoric acid and potash.
..	..	..	7	Timothy: 25 lbs. each of nitrogen, phosphoric acid and potash.

* Roughly speaking, 25 pounds each of nitrogen, phosphoric acid and potash may be obtained by buying 150 pounds nitrate of soda, 175 pounds of acid phosphate and 50 pounds of muriate of potash. The cost of the ingredients may be estimated from the following prices per pound, which will vary according to circumstances: nitrogen, 18 cents; phosphoric acid, 4 cents; and potash, 5 cents.

In the trucking regions of New Jersey, Delaware, Maryland and Virginia, two crops may frequently be secured in one season. Over much of this region tomatoes may be set as late as June 1st. This gives opportunity to grow a quick-maturing crop before the land is needed for tomatoes. If hay is needed crimson clover may be seeded in the fall and cut for hay the next spring, before the land is needed for tomatoes. Where canneries are available, early peas may be harvested before time to set tomatoes. This gives two crops in one season, both of which provide for the operation of the cannery and prolong its season of activity. Crimson clover may be seeded in the tomatoes at the last cultivation, and growth turned under the following spring for the benefit of a succeeding crop.

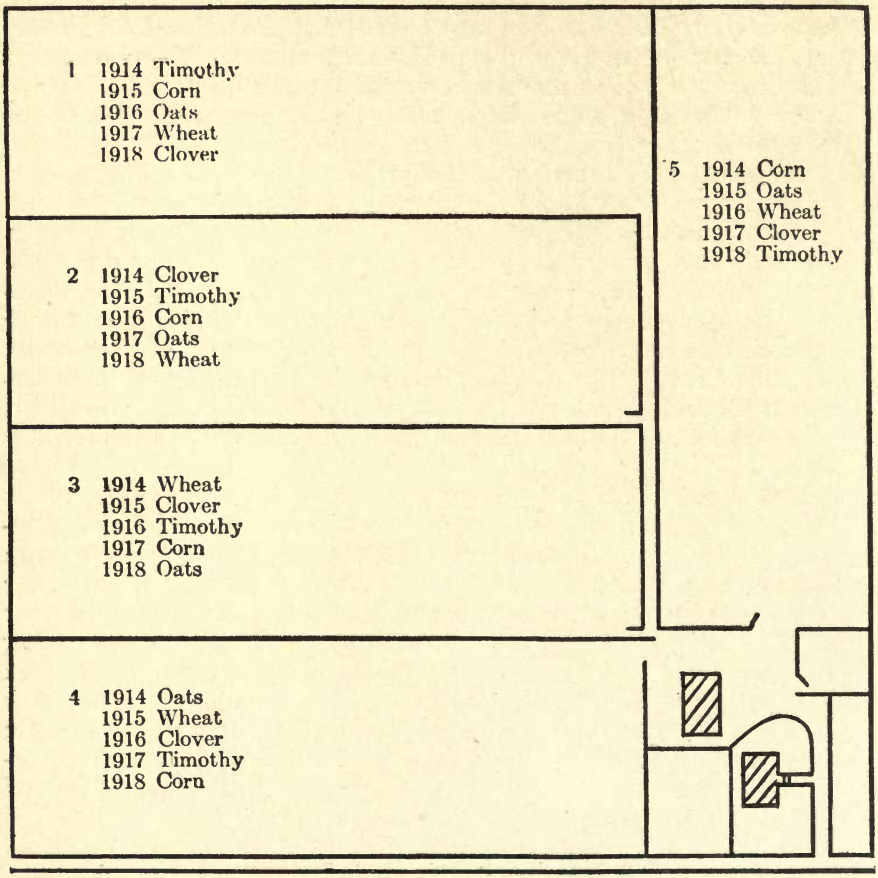
In this district a two-year rotation in which four crops are grown is found to be quite successful. Two of these are cash crops and two are renovating crops. The cash crops are corn and either potatoes or tomatoes. The renovating crops are crimson clover or soy beans or winter rye mixed with winter vetch. This makes the purchase of nitrogen in fertilizers unnecessary. Acid phosphate and potash are applied in moderate quantities and generally to the cash crops only. This system, without any manure and with the occasional use of lime, maintains the fertility of the soil.

In portions of Ohio and Indiana a three-year rotation of corn, wheat and clover is common. One strong point in this rotation is that one plowing answers for three crops. When the clover sod is plowed for corn in the spring the ground breaks up easily and makes an ideal seed-bed for corn. The cultivation given the corn provides a good seed-bed for wheat with no other preparation than thorough disking and harrowing of the corn stubble. This, of course, necessitates a removal of the corn stalks sufficiently early to seed wheat. It is not applicable where the growing season is too short. This rotation not only economizes in labor as above suggested, but makes a good distribution of labor. Furthermore, it provides for rather continuous occupation of the soil. If the sod devoted to corn is not plowed until spring and corn is followed by fall seeding of wheat in which grass and clover is seeded, the soil will be subject to erosion only during the time it is in corn. Erosion in this case may take place in times of heavy rains and on rolling land, by the water running down the furrows between the corn rows. This may generally be overcome by having the rows and cultivation at right angles to the slope.

This is a fairly good rotation for the stockman and dairy farmer. Corn furnishes the material for the silo, while clover hay supplies the protein in which corn is deficient, thus giving a well-balanced ration. The wheat straw makes good bedding, while the wheat may be either sold or exchanged for concentrates. On farms having no permanent pasture the clover and timothy may be left for another year, cut once and pastured afterwards, or, if necessary, it may be pastured throughout the fourth

year. If used for this purpose, both timothy and alsike clover should be seeded with the red clover.

The following five- and six-year rotations have been found successful



A Five-Year Rotation.

Field.	1914.	1915.	1916.	1917.	1918.
1—25 A.	Timothy	Corn	Oats	Wheat	Clover
2— "	Clover	Timothy	Corn	Oats	Wheat
3— "	Wheat	Clover	Timothy	Corn	Oats
4— "	Oats	Wheat	Clover	Timothy	Corn
5— "	Corn	Oats	Wheat	Clover	Timothy

in the Great Plains area: (1) corn; wheat; brome-grass; brome-grass; oats, barley or emmer; (2) corn; wheat; brome-grass; brome-grass; brome-grass; oats, barley or emmer. In these rotations the wheat may

be either winter or spring, and, furthermore, wheat may be substituted for any of the last-mentioned crops in either of the rotations.

Space will not permit the enumeration of all the rotations that are possible. With a clear understanding of the underlying principles and a knowledge concerning the utilization and market value of the crops to be grown, any farmer may plan crop rotations best suited to his farm.

Methods of Planning and Recording Rotations.—It is a principle that there should be as many fields as there are years and crops in the rotation, unless two crops can be harvested from the land in one year. It is also advisable that the fields be as nearly of equal size and productivity as possible. This provides for uniformity in distribution of work from year to year, as well as in the utilization of the products. Where livestock dominates the type of farming, it will often be found advisable to adopt two rotations, one known as the major and the other as the minor rotation. The former will include the staple crops grown both for feed and market, while the latter provide soiling and annual pasture crops. In such a scheme the minor rotation should be located near the farmstead where the small fields will be easily accessible. The tabulation on preceding page shows how a five-field rotation may be planned, and serves as a record of what has been and what will be in every field in any particular year.

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"Field Crops." Wilson and Warburton.
"Soils and Fertilizers." Snyder, pages 131–159.
Minnesota Expt. Station Bulletin 109. "Rotation of Crops."
Ohio Experiment Station Bulletin 182. "Maintenance of Fertility."
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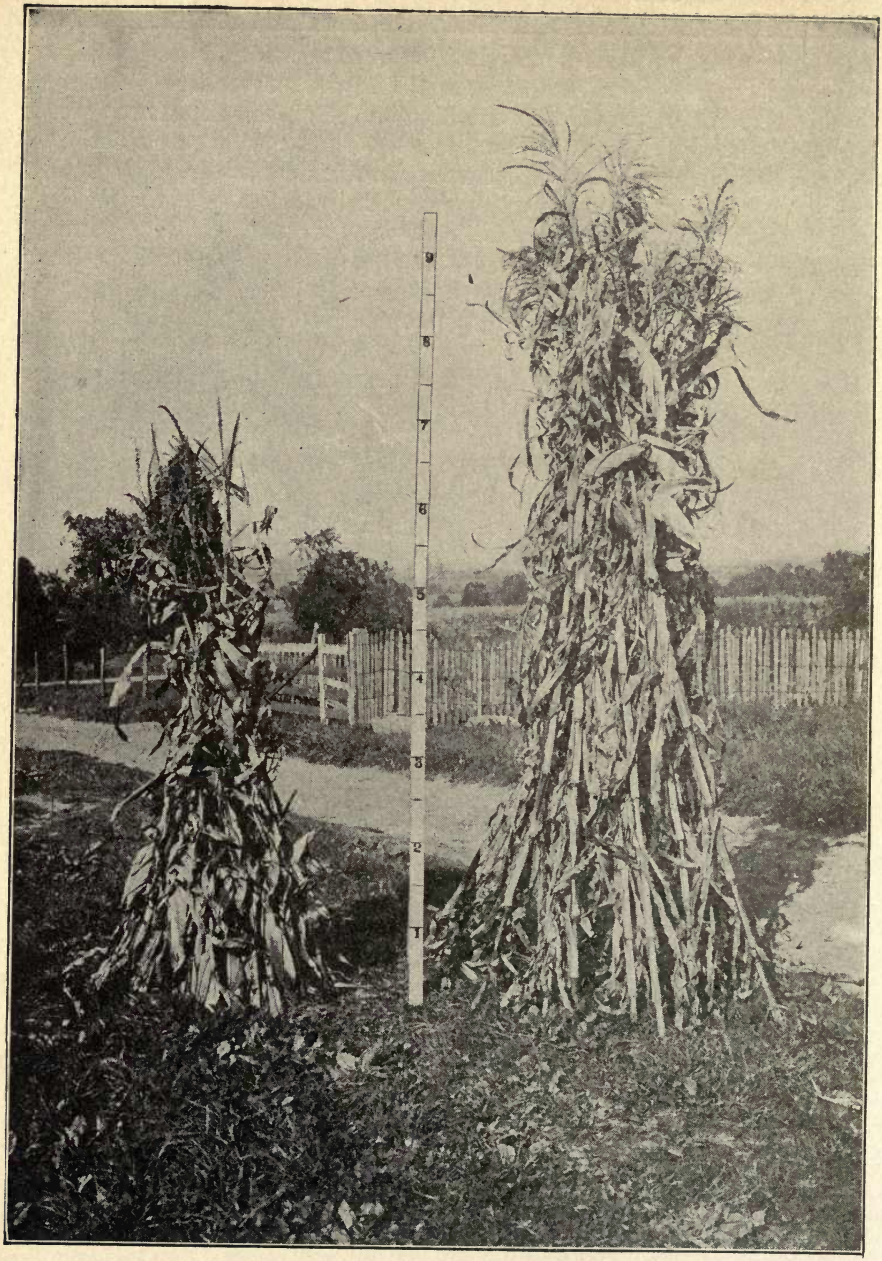


THE HEIGHT OF STALKS AND POSITIONS OF EARS MAY BE GREATLY CHANGED BY SELECTION OF SEED FOR THESE CHARACTERS.[1]

[1] Courtesy of Ohio Agricultural Experiment Station, Bulletin 282, "Corn Experiments."

CHAPTER 11

Corn (Zea Maize)

The average acre of corn produces more food value than an equal area of any other staple crop except potatoes. Corn has a longer season of growth than most other staple crops, and, consequently, it more fully utilizes the plant food that is made available by processes going on in the soil when reasonably warm and moist. It is adapted to a wide range of soil conditions. It fits well into the crop rotations without seriously competing with other crops for labor. It has a wide range of uses. The tillage which the crop receives leaves the soil in excellent condition for the crops which follow.

Classification of Corn.—There are six types of corn: dent, flint, sweet, pop, soft and pod. The first four only are of importance in America. Fully 90 per cent of the corn grown in North America is of the dent type. There are several hundred varieties of dent corn and a score or more varieties of flint corn. The types are classified according to color and size. Dent corn is divided into three classes with reference to size and time of maturity, namely: early, medium and late maturing varieties. It is also divided according to color into yellow dent, white dent, white cap yellow dent and mixed dent varieties.

Varieties of Corn.—Of the several hundred varieties of dent corn, comparatively few are worthy of cultivation in any particular locality; and yet one often finds many varieties within a restricted area. Where soil conditions are uniform over several counties, one or two varieties may be found best suited to the whole of the area.

Corn is a very minor crop in Canada, the most of it being grown in the Province of Ontario. Flint is the prevailing type. In the north-eastern part of the United States, including New England, New York, Pennsylvania and New Jersey, varieties of flint corn are extensively grown on the higher elevations and in the northernmost latitudes. Among the best known varieties of this class may be mentioned Longfellow, King Phillip, Smut Nose, Stickney's Yellow, Taylor's Improved Flint and Davis' Eight Rowed Flint. The prevailing varieties of dent corn in this section are Pride of the North, Early Huron Dent, Funk's 90 Day, Leaming and numerous strains of white cap dent, seldom having local names.

In the typical corn belt of Ohio, Indiana, Illinois, Iowa, Missouri and eastern Kansas and Nebraska, the leading varieties are Reed's Yellow Dent, Funk's Yellow Dent, Leaming, Reilley's Favorite, Clarage, Hogue's Yellow Dent, Hildreth's Yellow Dent, Hiawatha Yellow Dent, Boone

County White, Johnson County White, Silver Mine, St. Charles White and Kansas Sunflower.

In the Southern states we have among the large-eared varieties: Huffman, Excelsior, Chisholm, McMacnin's Gourdseed, St. Charles White, Boone County White, Rockdale, Singleton and Ferguson's Yellow Dent. Among the two-eared varieties may be mentioned Lewis' Prolific, Hickory King and Neal's Paymaster. Prolific varieties, producing two or more ears to a stalk, are Cocke's, Albemarle, Whatley's, Mosby's, Hasting's, Marlborough and Batts'.

In the northern portion of the corn belt, including the states of Michigan, Wisconsin, Minnesota, the Dakotas and the northern portions of Illinois and Iowa, the most common varieties are Silver King, Pride of the North, Wisconsin No. 7, Murdock, Wimple's Yellow Dent, Pickett's Yellow Dent and Golden Eagle.

The best variety for any locality can be determined only by local variety tests. Such tests have been conducted in many counties through the effort of the local organizations in co-operation with the state experiment stations. The results for such tests for sixteen counties in Iowa for the year 1911 are given in the following table:

VARIETY TEST, 1911.
Average of Sixteen Counties in Iowa.

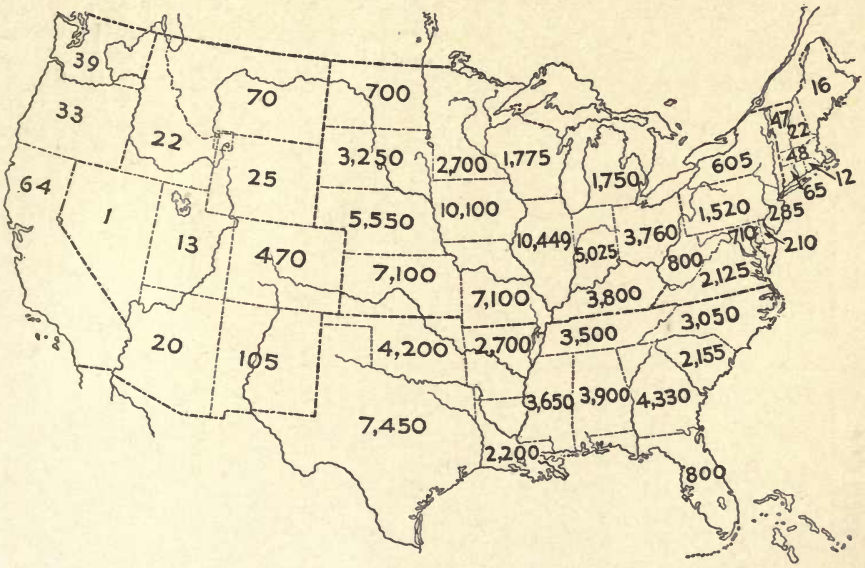
	Number of Samples.	Yield per Acre, bushels.	Standing, October, per cent.	Strong, per cent.	Weak, per cent.	Dead, per cent.	Barren, per cent.
Farmer's variety test.....	966	54.3	78.0	78.1	14.6	7.3	5.2
One-tenth highest yielding	97	62.0	81.5	80.5	14.5	5.0	4.4
One-tenth lowest yielding.	97	44.5	71.0	73.5	15.0	11.5	6.1
Imported seed.....	128	53.0	81.5	67.0	27.0	6.0	5.9
Seed-house seed.....	190	49.5	72.0	61.5	26.5	12.0	4.6

INDIVIDUAL EAR TEST, 1911.
Average of Sixteen Counties in Iowa.

	Number of Samples.	Yield per Acre, bushels.	Standing, October, per cent.	Strong, per cent.	Weak, per cent.	Dead, per cent.	Barren, per cent.
Individual ears.....	1,440	53.5	78.5	83.5	11.5	5.0	5.7
One-fourth highest yielding	360	62.0	83.0	85.5	11.5	3.0	4.5
One-fourth lowest yielding	360	43.5	71.5	77.5	11.5	11.0	7.6

The large number of samples tested and the average results secured make conclusions relative to the differences found in yield and other qualities rather definite. It will be noted that one-tenth of the samples giving highest yields averaged 62 bushels per acre, while one-tenth of

the samples giving lowest yields average 44.5 bushels per acre, or only about two-thirds as much as the best yielding samples. Note also that over 100 samples of imported seed averaged less per acre than did nearly 1000 samples of home-grown seed. Likewise, the 360 ear-to-row tests giving the highest yields were no better than the best one-tenth of the larger samples tested. One-fourth of the ear-to-row samples giving the lowest yield averaged a little more than two-thirds as much as the one-fourth giving the highest yields. The results show wide differences and emphasize the importance of the farmer selecting for his soil and locality the variety that will do best. Such selection will evidently make a great difference in the total yield of corn on a given acreage.



CORN ACREAGE BY STATES, 1915.
(Three ciphers omitted.)

The Chief Corn-Growing States.—In order of their respective production, they are Illinois, Iowa, Missouri, Nebraska, Indiana, Kansas, Ohio, Texas, Oklahoma and Kentucky. These ten states produce a little more than 70 per cent of all the corn produced in the United States. More than 80 per cent of the corn produced in the United States is consumed within the counties in which it is grown. The great use of corn is as a feed for livestock. There are a few counties, especially in the State of Illinois, where a considerable portion of the corn is marketed and goes outside of the counties in which it is produced.

North America produces three-quarters of the world's corn, nearly all of which is produced within the borders of the United States. Of the

remaining one-quarter of the world's production, Europe produces about two-thirds and South America and Australia the remainder.

Soil and Climatic Adaptation.—Corn is best adapted to well-drained soils that are deep, loamy and warm. Large yields demand a high-water capacity of the soil and this is materially increased by deep drainage, deep plowing and organic matter. Corn requires a growing season ranging from 100 to 170 days, through which period the temperature should be high and accompanied by warm rains. An abundance of rainfall properly distributed is essential. In the typical corn belt the rainfall during July and August is most important, and the yield of corn is determined to a considerable extent by the rain during these two months.

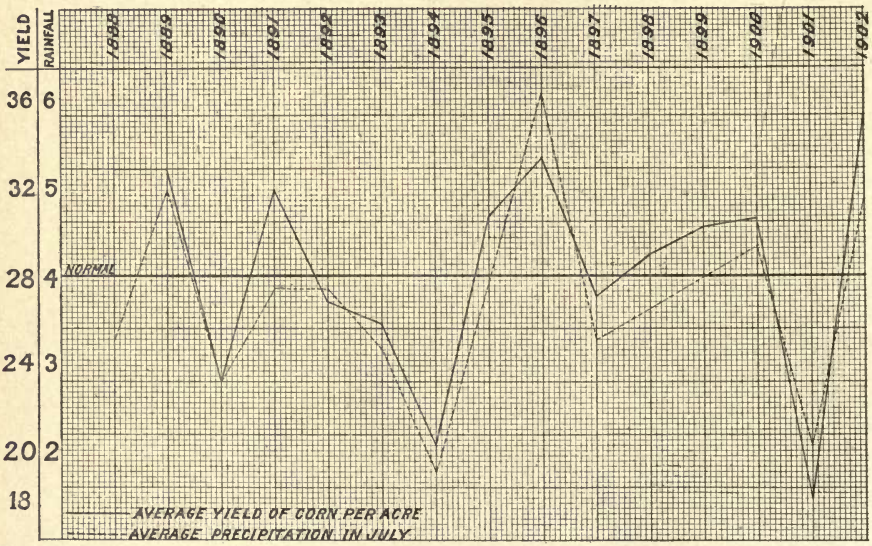


Chart Showing How Closely Corn Yield Follows Amount of Rainfall.

The accompanying chart shows the average yield of corn for a period of fifteen years, together with the July precipitation for the same years. There is a fairly close correlation between July rainfall and the average yield of corn.

It is not profitable to grow corn on very poor land. The nature of the corn plant is such that it will not produce grain unless the soil is sufficiently rich to afford considerable growth of stalk. In general, the richer the soil the heavier will be the yield of grain. Some other crops will produce fair yields on soil too poor to produce corn.

Crop Rotation for Corn.—Corn cannot be grown continuously on the same soil without diminished yields. A rotation of crops is, therefore, essential. In this rotation should occur at least one leguminous crop.

East of the Mississippi River and north of Mason and Dixon's Line, common red clover is best suited for this purpose. Alfalfa, crimson clover and alsike clover may be substituted for it under certain conditions. Over a considerable portion of this region the most usual rotation is corn, oats, wheat, and clover and timothy. This provides for a rotation ranging from four to seven years, depending on the length of time the land is left in grass and whether or not corn is grown more than one year in the rotation. In this rotation the corn should follow the sod on which may be scattered the manure prior to plowing. No other crop is better adapted to utilize the available nitrogen and mineral constituents that are slowly brought into a state of availability through decomposition of the roots, stubble and manure.

On fertile soils in a high state of cultivation corn may be grown two years in succession. This will require sufficient manure to apply on the corn land two years in succession, or will demand an application of commercial fertilizers for the second year's crop.

In the South the crops associated with corn in the rotation are quite different. In most cases cotton is the chief money crop; cowpeas and soy beans are the chief legumes; and winter oats is the principal small grain. The rotation frequently consists of cotton followed by cotton, with cowpeas planted between the cotton rows. The third year the land is planted in corn and seeded to winter oats after the corn has been removed. After the oats are harvested in the fourth year the land is broadcasted with cowpeas, and these harvested for hay. This rotation has proven successful in many parts of the cotton belt.

Many of the experiment stations have tested different rotations. The following tabulation gives the average results with corn in two rotations covering a period of more than twenty years at the Ohio Experiment Station:

CONTINUOUS *vs.* ROTATION CORN. TWENTY YEARS' WORK.

System.	Treatment.	Application per Acre.		Average Yield per Acre, bushels.				Average Yield for 20 Years.
		Per Crop.	Per 5 Years.	1st Period.	2d Period.	3d Period.	4th Period.	
Continuous....	None.....	....	....	26.26	16.76	10.43	8.44	15.47
Rotation*.....	None.....	....	....	31.89	30.82	31.04	20.31	28.95
Continuous....	Manure.....	5 tons	25 tons	43.13	40.11	34.62	30.22	37.02
Rotation*.....	Manure.....	8 tons	16 tons	40.73	49.52	59.75	55.83	51.81
Continuous....	Com. fert....	250 lbs.	1250 lbs.	38.86	39.09	28.00	26.83	33.19
Rotation*.....	Com. fert....	320 lbs.	985 lbs.	35.78	49.54	53.91	44.10	46.49
Rotation†.....	Manure.....	8 tons once in 3 years on corn.						60.20‡
Rotation†.....	None.....	Average of 8 unfertilized plots.						35.19‡

* Five-year rotation. † Three-year rotation. ‡ Average for 17 years.

It will be noted that where corn was grown continuously the yields have declined regardless of the character of the manure or fertilizer applied, whereas corn grown in a rotation has increased decidedly in yield when either manure or fertilizers have been used.

Plowing for Corn.—Plowing for corn may be done either in the fall, winter or spring. In many sections of the country fall plowing gives better results than spring plowing. The difference, however, is not sufficient to justify the advice that fall plowing should be universal. Every acre that is plowed in the fall or winter facilitates getting crops in the ground at the proper season in the spring. Deep plowing for corn deposits the trash and manure to a greater depth and induces the roots to go deeper into the soil, thus coming into contact with more plant food and soil moisture from which to draw nourishment. Deep plowing enables the soil to absorb a larger proportion of the rainfall, thus increasing its capacity for water. The further preparation of the seed-bed by disking and harrowing should leave it in a loose, friable condition to a considerable depth. Such a seed-bed is in marked contrast to the compact and finely pulverized one that is essential to wheat.

Manures and Fertilizers for Corn.—The amount and character of fertilizer for corn varies greatly in different localities, depending on the character of soil, length of time it has been in cultivation, and the rotation of crops. No definite formula is applicable to any very large territory. As a rule, no crop makes better use of barnyard manure than corn. Six to ten tons of stable manure to an acre of grass sod is generally sufficient. In growing corn, all of the nitrogen needed should be secured from the manure and leguminous crops that enter into the rotation. On soils not in a high state of fertility, the manure may be supplemented by about 200 pounds per acre of acid phosphate. In portions of Indiana, Illinois and Iowa, rock phosphate may be advantageously substituted for acid phosphate. On sandy soils and on swampy soils some potash may be advantageously used.

In the absence of barnyard manure good corn crops may be secured by the liberal use of a complete fertilizer in which phosphoric acid is the dominant ingredient. The amount of such fertilizer and its exact composition will depend on the character and condition of the soil in question. The average composition of such a fertilizer would be from 2 to 3 per cent of nitrogen, 7 to 10 per cent of phosphoric acid and 3 to 6 per cent of potash. The amount to use will range from 100 to 500 pounds per acre, depending on location. The character of fertilizer and the amount required can best be ascertained by actual test. In general, applications of less than 200 pounds may be applied through the fertilizer attachment to the corn planter. Where large amounts are used, it is best to distribute it throughout the soil before planting the corn.

Experiments that have been in progress for twenty years at the Ohio Experiment Station emphasize the importance of phosphorus in corn

TIME OF PLANTING, APRIL 29TH.[1]

production. A series of plats which received nothing save 320 pounds of acid phosphate per acre during each five-year rotation showed an increase in the yield of the several crops valued at $16.52 per acre. The acid phosphate cost $2.24, thus leaving a net gain of $14.28.

The addition of phosphorus to manure also increased the yield very materially.

Time and Method of Planting.—The time of planting corn varies with the location and character of season. It is never advisable to plant until the soil is sufficiently warm to cause a prompt germination of the

TIME OF PLANTING, MAY 7TH.[1]

[1] Courtesy of Ohio Agricultural Experiment Station, Bulletin 282, "Corn Experiments."

TIME OF PLANTING, MAY 16TH.[1]

seed. The best of seed will often rot in a cold, wet seed-bed. In the United States the corn planting season from the Gulf northward ranges from the 15th of February until June 1st, a period of three and one-half months. In the heart of the typical corn belt corn is generally planted between the 1st and 10th of May, while in the northernmost limit of successful corn production, the planting season ranges from the 15th to 31st of May. In any locality the best time to plant will not be far from the time when the leaves of the oak trees are the size of a squirrel's ear. If seasonal conditions retard the work and necessitate planting two weeks

TIME OF PLANTING, MAY 26TH.[1]

[1] Courtesy of Ohio Agricultural Experiment Station, Bulletin 282, "Corn Experiments.

later than the best time, it will be wise throughout most of the typical corn belt, and especially in the northernmost districts, to resort to varieties of corn of earlier maturity than those generally grown in the locality. In the Southern states the season is so long that there is a much wider range in the planting period. A uniform stand of vigorous plants is most easily secured by deferring planting until the soil is in the proper moisture and temperature condition.

Several of the state experiment stations have conducted tests extending over a number of years relative to the best time to plant corn. As an average of six years' work at the Ohio Experiment Station there was little difference in yield in planting any time between the 1st and 20th of May. For dates much later than the 20th there was a marked reduction in yield. Planting in the last week in April was nearly as good as

TIME OF PLANTING, JUNE 6TH.[1]

planting between the 1st and 20th of May. It is better to plant too early than to plant too late. Failure in case of early planting may be corrected by replanting, but there is no remedial measure for a planting that is made too late.

Rate of Planting.—A full stand of corn is essential. The number of plants per acre will vary with the fertility of the soil, the kind of corn and the purpose for which it is grown. Fertile soils will support more plants per acre than poor ones. Small varieties may be more thickly planted than large ones, and an abundant moisture supply in the soil will mature more plants than when dry. When planted for grain, 10,000 to 12,000 plants per acre are probably best throughout the greater portion of the corn belt. In the South, on thinner soils, fewer plants are often desirable. If grown largely for fodder or ensilage, corn may be planted one-quarter thicker than when grown for grain.

[1] Courtesy of Ohio Agricultural Experiment Station, Bulletin 282, "Corn Experiments."

Numerous experiments indicate that there is little difference within a reasonable range whether corn is planted in hills or drills. When planted in checks three kernels per hill, 3 feet 8 inches apart, an acre will contain 9720 plants. When planted in drills with the rows 3 feet 8 inches apart and one plant every 14 inches in the rows, an acre will contain 10,180 plants. Drilling is somewhat easier and safer on small, irregular fields and on land that is of uneven topography, and is preferable on most lands that are reasonably free of weeds. On badly weed-infested land checking the corn is recommended, because of the better facilities offered for cultivation and weed extermination.

On the better lands in the corn belt there has been a tendency in recent years to lessen the distance between hills, and in many districts 40 inches is now the common planting distance.

At the Ohio Experiment Station the average annual yield per acre for a period of ten years when corn was planted at the rate of 1, 2, 3, 4 and 5 kernels per hill, with hills 42 inches apart, the largest yield was secured from 4 kernels. The yields were as follows: 1 kernel, 31.7 bushels; 2 kernels, 50.8 bushels; 3 kernels, 60.8 bushels; 4 kernels, 64.9 bushels, and 5 kernels, 63 bushels per acre. The yield of stover was largest in case of 5 kernels per hill. The reduced size of ears and the increased labor in husking are such as to indicate 3 kernels per hill as the best rate of planting when grown for grain.

In regions of abundant rainfall corn is planted on the level, but in regions of low rainfall it is frequently planted in furrows by what is known as listing. This encourages a deeper rooting of the plants, which protects them from severe droughts.

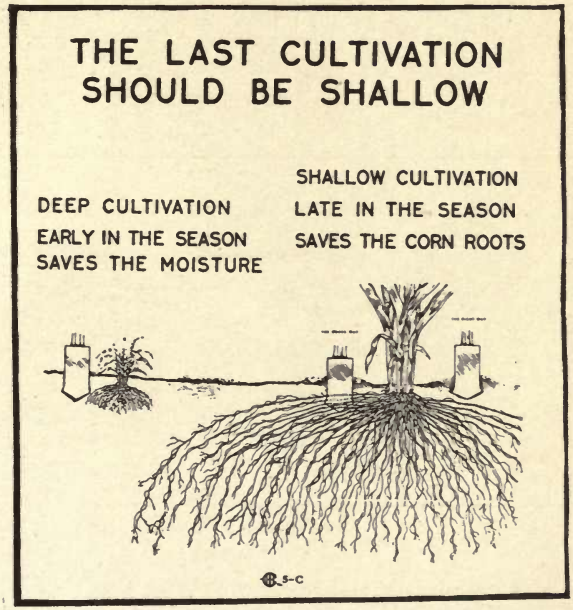
Depth of Planting.—The depth at which to plant corn will vary with the character and condition of the soil and the nature of the season. In loose, loamy soils the depth may safely be 3 inches, and in the absence of sufficient moisture near the surface 4 inches in depth may be justified. On wet, heavy soils $1\frac{1}{2}$ inches to 2 inches will be better than to plant deeper. No matter at what depth corn is planted, the permanent roots start at a point about one inch beneath the surface of the soil. The depth of rooting is not influenced by the depth of planting, unless the depth is less than one inch.

Preparation of Seed for Planting.—Before shelling corn for planting it is important to remove all irregular kernels from the butts and tips of ears. Such kernels will not pass through the corn-planter with uniformity. Before being shelled the ears should be assorted into two or three lots, according to the size of kernels, and the shelled corn from each lot kept separate so that the planter plates may be adjusted to each size. The same results may be secured by the use of a seed-corn grader, of which there are several kinds on the market.

The planter should be carefully adjusted to each lot of seed. A poorly adjusted machine may offset the advantages derived from the

carefully selected and graded seed. An actual count of the number of missing hills or plants on an acre would prove to the grower his loss through imperfect planting. Extensive investigations over large areas have shown that in certain years farmers secured not more than three-quarters of the full stand. If 75 per cent of a full stand produces 40 bushels to the acre, what will 95 per cent of a full stand produce?

Cultivation of Corn.—It is a trite saying that the cultivation of corn should begin before it is planted. This means that the final preparation of the seed-bed should take place just before planting, in order that all weeds that have just begun to grow will be destroyed. In the absence of such preparation weeds that have started will make so much growth before the corn comes up that it will make the first cultivation difficult. Small corn may be harrowed with a slant-toothed smoothing harrow without injury. A thorough harrowing at such a time will destroy many weeds that are beginning to grow, and is equally as effective as one good cultivation, and much more quickly done.



THE RIGHT AND WRONG WAY OF CULTIVATING CORN.[1]

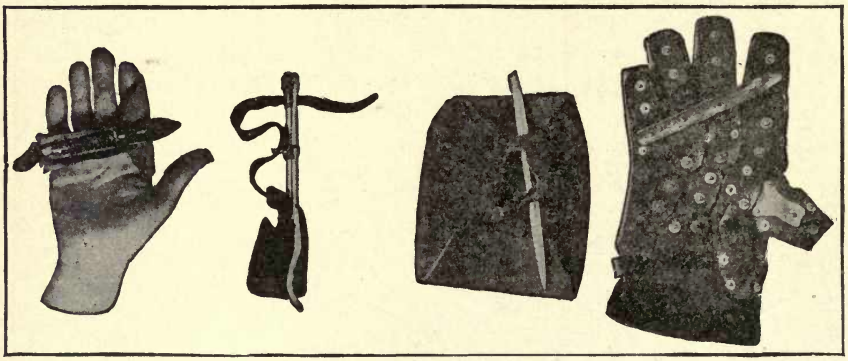
The chief objects of cultivation are: (1) to destroy weeds, (2) conserve moisture, (3) aerate the soil, and (4) increase the absorption of rainfall by keeping the surface loose. Under most conditions level and shallow cultivation is superior to deep cultivation and the ridging of the soil. Deep cultivation cuts many of the corn roots, thus reducing the ability of the plants to secure both plant food and moisture. In general, the first cultivation may be fairly deep, thus inducing a deeper rooting of the corn plants, after which shallower cultivation should take place which will interfere but little with the roots. One hundred and sixteen tests at thirteen experiment stations relative to the depth of cultivation for

[1] Courtesy of The International Harvester Company, Agricultural Extension Department. From pamphlet "Corn is King."

corn show a difference of more than 15 per cent in yield in favor of shallow cultivation. Sixty-one tests of deep cultivation gave an average yield of 64.9 bushels per acre, while 55 tests of shallow cultivation gave an average yield of 74.7 bushels, a difference of nearly 10 bushels per acre. One to two inches is considered shallow cultivation and four to five inches deep cultivation.

The frequency of cultivation will depend chiefly on the surface condition of the soil and the presence of weeds. In the absence of weeds and with the surface soil in a loose condition, little is to be gained by cultivation.

Methods of Harvesting.—Throughout the typical corn belt a large proportion of the corn is harvested from the standing stalks in the field, and the stalks are pastured or allowed to go to waste. This method fails to fully utilize the by-products of corn production, and is wasteful in



Several Forms of Husking Pegs.[1]

the extreme. In the eastern part of the United States the whole plant is generally harvested and utilized. When corn is grown for feeding dairy cows or steers the fullest utilization of the entire product is attained by storing in the silo. For this purpose it should be cut when the kernels have begun to glaze and the husks and lower leaves are turning brown. When not to be used for silage, corn should be put in shocks at a somewhat more advanced stage of maturity. Three to four hundred stalks make a shock sufficiently large to stand well and cure properly. The corn should be husked in three to six weeks after shocking, the ears stored in a well-ventilated crib, and the stover reshocked. Care should be exercised to so stand and slant the stover that the shocks will stand. They should be securely tied about two feet from the tops with strong binder twine. It is a waste of good material to allow the shocks to stand in the field until March or April.

[1] From Farmers' Bulletin 313, U. S. Dept. of Agriculture.

It is wise to feed stover during the winter period. Its feeding value may be increased by shredding. This encourages livestock to consume a larger proportion of the stalks. Fifty per cent of the feeding value of the corn stover lies in the portion of the stalk below the ear. When this is neither cut nor shredded very little of it is eaten by livestock. Shredding or cutting better fits the refuse for bedding purposes and facilitates the handling of the manure in which the refuse is finally deposited.

In storing cut or shredded fodder one should be certain that it does not contain too much moisture. It should be reasonably dry when stored in large bulk in order to prevent heating and spoiling. It is well, therefore, to shred when weather conditions are fairly dry, and not until the corn stover has become thoroughly cured.

SHRINKAGE OF CORN IN CRIB BY MONTHS. AVERAGE 8 YEARS, IOWA EXPERIMENT STATION.

Month.	Total Shrinkage to Date, per cent.	Average for the Month, per cent.
November	5.2	5.2
December	6.9	1.7
January	7.5	.6
February	7.8	.3
March	9.7	1.9
April	12.8	3.1
May	14.7	1.9
June	16.3	1.6
July	17.3	1.0
August	17.8	.5
September	18.2	.4
October	18.2	.0

The cheapest method of harvesting corn is to pasture with hogs. This is known as hogging down corn. The results of a four years' test at the Missouri Experiment Station showed that hogging down corn gave a return of 324.5 pounds of pork per acre, which, at 6 cents per pound, was valued at $19.48. The average number of hogs per acre was 14, and the number of days kept in the field was 35. This was on poor land and with corn yielding 25 to 30 bushels per acre.

Storing Corn.—The grain of corn is best stored for a time on the ear in a well-ventilated crib or building. Corn cribs of slatted sides with openings just small enough to prevent ears passing through are almost universally used for this purpose. They should be covered with roofs projecting some distance beyond the sides, and turn water without leaking. Cribs should be on elevated foundations, preferably of masonry or concrete. The concrete floors are the best. All precaution must be taken to prevent serious loss by rats and mice. Corn should not be put in the

crib until reasonably well cured. If very wet when cribbed it is likely to mould and decay. Ear corn at husking time will contain 15 to 40 per cent of moisture, depending on conditions. After standing for six months or more in the crib, the moisture, under normal conditions, will range from 10 to 12 per cent. After this time shrinkage from loss of moisture will be slight.

Shrinkage of Corn.—A knowledge of the average shrinkage of corn is important in connection with future prices, and should be taken into consideration by the farmer in connection with the holding of corn for a future market. The table on preceding page shows the average shrinkage of corn at the Iowa Experiment Station as determined for eight successive years.

Market Grades of Corn.—According to the act of Congress of June 30, 1906, and March 4, 1913, the Secretary of Agriculture has fixed the following definite grades of grain, which went into effect on July 1, 1914:

STANDARD GRADES OF CORN AND SPECIFICATIONS FOR SAME.

Grade and Classification: White, Yellow and Mixed Corn.	Moisture.	Maximum Percentage of Damaged Corn.	Maximum Percentage of Foreign Material, Including Dirt, Cob, Other Grains, Finely Broken Corn, etc.	Maximum Percentage of "Cracked" Corn, not Including Finely Broken Corn. (See General Rule 9.)
No. 1.....	14.0	*...	1	2
No. 2.....	15.5	*...	1	3
No. 3.....	17.5	*...	2	4
No. 4.....	19.5	†0.5	2	4
No. 5.....	21.5	†1.	3	5
No. 6.....	23.0	†3.	5	7

* Exclusive of heat-damaged or mahogany kernels.
† May include heat-damaged or mahogany kernels not to exceed the percentage indicated.
"Sample"—See General Rule No. 6 for sample grade.

GENERAL RULES

1. The corn in grades No. 1 to No. 5, inclusive, must be sweet.
2. White corn, all grades, shall be at least 98 per cent white.
3. Yellow corn, all grades, shall be at least 95 per cent yellow.
4. Mixed corn, all grades, shall include corn of various colors not coming within the limits for color as provided for under white or yellow corn.
5. In addition to the various limits indicated, No. 6 corn may be musty, sour, and may also include corn of inferior quality, such as immature and badly blistered.
6. All corn that does not meet the requirements of either of the six numerical grades, by reason of an excessive percentage of moisture, damaged kernels, foreign matter, or "cracked corn," corn that is hot, heat-damaged, fire-burnt, infested with live weevil, or otherwise of distinctly low quality, shall be classed as sample grade.
7. In No. 6 and sample grade, reasons for so grading shall be stated on the inspector's certificate.
8. Finely broken corn shall include all broken particles of corn that will pass through a perforated metal sieve with round holes $\frac{3}{64}$ of an inch in diameter.

9. "Cracked" corn shall include all coarsely broken pieces of kernels that will pass through a perforated metal sieve with round holes ¼ of an inch in diameter, except that the finely broken corn as provided under Rule No. 8 shall not be considered as "cracked" corn.
10. It is understood that the damaged corn, the foreign material, including pieces of cob, dirt, finely broken corn, other grains, etc., and the coarsely broken or "cracked" corn, as provided for under the various grades shall be such as occur naturally in corn when handled under good commercial conditions.
11. Moisture percentages, as provided for in these grade specifications, shall conform to results obtained by the standard method and tester as described in Circular No. 72, Bureau of Plant Industry, United States Department of Agriculture.

Composition and Feeding Value of Corn.—The following is a compilation of American analyses of the grain of the three principal types of corn and the stalks of dent corn, under three conditions:

COMPOSITION OF CORN (MAIZE).

	Grain.				Silage.	Fodder.	Stover.
	All Varieties.	Dent.	Flint.	Sweet.	Fresh.	Field Cured.	Field Cured.
Number of analyses	208.	86.	68.	26.	99.	35.	60.
Water	10.9	10.6	11.3	8.8	79.1	42.2	40.1
Ash	1.5	1.5	1.4	1.9	1.4	2.7	3.4
Protein (Nitrogen x 6.25)	10.5	10.3	10.5	11.6	1.7	4.5	3.8
Crude fiber	2.1	2.2	1.7	2.8	6.0	14.3	19.7
Nitrogen-free extract	69.6	70.4	70.1	66.8	11.1	34.7	31.9
Fat	5.4	5.0	5.0	8.1	0.8	1.6	1.1

The following tabulation gives the farm value and feeding value of corn per acre as compared with oats, wheat and hay, when grown in a four years' rotation on the limestone soil at the Pennsylvania Experiment Station:

THE AVERAGE ANNUAL YIELD DURING 25 YEARS OF 24 TREATMENTS ON 36 PLATS ON EACH OF 4 TIERS AT THE PENNSYLVANIA STATION.

	Average Yield per Acre.		Price per 100 pounds.	Farm Value per Acre.	Digestible Protein, pounds.	Energy Value, therms per Acre.
	Pounds.	Bushels.				
Corn, ears	3,534	50.5	$0.75	$26.51	160	3,198
Corn, stover	2,528	....	.125	3.16	40	671
Oats, grain	1,227	38.1	1.00	12.27	102	813
Oats, straw	1,772	....	.125	2.22	19	370
Wheat, grain	1,192	19.9	1.33	15.85	106	985
Wheat, straw	2,099	....	.125	2.62	8	348
Timothy and clover hay	3,609	....	.50	18.05	135	1,232

These figures may be condensed into a table that will bring out the comparison in a more striking manner, as shown below:

COMPARISON OF DIGESTIBLE PROTEIN, ENERGY VALUE AND FARM VALUE PER ACRE OF 4 CROPS WHEN GROWN IN ROTATION DURING 25 YEARS (1882–1906).*

	Digestible Protein, pounds.	Energy Value, therms.	Farm Value.
Corn	206	3,869	$29.67
Oats	121	1,189	14.49
Wheat	114	1,333	18.47
Hay	135	1,232	18.50

CORN IMPROVEMENT

No crop is more easily and rapidly improved by selection and breeding than corn. No work on the farm will come so near producing something for nothing as time intelligently spent in improving this crop. It is just as important to use well-bred seed-corn as it is to breed from an animal of good pedigree. The same principles apply in the breeding of both plants and animals. Well-bred seed-corn has often produced from five to twenty bushels per acre more than seed which has received no special attention when grown under identical conditions. A bushel of seed-corn will plant six acres; 10 bushels increase on each of six acres equals 60 bushels; 60 bushels at 60 cents per bushel equals $36 the value, of a bushel of good seed.

Securing Seed.—Seed-corn should be purchased in the ear so the buyer can see if it is as represented in regard to type, size and uniformity. It should have been grown on soil and under climatic conditions very similar to those surrounding the purchaser. Do not send far away for seed-corn. Many farmers have done so and have generally been disappointed.

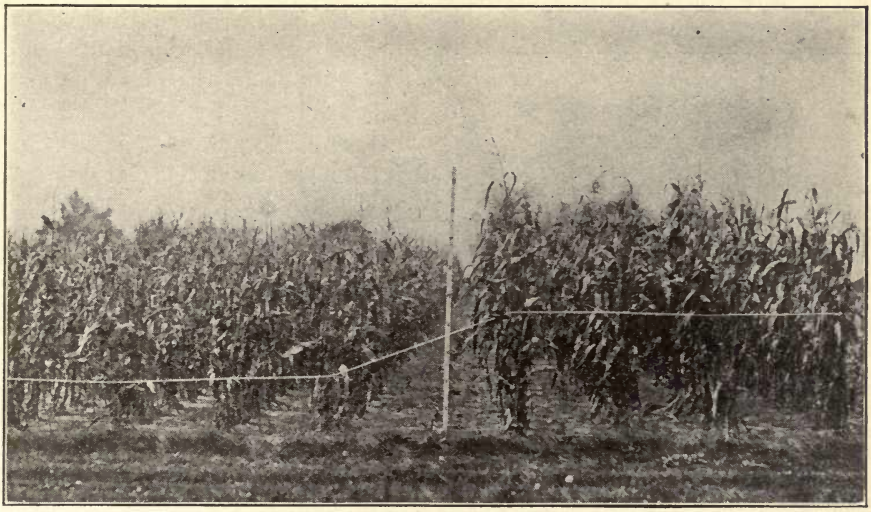
Selecting Seed.—Selection should be made in the field where both plant and ear can be seen. Seed plants should be under normal conditions relative to soil and stand. Good plants should be of moderate height. Short nodes or joints are preferable to long ones, for each node bears a leaf. The more the leaf surface, the greater the power of the plant to manufacture the elements of the air and soil into corn. The leaves are the most palatable, digestible and nutritious part of the forage. The plants should be free from smut, rust and any other fungous diseases.

The ears for a medium maturing variety of dent corn should be attached to the stalk at a convenient height of about four feet, and by a shank of moderate length and thickness. For very early varieties the ears may be a little lower and for large late maturing ones, there will be no objection to having the ears five feet above the ground. When the shank

* Refer to Bulletin No. 116, Agricultural Experiment Station, The Pennsylvania State College.

is too long it allows the ear to pull the stalk over, and when too short the ear is too erect and may be damaged at the tip by allowing water to enter the husks. The husks should be moderate in amount and sufficiently long to cover the tip of the ear and protect the kernels from insects, birds and damage by rain.

The size of the ear will vary in different districts, but for a medium maturing variety a good seed ear should be 8 to 10 inches long. The circumference two-fifths the distance from the butt should equal three-fourths but not exceed four-fifths of the length. The form should be cylindrical or but slightly tapering from butt to tip. The tip and butt should be well filled with kernels and the rows, 16 to 20 in number, should



HIGH AND LOW EARS.[1]

be straight and carry out well to the butt and tip with kernels of regular and uniform shape.

The depth of kernels should equal one-half the diameter of the cob. Kernels five-eighth inch long, three-eighth inch wide and one-sixth inch thick are a good size. The tips should be strong and full, for such indicates good vitality. The embryo or germ should be large and extend well up toward the crown. Large embryos produce vigorous plants and indicate high fat and protein content and consequently high feeding value.

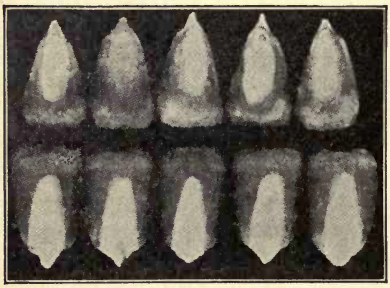
Care of Seed.—Seed-corn should be well cared for by storing in a dry and well-ventilated room and out of reach of rats and mice. Corn, thoroughly dried, will stand a very low temperature without injury, but

[1] Courtesy of Ohio Agricultural Experiment Station, Bulletin 282, "Corn Experiments."

if not well dried, a temperature not far below freezing will injure it and destroy its vitality or germinating power and make it worthless for seed.

Germination Test.—The importance of securing a perfect stand of strong plants in the cornfield cannot be overestimated. Aside from field conditions favorable to germination and the proper placing of the corn in its seed-bed, there are two dominant factors on which perfection of stand depends: first, the vitality of the seed; second, requisite number of kernels in each hill or regular and uniform spacing if planted in drills.

A vitality or germination test of seed-corn should always be made. It should be made several weeks before corn is required for planting, so that there may be time to secure a new supply in case the seed has been injured. There are several simple methods of making such tests, but in all cases every ear should be tested.



GOOD AND POOR TYPES OF KERNELS.[1]

The top kernels came from an ear with too much space at cob, indicating low yield, poor feeding value, immaturity. Compare them with the kernels in the bottom row.

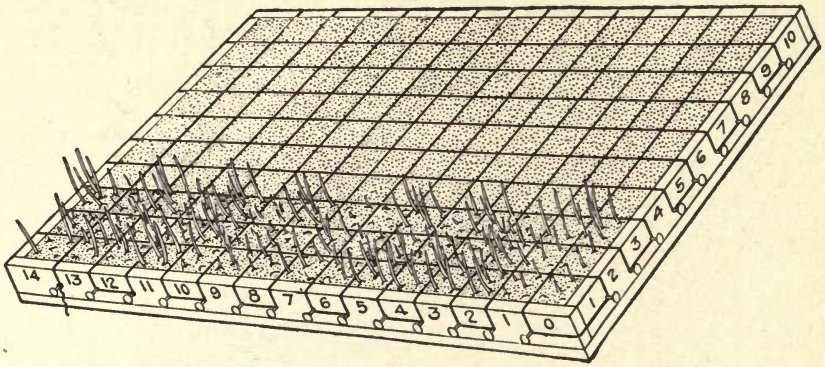
Germinating Box.—A box about 18 inches square and 3 inches deep, two-thirds full of clean sawdust or sand, is most convenient for germinating corn. The material should be thoroughly moistened and smoothed to a level in the box. Lay the ears of corn on the barn floor, tips to tips in double rows. Number every tenth ear with a small paper tag stuck between the rows. Remove from various parts around the ear, and from butt to tip, five grains from each ear. Now cover the sawdust in the box with a piece of white cloth marked off into squares $1\frac{1}{2}$ inches on a side with a lead pencil, preferably an indelible pencil, and numbered consecutively. In the squares, place the five grains from each ear separately, exercising care that the grains from each ear are placed in the square with the number corresponding. Cover the grains thus placed with another cloth of close weave or a fold of the one under the corn, to prevent the sprouts from coming through, and spread over all a piece of burlap or a gunny sack well soaked in water. The requisites for germination are air, warmth and moisture. The temperature of the living room or kitchen is about right, providing it does not fall below 55 degrees at night. If the temperature is favorable germination will have taken place in four to six days. Any ear failing to give five kernels vigorously germinated should be rejected. A handy man, working systematically, can test five or six bushels of corn in a day. It is work that should never be neglected

[1] Courtesy of International Harvester Company, Agricultural Extension Department.

and will pay for the labor involved many times over in a better stand and resulting larger yields of corn.

Improvement by Selection and Breeding.—The ear row method is the most satisfactory way of improving corn along any line. This method is based on the principle that like begets like, but fortunately this principle is not rigid. It is the variation in the progeny of any parent plant that enables us, through selection, to improve the variety, and it is the tendency for like to produce a larger percentage of progeny, differing but slightly from the parent that enables us to make progress in plant improvement.

Corn improvement by selection is easy, because the plant is large and its characteristics plainly visible; because the variations are sufficiently marked and frequent to enable man to select individuals with



A Good Germination Box Seven Days After Planting.[1]

The box is filled with wet sand and marked into checks by means of cord stretched across the top at even intervals.

desirable characteristics, and also because of the large number of plants that can be secured from the individual and the consequent rapidity of multiplication.

Corn breeding is somewhat difficult because of the natural cross-fertilization and the impracticability of keeping the breed pure, and also because close and self-fertilization are difficulties that must be guarded against. None but the choicest ears selected for desirable qualities of both ear and plant should be used in the breeding plat, and any ears that do not show a high standard in the germination test should be rejected.

The selected ears should next be tested for yield and prepotency. The ears should be numbered and a portion of each planted in a separate row of a test-plat having uniform fertility. The rows should be sufficiently long to contain about 200 plants. This will require about one-fourth of the kernels of each ear. The rows should bear the same numbers as ears

[1] From Farmers' Bulletin 409, U S. Dept. of Agriculture.

from which planted. The remaining portion of ears, with numbers securely fastened, should be saved for next year's multiplying plat. When corn is up, it should be thinned to a uniform stand for all rows. It should be frequently observed during growing season for rows that develop desirable characters. At harvest time each row should be husked separately and the corn weighed. The remnants of seed ears, from which a limited number of the highest yielding rows of best type were planted, should be shelled together and planted the following year in a multiplying plat which should supply seed for the general crop. From the multiplying plat should be selected choice ears for another test as above described. This method repeated each year makes progress in corn improvement.

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546. "How to Manage a Corn Crop in Kentucky and West Virginia."
553. "Pop Corn for the Home."
554. "Pop Corn for the Market."

CHAPTER 4

WHEAT (WINTER AND SPRING)

By W. H. Darst
Assistant Professor of Agronomy, Pennsylvania State College

The crop that furnishes the bread material of a country comes a little closer to the lives of the people than any other. In nearly all countries of the world wheat holds the first place as a bread crop, and for that reason deserves most careful attention.

The United States, with its rapidly increasing population, especially in the cities, and its constantly increasing demand for breadstuffs, may very soon find it necessary to import wheat. Under existing conditions the price of wheat must increase rather than decrease, and there will be more and more inducement for the farmer to increase his production.

The world's annual production of wheat for the three pre-war years 1912–14 was approximately 3,882,255,000 bushels. The six leading countries in production and in average acre yield were as follows:

Average Annual Production, 1912–1914.		Average Acre Yield, 1904–1913.	
Country.	Bushels.	Country.	Bushels.
United States	794,889,000	United Kingdom	32.8
European Russia	686,512,000	Germany	30.7
British India	349,273,000	France	20.1
France	325,650,000	Austria-Hungary	19.1
Austria-Hungary	226,732,000	United States	14.3
Canada	205,718,000	European Russia	10.0

It is an interesting fact that the two largest producing countries have the lowest acre yields. At one time these European countries had average yields very similar to our own. By years of systematic application of best known methods of production, the yields of these countries have increased enormously.

The climatic and soil conditions of some European countries are more favorable to the production of wheat than those in the United States. In European countries, also, the labor proposition is not so serious as it is in this country; consequently, they can afford to spend more time on their wheat crop.

Wheat Production in United States.—About one-half the wheat crop of the United States is produced in the North Central states west of

the Mississippi River. This section includes the states of Kansas, Nebraska, North and South Dakota, Minnesota and Iowa. Hard winter wheat and hard spring wheat (including Durham) are grown in this section.

About one-sixth of the crop is produced in the North Central states east of the Mississippi River. The wheat in this section is known as the soft or red winter wheat.

About one-sixth of the wheat crop of the United States is grown in the far West. This includes the irrigated districts of the Rockies and the Pacific Coast wheat districts. White and red spring, and some winter wheat, are grown in this section.

All other states not in the general districts mentioned produce approximately 100,000,000 bushels annually.

Climatic and Soil Adaptation.—Wheat has a very wide climatic adaptation, which makes it a staple crop in many countries of the world. Wheat is best adapted, however, to regions having cold winters, especially cool weather during the first of the growing season. Cool weather during early growth causes wheat to stool more abundantly, which generally results in a larger yield. This applies to spring wheat as well as to winter wheat.

Climatic conditions, viz: rainfall, temperature, sunshine and humidity, influence the milling quality of wheat to a greater degree than does the type or fertility of the soil. The map, roughly dividing the United States into wheat districts, shows that climatic conditions existing in any section determine to a large extent the milling quality of the wheat.

In the hard spring and hard winter wheat districts, the season is comparatively hot and dry during the fruiting period, forcing early ripening of the wheat. This results in a hard, flinty kernel, high in protein and of good milling quality. The fruiting period being shortened, the wheat does not have the opportunity to store as large amounts of starch in the grain as it would under more favorable climatic conditions.

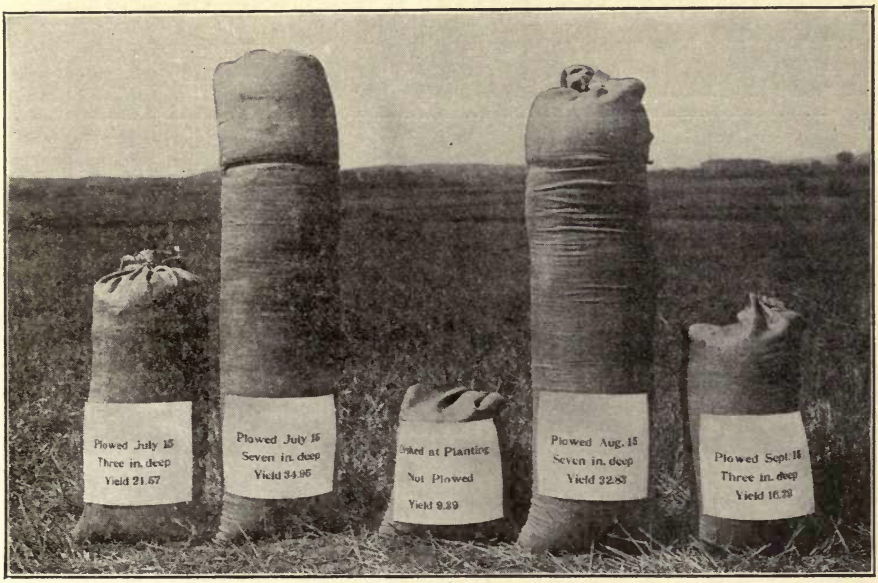
Where the fruiting season is longer and more favorable, as in the red winter wheat district and along the Pacific Coast, more starch is stored in the grain, which results in a starchy, light-colored wheat having lower milling quality.

A proper soil for wheat is important in that it determines the yield rather than milling quality. A large portion of the wheat in the United States is grown on the so-called "glacial drift" soils. These soils vary greatly in texture and structure, humus and plant food. The clay or clay loam uplands are usually better adapted to wheat than the low-lying dark-colored loamy soils. Dark-colored soils, rich in humus, are better adapted to corn. Wheat grown on such soil is apt to winter-kill and heave badly. The wheat grows tall and rank and may not fill out properly.

Rotations.—In parts of the Great Plains region, wheat is grown in continuous culture with fair returns, because the farming operations

are so extensive. Rotations, therefore, are not profitable as yet. Eventually these large farms will be made into smaller ones, and it will be necessary to properly rotate the crops for profitable yields.

Continuous culture of wheat not only reduces the fertility of the soil, but multiplies the insects and fungous diseases injurious to wheat. Rotations are greatly modified in different localities by the crop-producing power of the soil and by the crops produced. Wheat is frequently grown in a rotation in order to obtain a stand of grass. The value of



EFFECT OF TIME OF PREPARING SEED BED. YIELD OF BAGGED WHEAT.[1]

rotations from the economic standpoint has been discussed in a previous chapter.

Preparation of the Seed-Bed.—The method used in preparing a seed-bed for wheat is determined by the rotation and kind of wheat grown. In winter wheat sections wheat may follow corn, oats, potatoes or tobacco. Wheat requires a firm, fine and moist, seed-bed, whether it be sown in the fall or spring. When wheat follows corn, potatoes or tobacco, the ground should be thoroughly plowed for these crops in the spring of the year, and the crop grown should receive thorough and regular cultivation as long as possible. After the crop is harvested double disking should put the ground in ideal shape for the seeding of wheat.

When winter wheat follows oats the stubble should be plowed as early as possible. The early breaking of oat stubble gives more time

[1] Courtesy of Kansas Agricultural Experiment Station.

for the preparation of the seed-bed, the firming of the soil and the conserving of moisture.

If plowing is done late in the season, each day's work should be harrowed as soon as finished. Plowed ground that is allowed to remain a few days before working is likely to become very dry and cloddy. A well prepared seed-bed insures quick germination, a good root system and results in less pulling and winter killing.

The following table taken from Bulletin No. 185 of the Kansas Experiment Station, shows that yield of wheat is greatly influenced by both the time and method of preparing the seed-bed:

METHODS OF PREPARING LAND FOR WHEAT. CROPPED TO WHEAT CONTINUOUSLY.

Method of Preparation.	Average 3 Years, 1911–1913.		
	Yield per Acre, bushels.	Cost per Acre for Preparation.	Value of Crop, Less Cost of Preparation.
Disked, not plowed	6.63	$2.07	$3.64
Plowed Sept. 15, 3 inches deep	13.24	2.83	8.35
Plowed Sept. 15, 7 inches deep	14.15	3.33	8.60
Plowed Aug. 15, 7 inches deep	22.19	4.00	16.34
Plowed Aug. 15, 7 inches deep. Not worked until Sept. 15	20.48	3.33	13.65
Plowed July 15, 3 inches deep	20.77	4.85	12.25
Plowed July 15, 7 inches deep	27.11	5.35	16.87
Double disked July 15. Plowed Sept. 15	19.71	3.93	12.37
Double disked July 15. Plowed Aug. 15, 7 inches deep	23.40	4.93	14.30
Listed July 15, 5 inches deep. Ridges split Aug. 15	22.90	3.92	14.73
Listed July 15, 5 inches deep. Worked down	22.77	4.05	14.53

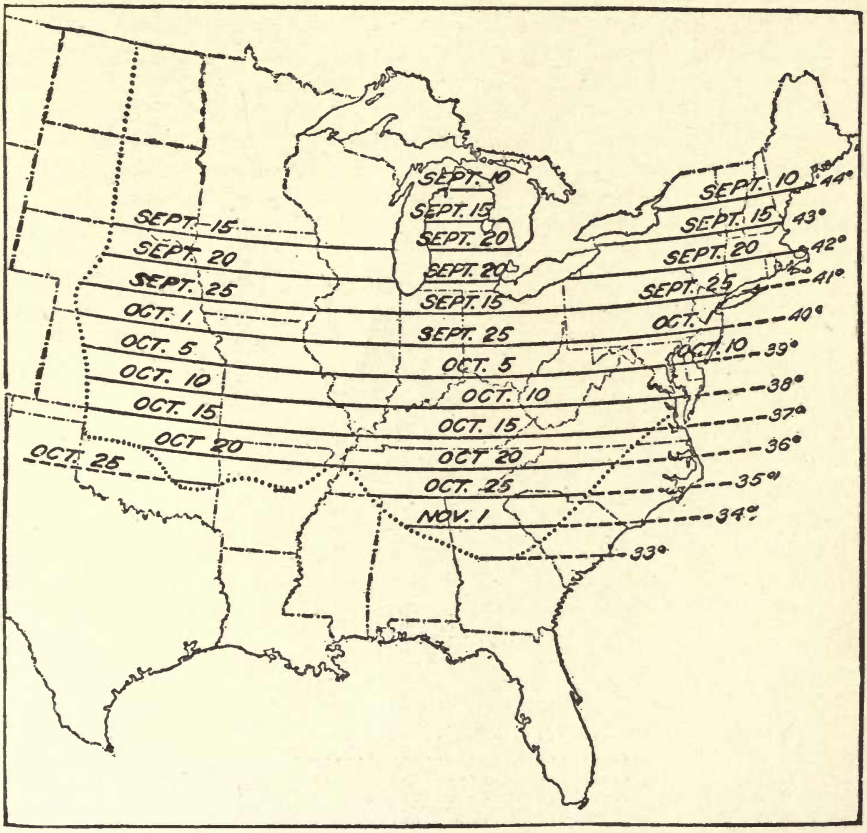
Early preparation of the seed-bed gave a profitable increase in yields. Early disking of the stubble, and plowing later, also gave very good returns. The possible objection to early plowing (July 15th to August 15th) is the lack of labor and teams at this time. In this case the stubble may be disked early and plowed later when work is less pressing. Disking a stubble before plowing tends: (1) to conserve moisture, (2) to kill weeds, (3) to lessen the draft and cost of plowing the land, (4) to pulverize that portion of the seed-bed that eventually will be turned under, and (5) to aid in destroying the Hessian fly.

In the semi-arid districts of the United States the lister is often used in preparing the seed-bed for wheat. The lister leaves the bottom of the furrow in ridges, however, and should not be used year after year in the preparation of the soil.

Fertilizers for Wheat.—A detailed discussion of fertilizers has been given in a previous chapter. Two methods of supplying plant food to

the wheat crop are: (1) by the application of barnyard manure, and (2) by the use of commercial fertilizers.

Where clover or grass is followed by corn in a rotation, better returns are obtained from manure when placed on the sod and plowed under for corn. For soils low in plant-food and humus, manure may be applied profitably to the wheat crop. Unless the ground is too rolling the manure



Approximate Date of Seeding Winter Wheat.[1]

should be applied to the wheat as a top dressing before seeding rather than plowed under, or it may be applied after seeding. Soluble plant-food from the manure will leach down into the soil and the strawy remains will act as a mulch during the winter.

The needs of the soil upon which the wheat crop is to be grown will determine the proportion of different plant-food elements to be used. The intelligent use of fertilizers for wheat calls for a knowledge of the

[1] Courtesy of U. S. Dept. of Agriculture.

needs of the soil. This may be ascertained partly by knowing the previous treatment of the soil and by studying the appearance of the crops now growing upon it. More definite information may be secured by the use of different fertilizing elements on small plats conducted as a test during one or more years for the purpose of ascertaining the needs of the soil.

Phosphorus is the element most often needed on ordinary wheat soils of most northern states, and is the one that usually gives the greatest increase in yields. In many localities the yield may be further increased by the addition of small to moderate amounts of potash. In many cases, some nitrogen will produce still further increase. However, it is poor policy to pay 18 cents a pound for nitrogen that can be produced more cheaply on the farm by the use of various leguminous crops in the rotation.

Time of Seeding.—The time to seed wheat in a given section will be determined largely by previous experience. The latitude, season, soil conditions and insect enemies all help determine the proper time for seeding.

The chart on preceding page prepared by the United States Department of Agriculture gives the approximate date of seeding winter wheat, where the Hessian fly must be considered as a factor.

Spring wheat should be sown as early as the ground can be prepared properly. Early seeding insures cool weather during the early growth and permits the crop to ripen before the severe storms of late summer. Wheat is generally seeded with a grain drill, although broadcasting is still practiced is some parts of the far West.

Rate of Seeding.—The rate of seeding varies greatly in different wheat districts of the United States. East of the Mississippi River two bushels of well-cleaned seed will generally give the best results. Results by the Ohio Experiment Station, located near the center of the humid region, teach a valuable lesson on this point.

THICK AND THIN SEEDING OF WHEAT. TEN DIFFERENT VARIETIES USED. SIXTEEN-YEAR AVERAGE.*

3 pecks	per acre	20.26	bushels per acre
4	"	21.64	"
5	"	22.97	"
6	"	24.11	"
7	"	24.36	"
8	"	25.01	"
9	"	25.46	"
10	"	25.43	"

In the dry farming area of the West the amount of seed required ranges from two to three pecks in the driest sections to six or eight pecks in the more humid sections. The rate of seeding for any section should be determined by actual tests.

Wheat should not be covered too deeply. The depth of seeding will depend on the type of soil and the preparation of the seed-bed. The

*Taken from records of the Ohio Experiment Station.

usual depth of drilling is from two to three inches. To secure ideal condition for germination the seed should be placed in the drill furrow on firm, damp soil, which will supply moisture for rapid germination and the development of roots.

Grain Drills.—For general use a good single-disk drill does very good work. On stony, trashy land it does better work than double-disk or shoe drills. In the absence of trash and on a well-prepared seed-bed, the shoe drill is more readily regulated to a uniform depth of seeding. The press drills are preferred for use in light, droughty soils and drier climates.

Winter Killing.—Winter killing of wheat is a source of great loss throughout the winter wheat districts of the United States. Winter killing may be due to: (1) alternate freezing and thawing of wet soils, which gradually lifts the plants, exposing and breaking the roots; (2) weak plants, resulting from late sowing, lack of moisture or freezing in a dry, open winter; (3) smothering of the plants under a heavy covering of ice and sleet. A heavy growth of early seeded wheat is more apt to smother than that sown later. When unfavorable weather conditions exist, very little can be done to prevent winter killing. However, preventive measures such as the following are advised: (1) Grow a hardy variety of wheat; (2) drain wet spots in the wheat field; (3) thoroughly prepare the seed-bed; (4) sow seed early enough to secure strong, vigorous plants; (5) roll wheat that is pulled by freezing and thawing. Rolling early in the spring firms the soil about the roots and benefits the wheat if the pulling has not progressed too far.

Wheat Districts.—The United States may be divided into five wheat districts according to the color and composition of the grain. These districts are not sharply defined, but a brief outline of them should give the reader a better idea of the kind of wheat grown, the leading varieties and the milling qualities of the wheat in the different parts of the United States.

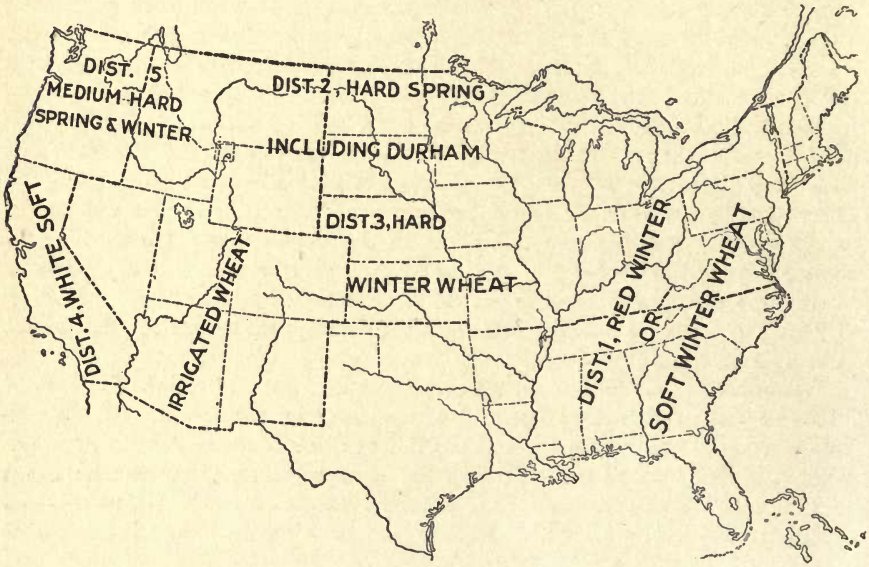
District No. 1.—All wheat east of the Mississippi River is known as Red Winter, or soft winter wheat. It varies in color from white to red and amber. The quality of this wheat varies from medium in the northern part to poor in the southern part of the district. The leading varieties in the northern portion are Fulcaster, Pool, Dawson's Golden Chaff, Gypsy, Harvest King, Fultz, Rudy and Michigan Amber. In the southern portion the leading varieties are Fulcaster, Pool, Purple Straw, Bluestone and Mediterranean.

District No. 2.—The hard spring wheat, including Durham, is located in the Dakotas, Minnesota and parts of Nebraska, Iowa and Wisconsin. The wheat in this district is small and shriveled in kernel, hard and dark in color. The milling quality of hard spring wheat is excellent. The principal varieties are Bluestem, Velvet Chaff, Fife and Durham (Kurbanka and Arnautha).

District No. 3.—The hard winter district includes Kansas, Nebraska, Oklahoma, Iowa and Missouri. The wheat in this district is red to amber

in color. The grain is hard and flinty, but larger and plumper than the hard spring. The milling quality of the wheat is excellent, although the quality of the gluten is not as high as in the hard spring wheat. The principal varieties grown are the Turkey and Kharkof.

District No. 4.—White soft or Pacific Coast wheat, grown mostly in California, is soft and starchy, and yellow to red in color. The milling quality varies from fair to poor. For bread purposes this wheat must be blended with the hard wheats. The wheat in this district is classed as soft winter on the market. The leading varieties are White Australian, Sonora, Club, King's Early and Early Baart.



Wheat Districts of the United States.

District No. 5.—The medium hard spring and winter wheat is grown in the extreme Northwest, Washington, Oregon and Idaho. The wheat in this section is medium in quality, much of it having a bleached, dull appearance. The principal varieties of winter wheat are Forty Fold, Red Russian and Jones' Winter Fife. Bluestem is the leading spring variety.

Wheat Improvement.—Every wheat grower should ascertain, by test or otherwise, the variety best suited to his conditions. The variety tests at the nearest experiment station will generally indicate the best varieties for similar conditions. For a community located on soil different from that of the nearest experiment station, an ideal plan is to organize a community seed association. A variety test of wheat should be con-

ducted on some central farm. After the best variety is determined, the farmers of that community will find it advantageous if all grow the same variety of wheat. The advantages of such a plan will be: (1) larger yields for all; (2) better and more uniform quality, resulting in higher prices; (3) the production of pure seed, true to name; and (4) the providing of a better opportunity to improve the variety. When farmers of a community are all interested in one variety of wheat, they will naturally be interested in its improvement.

The so-called "mass selection" will be found both practical and profit-

A Profitable Yield of Wheat.[1]

able in improving a variety of wheat. The procedure is as follows: A field of good wheat is examined at harvest time and enough of the choicest heads are selected to make a bushel or more of seed. This is threshed by hand and carefully stored until seeding time. This selected seed should be sown in a marked portion of the general wheat field. At harvest time choice heads are again hand selected from this special plat. The remaining wheat is harvested for seed to be multiplied for the general field wheat. By continuing this process of selection each year there will be a tendency to improve the variety continually, or at least to eliminate all danger of the wheat running out.

[1] Courtesy of Penn State Farmer, State College, Pa.

Harvesting.—Wheat is generally harvested as soon as ripe. The straw should be yellow in color and the grain in hard dough, before the wheat may be safely harvested. In the wheat-growing section along the Pacific Coast the wheat is allowed to stand a week or two after it is ripe, and is then harvested with a combined harvester and thresher.

Wheat should be shocked the same day it is cut. Considerable starch is transferred from the leaves and stems to the grain after the wheat is harvested. Immediate shocking of the grain prevents rapid drying and aids this action.

When not to be threshed from the shock, wheat should be hauled in and stacked or stored in the barn as soon as possible (a week or ten days). Hot sun bleaches wheat rapidly; rainy weather often damages and sometimes destroys the crop in the shock. In the eastern United States threshing generally takes place in the barn in the late fall. In the corn belt section and Great Plains region most of the wheat is threshed out of the shock or in the field by a combine.

Threshed wheat should be stored in tight, clean granaries. When it is to remain in storage for some time the granary should be cleaned thoroughly to make sure of the removal of grain moths, weevils and fungous diseases. If the granary is constructed so as to keep out vermin and insects, there is practically no loss of weight in storage.

Cost of Producing Wheat.—The fixed charges of growing an acre of wheat are about the same, whether the yield is 15 bushels or 30 bushels per acre. A rough estimate of the cost of growing wheat in the United States is between $10 and $12 per acre. The United States Department of Agriculture has secured from many farmers itemized estimates of the cost of producing wheat in all of the states. Those for a few of the widely separated states are as follows:

	Pennsylvania.	South Carolina.	North Dakota.	Illinois.	Kansas.
Plowing	$3.80	$1.46	$1.95	$2.01	$1.81
Seed	1.94	1.36	1.31	1.50	1.22
Planting	.60	.89	.44	.35	.41
Harvesting	1.79	1.23	1.03	1.19	1.49
Threshing	1.60	1.33	1.60	1.46	1.44
Rent	3.50	3.03	2.22	5.33	3.41
Fertilizer	2.83	2.66	.06	.27	.06
Miscellaneous	.62	.35	.38	.43	.45
Total	$16.68	$12.31	$8.99	$12.54	$10.29
Cost per bushel	.84	.96	.62	.64	.63
Net profit per acre	3.42	3.85	4.87	6.41	5.66
Number of reports	131	40	177	256	309

The estimated cost in Kansas was based on the reports of 309 farmers who, during the year 1909, secured an average yield of 16.3 bushels per

acre. This is representative of Districts 2 and 3 that produce one-half of the wheat grown in the United States. The average acre yield in the United States is 14.8 bushels. It will be seen that there is little profit in raising less than 15 bushels to the acre.

Enemies of Wheat: Weeds, Insects and Fungous Diseases.—Weeds, common in wheat fields, are not, as a rule, difficult to eradicate. Weeds damage wheat by reducing the yield and by injuring the milling quality of the grain. The weeds most objectionable in wheat are garlic, cockle, cheat or chess, wild oats and wild mustard. These are usually controlled by proper cleaning of the seed wheat, by carefully preparing the seed-bed and by a suitable rotation of crops.

Insects.—The Hessian fly and chinch bug are probably the most destructive of wheat insects. The methods of control are preventive for the most part. The burning over of stubble land any time from harvest to the middle of August will destroy many of the Hessian flies and chinch bugs. The planting of trap crops also will aid in reducing Hessian fly trouble. A strip of wheat sown early in August will induce the fly to lay eggs. This wheat should be carefully plowed down after the first frost, so as to destroy the fly. Often an early strip of wheat may be plowed down in time for proper preparation and reseeding.

A stinging frost will kill the adult Hessian fly. If the season is not too backward it is well to delay seeding of wheat until this time. However, wheat should be seeded early enough to become rooted before winter sets in.

A patch of millet sown early in the spring will attract many of the chinch bugs, thus keeping them out of the wheat and corn.

The common insects of the granary are the granary weevil (*Colandra granaria*) and the Angoumois moth (*Sitotroga cerealella*). Both these insects multiply rapidly and should be attended to at once.

Used granaries should always be cleaned thoroughly before the new wheat is stored. Granaries should be repaired when needed so as to make the sides and floor as tight as possible.

Fumigation should be resorted to when insects first appear. Carbon bisulphide is a very effective chemical to use in a good tight granary. One and one-half pints to one ton of grain, or 1000 cu. ft. of space, is the recommended amount to use. The liquid should be poured into shallow pans and placed over the wheat. For the best results fumigation should be repeated in two weeks' time. Hydrocyanic acid gas is used in elevators and mills, but would be very dangerous in the ordinary barn where livestock is housed.

Fungous Diseases.—Rust and smut are perhaps the most destructive among wheat diseases. There is no known remedy for rust other than the growing and breeding of rust-resistant varieties of wheat. Stinking smut may destroy as much as 10 per cent of the total wheat crop of the United States. It does not change the general appearance of the wheat

head while in the field, but develops within the kernel as the wheat ripens. At threshing time the infected kernels may be broken, exposing a black, stinking, greasy mass of smut spores. The handling of smutty wheat aids in the infecting of all sound wheat that comes in contact with it. The smut spores adhere to the outside of the kernel until it is planted. The fungus grows within the wheat plant and finally takes possession of the newly formed berry. Stinking smut can be controlled by the formaldehyde treatment.

Treatment.—One pint of 40 per cent formaldehyde is added to 40 gallons of water. This is sufficient to treat 40 bushels of wheat. The wheat should be spread on a good tight floor and sprinkled with the solution. The wheat should then be shoveled over until the grain is well moistened, after which it should be shoveled into a pile or ridge and covered with canvas for several hours. The wheat should then be spread out on the floor to dry. The kernels will absorb water and become larger. If seeding takes place before the wheat is thoroughly dry, one-fifth to one-fourth more seed to the acre is sown than when untreated seed is used.

Loose smut is less injurious to wheat then the hidden or stinking smut, but is more difficult to treat and control. It destroys the head in the field, leaving the bare rachis as evidence of its presence. The mature spores are scattered by the wind. If they gain entrance to the growing berry in the head, they germinate and send mycelium into its tissues to await the time when the wheat is sown in the ground. The formalin treatment, which simply acts on the outside of the berry, is ineffective.

The hot-water treatment is recommended for the loose smut of wheat. This treatment requires careful and painstaking work, and is not practical for large quantities of seed. A small quantity of seed should be treated and sown in a separate plot to be used for seed purposes the following year, thus eliminating the smut.

Treatment.—The equipment required for the hot-water treatment is as follows: 3 large kettles, 1 tub, several wire baskets holding about 1 peck of grain, and 1 good thermometer. The seed wheat should be soaked several hours in cold water placed in tub. The water in kettle No. 1 is heated to 127° F., and in kettle No. 2 to 130° F. This can be done by heating water in the extra kettle and regulating to the required temperature the water in kettles No. 1 and 2. A wire basket should be filled with wheat from the tub of cold water, allowed to drain, and immersed in kettle No. 1 for two minutes. It should then be taken out and immersed in kettle No. 2 for ten minutes, after which the wheat should be spread out to dry. This treatment frequently kills a small percentage of the kernels, the amount of which should be determined so as to regulate the proper rate of seeding. A germination test is therefore advised before seeding.

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CHAPTER 5

OATS, BARLEY AND RYE

OATS

As a farm crop in North America, oats rank fifth in value. It has a short season of growth, is easily raised by extensive methods and brings quick returns. It is, therefore, a popular crop, especially with the tenant farmer. The yield and cash value per acre is low compared with the best oat-producing countries of Europe, and some question the advisability of continuing its cultivation so extensively in this country.

Oats fit into the general crop rotation and follow corn better than most other crops. In the North Central states it is extensively used as a crop in which to seed the clovers and grasses. It makes a desirable feed for all classes of livestock except swine, and is highly prized for horses. The straw is valuable as roughage and as an absorbent in stables and has considerable fertilizing value.

The average acreage, yield, production and value of oats in the United States for ten years ending 1914 is given in the following table:

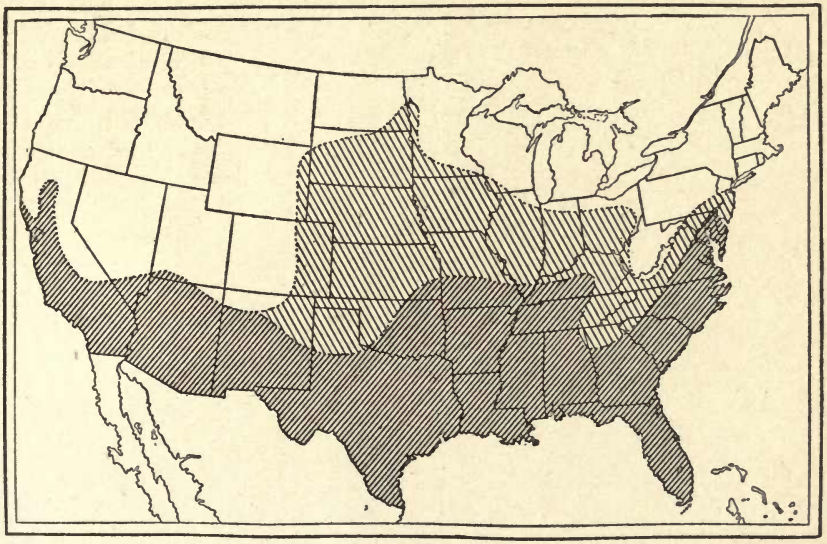
AVERAGE ANNUAL ACREAGE, PRODUCTION AND FARM VALUE AND MEAN ACRE YIELD OF OATS IN THE TEN STATES OF LARGEST PRODUCTION FOR THE TEN YEARS FROM 1905 TO 1914.

	Area, acres.	Mean Yield per Acre, bushels.	Production, bushels.	Farm Value, December 1.
Iowa	4,581,000	31.9	146,618,000	$48,182,000
Illinois	4,160,000	31.2	130,096,000	46,920,000
Minnesota	2,697,000	30.8	84,739,000	27,526,000
Wisconsin	2,337,000	32.5	73,386,000	29,202,000
Nebraska	2,373,000	25.3	59,384,000	19,938,000
Ohio	1,636,000	32.4	53,581,000	20,881,000
Indiana	1,719,000	29.0	49,887,000	18,018,000
North Dakota	1,737,000	27.7	48,233,000	15,233,000
Michigan	1,424,000	30.8	43,704,000	17,327,000
New York	1,268,000	31.5	39,973,000	18,761,000

Soil and Climatic Adaptation.—In the production of oats, favorable climate and cultural conditions are more important than the character and fertility of the soil. They do best in a cool, moist climate. In North America oats succeed best in Canada and those states of the Union lying next to the Canadian border. The acreage of spring oats below 38 degrees north latitude is very small. Oats require an abundance of water and loam, and clay loam soils are generally best adapted to them.

Classes and Varieties.—Oats are divided into spring and winter oats. By far the larger proportion in North America belongs to the former class. Spring oats are divided into two classes, namely, those having open panicles and those with closed panicles. By far the larger number of varieties falls into the first class. They are further classified by color into white, yellow, black, red and shades of black and red. They are also divided according to time of maturity into early, medium and late varieties. The time for maturity ranges from 90 days to 140 days. In the Central states in favorable seasons early oats should ripen in 90 days from time of seeding.

The accompanying map shows the three oat districts of the United States.



MAP OF THE UNITED STATES, SHOWING APPROXIMATELY THE AREAS TO WHICH CERTAIN TYPES OF OATS ARE ADAPTED.[1]

In the unshaded portion rather late maturing, large-grained white oats are usually best; in the lightly shaded portion early, small-grained, yellow varieties are most important; while in the heavily shaded portion brownish-red or gray varieties, which in the warmer sections are sown in the fall, are most certain to succeed.

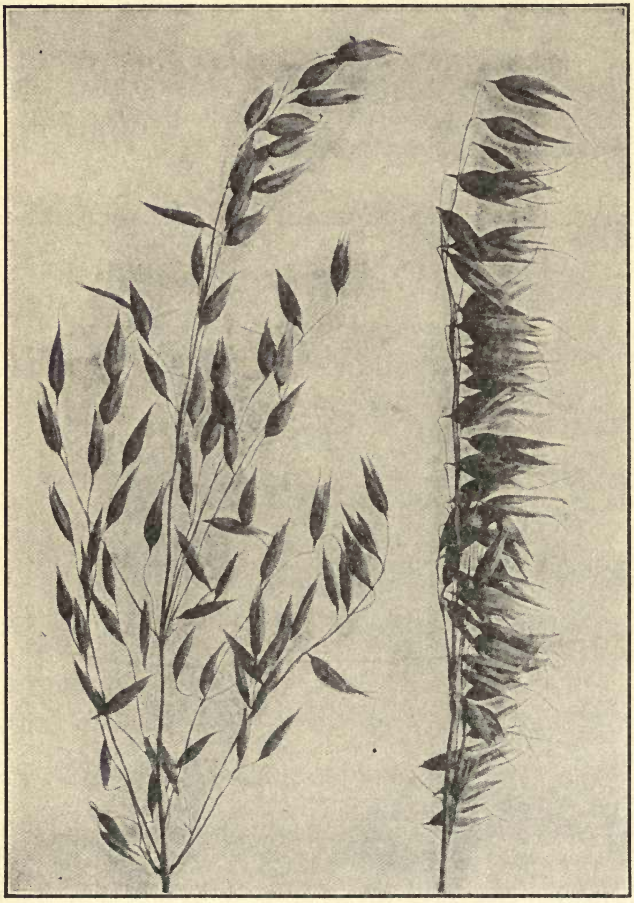
In the northern district the medium-maturing and late-maturing varieties generally give best results. The leading varieties in this district are American Banner, Big 4, Clydesdale, Lincoln, Probstier, Siberian, Silver Mine, Swedish Select, Tartarian, Wide Awake and White Russian.

In the central region the principal varieties are Big 4, Burt, Clydesdale, Kherson, Lincoln, Red Rust Proof, 60-Day, Silver Mine, Siberian and Swedish Select. In the southern district the chief varieties are Burt

[1] Courtesy of U. S. Dept. of Agriculture. Farmers' Bulletin 424.

and Red Rust Proof, together with Winter Turf, which is a strictly winter variety. Burt and Red Rust Proof may be seeded either in the winter or spring.

Seed Oats and Their Preparation for Seeding.—It is important to seed only varieties that are adapted to the conditions that prevail, giving particular attention to time of maturity as related to the prevailing climatic conditions during the oat-growing period. Seed oats should be thoroughly cleaned by the use of a good fanning mill before seeding. The screens of the mill and the blast of air should be such as to remove all foreign seed, hulls, trash and light and small oats. Frequently one-quarter or one-third of the oats may be removed in this way. Such thorough cleaning makes for a uniform stand of vigorous plant in the field.



Two Types of Oat Heads.[1]

Spreading, or panicled, oats (on the left); side, or horse-mane, oats (on the right).

If there is any trouble from smut, seed should be treated with formaldehyde; one pound of 40 per cent formaldehyde to 45 gallons of water. This is sufficient for treating about 45 bushels of oats. The solution must be brought in contact with every berry in order to be thoroughly effective. The oats may be

[1] From Farmers' Bulletin 424, U. S. Dept. of Agriculture.

spread out in a thin layer on a clean floor and the solution applied with a sprinkling can. Several thin layers of oats may be placed one on top of another, and each sprinkled in this way, after which the whole pile should be thoroughly stirred, shoveled into a compact heap, covered with a wet blanket and allowed to remain for twelve hours. The blanket should then be removed and the oats spread out and occasionally stirred until thoroughly dry.

Preparation of the Seed-Bed.—A large portion of the oats grown in the corn belt are seeded on corn ground without any preparation. The ground is disked and harrowed, or sometimes cultivated once or twice after seeding the oats. It is much better to double disk and harrow once before seeding. The better preparation in this way will usually more than pay for the increased expense. In some localities shallow plowing for oats may prove to be the best method of preparing the seed-bed. When seeded on corn land the stalks should be broken down. This is most easily accomplished by dragging a heavy pole or iron rail broadside across the field on a frosty morning when the ground is frozen. A mellow, loose surface soil with a firm subsoil is best for oats. This character of seed-bed is secured on corn land by the methods above described.

Fertilizers and Manures for Oats.—Over most of the spring oat region oats are grown without the direct application of either manure or fertilizers. When soils call for manure or fertilizers it is best to apply them to the crop preceding oats. In this way the oats receive only the residual effect, but this generally meets the needs of the crop. This avoids the danger of too rank a growth of straw that is likely to cause oats to lodge. Oats that lodge badly are not only difficult to harvest, but generally cause a failure of grass and clover seeded with them and give rise to a reduced yield of grain. On soil that is in a low state of fertility, or which receives no manure or fertilizer for the preceding crop, rather light applications of either manure or a complete fertilizer may be applied for oats with profit. Experiments show that phosphorus is the most important ingredient to be applied. Some nitrogen, preferably in an immediately available form, is generally advisable. Nitrate of soda at the rate of 75 to 100 pounds per acre will generally fully meet the needs for nitrogen.

The fertility removed by oats is given in Table II, Part III.

Time, Rate and Manner of Seeding.—The time of seeding will vary with the season and locality, but generally should be as early in the spring as soil conditions will permit the preparation of the seed-bed. Throughout a considerable part of the oat region, oats are seeded during April. Those seeded during the first half of this month are found to give larger yields than those seeded during the last half. In the southern part of the district, seeding in March usually gives good results, and in the Southern states seeding may take place much earlier. Oats do best if they can make the major portion of their growth during the cool part of the season. They are often injured by a short hot spell as they near

maturity. Frosts or even hard freezes after they are seeded seldom do injury, although prolonged wet weather immediately following seeding may cause the seed to rot in the soil and reduce the stand. A few farmers in the Northern states are now seeding ordinary spring oats in the late fall or early winter, so timing the seeding that the oats will not germinate until spring. This method is still in the experimental stage, and farmers should try it only on a limited scale and in an experimental way until it is demonstrated to be satisfactory.

The rate of seeding depends on the character and condition of the soil, the fertility of the soil, the quality of the seed, the size of the grains and the manner of seeding. Fertile soils require less seed than poor ones, because the plants tiller more. Abundance of seed should be used on weedy land, and seed broadcasted should be used more freely than when it is drilled. It will require more seed of the large-grained than of the small-grained oats.

In general, the rate of seeding ranges from 8 to 12 pecks per acre, the smaller amount being used when drilled and the larger amount when broadcasted. At several state experiment stations drilled oats have yielded three to five bushels per acre more than oats broadcasted under identical conditions. Where satisfactory results have not been secured by drilling oats, it has usually been attributable to covering the seed too deeply. Under average conditions oats should be covered from 1 to 1½ inches in depth, although in very loose soils or in a dry seed-bed, deeper covering will be satisfactory.

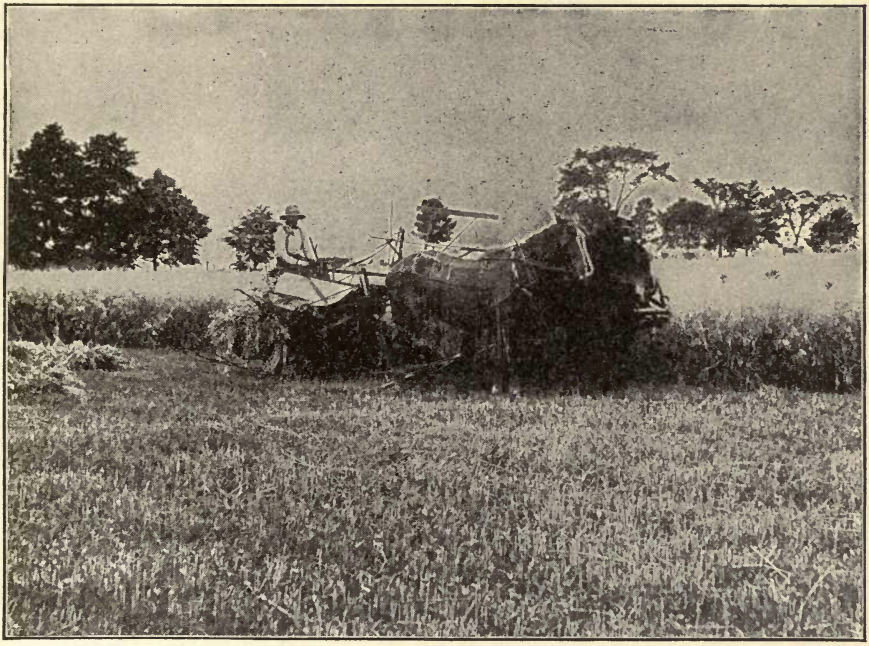
Oats as a Nurse Crop.—Oats are frequently used as a nurse crop for clovers and grasses. When used in this way early varieties and rather thin seeding is advisable. This encourages a good catch and stand of the clovers and grasses.

Harvesting, Shocking and Threshing.—Oats should be harvested when the grain is in the hard dough stage. If allowed to become fully ripe, the grain shatters badly in the process of harvesting, thus causing considerable loss. When cut early the straw will have a higher feeding value than when allowed to fully mature. Any shrinkage in grain that may take place as a result of cutting early will be more than offset by the increased value of straw. In regions where the straw is not utilized (and there should be no such regions) the harvesting should be carefully timed in order to secure the largest possible yield and yet avoid loss of grain.

When cut rather green or when the straw is damp, or when the oats are foul with weeds and grass, the harvester should be set for small bundles. When harvested in a thoroughly ripe condition the bundles may be placed into shocks immediately. When damp or green it is generally best to allow the bundles to lie several hours before shocking. When the oats are in a good, dry condition round shocks with a cap sheaf are to be preferred. Twelve bundles to each shock, exclusive of the cap sheaf, is the best number. The cap sheaf should be broken near the

band and the heads placed toward the direction of the prevailing wind. Where wind storms are very prevalent at this time of the year it is best not to use cap sheaves. When oats are green or damp, long shocks, made by standing the sheaves in pairs and extending north and south, are to be preferred. It pays to have the grain properly shocked, even though it is to be threshed in a short time and directly from the field.

If the grain is to be stacked, stacks should be well built. Rails or old straw should be used for the foundation to prevent damage to the first layer of sheaves. Stacks may be either round or long. The butts should



A Field of Good Oats being Harvested with a Modern Self-Binder.

always be laid toward the outside of the stack, and the outside layer should always slope downward so that the stack will turn rain. The greatest diameter of the stack at the time of construction should be five or six feet above the ground. This form in settling accentuates the sloping of the outside sheaves in the upper portion of the stack. Whether oats are to be threshed from the field or stack will be determined largely by the threshing custom of the locality. Where the custom of threshing from the field prevails, it will be difficult to get stacked oats threshed until field threshing is completed. Stacking entails some additional work, but generally improves the quality of the oats. Oats in the shock are

often badly damaged and suffer great loss from rains. This is largely obviated by stacking as soon as in proper condition.

In threshing, the concaves of the machine should be so adjusted that all grain will be separated from the straw, but the adjustment should be such as not to cause serious hulling of the berries or undue cutting of the straw. Oats are easily threshed when in a dry condition. The straw at threshing time should be either carefully stacked or run directly into a hay-loft or storage-shed, depending on facilities.

Storing and Marketing.—The threshed grain should be dry when put in bins and should be kept dry by adequate protection from rains or absorption of moisture from any source. Mustiness lowers the feeding value and endangers the health of animals. It also lowers the market value of the grain. Where grain weevils and other insects seriously affect stored grain, tight bins which can be fumigated are advisable. Under favorable conditions oats may be stored for a considerable time with very little shrinkage and loss. The highest market price generally prevails during the early part of the year and just prior to the oat harvest.

Composition and Feeding Value.—A large portion of the oats grown in America are fed to livestock. Limited quantities are used for the manufacture of prepared cereals. Oats are high in protein and are well adapted for work horses and growing animals. They are especially desirable because of the hulls which they contain, and which dilute the concentrate to about the right extent for healthy digestion. They are generally fed whole, although not infrequently are they chopped and mixed with other grains. An average of thirty analyses of oats gives 13.3 per cent protein, 5.6 per cent fat and 67.1 per cent carbohydrates, as compared with 11.8, 6.1 and 78.1 per cent for those respective items in corn.

Value of Oats for Hay and Soiling Purposes.—If cut when the grain is in the milk, oats make a palatable and nutritious hay, especially well suited for horses. Oats seeded with Canada peas make a good hay for milch cows and other cattle. This mixture is also well suited for soiling purposes and provides an early soiling crop. By seeding at different times the season of available soiling crops from this source may be considerably prolonged. A common rate of seeding this mixture is 1 bushel of peas to $1\frac{1}{2}$ bushels of oats. This mixture also makes good pasture for stock of all kinds.

Oat Straw and its Utilization.—Oat straw has a higher feeding value and is more palatable than straw from the other grains. It is quite generally used for feeding horses during the winter, and as a maintenance roughage for cattle and sheep. Its feeding value and palatability are best when the grain is harvested fairly early and the straw is secured without damage by rains. It pays to store it carefully and utilize it for feed as fully as possible. The refuse portion makes a valuable bedding and the straw has a fertilizer value of about $3 per ton.

Cost of Producing Oats.—The Bureau of Statistics of the United States Department of Agriculture secured estimates from about 5000 farmers in all parts of the country on the cost of producing oats in 1909. The estimates show an average cost of $10.91 an acre, or 31 cents a bushel. On the same farms for that year the average value of the oat crop was $14.08 an acre, or 40 cents a bushel. The average net return from grain was estimated at $3.17 an acre, to which was added the value of by-product to the amount of $1.42, making an average total profit of $4.59 per acre.

Oat Improvement.—The improvement of this crop has received much less attention from plant breeders and farmers than has corn and wheat. There are, however, many varieties of oats, most of which have originated through selection and breeding. It is important for the farmer to secure a variety well suited to his local conditions, and to improve that variety by thorough cleaning and grading of seed. There are opportunities, however, for improvement by selecting exceptional stools of oats and threshing these by hand and planting each in a separate row. These should be harvested separately and the best ones retained, threshed and used for seeding longer rows the following year. In this way new strains are frequently secured that are superior to the general crop.

BARLEY

The world's production of barley is about 1,500,000,000 bushels, of which North America produces one-seventh. Of this the United States produces 166,000,000 and Canada 48,000,000 bushels. In the United States, California, Minnesota, Wisconsin, North and South Dakota lead in barley production. These five states produce 73 per cent of all the barley grown in the United States.

Soil and Climatic Adaptation.—Barley is adapted to a wide range of climatic conditions, but it does best in the North Temperate Zone. It is somewhat more exacting in its soil requirements than either wheat or oats. It does best on a well-drained loam that is well supplied with organic matter. It is quite resistant on alkali soils, and is, therefore, adapted to such soils in the irrigated districts.

Classes and Varieties.—Barley is divided into two-rowed and six-rowed forms, depending on the character of the spike or head. In the United States the six-rowed form predominates. Manchuria and Oderbrucken are the leading varieties of this type. It is also divided into spring and winter, and bearded and beardless types. The bearded spring varieties prevail.

Preparation of Land and Seeding.—Barley demands a well-prepared seed-bed, and should be seeded in the spring as soon as all danger of freezing is past. Best results are secured by drilling at the rate of six to eight pecks per acre. Broadcasting the seed usually gives much lower yields than drilling.

Harvesting and Use.—Barley is harvested in the same manner as oats. It should be shocked in round shocks with cap sheaves, and in threshing the cap sheaves are usually threshed separately in order to secure as large a proportion as possible of unstained grain. Barley that is discolored by rains commands a much lower price than bright, unstained grain.

More than half of the barley produced in North America finds its way into the market, and much of it is used in the manufacture of malt. Malt is largely used in the production of beer and other malt liquors. Barley for this purpose should be clean and bright in color, and should

A Field of Winter Barley Seeded after Corn, Anne Arundel County, Md.[1]

be free from foreign seeds and broken grains, and possess a high germinating power.

Use of By-Products.—Straw from barley is less palatable than that of oats or beardless wheat, and is also somewhat less nutritious. It makes excellent bedding, although the beards are more or less irritating to both man and beast.

RYE

Rye is of minor importance both in the United States and Canada. Pennsylvania, Wisconsin, Michigan, Minnesota and New York produce 64 per cent of that grown in the United States, while Ontario produces the most in Canada.

[1] From Farmers' Bulletin 518, U. S. Dept. of Agriculture.

Adaptation and Culture.—Rye will grow on rather poor soil, and is most extensively grown in districts in the temperate zone where the soils are low in fertility. It is more hardy than wheat, and this is one of the principal reasons for growing it. The time of seeding and cultural methods are the same as those for wheat, although there is a somewhat wider range in the time of seeding. It may be seeded late in the summer and pastured so as to prevent heading during the autumn. It is quite extensively used as a cover crop and for green manure. Its hardiness and adaptation on poor soils make it especially valuable for these purposes in the temperate zone.

Rye is frequently broadcasted, although it gives better results when seeded with a drill. A well-prepared seed-bed is essential to a good stand of plants. Five to six pecks of seed per acre are required.

Uses of Rye.—Rye is frequently used as a soiling crop and occasionally cut for hay. When used for hay, it should be cut just before the heads are out. If not cut early, the straw hardens and makes a tough, unpalatable hay. A large part of the grain of rye in America is used in the manufacture of alcohol and alcoholic beverages. The grain is excellent for feeding stock, but it gives best results when used in small quantities and combined with other grains. It is best suited for hogs, horses and poultry. The grain, being very hard, generally gives best results when coarsely ground.

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CHAPTER 6

BUCKWHEAT, RICE, FLAX, EMMER, KAFFIR CORN AND SUNFLOWER

BUCKWHEAT

Buckwheat is a minor crop in most parts of America. It can be considered a staple crop only in New York and Pennsylvania. For a number of years its acreage has remained about stationary. The entire area devoted to it in the United States is about 800,000 acres. New York and Pennsylvania produce about 77 per cent of the total production.

It is often spoken of as the "lazy man's crop." It lends itself well to the farmer who lacks capital. It brings quick returns and finds a ready market at fair prices. It is the only grain for which a farmer can buy fertilizer on a ninety-day note and pay for it out of the crop.

Soil and Climatic Adaptation.—Buckwheat does best in a moist, cool climate and at high altitudes. High temperatures during the period of seed formation, accompanied by hot sunshine followed by showers, is generally disastrous to the crop. Buckwheat will mature a crop of grain in eight to ten weeks under favorable conditions.

Buckwheat is adapted to a wide range of soils, but does best on well-drained soils that are rather light in texture. It succeeds on poor soils and is most extensively grown in those regions where the soils are of rather low fertility.

Varieties.—The varieties common to the United States are Japanese, Silver Hull and Common Grey. The Silver Hull is slightly smaller than the Common Grey. The seed is also smaller, plumper and lighter in color than the Japanese. If there is no objection to mixing varieties it is thought larger yields can be secured by mixing the large and small growing varieties, which affords a better distribution of the seed heads in the field.

Preparation of Soil and Seeding.—Early plowing of the land in order to permit harrowing at intervals of two weeks and a thorough settling of the soil before seeding time, is advised. If early plowing is not possible, greater attention should be given to a thorough fitting of the seed-bed immediately following plowing.

The amount of seed per acre varies from three to five pecks, depending on manner of seeding, character of seed and condition of seed-bed. It may be seeded either with the grain drill or broadcasted and harrowed in. When drilled a smaller amount of seed will prove satisfactory, but the distribution of plants secured by broadcasting is preferable to that secured by drilling,

unless the drill hoes are close together. The later buckwheat is sown so as to get ripe before frost, the better the yield will be. It is seldom advisable to seed earlier than the last week in June, and in some localities it may be seeded as late as the second week in July.

Fertilizers and Rotations.—Buckwheat seeded on poor land responds well to a moderate dressing of low-grade fertilizer. On heavy soils where it is desired to grow potatoes, buckwheat is recommended as a good crop to precede potatoes. The following rotation is recommended for such soils: clover, buckwheat, potatoes, oats or wheat seeded with clover. With this arrangement the first crop of clover is harvested early and the land immediately plowed and seeded to buckwheat. This gives two crops during the season preceding potatoes, and leaves the land in excellent condition for potatoes.

Harvesting and Threshing.—The harvesting of buckwheat should be delayed until the approach of cold weather, because the plants continue to bloom and produce seed until killed by frost. The self-rake reaper is well adapted to cutting buckwheat. The machine used should leave the buckwheat in compact gavels with as little shattering as possible. The self-binder is sometimes used, being set to deliver small bundles loosely bound. However it may be harvested, it should be set upright in the field so as to prevent the grain lying on the ground. It is customary to haul the grain directly from the field to the threshing machine, as it is likely to mould when placed in stacks.

In threshing by machinery, neither the crop nor the day need be especially dry. The spiked concave of the thresher is generally replaced with a smooth one or a suitable plank. This avoids serious cracking of the grain and unnecessary breaking of the straw.

Buckwheat weighs 48 pounds to the bushel, and 35 bushels per acre is considered a good yield, while 25 bushels is satisfactory. The average yield of buckwheat in the United States is 18 to 19 bushels per acre.

Uses of Buckwheat.—Buckwheat is used chiefly in the manufacture of pancake flour. In some sections, and especially when the market price is low, it is used quite extensively for feeding livestock. It is an excellent poultry feed. The straw, being coarse and stiff, is of little value except for bedding or to make manure.

In some localities buckwheat is used as a green manuring crop. It serves well for this purpose because it grows quickly, may occupy the land after an early crop is removed, and leaves the soil in a loose condition. The seed being comparatively inexpensive and requiring only a moderate amount, makes it inexpensive from the standpoint of seeding. It is frequently used as a catch crop, being seeded in fields where other crops fail from whatever cause.

Buckwheat is an excellent bee feed. It blossoms for a considerable period of time and affords an abundance of nectar which makes honey of good quality.

RICE

Rice is unique in its culture, because it depends upon irrigation. It is one of the oldest cereals, and is also one of the greatest food crops, being a staple article of diet for millions of people in India, China and Japan. The world's annual production is approximately 175,000,000,000 pounds of cleaned rice, the greater portion of which is grown in India, China and Japan. As an article of food in the United States it is of minor importance, and yet the production in this country falls short of the consumption by about 200,000,000 pounds annually.

Soil and Climatic Adaptation.—Rice is adapted to a moist, warm climate, and its production in the United States is confined to the South Atlantic and Gulf Coast states. The bulk of the crop is now produced in Texas, Louisiana and Arkansas. Prior to 1890 it was produced mostly in the Carolinas and Georgia.

Since the lowland forms which constitute the principal source of the crop require irrigation, it demands a level soil with a compact subsoil that will prevent rapid downward movement of water. Such soils are found along the bottom lands of the rivers and on the level prairies of Texas and Louisiana.

Preparation of Land and Seeding.—The land is usually plowed in the spring and disked and harrowed to provide a good seed-bed. The rice is seeded at the rate of one or two bushels per acre with a seed drill, usually from April 15th to May 15th. Unless water is needed to germinate the seed the land is not flooded until the plants are six to eight inches high. If the soil is too dry the land may be flooded immediately after seeding for a few days to sprout the seed, after which the water is removed until the plants are six to eight inches high.

Weeds are often a serious menace to rice culture. Such weeds may be brought on rice fields in the irrigation water or may find their way there in the seed rice. Red rice is a serious pest, and seed should not be used in which it occurs. The presence of red rice in milled rice lowers its grade and reduces its price. Red rice, being stronger, hardier and more persistent than white rice, soon gets a foothold in the fields unless precautions are taken to prevent it.

Fertilizers are seldom used in the production of rice, because the practice of irrigation brings to the land some fertility in the water. This is especially true when the water is not clear. Furthermore, rice lands, being either river bottom land or prairie land, are generally very fertile. In the course of time, however, if rice is grown continuously, fertilizers will be needed.

Flooding or Irrigation.—Water is let into the rice field to a depth of three to six inches, and is maintained at this depth until the crop is nearly mature. Water of a rather high and uniform temperature is preferred. Cold water from mountain streams is undesirable. The water is constantly renewed to prevent it from becoming stagnant. This necessitates a slow

movement of water across the rice field, and for this reason it is not advisable to have the fields too large. Irrigation necessitates the land being practically level and surrounded by dikes.

There should be good facilities for draining, since land must be in good condition when prepared for seeding and should be fairly dry at the time of harvesting.

Harvesting and Threshing.—It requires from four to six months to mature a crop of rice and the date of harvesting in the United States varies from August to October, depending on time of seeding, character of season and variety of rice. The crop should be harvested when the grain is in the stiff dough stage and the straw somewhat green. The ordinary grain binder is used for harvesting the crop, and the methods of shocking, stacking and threshing are very similar to those used in wheat production.

Yields and Value.—Rough rice weighs 45 pounds to the bushel. It is generally put into barrels of 162 pounds each, and the yield is spoken of in barrels, and ranges from 8 to 30 barrels per acre; 12 barrels is considered a good yield. The hulls or chaff constitute 12 to 25 per cent of the weight of the rice, depending on variety and condition. In 1910 the total crop in the United States was valued at $16,000,000, or about $20 per acre. The rice is prepared in mills which remove the husk and cuticle and polish the surface of the grain. In this condition it is placed upon the market.

FLAX

Flax is grown in Canada and in a few of the Northern states. Nearly nine-tenths of the flax of the United States is grown in North and South Dakota and in Minnesota.

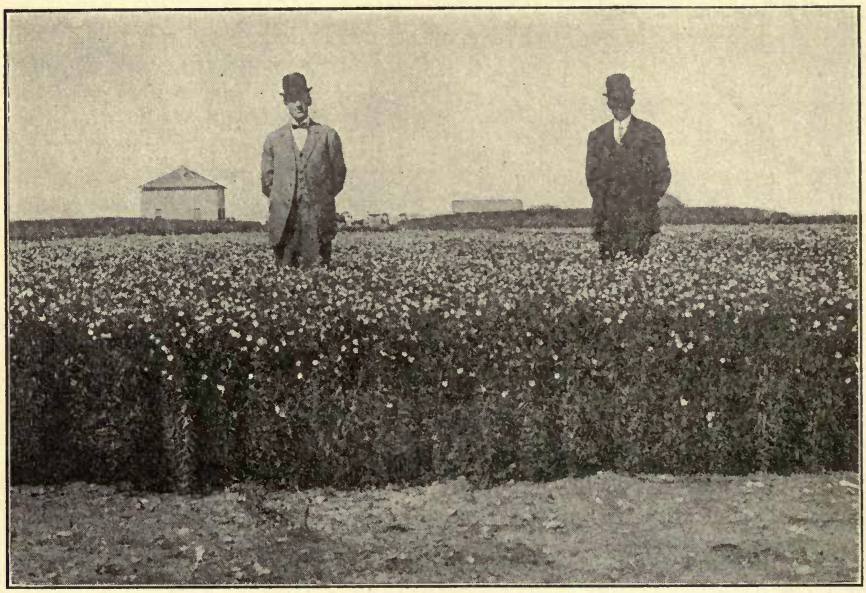
Soil and Climate Adaptation.—Flax grows best in a cool climate and on soils that are not too heavy. Sandy loams are better adapted to the crop than clay loams or heavy clays. It is extensively grown on virgin prairie soil, and is well adapted for seeding on the rather tough prairie sod when plowed for the first time. The roots of flax develop extensively near the surface of the soil. It is often considered an exhaustive crop, but the actual removal of plant-food constitutents is less than in most other farm crops Its shallow, sparse root system and the small amount of stubble usually left in the field probably explain why it is considered exhaustive.

Preparation of Land and Seeding.—Where grown on virgin prairie land, the sod should be broken about four inches deep and completely inverted in order to make a smooth surface for seeding the flax. On newly plowed land flax is seeded broadcast at the rate of one-half bushel per acre, and covered by harrowing. It is thought better to fall-break sod, and to provide a better prepared seed-bed the following spring by thorough disking and harrowing. In this process the sod should not be loosened from its place, and the roller is frequently used to compact the seed-bed and keep it smooth and also level to facilitate the covering of the seed at a uniform depth.

Where flax is grown on old land it follows corn to good advantage, and

the seed-bed may be prepared by disking and harrowing in a manner similar to preparing the land for oats. In recent years a seed drill has been used for seeding flax with good results. The seed should be covered from one-half inch to an inch deep.

Thin seeding encourages the branching of the plants and within reasonable limits encourages large yields of seed. On land foul with weeds it is better, however, to seed somewhat thicker to prevent weed develop-



A Field of Flax in Bloom.[1]

ment. When flax is grown chiefly for the fiber one and a half to two bushels of seed per acre are used.

Harvesting and Threshing.—Flax may be harvested either with the self-rake reaper or self-binder. When harvested with the reaper the gavels should be rolled and set upright. The heads become entangled in such a way as to hold the rolled gavels together. The straw is frequently so short that it is necessary to cut as close to the ground as possible, and this calls for a level seed-bed that will facilitate close cutting with machinery. When cut with the binder the bundles should be set in small, loose shocks to facilitate drying. The highest quality of seed for market demands threshing from the shock as soon as it can be safely done.

Threshing is done with the ordinary threshing machine and necessi-

[1] Courtesy of Webb Publishing Company, St. Paul, Minn. From "Field Crops," by Wilson and Warburton.

tates having the concaves set fairly close in order to separate all the seed from the straw. The seed is small and flat and is but little broken in the process of threshing.

The threshed seed is generally placed in strong, closely woven bags and securely tied. The seed, being small, flat and exceedingly smooth, will run almost like water, and requires exceedingly tight bins for its storage and very tight wagon boxes in case it is to be hauled unbagged.

Yield and Value of Crop.—The yield of flax seed ranges from 8 to 20 bushels per acre. Since most of the flax is produced by extensive methods and on new land, the average yield for the United States is about 9 bushels. The price generally ranges from $1 to $1.50 per bushel. During the last few years a scarcity of flax has caused a somewhat higher price. A bushel of flax will produce about twenty pounds of crude linseed oil, and the oil cake after the removal of the oil is worth from 1 to 1½ cents per pound. The average annual production in the United States for ten years ending 1911 was about 24,000,000 bushels, valued at approximately $28,000,000.

Utilization.—Flax is grown chiefly for its seed, from which is made linseed oil, extensively used in the manufacture of paints. The meal, after the extraction of the oil, finds a ready sale as a nitrogenous stock food, and is extensively used as a concentrate for dairy cows.

The straw is utilized in only a limited way. It makes fair roughage for stock, although not as valuable as oat straw. In some localities the straw is used in the manufacture of tow, which is used in making rough cordage and twine.

In the old world the plant is extensively used for the manufacture of fiber. This necessitates pulling the plants by hand and requires special facilities for treating the straw and separating the fiber. Labor is too expensive in this country to enable American flax to compete with that of the old world in this respect. Ground flax seed in small amounts is a splendid feed for all kinds of stock. It acts as a tonic and has a good effect upon the digestive system.

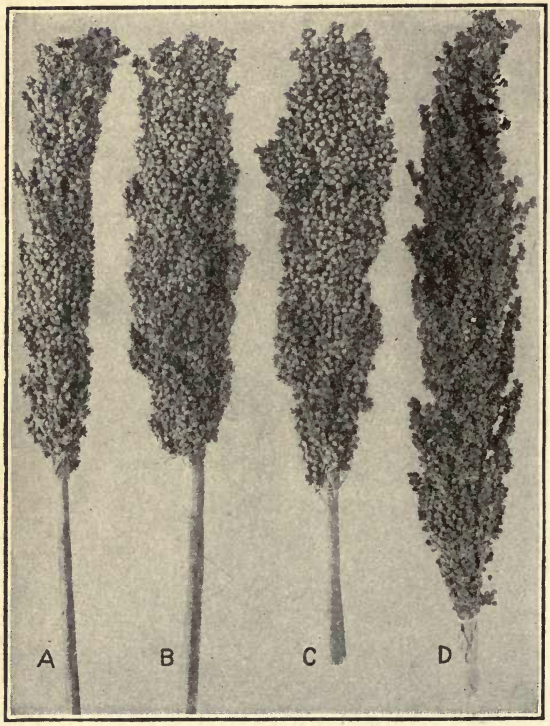
Diseases of Flax.—Flax is so seriously troubled with a disease known as flax wilt that it necessitates the use of treated seed selected from wilt-resistant plants. The formalin treatment described for wheat serves equally well for the treatment of flax seed. Flax seed will require only about one-half gallon of the solution to each bushel of seed. It should be thoroughly stirred after sprinkling, covered with canvas treated with formalin, and allowed to remain two or three hours and then stirred and dried. After thoroughly dry it may be placed in bags which have been treated with formalin to prevent the presence of wilt spores.

Since this disease may live in the soil for several years in the absence of flax, it is necessary to practice long rotations in which flax will not be grown more frequently than once in five to seven years.

KAFFIR CORN

Kaffir corn is a non-saccharine sorghum. The sorghums are generally divided into three classes: (1) those cultivated chiefly for grain, of which Kaffir, milo and dura are the best types; (2) those cultivated for the manufacture of brooms; and (3) those grown chiefly for the production of syrup.

Regions of Production.—Kaffir corn, milo and dura are grown chiefly between the 98th meridian and the Rocky Mountains, and south of 40 degrees north latitude. This crop is drought resistant and adapted especially to the dry conditions of the Great Plains region.



HEADS OF FOUR VARIETIES OF KAFFIR.[1]

A—White Kaffir; B—Guinea Kaffir (Guinea corn of the West Indies); C—Blackhull Kaffir; D—Red Kaffir. (About one-fifth natural size.)

Value and Uses.—Kaffir corn is used chiefly as a source of stock food. The grain is similar in composition to ordinary corn, and has about the same feeding value. In composition there is very little difference between the stover of corn and Kaffir corn. Any surplus of the grain finds a ready market, and is in much demand for poultry feed. The grain may be fed either whole or crushed. It is somewhat softer than the grain of corn and the kernels, being smaller, can be used for poultry without crushing. It makes excellent feed for horses, cattle and swine.

Varieties.—There are many varieties in each of the three classes of non-saccharine sorghums. The Kaffir corn proper has erect, compact seed heads and the foliage is more leafy than that of milo. The seed heads of the latter are usually pendant, the stalks are less leafy and the plant is generally earlier in maturity. It is, therefore, adapted to the northern portion of the Kaffir corn region, and to those localities where seed production is most important.

[1] From Farmers' Bulletin 686, U. S. Dept. of Agriculture.

Production and Harvesting.—The preparation of the land, the planting and the cultivation of Kaffir corn are similar to those required for corn under the same conditions. The seed should be drilled in rows sufficiently far apart to facilitate cultivation with two-horse cultivators, usually 3½ feet apart. The seed is drilled at such a rate that the plants in the row will stand from 4 to 6 inches apart. For small growing varieties plants may be closer than in case of the larger varieties. Planting should not take place until the soil is quite warm. It is usually best to plant about ten days later than the best time for planting field corn. It is advisable to have a well-prepared seed-bed free from weeds. The plants as they first appear are small and make slow growth.

The crop may be harvested by cutting the whole plant and placing in small shocks, or the seed heads may be removed and stored in narrow, well-ventilated cribs. After removing the seed heads the stalks may be cut and shocked or they may be pastured as they stand in the field. In some localities the whole plant is cut and put in the silo in the same manner as making ensilage of field corn. The yield of grain is fully as large as that of field corn grain under similar conditions, and the drought-resistance of the crop makes it more certain than corn. Fifty bushels per acre is considered a good yield. The seed is separated from the head by means of a threshing machine. The weight of threshed grain per bushel is 56 pounds.

EMMER.[1]
A good substitute for oats and barley.

EMMER

Emmer, also known as spelt, is closely related to wheat, but is distinguished from it by the grain, which remains enclosed in the glumes when threshed. There are both spring and winter varieties. The spring varieties are most extensively grown in the northern portion of the Great Plains region. The crop is characterized by its ability to make a satisfactory growth on almost any kind of soil. All of the varieties are drought resistant, and the winter varieties are fairly hardy. It is not attacked by rusts and smuts to the same extent as wheat and oats.

[1] From Farmers' Bulletin 466, U. S. Dept. of Agriculture.

It stands up well in the field and is little damaged by wet weather at harvest time.

The methods used in the seeding of other spring grains will apply to emmer. The seed should be drilled at the rate of about two bushels per acre. It is important to sow early. The grain will stand a great deal of spring frosts.

Emmer is well adapted to the feeding of stock, and will easily take the place of oats, barley or rye.

A comparative test of emmer as compared with other spring grains covering a period of eight years at the North Dakota Experiment Station shows comparatively little difference in the yield of grain from the several crops. Oats led with 1969 pounds per acre, while emmer was second with 1945 pounds to the acre. The lowest yield, 1711 pounds per acre, was from wheat.

While this crop is especially adapted to the semi-arid conditions of the Northwest, it is suggested that it might prove a profitable substitute for oats in those portions of the Central, Southern and Eastern states where oats prove unsatisfactory.

SUNFLOWERS

Sunflowers are a native of America, and are widely but not extensively grown. The leaves and heads of the plant make good fodder for horses and cattle. The seeds are used for bird and poultry food and also for the manufacture of oil. Sunflowers succeed best on rather fertile soil and with warm climatic conditions. The requirements are similar to those for corn. The seed should be planted in drills sufficiently far apart for cultivation, and should be thinned to one plant every 12 to 14 inches in the row.

When the heads form, it is advisable to remove all but two or three on each plant.

The heads should be harvested before the seed is fully ripe. This prevents loss of seed by shattering and damage by birds. The heads should be spread out on a barn floor or other suitable place until dry. They may then be stored in bulk. Where used on the farm for poultry, there is no need for threshing the seed. The cost of growing sunflowers is much the same as for corn. The harvesting, however, is much more expensive, and until suitable methods for harvesting and threshing and storing are devised, the crop is not likely to be extensively grown.

Yields ranging from 1000 to 2250 pounds of seed per acre are reported. The seed weighs 30 pounds per bushel.

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CHAPTER 7

Meadow and Pasture Grasses

Meadow and pasture grasses constitute an important and desirable part of the roughage for most classes of livestock. Livestock is indispensable as a part of good agriculture. An old Flemish proverb says, "No grass, no cattle; no cattle, no manure; no manure, no crops." The history of agriculture of many countries shows that where the production of grasses has been neglected, agriculture has declined. England neglected the grass crops and her yield of wheat fell to less than fifteen bushels per acre. She then turned her attention to grasses and the yield increased to over thirty bushels per acre. Of her 28,000,000 acres of tilled land, over one-half are now in permanent pastures. For the past forty-five years permanent pastures of England have increased at about one per cent annually. This should convince the American farmer that in order to grow grain profitably crops must be rotated, and in this rotation grass should find a prominent place. Some far-sighted farmers in North America saw this many years ago, and in the corn belt those who have grown grass are today husking sixty bushels of corn per acre, while those who did not must be content with about thirty bushels.

Importance and Value of Grasses.—According to the last census the hay crop of the United States was 61,000,000 tons, valued at $750,000,000. This does not include the annual hay and forage crops and various kinds of by-products, such as straw and corn stover. This amount of hay will sustain the livestock of the United States about one-fourth of the year, and must be supplemented by about 200,000,000 tons of other forms of feed. Considerable of this comes from the pastures, for which we have no definite statistics. The combined value of hay and pasture grasses far exceeds that of any other crop excepting corn.

Regions of Production.—The perennial hay and pasture grasses succeed best in the northeastern one-fourth of the United States and in southeastern Canada. This grass region extends south to the Potomac and Ohio rivers and to the southern border of Missouri and Kansas, and is limited on the west by about the 96th meridian. The region is characterized by a cool, moist climate and moderate to abundant rainfall.

Principal Grasses of North America.—There are several hundred species of grasses, but of these there are less than one dozen that are of economic importance in North America. Those of greatest importance in the order mentioned are timothy, blue grass, redtop, Bermuda grass, orchard grass, smooth brome grass and Johnson grass. There are a number of others that are grown on a very limited scale, among which

may be mentioned tall oat grass, meadow fescue, tall fescue, English rye grass, Italian rye grass, sheep's fescue, red fescue, Sudan grass and sweet vernal grass.

Valuable Characteristics.—To be valuable under cultivation grasses should give satisfactory yields, possess good feeding value, be capable of easy reproduction and be reasonably aggressive. To these might be added, habit of seeding freely so that seed can be cheaply harvested, together with hardiness or ability to withstand adverse climatic conditions.

Choice of Grasses.—The kind of grass to grow will depend on what one wishes to do with it. For pastures a mixture or variety of grasses is

MAP SHOWING REGION OF GRASS PRODUCTION IN THE UNITED STATES.[1]

desirable for a number of reasons. In the first place, a variety of grasses lends variety to the forage for the pastured animals, and induces them to partake of more food and consequently make more growth. A variety often prolongs the season of pasturage, some grasses making their growth in the early and late portions of the growing season when weather conditions are cool, and others growing more freely in the warmer portion of the season. Variety also increases the total yield because of the variation in habits of growth of both roots and foliage.

When grown chiefly for hay, the yield, quality and palatability of the crop secured are important. The cost of establishing, both in direct outlay for seed and in the preparation of the seed-bed, should be considered,

[1] Courtesy of The Macmillan Company, N. Y. From "Forage Plants and Their Culture," by Piper.

as should also the duration of the grasses and the length of time required to come to perfection. Consideration should also be given to time of maturity as related to favorable or unfavorable weather. Abundant sunshine and freedom from rains facilitate making hay of good quality. Where two or more grasses are grown, those should be selected that will mature at approximately the same date.

Seed and Seeding.—There is no crop in which more seed is wasted than the grasses. Of the seed sown a relatively small percentage develops plants, and probably there is no crop in which failure to secure a satisfactory stand of plants is more common. This is due to a number of factors, among which may be mentioned the poor preparation of the seed-bed, the faulty covering of the seed and the adverse conditions that frequently follow seeding, thus causing a large percentage of the small plants to perish. The poor quality of the seed used is also a factor and one that can be largely avoided by the purchase of only first-class seed. As a rule, first-class seeds, although costing more than poor ones, are the cheapest. The following table gives the rate of seeding, the cost of seed per pound and the calculated cost per acre:

Cost of Seed per Acre, Using Average Amount.*

Plant.	Rate of Seeding, pounds.	Cost of Seed per Pound.	Cost of Seed per Acre.
Timothy	15	$0.06½	$0.975
Orchard grass	20	.15	3.00
Redtop	10	.10	1.00
Brome grass	20	.10	2.00
Kentucky blue grass	25	.14	3.50
Italian rye grass	30	.05	1.50
Perennial rye grass	30	.05	1.50
Tall oat grass	30	.14	4.20
Tall fescue	20	.18	3.60
Meadow fescue	20	.11	2.20
Red clover	12	.17	2.04
Alsike clover	8	.20	1.60
Alfalfa	20	.15	3.00
Sweet clover	20	.20	4.00

Since failure to secure a satisfactory stand of grass is so common, farmers are advised not only to use every precaution in the preparation of seed-bed and time and manner of seeding, but also to use an abundance of good seed. As land values increase and the price of product becomes higher, the necessity for these precautions becomes greater. The extra expense for liberal seeding will pay abundantly in the vast majority of cases. The ideal seed-bed is moist and finely pulverized. The slant-toothed harrow is the best implement for making the final preparation.

* The prices given were New York wholesale prices in January, 1914, as given in "Forage Plants and Their Culture," by Piper. Rate of seeding for red, alsike and sweet clover changed.

Harvesting.—The time of harvesting grasses for hay will be determined: (1) by the weather conditions that prevail at the period of maturity, (2) the injury to the succeeding crop as determined by time of cutting, (3) the total yield as determined by stage of maturity, (4) the amount of digestible nutrients secured, and (5) the digestibility and palatability of the product. These factors will vary somewhat with different species of grasses and with the character of animals to which they are to be fed. In general, hay cutting should take place from the period of bloom until seeds are in the dough stage. The total pounds of dry matter will generally increase up to fair maturity. Palatability will be lessened and digestibility diminished if harvesting is too long delayed. If a large acreage is to be handled and weather conditions are uncertain, the harvest period is likely to be prolonged. It is, therefore, well to begin

THE SIDE DELIVERY RAKE.[1]

harvesting rather early in order that the harvest may be completed before the grass becomes too mature.

The market demands a product of timothy hay that is fairly mature when harvested. Such hay is more easily cured and less likely to contain dust and moulds. The large part of timothy that is placed upon the market is used for feeding horses, and feeders object to dusty and mouldy hay.

The quality of hay is determined to a large extent by the manner in which it is handled and cured. This in turn depends to no small degree upon weather conditions. Warm weather, accompanied by plenty of sunshine and a fairly dry atmosphere, is favorable to hay making. If the grass is fairly mature it may be cut late in the afternoon or early in the morning, and placed in the windrow or shock during the evening. Where hay is produced extensively, it is advisable to use up-to-date

[1] Courtesy of The International Harvester Company, Chicago.

mowing machines, side-delivery hayrakes, tedders and convenient and automatic forks for conveying the hay from wagons to mows or stacks. With such an equipment the hay is secured with the minimum of labor and the least possible handling and consequent loss of the leaves and finer portions.

It is maintained, however, that hay of better quality is obtained by curing it in the field in the shock. Cocking hay so that it will not be unduly exposed to rain entails additional labor. Canvas covers are advised if weather conditions are uncertain.

Hay placed in the mow or stack before thoroughly dry goes through a sweating process. A certain degree of sweating is deemed desirable, but should not proceed sufficiently far to develop moulds or cause discoloration. The amount of sweating is dependent on the moisture in the hay. The amount of moisture in hay as it is hauled from the field varies greatly, but ordinarily will not exceed more than 25 to 28 per cent; 20 to 25 per cent of moisture is favorable to a good quality of hay, and is better than to have it too dry or too moist when stored. Numerous determinations of the shrinkage of hay in stack or mow show a loss in a period of six months ranging from as low as 3 per cent to over 30 per cent. This loss is due chiefly to the loss of moisture from the hay. Where the sweating is intense and the temperature runs high, there will also be some loss of organic matter.

Combined Sweep Rake and Stacker.[1]

In stacking hay great care should be exercised in the construction of the stacks in order that they shed water. The stacks should be built of good form, and the central portion should be more thoroughly compacted than the outsides. Where hay is valuable, it pays to cover the stacks with good canvas covers or to provide a roof of boards. The stack should be protected from the earth by a foundation of rails or by a thick layer of straw.

Hay is marketed both baled and unbaled. It is graded according to its quality and freedom from weeds and grasses other than that of the name under which sold. Market grades can be secured from grain dealers' associations, and are generally given in market quotations.

[1] Courtesy of The International Harvester Company, Chicago.

TIMOTHY

Timothy is the most important and the most extensively grown of any of the meadow grasses in North America. It is the standard grass for hay purposes and finds a ready sale in all of the hay markets.

Soil and Climatic Adaptation.—Timothy is a northern grass and seldom does well in North America south of latitude 36 degrees, excepting in high elevations. Cool, moist weather during the early part of the growing season is favorable to good yields of hay. It is best adapted to loam and clay loam soils. It is not adapted to swampy soil conditions, neither does it succeed on sandy or gravelly soils. It is not drought

A Field of Good Grass (Timothy), College Farm, Pa.
Yield, five tons per acre field-cured hay.

resistant, and does best on moist, well-drained soils. It calls for a fair degree of soil fertility and does not do well on acid soils.

Advantages of Timothy.—The importance of timothy lies chiefly in its ability to produce good yields of hay that find a ready market at a fair price. The plants seldom lodge and are easily cut and cured, and the period during which it may be cut is longer than that for most grasses. It seeds abundantly, and seed of a high degree of purity and of good germination can be secured at a low cost. It fits well into the crop rotations, and is adapted to seeding with small grains, such as wheat, oats, rye and barley, either in the autumn or in the spring.

Seed and Seeding.—The low price of timothy seed and its appearance make it difficult of adulteration. No grass seed on the market so nearly

approaches absolute purity as timothy seed; consequently, the standard of purity is placed at 99 per cent, and that of germination at 98 per cent. Timothy seed contains about 1,200,000 seeds to the pound, and weighs 42 to 48 pounds per bushel. The legal weight is 45 pounds. Four pounds of timothy seed furnish 100 seeds to the square foot on an acre. If every seed produced a plant there would be a great many more plants than are required to make a satisfactory hay crop. The seeds, however, are so small, and the conditions for germination and early growth often so unfavorable, that 12 pounds per acre are usually required. Tests at several of the experiment stations with different rates of seeding show that the largest yield of hay has been secured by using amounts somewhat in excess of 15 pounds per acre.

The Hay Loader in Operation.[1]

Under favorable temperature and moisture conditions the seed germinates in five to six days. Although a large percentage of seed three or four years old will grow, it is safest to use seed that is not more than one year old. New seed is sometimes adulterated with old seed. Old seed can generally be detected by its lack of luster, but a germination test to determine the quality of the seed is advised.

The seed is sown broadcast and where seeded with a nurse crop is generally applied by means of the grass seed attachment to the grain drill. There are two methods of distributing the seed by this attachment. In some cases the grass seed distributors are turned in front of the drill hoes. This provides for considerable covering of the timothy seed, and

[1] Courtesy of The International Harvester Company, Chicago.

is applicable only when the soil is of a sandy nature, or in excellent physical condition. Otherwise, it is generally best to distribute the seed behind the drill hoes, and allow it to become covered by the action of rain.

The wheelbarrow seeder is also used, and where the seeding by the above-mentioned method cannot be entrusted to thoroughly competent labor, it is better to use the wheelbarrow seeder. In this way the operator has only the seeding of grass to look after and will do a better job than is likely to be done when the seeding is combined with the distribution of grain and fertilizers all in one operation.

ROWS OF TIMOTHY, EACH PROPAGATED BY SLIPS FROM THE ORIGINAL SEEDLINGS.[1] Each row represents a distinct type. Note the variation in size and vigor.

When winter grains are grown, most of the timothy is seeded with them in the fall. When seeded in this way it makes but little growth the succeeding year, and no hay crop is secured. The second year a full crop of hay is secured. In some localities timothy is seeded alone in the fall. This method is applicable in the southern portion of the timothy region. It involves more labor, but results in a full crop of hay during the following season.

Where spring-sown grains prevail, timothy is more frequently seeded with them in the spring. With this method, no crop is secured the first

[1] Farmers' Bulletin, 514, U. S. Dept. of Agriculture.

season. In the southern portion of the timothy belt spring seeding without a nurse crop is practiced to a limited extent. Such seeding is successful only on land that is free from weeds and annual grasses. Under such conditions a light cutting of hay is secured during the first year.

Timothy may be seeded on wheat that has been severely winter killed. If seeded early and the wheat is not harvested too early, both wheat and timothy may be cut for seed at one and the same operation. By using a fanning mill with proper sieves the wheat and timothy seed are easily separated after threshing.

Fertilizers and Manures.—Timothy responds abundantly to light top dressings of manure. The manure should be applied with a manure spreader, and best results will be secured when used at the rate of six to ten loads per acre. It may be applied any time during the autumn or winter. In the absence of manure, a top dressing with a complete fertilizer early in the spring just as the grass begins to start is very beneficial. In several of the states 350 pounds per acre containing about seven per cent of each of the three constituents have given excellent results.

Tests at several of the experiment stations relative to the position of the roots of timothy in the soil show that 85 to 90 per cent of the roots are found in the first six inches of soil. In one case 63 per cent occurred in the upper two inches of soil. This is important in connection with the top dressing of timothy and shows that such top dressing is very close to the great bulk of the active roots of the crop.

Mixing Timothy with Other Grasses and Clovers.—If the hay product is to be fed on the farm, it is advisable to seed clover with timothy. In this practice the amount of timothy seed is reduced to eight or ten pounds per acre, and may be seeded either in the fall or spring, depending on local practice. In the northern part of the timothy region the clover can be safely seeded only in the spring. Six to ten pounds of clover seed per acre will be required, depending on soil conditions and the kind of clover. The first crop of hay will be largely clover, the second chiefly timothy.

Where meadow land is to be used for hay during the first year or two and afterwards devoted to pasture, it is well to include redtop, blue grass and some other grasses and clovers with it. It is also thought wise on very wet lands or on sour soil to include some redtop with the timothy for hay purposes.

Harvesting.—Many experiments relative to the time of harvesting show that the best results are secured only when cut between the time of full bloom and the soft dough stage of the seed. Since timothy is shallow rooted and much of its vitality depends on the thickened bulb-like base of the stem, it is desirable not to cut too closely. Close cutting, or pasturing closely with stock after cutting, injures the subsequent crops by exposure of the bulbs and by injury from tramping. Only when the aftermath is abundant should pasturing be allowed. In no case is it

deemed desirable to pasture with sheep, since they are apt to rip off the crown of the plant and thus destroy it.

Pasturing.—Timothy is distinctly a grass for hay rather than for pasturing. It may be used in pasture mixtures to give early grazing, and will give way to the more permanent grasses which are slower in becoming established. It is a common practice to cut timothy for hay purposes for one or more years and then pasture during the year just preceding the devotion of the land to another crop.

FIELD OF TIMOTHY PLANTS GROWN FOR SELECTION, SHOWING VARIATION IN SIZE AND FORM OF INDIVIDUAL PLANTS.[1]

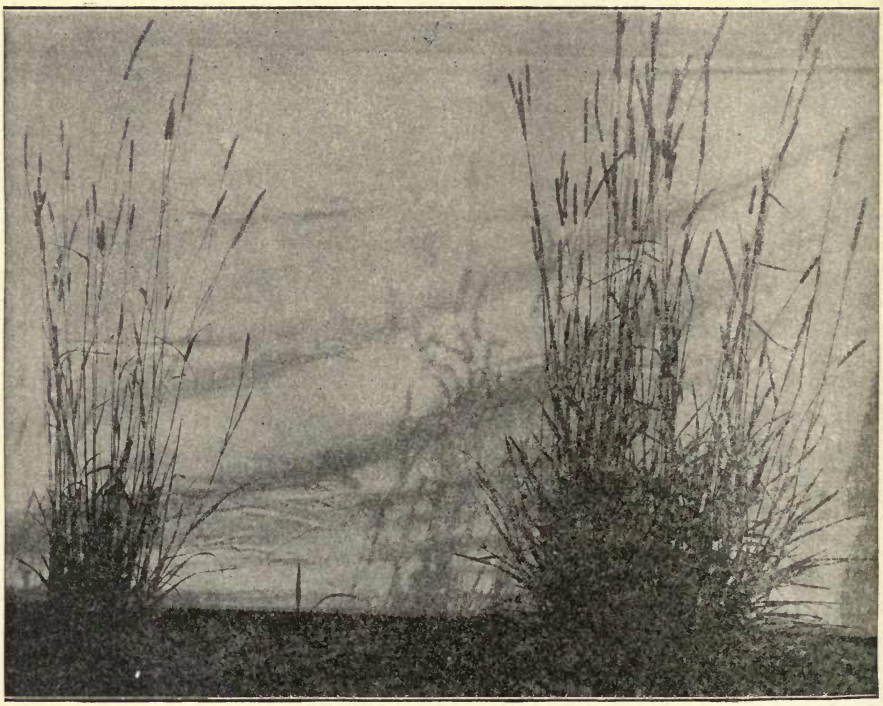
Slips and seeds from choice plants are used for propagating new strains.

Seed Production.—Timothy generally produces between five and twelve bushels of seed per acre. It is most conveniently cut with the self-binder, and is threshed with the ordinary threshing machine, using special sieves to clean and separate the seed. Loss from shattering will be severe if allowed to become over-ripe. If cut promptly the straw has considerable feeding value. The principal seed-producing states are Illinois, Iowa, Minnesota, South Dakota, Kansas and Ohio.

Composition and Feeding Value.—Timothy hay contains about 6 per cent of protein, 45 per cent of carbohydrates, 2.5 per cent of fat and 29 per cent of crude fiber. About one-half of this is digestible.

[1]Farmers' Bulletin, 514, U. S. Dept. of Agriculture.

Improvement of Timothy.—Although timothy has been an important crop and large quantities of seed are bought and sold, as yet no varieties have been developed. Timothy plants show marked variation in size, vigor, character of foliage and resistance to drought. Improvement of the crop for special purposes can be made by the selection and propagation of desirable plants. Several of the experiment stations have made progress along this line and have already developed strains of timothy that have



VARIATIONS IN TIMOTHY.[1]

outyielded that secured from commercial seed by as much as one ton per acre.

Marketing the Hay.—The bulk of timothy hay is placed upon the market in bales of about 100 pounds each. The market calls for bright, clean timothy hay, free from weeds and various grasses. When mixed with clover, redtop or other grasses, quotations will be somewhat lower than for pure timothy.

BLUE GRASS

There are two chief species of blue grass in North America, namely, Kentucky blue grass and Canada blue grass. These grasses spread by

[1] Courtesy of The Macmillan Company, N. Y. From "Plant Breeding," by Bailey.

means of seed and also by underground root stocks. They give rise to an even and continuous turf, and are especially adapted for pasture purposes. They are aggressive grasses and tend to take possession of the land and crowd out weeds and other grasses. The Kentucky blue grass is superior in both quality and yield. Its climatic adaptation is essentially the same as that for Canada blue grass, and ranges from Virginia northward into Canada, and westward to the central part of Kansas and Nebraska. It reaches its highest development in the region of limestone soils. Parts of Kentucky, Missouri, Virginia and Tennessee are noted for their blue grass regions. It also succeeds well on both the timber and prairie soils of Ohio, Indiana, Illinois and Iowa.

Soil and Climatic Adaptation.—These two prominent pasture grasses are adapted to a cool, moist climate having thirty inches of rainfall and upward. They are exceedingly resistant to cold, never freezing out in even the most severe winters. These grasses prefer well-drained loams or clay loams. They are not adapted to loose, sandy soils. The Kentucky blue grass calls for a fair to good degree of fertility, and where these two grasses are seeded together on such soil, the Kentucky blue grass will soon take full possession. The Canada blue grass has the ability to grow on poor soils, although it will produce only small crops and poor pasturage under such conditions. On poor soils the Canada blue grass will take possession finally to the exclusion of Kentucky blue grass.

Although these two grasses will make hay of fair quality, the yield is so low that they are not adapted to hay purposes.

Importance of Blue Grass.—As pasture grasses these are unexcelled for the temperate portions of North America where the rainfall is fairly abundant. They are not only valuable as summer pasture, but as winter pasture for horses and sheep, have no equal. When desired for winter pasture they should not be closely pastured during the summer. Winter pasture from these grasses can often be provided by turning the stock into the fields from which the spring crops have been harvested and on to meadow land during the late summer and autumn. This permits the blue grass to make good growth for winter pasture. Even when covered with snow, horses and sheep will paw off the snow and pasture on the grass.

Severe drought during the summer may completely suspend the growth of blue grass and cause it to appear dead. No matter how long the period of drought, rains will quickly revive the grass and it will resume its normal growth and condition. It will stand a great abundance of tramping without serious injury. The writer has seen calves retained in hurdle pens during wet weather on blue grass until the surface would be thoroughly puddled and no grass visible. A few weeks after removing the pens the grass would be in as thrifty a condition as ever.

Methods of Establishing.—Blue grass seed weighs from fourteen to twenty-eight pounds per bushel, the legal weight being fourteen pounds. The weight is determined chiefly by the presence or absence of the glumes

or hulls that enclose the seed proper. Blue grass seed is frequently of low vitality, due to faulty methods of harvesting and curing. It is always well to test the seed before seeding as a guide to the amount of seed desirable to use. Blue grass is very slow in becoming thoroughly established, and good pastures can seldom be secured in less than two years from time of seeding, and in some cases more time is required. It is generally advisable to seed with a mixture of grasses and clovers, some of which will give prompt pasture. Timothy, orchard grass, and red and alsike clover are, therefore, frequently used. These ultimately give way to the blue grass. Virgin grass land and meadow land are frequently converted into blue grass pastures by seeding blue grass, which gradually spreads and takes possession. When used for lawn purposes, the rate of seeding should be three to four bushels per acre. As little as eight to ten pounds per acre may be used when seeded with other grasses and when plenty of time is allowed for becoming well established. Ordinarily, twenty to twenty-five pounds of blue grass should be used when it is the chief grass for the pasture.

It is difficult to distinguish between seed of Kentucky blue grass and Canada blue grass. The latter is sometimes used to adulterate the former, since it generally is less costly.

Pasture Maintenance.—Blue grass, because of its numerous underground root stocks, tends to form a sod-bound turf. This condition may be obviated by seeding blue grass pastures with red or alsike clover every three or four years. This can be done by using a disk drill early in the spring. The use of the disk will also help to overcome sod-binding. The presence of the clover will enhance the pasture for the time being, and especially during the dry period when the blue grass will remain dormant. The clover roots tend to loosen up the ground and supply nitrogen to the blue grass. White clover is advantageous when seeded with blue grass. It re-seeds itself and becomes permanent so long as soil conditions are favorable. Under favorable conditions and with proper treatment, blue grass pastures improve with age, at least for several years. There are many instances of such pastures having been undisturbed for thirty or forty years.

REDTOP

Redtop is a native grass of North America, and grows naturally in cold, wet soils. It is a perennial provided with long, creeping underground root stems, and spreads both by means of these and seeds. It forms a continuous and fairly even turf, and is, therefore, well adapted for pasture purposes. It has a wider range of adaptation, both from the soil and climatic standpoint, than any other cultivated grass. It is resistant to cold and withstands summer heat much better than timothy. It does not show much preference for type of soil, but does best on loams and clay loams. It is exceedingly tolerant of soil acidity. It is also fairly drought resistant and succeeds better than most grasses on poor, sandy soils.

Importance of Redtop.—Redtop is the third or fourth most important perennial grass in America. It is adapted to both pasture and hay purposes, although it is not equal to timothy as a hay producer nor to Kentucky blue grass for pasture purposes. As a pasture grass it is not so palatable as Kentucky blue grass.

Culture.—Like Kentucky blue grass, redtop is aggressive and frequently takes full possession of the land. It is seldom seeded alone, usually being included in mixtures. The rate of seeding depends on the quality of the seed and the nature of the mixture in which seeded. With re-cleaned seed, twelve to fifteen pounds per acre are sufficient when seeded alone. Much smaller amounts will meet the requirements in mixtures. The time and manner of seeding are similar to those for timothy.

Yields and Uses.—Redtop has been tested at a number of state experiment stations and yields of hay ranging from 3000 to 5600 pounds per acre are reported. In order to be of good quality redtop should be cut early. If allowed to become fairly mature it makes hay that is fibrous and unpalatable. Numerous analyses show that redtop hay contains more nutrients than timothy hay.

ORCHARD GRASS

Orchard grass, a native of Europe, is grown quite generally throughout the United States, except in the semi-arid sections and the extreme south. It is a rather deep-rooted, coarse grass which grows in tufts or bunches and is without creeping root stocks. It does best in a temperate climate, but will stand more heat than timothy, and is less resistant to cold. In the United States it is cultivated more abundantly southward than northward. It begins growth earlier than most grasses, and often produces a second cutting of hay.

Importance.—Orchard grass ranks fourth or fifth in importance among the perennial cultivated hay grasses in North America. It is most extensively grown in Maryland, Virginia, West Virginia, North Carolina, Kentucky, southern Indiana, Iowa and Oregon.

Culture.—The seed of orchard grass weighs from fourteen to twenty-two pounds per bushel, and when seeded alone requires about thirty-five pounds per acre. Germination of the seed is complete in about fourteen days. It may be seeded either in the fall or very early spring. When seeded in the fall, early seeding is desirable to prevent winter killing. The seed, being of an exceedingly chaffy character, does not feed well through a seed drill, and is generally sown by hand or with the wheelbarrow or other types of seeders.

Ordinarily, the grass does not form seed the first season. It is long-lived, and individual plants are known to live eight years, and will probably live longer.

Yields and Uses.—Whether seeded in fall or spring, the first year's growth rarely gives a hay crop, but it may be utilized for pasture. When

used for hay it should be cut as soon as in full bloom. The stems become woody if it stands longer. It is usually about three weeks earlier than timothy and is advantageous on lands infested with ox-eye daisy, flea-bane and other weeds that do not ripen seed before time of harvesting it. It yields about as well as timothy, and yields reported from several experiment stations range from three-quarters of a ton to two and one-half tons per acre, the average being 1.4 tons.

It is considered valuable as a soil binder and serves to prevent soil erosin on land subject to washing.

It is recommended as a constituent of mixed pastures. It is valuable in this respect because of its early growth and its ability to grow during cool weather. It succeeds best under heavy grazing, and is admirably adapted for shady pastures and in orchards that are to be grazed.

Brome grass.—Brome grass is of comparatively recent introduction. It is a long-lived perennial, spreading both by seeds and root stocks. It forms heavy clumps, frequently twelve inches in diameter, but when seeded abundantly these join and form a compact sod. It is quite deep rooted and is adapted to a wide range of climatic conditions, both from the standpoint of temperature and rainfall. It is especially important, both as a hay and pasture grass, for the Great Plains region and the Pacific Northwest.

The method of seeding is similar to that for timothy. It is especially valued for hay during the first two years after seeding. There is then a tendency to become sodbound, after which it serves better for pasture. It is both palatable and nutritious, whether used as hay or for pasture.

Tall Oat Grass.—This grass has a climatic adaptation very similar to orchard grass. It is fairly drought resistant and does poorly on wet land. It does best on rather loose, deep loams, and succeeds well on calcareous soils; also does well on sandy and gravelly soil, but is not adapted to poor land. It is a perennial and is strictly a bunch grass.

When used for hay it should be cut promptly while in bloom. After this period the stems rapidly become woody. It yields well, but is of low quality, the hay being somewhat bitter in taste. For this reason it is generally best grown in mixtures.

The Fescues.—There are a number of fescues, among which may be mentioned meadow fescue, tall fescue, reed fescue, sheep's fescue and red fescue. None of these are of much importance in American agriculture. They have about the same range of adaptation as timothy.

Sheep's fescue is a fine-textured, small-growing species adapted for lawn grass mixtures. Sheep eat it quite freely, but cattle avoid it if other grasses are available.

Red fescue makes a dense growth under favorable conditions and may attain a height of two feet or more. It makes fair yields of hay, but is not equal to many of the better species for this purpose.

Rye Grasses.—Perennial rye grass is a short-lived, rapid-growing perennial, living usually only two years on poor land, but somewhat longer

under favorable conditions. It is seldom employed except in lawn mixtures.

Italian rye grass is adapted to moist regions with mild winters. It succeeds best on loam and sandy loam soils. It is adapted for hay purposes and may be cut several times during the season.

Sudan Grass.—A tall annual grass resembling Johnson grass, but spreads only by seeds. It has been recently introduced and seems to be best adapted to the semi-arid belt. It has been tried in an experimental way in many of the states and has generally made a good growth.

SUDAN GRASS, A NEW ACQUISITION.[1]

Bermuda Grass.—Bermuda grass is a perennial with numerous branched leafy stems, which, under favorable conditions, attain a height of twelve to eighteen inches. Ordinarily, it is not so tall. This grass occurs chiefly in the southern part of the United States, but extends as far north as Pennsylvania and Kansas. It is especially adapted to the cotton belt, and is to the South what blue grass is to the North. While it is more particularly adapted as a pasture grass, it is also quite extensively used as hay. It will grow on all types of soil, but does best on rich, moist bottom lands that are well drained. It is also used as a lawn grass. Bermuda grass does not seed at all freely and most of the seed is imported. It is most easily propagated by cutting the culms into short pieces, scattering them on the

[1] Courtesy of The Macmillan Company, N. Y. From "Forage Plants and Their Culture," by Piper.

field to be seeded and covering them with disk, harrow or other suitable implements. These fragments of grass take root and spread rapidly by means of numerous root stocks or creeping stems.

Bermuda grass meadows and pastures frequently become sod-bound and fall off in yield. This condition may be alleviated by disking or by plowing and harrowing. After such treatment the growth will become much more vigorous.

Johnson Grass.—It is a coarse, large-growing species adapted to the whole of the cotton belt. It grows well in the summer as far north as 37 degrees north latitude, but usually will not withstand winters in such latitude. It spreads both by seeds and rhizomes, and when once established it is difficult to eradicate. It is utilized for both hay and pasture. Two or three crops per season are frequently harvested.

Para Grass.—This is a rank-growing tropical species adapted to moist loams or clay loams. In the United States it is adapted only to Florida, and the Gulf Coast to southern Texas. This grass is easily propagated by cuttings of the long, prostrate runners in much the same way that Bermuda grass is propagated. It is of value both for pasture and for feeding in the fresh state. It is seldom used for making hay.

Guinea Grass.—This is a long-lived perennial with short, creeping, root stocks. It generally grows in immense tufts, sometimes as much as four feet in diameter. The culms are large, erect, tall and numerous. It is adapted to tropical conditions, but may be grown in Florida and along the Gulf Coast of North America. Both this and the preceding grass may be cut several times each year. Under strictly tropical conditions, cuttings are frequently made every six or seven weeks.

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CHAPTER 8

THE CLOVERS

Clovers are important on account of their high protein content and nutritive ratio. They are especially valuable as forage for all classes of livestock. Clovers enrich the soil in nitrogen and organic matter, and improve its physical condition through the deep penetration of roots. For years farmers have paid out large sums in the purchase of nitrogen for the soil and protein for livestock. This can be largely avoided by growing an abundance of leguminous crops on the farm.

Characteristics of Clovers.—The true clovers are herbaceous leafy plants having three palmately arranged leaves. The larger growing species have deep roots on which occur nodules containing certain species of bacteria. These bacteria enable the plants to secure nitrogen from the air and use it in their development. For this reason legumes are richer in protein than other classes of plants. Of the total nitrogen in the plants about two-thirds are in the tops and one-third in the roots.

Uses of Clovers.—As a rule from one-half to two-thirds of the roughage in the ration for milk cows and young stock should consist of legumes, among which the clovers as hay are most convenient to use and most economical. The larger growing clovers are also quite extensively used for soiling purposes, and in some cases have been used for ensilage. The clovers are also among the most important crops for green manuring and as cover crops.

Inoculation.—Since all of the legumes contain bacteria in the nodules on their roots, it is best to inoculate many of the legumes when grown for the first time in any locality. In most of the clover region soils are already inoculated for the clovers. If inoculation is advisable, it may be effected either by soil transferred or by the use of artificial cultures. In this connection it should be borne in mind that as a rule each legume has a particular species of bacteria. Three to four hundred pounds of soil transferred from a well-established field of any species of clover to a new field will effect satisfactory inoculation of the latter. The soil should be taken from the zone of most abundant root activity, thoroughly distributed on the new field and at once mixed with the soil by disking or harrowing.

Artificial cultures have now been perfected and can be purchased at reasonable prices from many manufacturing firms. The culture is generally applied directly to the seed just before it is sown.

Composition and Feeding Value.—The composition of several species of clovers in the green state and in forms of preservation will be found in Table I, in Part III. Clovers, whether used for ensilage, soiling, hay

or pasture, all possess high feeding value, and are especially desirable for the production of milk, butter and the growth of young animals. They are among the most highly nutritious forage plants, and should supplant as far as possible the expensive concentrates such as bran, oil meal, cotton-seed meal, etc.

Harvesting Methods.—The purpose for which the product is used will determine the method of harvesting. When used for soiling, it is advisable to cut clover each day in quantities sufficient to meet the day's ration. If used for silage it should be cut when fairly mature, and go directly to the silo with but little loss of moisture.

When clovers are cut for hay, both the quality and quantity of feed should be considered. If the acreage to be harvested is large it will be

A Clover Field in Blossom.[1]

advisable to commence early in order to complete the work before the crop becomes too mature. The more uncertain the weather, the earlier the process should begin.

The best quality of hay is secured by a comparatively slow process of curing. In this process the moisture should leave the plants almost entirely through the leaves. Clover cut in the middle of a hot, dry day when the ground is dry and the sunshine bright, will dry so rapidly that the leaves soon lose their structure, become brittle and cease to give off moisture. Although there may still be much moisture in the stems of the clover, the leaves will break and be largely lost in the handling of the hay. These leaves are high in feeding value. It is wise, therefore, to cut in the evening and to place the hay in the windrow before the leaves become sufficiently dry to break and shatter. The best quality of hay is secured by placing in shocks before thoroughly cured and allowing curing to be completed slowly within

[1] Courtesy of Hoard's Dairyman.

the shock. This entails much additional work, and if weather conditions are favorable a good quality of hay may be secured without resorting to shocking.

Clover hay may go into the mow or stack with 25 to 30 per cent of moisture without injury. Good judgment and prompt and systematic work on the part of the haymaker are necessary to secure the best results.

The hay tedder and side-delivery rake are important adjuncts to securing a good quality of clover hay, and may be considered necessities where the acreage is sufficiently large to justify their purchase.

RED CLOVER

Red clover is a native of western Europe, and has long been cultivated in North America. It is now the most important leguminous crop in the Northern and North Central states and eastern Canada. While red clover is grown to some extent in every state and province of the United States and Canada, it is most extensively grown in those states lying north of the Ohio River and east of the Missouri River. Kansas and Nebraska, however, produce a large acreage. The accompanying map shows the distribution of red clover, grown alone and with timothy, by states and provinces for the United States and Canada.

Soil and Climatic Adaptation.—Red clover is quite resistant to cold and endures winters well in Nova Scotia, Maine and Minnesota. Northern grown seed is, therefore, generally preferable for seeding in cold latitudes. It does not do well in an extremely warm climate, and in the South succeeds only when planted in the fall, and usually survives only one year. A moderate to abundant rainfall is desirable.

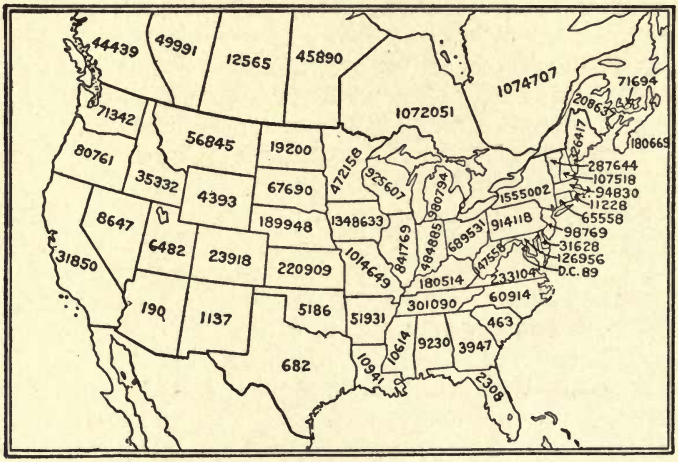
It is adapted to quite a wide range of soils, but makes its best growth on fertile, well-drained soil well supplied with lime and organic matter and reasonably free from weeds. Any soil that will grow corn successfully is well adapted to red clover. It does not do well on poorly drained land. On such soil alsike clover succeeds better.

Endurance of Red Clover.—Red clover is generally considered a biennial, the plants dying at the end of their second year. Some plants, however, will live over for a third year and a few frequently die at the close of their first year. The time of seeding and the treatment during the first year doubtless influence the life of clover plants. It is a common belief that if clover blooms abundantly toward the close of the first year many of the plants will fail to continue their growth the following year. For this reason clipping or light pasturing is advised.

Clover on wet soil may be killed in severe winters by repeated freezing and thawing. The plants will be so nearly pulled out of the soil that they perish in the spring for want of moisture and plant food. If the ground is deeply frozen and the surface only thaws and freezes the taproots are broken. This difficulty is best overcome by a thorough drainage of the soil and by providing a surface mulch.

Securing Clover Seed.—The intelligent selection of clover seed calls for knowledge relative to the characteristics of both good and poor seed. Good seed is plump and has a bright luster, and is generally violet to bright yellow in color. The proportion of violet to yellow varies considerably in different lots of seed. Good seed should be free from noxious weed-seeds and adulterants of any kind. The standard of purity should not be below 98 per cent and the germination should be about 98 per cent. Frequently some of the clover seeds will be so hard that they will not germinate promptly. The hardness of the coat prevents absorption of moisture. The percentage of hard seeds is largest in new seed.

Home-grown seed possesses several advantages: (1) it is likely to be adapted to local climatic and soil conditions; (2) its use avoids the intro-



Map Showing the Acreage of Red Clover in the United States, 1909, and Canada, 1910.

duction of obnoxious weeds foreign to the neighborhood. Among the most obnoxious weeds are clover dodder, buckhorn, Canada thistle and dock. Most weed-seeds may be removed by the use of suitable screens. The longevity of clover seed is three years. The deterioration in vitality depends largely upon the conditions of storage. Continuous warm, moist conditions cause deterioration and make it inadvisable to use seed more than two years old. A considerable percentage of the seed as determined by numerous tests will retain its vitality for quite a number of years, and the hard seeds have been known to germinate after fifteen or twenty years.

Seed of mammoth clover is so much like that of red clover that it is difficult to distinguish between them. Ordinarily, mammoth clover seed is a little larger than that of red.

Preparation of Seed-Bed.—Red clover is usually seeded in the winter

or spring, in which case no special preparation of the seed-bed is necessary. When seeded in this way natural covering results from the freezing and thawing of the ground and the beating of rains. If conditions for spring seeding with wheat necessitate seeding rather late, it is best to harrow the wheat, thus covering the clover seed.

When seeded with spring grain the preparation for the grain is generally sufficient for the clover. It will pay, however, to provide a well-prepared seed-bed that will fully meet the needs of clover seed, even though equally thorough preparation is not necessary for the spring grain. A fair degree of compactness and a thorough covering of the seed are desirable.

Time, Manner, Rate and Depth of Seeding.—In all regions of moderate to severe winters, winter or spring seeding is advisable, except when clover may be seeded in midsummer without a nurse crop. Further south, fall seeding may be practiced without winter injury to the young clover plants.

While clover seed is generally broadcasted, recent tests show that better results can be secured with less seed by using a grass seed drill. Such implements are now available and are so constructed as to drill the rows at intervals of four inches. Their adjustment permits of a shallow covering of the seed. The rate of seeding when clover is grown alone should be ten to twelve pounds of good seed per acre if broadcasted and a somewhat smaller amount when drilled. When seeded in mixtures the amount may be reduced, depending on the character of the grass seed mixture. Clover seed should be covered from one-half to two inches in depth. On very loose, dry soils it may be covered as much as three inches deep with fairly good results.

Failure to secure a satisfactory stand of clover frequently results from various causes. The condition of newly seeded clover fields immediately after the nurse crop is harvested should be observed. If there are indications of insufficient plants for a satisfactory stand, it is generally advisable to re-seed at once. This re-seeding may take place over those portions of the field where the stand is poor, or may cover the entire field as conditions require. A disk should be used to loosen the soil before seeding, and after seeding it should be harrowed. Disking may injure some of the clover present, but not seriously.

Good results are also secured by seeding in August without a nurse crop. Such seeding takes place after the wheat or oat harvest and provides for a full clover crop the following year. The chief objection to this method is the extra labor of preparing the seed-bed and seeding.

Nurse Crops for Clover.—Where clover grows without difficulty, it is common practice to seed with some nurse crop. In sections where winter wheat is grown, this crop is a favored nurse crop for clover. Winter wheat is seldom seeded before the latter part of September and this does not give sufficient time for clover to make enough growth to protect itself during the winter. As a result the clovers north of latitude 36 should be seeded in

the late winter or early spring in the growing wheat. Of the spring-seeded grains, barley and oats are the best nurse crops for clover. These should not be seeded very thick, otherwise the clover may be smothered. The nurse crop should be cut sufficiently high to leave a stubble that will protect the young clover as much as possible.

Fertilizers for Clover.—As a rule, no fertilizers or manures are applied directly for the benefit of the clover. The residual effect of that applied to the crop preceding the clover is generally sufficient. This is especially true when seeded with winter wheat. On soils of low fertility, especially when there is little organic matter present, top dressing with manure previous to the time of seeding is very beneficial to the clover. No nitrogen is needed when commercial fertilizer is used. Moderate amounts of phosphorus and potash applied broadcast will meet the needs.

After-Treatment of Clover.—Clover seeded with a grain crop seldom requires any special treatment during the first year. Under favorable conditions it may make sufficient growth after the harvest of the grain to produce a cutting of hay. This is thought by some to be injurious to the following year's clover crop. It is, therefore, advised to clip the clover before it comes extensively into bloom, and allow the clipping to lie on the field. If so abundant as to smother the plants, it may be removed. Clipping is also advisable to prevent the ripening of the seeds of obnoxious weeds and grasses that are always present to some extent. The clipping should be so timed as to prevent the seeding of the largest possible number of such plants. If too early, seeds may develop after the clipping, and if too late some of the seeds may have already matured. The ordinary mowing machine with the bar set rather high is well suited for this purpose.

Light pasturing may be practiced instead of clipping. Pasturing with sheep is best, since sheep are fond of many of the weeds and grasses, and will eat the seeds in great abundance.

Since red clover lives only two years, the first crop during the second year is generally cut for hay and the aftermath is either used for a seed crop, is pastured or plowed under for the benefit of the soil. If the second crop is to be used for seed it is wise to cut the first crop early. This encourages a better development of the second crop and increases seed production. The first crop should be cut just as it is coming into bloom. If the clover is to remain for the third year, seed must be allowed to mature during the late summer of the second season, with a view of having the clover re-seed itself naturally. This is not a very satisfactory method, however, because the seed heads generally fall to the ground and give rise to an uneven distribution of the seed. This, however, may be obviated by thoroughly harrowing the field after the seed heads are mostly on the ground. The harrowing breaks up the heads and distributes the seed. It should be so timed as to avoid destruction of clover plants when just starting.

Harvesting Clover.—Red clover, harvested for hay, should be cut when one-third of the blossoms have begun to turn brown. At this time

the plants will contain about all the nutrients they ever will have, and the product will cure readily and make a palatable, digestible hay. After this period the lower leaves begin to fall rather rapidly and the clover is apt to lodge so that loss takes place.

When used for soiling purposes, cutting may begin as soon as the first blossoms appear, and continue until the crop is fairly mature. When used for silage, the plants should be fully as mature as when cut for hay. If cut too green it makes a sloppy, sour silage of poor quality. When used for silage, clover gives best results when mixed with non-leguminous crops. The second cutting of clover can frequently be used to mix with corn in the making of silage.

The least expensive way of harvesting is to pasture. While red clover is not especially well adapted to pasture purposes, it makes a good quality of pasture, and especially when mixed with grasses. It is especially suited to cattle, sheep and swine. Sheep and cattle are sometimes subject to bloating when allowed to feed on red clover when it is especially succulent or when wet with dew or rain. Such trouble occurs only when the animals are unaccustomed to it and when they feed too heavily.

Clover Seed Production.—Red clover seed may be successfully produced in practically all areas adapted to the production of clover hay. It differs in this respect from alfalfa.

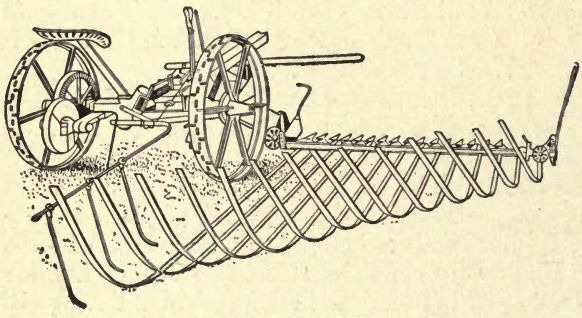
Seed production is encouraged by retarding somewhat the vegetative growth. Conditions that will produce a medium growth of plant usually induce the best setting of seed. Good seed crops are seldom secured from a rank growth of clover. Under such conditions the heads are few and are not well filled. The probable yield of seed and advisability of saving the crop for that purpose can be determined by a careful examination of a number of seed heads. If the seed heads are fairly abundant and contain an average of twenty-five to thirty seeds each, it indicates a yield of one to two bushels per acre, and justifies saving for seed purposes. If the average number of seeds is not more than twenty it will generally not pay to cut for seed. This determination must be made fairly early in order to cut the crop for hay before it becomes too mature in case it will not pay to save for seed.

It is a common belief that seed production calls for a pollination of the flowers by insects. The ordinary honey bee cannot reach the nectar of the average clover blossom, and is, therefore, not instrumental in the fertilization of the flowers. Bumble bees, however, are supposed to be the most effective agents in this process. There are probably numerous very small insects that also produce pollination. However this may be, the second crop is the one that gives best results for seed purposes. At that time insects are more numerous, weather conditions are drier and the plants tend to produce seed more abundantly than earlier in the year. Occasionally the first crop will produce plenty of seed. The seed crop should be cut when the largest number of heads can be secured. If cut too early, the

late blossoms will have no seeds or will have poorly developed seeds. If cut too late, the early blossoms will have shattered off.

The old-fashioned self-rake reaper is best adapted to cutting the seed crop. It leaves the cut clover in bunches of convenient size, sufficiently far from the standing clover for the team and machine to pass for the next swath. These bunches of cut clover do not need to be disturbed until they are ready to be hauled to the threshing machine. In the absence of the self-rake reaper, a mowing machine with a buncher may be substituted. If the buncher leaves the clover in the path of the team and machine, a man should follow the machine with a barley fork and move the bunches. Serious shattering in the cutting process may be avoided by harvesting the crop in the evening or early in the morning, or on damp days.

The clover is generally threshed with a clover huller. This machine should contain two cylinders. Concaves must be set rather close in order to remove all of the clover seed from the hulls. The seed being valuable, it is advised to spread canvas beneath the machine to save the clover seed which shatters out in the threshing process. Where threshing is done on a barn floor canvas will not be required.



A Clover Buncher Attached to a Mowing Machine.[1]

The seed should be thoroughly cleaned before being placed upon the market or used for seed purposes. Nearly all foreign matter and weed seeds can be removed by use of a suitable fanning mill. Occasionally there are seeds present of about the same size and weight as clover seeds, and these will be difficult to remove. Buckhorn seed is difficult to remove in this way. It is a very troublesome weed in meadows and the following process of removing it from clover seed is recommended. Thoroughly wet the clover seed with water at about room temperature, and allow to stand in the water for five minutes, or as much as eight minutes if the temperature of the water is low. The water is then drained off and the moist seed thoroughly mixed with sawdust; about four parts of sawdust to one part of seed by measure will be required. Two or three minutes of thorough mixing will cause the sawdust to absorb the free surface moisture from the seed. The buckhorn seeds become mucilaginous and the sawdust adheres to them. The mixture is now run through two screens, preferably in a fanning mill. The upper one should be perforated with round holes

[1] Courtesy of U. S. Dept. of Agriculture. From Farmers' Bulletin 495.

one-fifteenth of an inch in diameter. The lower should be a No. 22 mesh wire screen. The buckhorn seeds with sawdust adhering will pass over the surface of the upper screen and be removed. The clover seed will pass through the openings and be retained by the lower screen, passing off at the edge, where it may be collected. The sawdust should be fine and will pass through the lower screen. Through this process the separation is made complete.

Red Clover Troubles.—The principal enemies of red clover are insects, fungous diseases and weeds. Much is heard concerning clover sickness,

RED CLOVER ON LIMED AND UNLIMED LAND.[1]

but little is known relative to the nature of the malady. Failure to grow continuous crops of clover may be due to any one of several causes. Soil acidity is probably the most common cause of clover failure. This, as previously stated, is overcome by the use of lime. One of the most common diseases of clover is anthracnose. In some sections nematodes have also been responsible for clover failure.

Alsike Clover.—Is a perennial plant intermediate between red and white clover in size and appearance. It is adapted to ground that is too wet for red clover and is also more tolerant of acidity.

[1] Courtesy of The Macmillan Company, N. Y. From "Crops and Methods for Soil Improvement," by Agee.

As a hay crop it will not yield as much as red clover, although it makes hay of finer textures and retains the leaves better. It is hardier than red clover, but lodges worse. The foliage is slightly bitter and not relished as well by cattle. For this reason it is better to mix it with red clover or with grasses. It matures about two weeks earlier than red clover; consequently, does not fit into mixtures as well as the red. It may be grown with early-maturing grasses such as orchard grass and redtop. Alsike clover and redtop make an admirable mixture for wet, sour soil, and may be used both for hay and pasture purposes.

It seeds abundantly and the seed, though much smaller than that of red clover, commands about the same price. Six to eight pounds per acre when seeded alone are sufficient. Smaller amounts may be used in mixtures.

White Clover.—White clover is a low-growing perennial, having abundant solid, creeping stems. It is well adapted to moist soils in nearly all of the temperate zone. It is especially well adapted for pasture purposes and is frequently used with blue grass both in pastures and lawns. It seeds abundantly, often producing from two to six bushels per acre, the price ranging a little above that for common red clover. It has long been valued as a honey plant. The blossoms when excluded from insects usually set no seeds.

Ladino Clover.—This clover is similar to white clover, but much larger. It has but recently been introduced into North America. It furnishes good yields of excellent pasturage and under favorable weather conditions attains sufficient size to be harvested for hay.

Crimson Clover.—This is a winter annual adapted only to regions of mild winters. It is extensively used as a green manuring and cover crop. It may be seeded from May to August, either alone or in other crops such as standing corn. It makes hay of a good quality if cut just as it comes in flower. The plant is somewhat hairy and the seed heads are abundantly supplied with long hairs. If the heads become rather mature, the hairs harden and cause serious trouble when fed to livestock. It is never advisable to feed straw from crimson clover to horses. Either the mature hay or straw causes hair balls in the stomach and intestines that frequently result in the death of the animals. Both the hay and seed crops are handled in about the same way as red clover.

Sweet Clover.—This plant has come into prominence in recent years, and has been extensively discussed in the agricultural press. Recent careful inquiries and investigations indicate that it is destined to become an important legume, both as a forage crop and for soil improvement.

There are several species of sweet clover, but the white sweet clover (*Melilotus alba*) is the most valuable under most conditions. It is adapted to a wide range of both soil and climatic conditions. It is exceedingly hardy and makes fair growth under adverse conditions. It is a biennial. It is often spoken of as a roadside weed, and occurs along roadways in many

parts of nearly every state in the Union and the provinces of Canada. It seeds abundantly, the seed being similar to that of alfalfa. The plant also closely resembles alfalfa in its early stages of growth, although the blossoms and seed heads are quite different.

It is deep rooted and the tops often attain a height of four to five feet. The composition of sweet clover is nearly the same as that of alfalfa. It is high in digestible protein and very nutritious as feed. Because of a peculiar odor and taste, animals seldom eat it at first. They soon acquire a taste for it and eat it with avidity and thrive on it.

Sweet clover is especially valuable for soil improvement. Its greatest benefit will result by plowing it under the second season before it blooms. The seed should be sown at the rate of fifteen to twenty pounds of hulled seed, or at the rate of twenty-five to thirty pounds when hulls are present.

PASTURING SWEET CLOVER IN KANSAS.[1]

It may be seeded either in August or early in the spring. The methods of seeding are similar to those for red clover.

Lespedeza or Japan Clover.—This is a small-growing summer annual, attaining a height of six to eighteen inches, depending on soil conditions. It is adapted especially to the cotton belt. It is to the South what white clover is in the North. It is especially adapted for grazing purposes, and a mixture of Bermuda grass and Lespedeza makes a good pasture for many parts of the South. It begins growth in the middle spring and reaches maturity in September or October. It may be distinguished from the yellow-flowered hop clovers which it closely resembles by its purple blossoms, which do not appear until August or later, while the hop clovers bloom early. It seeds freely and perpetuates itself from year to year by self-seeding.

Bur Clover.—This is a rather small-growing clover indigenous to Texas and California, and is closely related to alfalfa. It is of very little value for hay, and will give only one cutting. It serves best for winter and early spring grazing. It is especially valuable because it affords

[1] Courtesy of Kansas Agricultural Experiment Station.

grazing in the South for about two months before Bermuda grass and other summer grasses are available for this purpose. It makes a good combination with Bermuda grass for an all-year-round pasture.

Hop Clover.—Common in the Southern and Eastern states on sandy soils and along roadsides. Periodically this plant comes into notice, due probably to favorable seasonal conditions inducing an abundant growth of unusual size. It often attracts the attention of farmers to such an extent that they become interested in its economic possibilities and send samples to their experiment station for information and advice.

There are several species of hop clover and the talier one doubtless is worthy of cultivation for pasture purposes and for soil improvement, especially on run-down soils that are best suited for pasture purposes.

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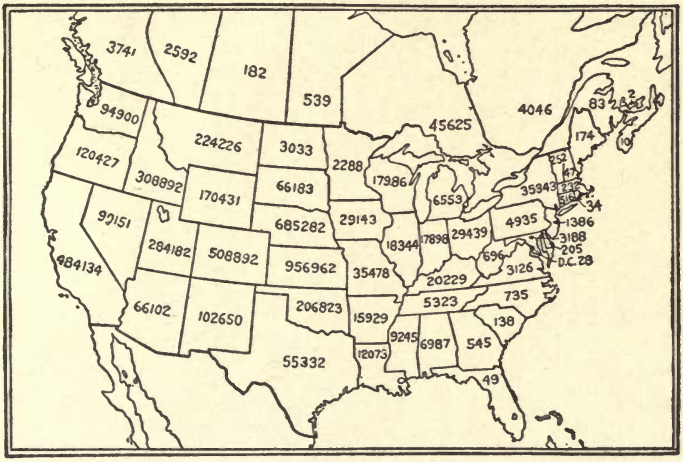
CHAPTER 9

ALFALFA

Alfalfa is one of the oldest forage crops. Its history has been closely related to that of man throughout past ages. It was highly esteemed by the ancient Persians as the most important of forage crops, and followed their invasion by Xerxes into Greece, 490 B. C. During the early centuries of the Christian era it spread throughout the countries of Europe, and it was brought to North America by the early colonists. It was introduced into the Eastern colonies under the name of Luzerne. It found its way into



MAP OF THE UNITED STATES AND CANADA SHOWING ACREAGE OF ALFALFA. FIGURES = ACRES.[1]

California and other Western states probably by way of South America, and brought with it the Spanish name of alfalfa.

Alfalfa is characterized by its deep root system, on which are found nodules similar to those described under the clovers. The bacteria in these nodules enable the alfalfa to secure nitrogen directly from the air. Alfalfa plants are propagated only by seeds. They do not spread, as do some of the clovers and many of the grasses, by creeping stems and underground root stocks. Alfalfa is a perennial and under favorable conditions lives many years and attains a large size. The crowns of the plant become

[1] Courtesy of The Macmillan Company, N. Y. From "Forage Plants and Their Culture," by Piper.

much branched and old plants frequently give rise to as many as 200 stems.

Distribution of Alfalfa.—This plant is grown as a crop in every state in the Union and most of the provinces of Canada. The map on the preceding page gives the acres by states and provinces.

Soil and Climatic Adaptation.—Alfalfa is best adapted to a warm, dry climate. In North America it is most extensively and successfully grown under the semi-arid conditions that prevail in the western half of the United States. More than two-thirds of the hay grown in New Mexico is alfalfa. Over one-half of that grown in Colorado is alfalfa. Kansas produces more than Nebraska, and Nebraska more than the Dakotas. The relative production of alfalfa as compared with other forms of hay and forage decreases as we proceed northward and eastward. Alfalfa has been cultivated so long that strains and varieties have been developed that are adapted to a wide range of climate. For this reason it is extensively grown in North America. It will withstand great heat and extreme cold in the arid regions, but is more sensitive to such extremes in the humid regions, and rarely succeeds in tropical or sub-tropical regions where the humidity is high and rainfall abundant.

It is adapted to a wide range of soils, growing well on loose, sandy soils as well as upon heavy clays. It succeeds best on soils of medium texture that are capable of deep penetration by roots and well supplied with mineral plant foods. It will not succeed on soils closely underlaid with hardpan, impervious rock or standing water. Neither will it thrive on sour soils.

Essentials for Success.—In the western half of the United States there are probably few localities where alfalfa will not succeed with the most ordinary treatment. Its growth would be curtailed or possibly prevented by the presence of too much alkali or by over-irrigation. In the eastern half of the United States where conditions are less favorable, there are certain essentials necessary to the success of this crop that must be carefully considered. These are good drainage, freedom from weeds, absence of acidity or presence of plenty of lime, a fair degree of organic matter in the soil, thorough preparation of seed-bed, most favorable time of seeding, inoculation of seed or seed-bed and the use of plenty of good seed. Added to this will be the after treatment, such as time of cutting, care in pasturing, cultivation and mulching.

The treatment essential to success being so diverse and exacting, farmers contemplating growing alfalfa are advised to first undertake it on a small scale. There are a number of advantages in doing this, such as the practical experience gained and the providing of inoculated soil.

Varieties of Alfalfa.—Thus far varieties and regional strains of alfalfa have been relatively unimportant. At least 95 per cent of the alfalfa in North America may be called ordinary alfalfa. A number of strains have been introduced from time to time, some of which are superior for hardi-

ness. Aside from the common or ordinary alfalfa, Turkestan, Arabian, Peruvian and Grimm are of some importance. The common or ordinary alfalfa is that generally grown in North America, Europe, Argentine and Australia.

Turkestan alfalfa closely resembles ordinary alfalfa, and neither plant nor seed can be easily distinguished from it. It is thought to be a little more drought and cold resistant than ordinary alfalfa, but is inferior to the ordinary alfalfa for the eastern half of the United States.

Arabian alfalfa may be recognized by its hairiness, large leaflets, rapid growth and short life. It begins growth and continues to grow at a somewhat lower temperature than common alfalfa.

Peruvian alfalfa may be recognized by its somewhat bluish appearance, coarse, erect stems and large leaflets.

Grimm alfalfa, brought to this country from Germany, has been cultivated here for a long time, and through elimination of the less hardy plants has become adapted to severe climatic conditions. It is, therefore, recommended for the Northern states. It is claimed to resist severe pasturing better than ordinary alfalfa, and is thought to be somewhat more drought resistant. The seed is higher priced than that of the ordinary alfalfa.

Sources of Seed.—Best results are usually secured by the use of locally grown seed. In the eastern half of the country, very little seed is produced, and imported seed must be relied upon. It is, therefore, advisable to secure seed from approximately the same latitude or preferably somewhat north of the latitude in which it is to be used. Nebraska-grown seed is good for Illinois, Indiana and Ohio. Kansas-grown seed is generally a little cheaper and will be good for Missouri and southern Illinois. Dakota seed will be higher priced, but should be used in Wisconsin, Minnesota and Michigan.

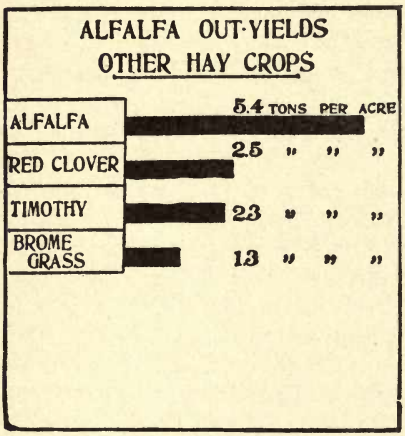
Alfalfa seed varies in purity, germination and price. It is, therefore, wise to secure samples from several sources before purchasing. These should be examined for impurities and tested for germination as a basis for calculating which will be the cheapest. None but first-class seed, free from noxious weed seeds and showing good germination, should be used.

A pound of alfalfa contains about 220,000 seeds. If evenly sown on an acre these would average over five seeds to the square foot. Alfalfa fields one year old rarely contain more than twenty plants to the square foot, and older fields usually have less than ten. It is evident from this that a large percentage of the seeds sown fail to produce plants. It is very important that a full stand be secured on all parts of the field. Vacant spots give an opportunity for grass and weeds to start, and these encroach upon the alfalfa.

The percentage of hard seeds in some lots runs very high and necessitates treating the seed to increase its germination. Hard seeds are treated with a mechanical device through which they are passed with much force, and the hard coats are weakened by striking against a hard, rough surface.

Alfalfa seed two years old may generally be used with safety. Old seed can be detected by its having a much darker color and less luster than fresh seed. Good seed will usually germinate in less than ten days. One hundred seeds placed between blotters or in a flannel cloth between two dinner plates will make a satisfactory test.

Need for Fertilizers and Lime.—In the western half of North America commercial fertilizers and lime are seldom needed for alfalfa, but in the eastern half these are frequently of great importance. Large crops of alfalfa remove from the soil considerable quantities of lime and the essential mineral plant foods. For this reason, large crops cannot be maintained except on fertile soils or soils that are well supplied with plant food and lime; 400 or 500 pounds of a fertilizer containing about 10 per cent of phosphoric acid and 6 to 8 per cent of potash should be applied at the time of seeding. If the field is continued in alfalfa for several years it should be top dressed with manure or commercial fertilizer every year or two. There is no danger of getting the soil too rich for alfalfa. Manure should be used that is as free from weed and grass seeds as possible. Their introduction into the alfalfa should be guarded against, and the alfalfa cultivated for weed destruction if necessary.



ALFALFA OUT-YIELDS OTHER HAY CROPS.

Alfalfa has but little tolerance for soil acidity. It removes much lime from the soil and grows best on soils well supplied with lime. Soils should be tested for acidity before seeding to alfalfa, and a liberal supply of lime provided wherever there is any indication of its need. It is immaterial in what form this is applied. The finely pulverized raw limestone is fully as effective as equivalent amounts in any other forms.

Preparation of Seed-Bed.—Alfalfa demands a finely pulverized, moist, fairly compact seed-bed, free of weeds. This can generally be best provided by devoting the land during the preceding year to an inter-tilled crop, such as corn, potatoes or tomatoes. The preceding crop, if liberally manured, will obviate the necessity of applying manure directly for the benefit of alfalfa. This has the advantage of permitting weed and grass seeds in the manure to germinate and be destroyed. The residual effect of the manure will be sufficient to start the alfalfa. The best seed-bed can be secured by plowing late in the spring and disking or harrowing at intervals of ten days or two weeks until the first half of August. Such treatment pulverizes the soil, compacts it, conserves soil moisture

and destroys weeds. It provides an ideal seed-bed on which alfalfa may be seeded.

Time, Rate, Depth and Manner of Seeding.—Alfalfa may be seeded either in the spring or late summer. In the western half of the United States spring seeding predominates. In the eastern half, summer seeding is more certain. Seeding either very early in the spring or too late in the season should be avoided. A satisfactory stand is more certain when the seeding is made on soil that is sufficiently warm to produce prompt germination of the seed and rapid growth of the young plants. At 40 degrees north latitude spring seeding may be made during the last part of April or early May. Northward or at considerable elevations the date should be a little later, while southward or at low elevations it may be a little earlier. For latitude 40 degrees north, late summer seeding should generally be during the first half of August, northward it may be a little earlier, and southward considerably later depending on latitude. In any event there should be sufficient time for the alfalfa to become well established and make considerable growth before winter sets in.

The rate of seeding varies greatly, but in the eastern half of the United States and Canada twenty to thirty pounds of seed per acre is advised. In the western half of the United States seeding generally ranges from ten to twenty pounds per acre. Where grown under the dry land system of farming, five to ten pounds of seed per acre often gives satisfactory results.

The seed should be covered anywhere from one-half inch to two inches in depth, depending on character of soil and presence of moisture. The manner of seeding must be determined by local conditions and available machinery. Alfalfa drills are advised when they are available. The most of the seed, however, is sown broadcast and covered with the harrow. Summer seeding is made without a nurse crop and spring seeding generally with a nurse crop. The principal nurse crops are winter wheat, rye, spring oats and barley. Barley is considered preferable to oats, and winter rye seeded in the spring is considered best of all. The nurse crops should be seeded rather thinly in order to encourage the growth of the alfalfa.

Inoculation.—West of the Missouri River the soil seldom needs inoculation for the successful growth of alfalfa. East of that, however, inoculation is generally necessary. Wherever sweet clover is not a common weed and wherever alfalfa has never been grown, it is always advisable to inoculate this crop.

There are two general methods of inoculation: (1) by soil transfer, (2) by artificial cultures. Inoculation by soil transfer is simple, easy and, with reasonable precautions, generally successful. It consists in securing from a well-established field or from a field where sweet clover grows, soil from that portion of the root zone where nodules are most abundant. This is transferred to the new field and spread broadcast at the rate of 300 to 500 pounds per acre, and thoroughly mixed with the soil by disking or harrowing. The inoculated soil should be spread on a cloudy day, or in

the morning or evening, and the field thoroughly disked and harrowed at once.

When soil must be secured from a long distance the freight charges, cartage, bags, etc., may make it costly, in which case smaller amounts may be used and more time allowed for the inoculation to develop. Certain precautions are advised relative to the introduction of noxious weeds in this way. If alfalfa is to be grown rather extensively, it is economical to first seed a narrow strip of alfalfa through the center of the field and thoroughly

A Standing Field of Alfalfa.[1]

inoculate it. At the end of one year this will serve as a source of inoculation for the entire field, and a suitable drill or fertilizer distributor may be used going back and forth across the field at right angles to this strip, and filling the distributor from the soil of the strip each time the machine passes.

Artificial cultures have recently been developed and may be secured from a number of sources. By carefully following directions, they are generally successful. The artificial cultures are applied, according to instructions, directly to the seed so that the bacteria are introduced into the soil on the seed and immediately where the young plants start growth. In this way the minimum number of bacteria accomplish the maximum result.

[1] Courtesy of The Pennsylvania Farmer.

After-Treatment.—The after-treatment of alfalfa is more important than in case of the clovers and grasses. Clipping the alfalfa at the close of its first season has been quite generally recommended, but is a doubtful practice so far as direct benefit to the alfalfa is concerned. If, however, weeds and grasses are abundant, or if the alfalfa was seeded early and is blooming rather freely, clipping in the fall is advised. The clipping should be so timed as to prevent maturing of weed seeds. The alfalfa should be clipped rather high and the clippings left on the field for winter protection.

Winter killing of alfalfa is most severe during the first winter and in severe climates or on soils subject to heaving. Winter protection by mulching or otherwise is advised. The more hardy varieties of alfalfa will stand a temperature twenty to thirty degrees below zero if the soil is reasonably dry. The chief trouble occurs as a result of the plants being heaved out of the soil by repeated freezing and thawing, generally toward the close of the winter.

Disking and harrowing alfalfa fields have been frequently recommended for the purpose of killing weeds and grass, for loosening the soil and for splitting the crowns of the alfalfa plants. The improvement of soil and destruction of weeds is justifiable, but injury to the alfalfa plants should always be avoided. Under favorable conditions considerable injury may not prove serious, but in the eastern part of the country, injury to the crowns of the plants results in decay of the roots and shortens their life. The ordinary disk is, therefore, not recommended. Suitable harrows and the spike-toothed alfalfa disk harrow may be used to good advantage. The spring-toothed harrow with the teeth brought to a sharp point is recommended. There is enough spring in the teeth so that they will pass around the crowns of the alfalfa plants without serious injury, and at the same time will uproot small weeds and grasses.

Cultivation should take place just after cutting, and is generally not necessary during the first year of the alfalfa.

Making Alfalfa Hay.—The time of cutting alfalfa should be carefully regulated in order not to injure it. If cut too early the second crop is slow in starting and the exposed crowns of the plants may be injured by hot, dry weather. Neither is it advisable to delay the cutting, for this will result in clipping off the new shoots that produce the new crop. Alfalfa should be cut for hay when the small shoots starting from the crown and which produce the next crop are one-half inch to one and one-half inches in length. At this time about one-tenth of the blossoms will usually be out. In the eastern part of North America leaf spot is quite common and spreads rapidly through the field as the plants approach the hay-making stage. If this trouble is very prevalent the leaves fall rapidly and harvesting should be hastened somewhat to prevent loss. A fair degree of maturity of the alfalfa makes the curing of hay easier than if cut when too succulent. In the western half of the United States there is very little difficulty in this respect. Weather conditions are more favorable and hay of good quality

can be made with the minimum amount of labor. In the eastern half of the country rains are prevalent, especially at the time of the first cutting. This calls for special precautions and often necessitates extra labor and the use of canvas covers to secure hay without serious injury.

It is advised to cut in the evening and early morning, and follow the mower with the tedder before any of the leaves become dry. The second teddering at right angles to the first is advised if the alfalfa is heavy. With favorable weather it may be possible to put the alfalfa in the windrow toward evening of the first day. One more day's exposure in the windrow under favorable conditions will generally cure it sufficiently to go directly to stack or mow. This reduces handling to the minimum and prevents loss by shattering.

Curing Alfalfa Hay in Shocks.[1]

If weather conditions are threatening, it will be best to put into moderate-sized shocks at the close of the first day, and cover with canvas to protect from rains. It requires from three to seven days to cure in the shock, depending on weather conditions.

A little more than two-fifths of alfalfa hay is leaves and about three-fifths stems. The leaves, however, contain fully three-fifths of the protein. It is, therefore, advisable to save the leaves as fully as possible. Do not rake or tedder alfalfa in the middle of the day if dry. This is sure to shatter the leaves and cause serious loss.

Number of Cuttings and Yield.—Alfalfa is a remarkable hay and forage plant because of its long life and the frequency with which it may be cut every year. The number of cuttings varies with the locality and ranges from two or three cuttings in the provinces of Canada and the northern tier of states to as many as ten or eleven cuttings annually in the Imperial Valley in California. In the warmer portions of Texas seven or eight cuttings are not uncommon. In most parts of the country, a second crop may be harvested within from thirty to forty days after the first cutting. In warm regions where the growing season is long, cuttings during this season may be made about every five weeks.

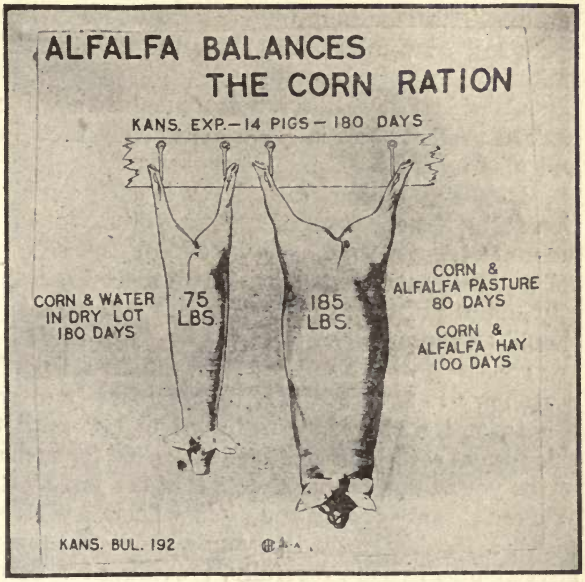
[1] Courtesy of The Pennsylvania Farmer.

The yield is generally largest for the first cutting of the season and declines slightly for subsequent cuttings. Much, however, will depend upon rainfall and available moisture which influences the growth.

Alfalfa yields about twice as much as red clover and, being richer in protein, produces about three times as much protein per acre.

Other Uses of Alfalfa.—Alfalfa makes an excellent soiling crop and produces a succulent nitrogenous roughage, especially desirable for dairy cows. Since it may be cut three or more times each season it may be quite extensively used for this purpose. It, therefore, takes a very important place in a soiling system wherever it can be satisfactorily grown.

The last cutting of alfalfa comes at about the right time to combine with corn for the making of ensilage. One load of alfalfa to every three or four loads of corn makes an excellent combination. Alfalfa is sometimes made into silage by itself, but makes a rather sour, slimy product.



Comparison of Hogs Fed on Corn and on Alfalfa.[1]

While alfalfa is not a pasture plant and is easily injured by pasturing, it may be used especially for young stock and for swine. It makes a most excellent pasture for the latter, and where it is to be used for this purpose will carry about forty pigs and their dams per acre without being injured. It is generally thought advisable to divide the field into two or three parts, pasturing one part for a period, and then turning into another part. Frequently some hay may be harvested in addition to pasturing.

Alfalfa makes a range for poultry and may also be fed to poultry and swine in the form of hay.

Composition and Feeding Value.—The composition of alfalfa is given in Table I in Part III. The nutritive ratio of alfalfa hay is about 1 to 4. Extensive experiments at a number of experiment stations

[1] Courtesy of The International Harvester Company, Agricultural Extension Department. From pamphlet "Livestock on Every Farm."

have clearly demonstrated the high feeding value of alfalfa. Experiments with forty cows covering a period of two years at the New Jersey Experiment Station clearly demonstrated that eleven pounds of alfalfa hay were equal in feeding value to eight pounds of wheat bran. Plenty of alfalfa as roughage materially reduces the bills for the purchase of protein in costly concentrates.

The hay is exceedingly palatable and highly digestible and is eaten with avidity by all classes of livestock. When fed to horses the ration should be limited. Horses, if allowed to eat their fill, generally consume nearly twice as much as is necessary to provide the required protein of their ration. This results in unnecessary waste of feed. Alfalfa hay and corn make a good combination, since the corn tends to properly balance the ration.

Considerable alfalfa hay is made into alfalfa meal for shipment to the eastern markets and is quite extensively used in rations for dairy cattle and also for poultry.

Irrigation of Alfalfa.—Alfalfa is exceptionally well adapted to irrigation and a large portion of that grown in North America is irrigated. The amount of water to use will be determined chiefly by the character of the soil and rainfall of the region. It is a good practice to irrigate rather liberally and at rather remote intervals. Alfalfa is so deep-rooted that the soil should be thoroughly wet to the depth of three feet or more. Ordinarily, one good irrigation should produce a full cutting of alfalfa. It is, therefore, customary to irrigate the fields immediately after the hay is removed and this irrigation should be sufficient to last until the next cutting. With this system certain precautions are called for such as to prevent the scalding of the young and tender shoots that are just starting to grow at this time. Where fields are deeply and rapidly flooded with water carrying much sediment, a deposition on the young shoots frequently causes injury. It is advisable to irrigate carefully, providing for slow movement of the water across the fields without attaining any considerable depth at any point. Over-irrigation is to be avoided, since it not only wastes water, but often causes a rise in the ground-water table and brings alkali salts to the surface of the soil.

Winter irrigation is practiced in some localities where the winters are mild and where water is abundant at this time of the year. The principal object is to conserve water which would otherwise go to waste. This is especially desirable where water is scarce in summer. Such winter irrigation will often result in one good crop that could otherwise not be secured.

Seed Production.—The production of alfalfa seed in North America is confined chiefly to the semi-arid regions. East of the Missouri River the production of seed is small, except when drought prevails. It is estimated that about one-half of the seed used in North America is produced on irrigated lands in regions of dry summers. There is also a considerable amount produced on unirrigated semi-arid lands, and such seed is con-

sidered preferable for dry farming purposes. When produced on unirrigated lands alfalfa is seeded very thinly. In some cases it is seeded in rows sufficiently far apart to permit of cultivation. Isolated plants that can branch abundantly and receive plenty of sunlight, seed more abundantly than when they are close together. When grown under irrigation, irrigation water is withheld during the period of seed formation. The presence of rains or the application of water stimulates the vegetative growth and reduces seed production. Usually the second crop is utilized for seed production, although in the extreme Northern states the first crop is necessarily used. There are various conditions that influence the yield of seed, such as thickness of stand, moisture supply, conditions favorable to pollination, etc. Yields of as much as twenty bushels per acre have been reported, but eight bushels are considered a good yield. Two to five bushels probably represent the average crop.

A Well-set Cluster of Alfalfa Pods.[1]

Little is known relative to seed production east of the Missouri River, although numerous observations have shown that plants frequently seed quite abundantly. In the corn belt it is quite possible that certain crops could be used for seed to good advantage. The probable yield of seed is indicated if the crop has been in bloom for some time and considerable seed is set before new shoots appear. If dry weather prevails when these conditions are evident there is a fair chance of a crop of seed.

The hope of securing varieties adapted to eastern conditions lies in the possibility of seed production in the various localities.

The method of harvesting the seed of alfalfa is essentially the same as that for red clover.

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[1] Courtesy of U. S. Dept of Agriculture. From Farmers' Bulletin 495.

CHAPTER 10

Meadows and Pastures

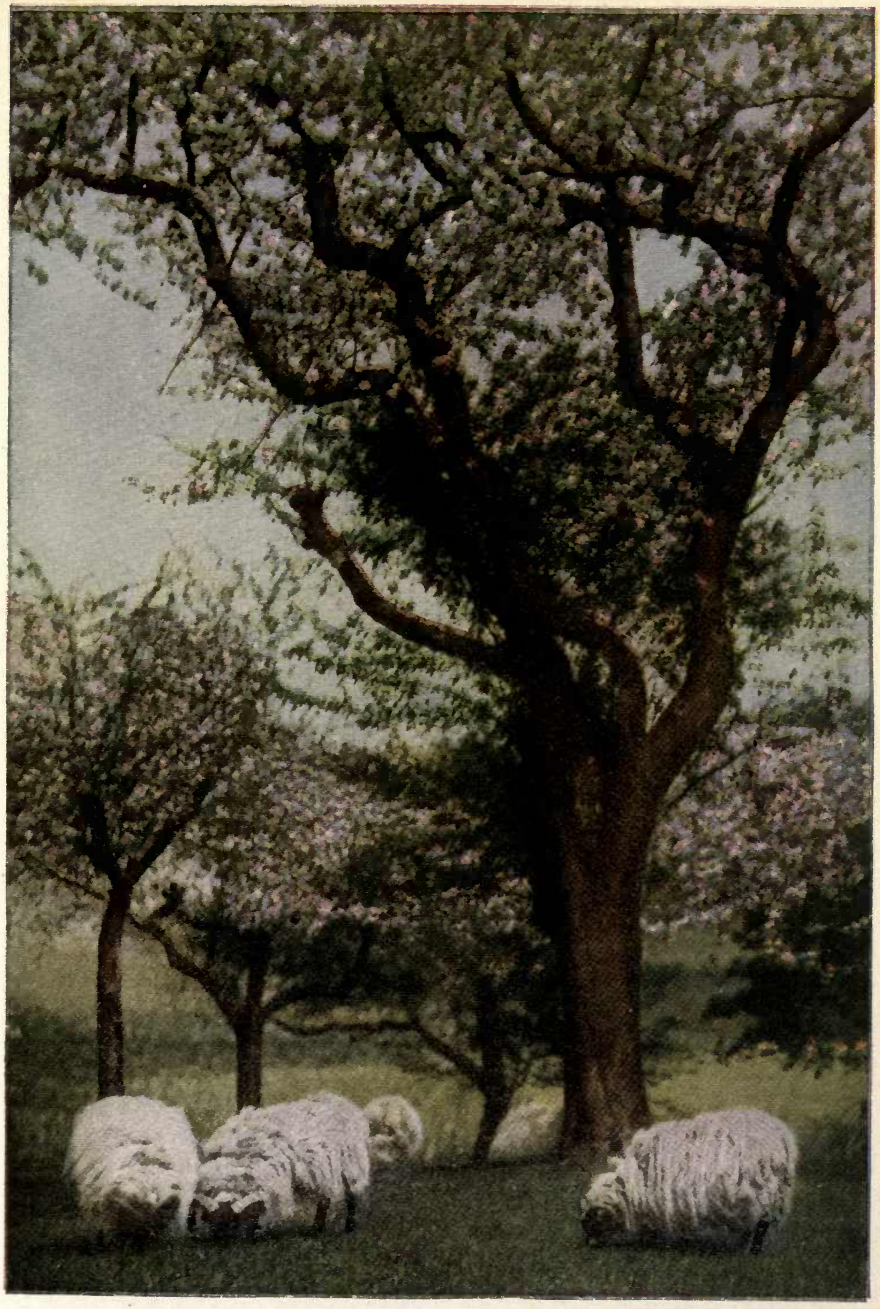
Success with livestock is conditioned on the production of good grass. This may be in the form of meadows or pastures, but a combination of the two is generally desirable. In latitudes of long winters the importance of meadows may predominate, whereas in regions of short winters, pastures may be the more important. With minor exceptions, meadows and pastures are the most economical source of the farm income.

As a rule, the highest type of general agriculture includes the rearing of farm animals. They may be considered machines for the manufacturing of the roughage produced on the farm into more concentrated and valuable products, such as meat, milk, butter, wool, etc. These require more skill on the part of the farmer and give to him continuous employment.

Extent, Value and Importance.—It is estimated that about thirty per cent of the improved land in the United States is pasture land. The largest area of land used for grazing is embodied in the extensive ranges lying in the western half of the United States. To this range land and the permanent pastures on farms may be added large deforested areas that are capable of producing pasture. The value of the products per acre from the grazed land is exceedingly low, but since the area is so large, the aggregate return is great. The return per acre from meadow land is also comparatively low, but much larger than that from pasture lands. No statistics are available by which to estimate the returns from pasture lands, although there are fairly accurate statistics for the meadows, as indicated in the chapter on "Meadow and Pasture Grasses."

Essential Qualities of Meadows and Pastures.—The essential qualities of meadow grasses are given in the chapter under that name. It is not so essential that meadows become permanent, except in case of wet land or land too rough or stony to be cultivated, and which for any reason cannot be pastured.

It is generally important, however, that pastures be made as permanent as possible. This calls for a mixture of grasses that are either very long lived or that are capable of reproduction under pasture conditions. A good pasture should start growth early in the season and continue to produce until late in the fall. The grasses should be palatable, nutritious and present variety and give abundant growth. They should also form a continuous, compact turf that will withstand much tramping by animals. A variety of grasses that will provide for growth under both moist and dry soil conditions is also advantageous. The deep-rooted grasses and clovers can, therefore, be advantageously included with the shallow-rooted ones



SHEEP PASTURING ON HILLY LAND.[1]

Land that is too rough or steep for plowing can often be made profitable by using it for grazing purposes.

[1] Courtesy of "The Field, Illustrated," N. Y.

such as blue grass and white clover. The latter are more substantial, both in quality of grazing and in the character and durability of turf which they form.

Advantages of Meadows and Pastures.—Where land is moderate to low in price and labor is costly, no feed will produce results with cattle and sheep as economically as good pasture. While a given area in meadow will produce three times as much weight in hay as it will in pasture, yet there is about three times as much protein in a given weight of dry material in pasture grass as there is in the same material in hay. The increased energy value of the hay over that of an equal area of pasture will generally be offset by the increased labor required in harvesting and feeding the hay. Meadows require on an average one unit of man and horse labor per acre annually. This consists of ten hours work per year. The cultivated crops

LIVE STOCK ON PASTURE.

require from two to as high as fifteen or sometimes twenty units of labor per acre.

Pastures, on the other hand, require no labor unless it be for the purpose of applying manure or fertilizers, or for improvement by re-seeding or cultivating. It is from the standpoint of labor that meadows and pastures are especially economical. When land values become exceptionally high, farmers may be justified in reducing the acreage of pasture and resorting to cultivated crops as a source of feed for livestock. This is an economical problem that must be determined by local conditions.

Meadows and pastures make use of land which cannot be economically used for cultivated crops. This is especially true in the case of woodland pastures or pastures along streams that are irregular and subject to overflow. Stony portions of farms are often utilized as meadows or pastures. Irregular corners, cut off by roads or streams, are more economically devoted to hay than to a cultivated crop requiring tillage.

Soil and Climatic Requirements.—Most of the grasses and clovers succeed best in moist, cool climates and on soils that range from medium to heavy in texture. On the other hand, there are a few grasses and clovers

that succeed in regions of continuous high temperature. There are, however, no regions in the world within the tropics that are especially prominent for the production of meadows and pastures. These attain their greatest perfection in temperate climates with abundant and well-distributed rainfall. England and Scotland represent the ideal conditions for meadows and pastures. The range in variety of grasses and clovers makes possible meadows and pastures which are more or less successful in all parts of North America. Of course, there are considerable areas of sandy soils, especially in the warmer sections, that are impracticable of utilization in this way.

Formation of Meadows and Pastures.—Since meadows and pastures are to remain for a considerable period of time, the necessity of thorough preparation for their establishment is more imperative than in case of annual crops. The successful orchardist goes to much expense in the preparation of land and the setting of trees for the orchard, realizing that orcharding is a long-time proposition. The same policy is applicable in case of permanent pastures or meadows. The shorter the period of time that a meadow is to remain as such, the less will be the expense justified in its establishment.

The first consideration is the adaptation of the land for meadow or pasture purposes. The value of the land and the possibility of its utilization for other purposes should be considered. Consideration must also be given to the variety and character of grasses adapted to the soil and climate and that will meet the requirement of the livestock to be pastured. No definite formula can be given, since conditions vary greatly.

Preparation of Soil.—The preparation of the soil for either meadows or pastures should begin at least a year in advance of the time of seeding. There are two things essential to the establishment of grasses and clovers, namely, absence from weeds and a good physical condition of the soil. This may be provided by growing an inter-tilled crop which is given thorough cultivation during the year preceding the seeding of grass.

Organic matter in the soil is decidedly helpful for both grasses and clovers, but not essential. In plowing for seeding grasses and clovers, manure and organic matter should not be turned under too deeply, but should be left as near the surface as possible. A thorough preparation of the seed-bed is essential for both meadows and pastures. For meadows, the soil should not only be thoroughly pulverized and made moist and compact, but should also be level to facilitate cutting at a uniform height. The presence of hummocks or depressions in a meadow means that some of the plants will be cut close to the crowns and others cut far above.

A moist, compact, finely-pulverized seed-bed is essential in pastures, but it need not be necessarily level, since animals can graze with as much satisfaction on uneven land.

When seeding is to be made in August it is well to plow the land in the spring. An occasional disking or harrowing during the summer will

destroy the weeds, conserve moisture and provide a pulverized seed-bed for the grass. It is advisable to plow land for spring seeding of grass and clover the preceding year, or at least several weeks in advance of seeding time, in order that it may become thoroughly settled before seeding.

Meadow and Pasture Seed Mixtures.—From the standpoint of both variety and total yield, mixtures give best results in both meadows and pastures. Experiments at several experiment stations report yields for mixtures of two or more grasses and clovers that exceed the yield of any of the varieties entering into the mixture when seeded alone under identical conditions. There are a few exceptions, namely, that of alfalfa which is cut several times a year, and which generally gives best results when grown alone. The same has been found true with Italian rye grass.

Mixtures yield better than pure cultures because: (1) the requirements of the different plants entering into the mixtures are dissimilar and do not make them direct competitors for plant food; (2) the root habits being different, their distribution through the soil is more thorough; (3) the average yearly return is more nearly even through a long period of time; (4) variation in light requirements of different plants enable some species to do well in the shade of taller ones, thus increasing the quantity of herbage; and (5) legumes mixed with grasses increase the nitrogen supply for the latter.

As before indicated, mixtures for mowing purposes should contain only plants that mature near the same time. This will generally confine the mixture to two or three species, although occasionally a larger number may be advantageously used. Timothy and red clover constitute the mixture most common and practical over a large region of the hay-producing district of North America. Redtop and alsike clover are frequently included, especially where soils are wet and inclined to be sour. Alsike clover and redtop are occasionally used without the timothy and red clover. Orchard grass and alsike clover work well together, both as to character of growth and time of maturity.

In pasture mixtures there is opportunity for a much greater variety and wider range as to time of maturity in the plants used. In North America, however, mixtures made up of a great number of clovers and grasses are rather unusual, although these seem to be the rule in pasture mixtures of England and Scotland.

Soil and climatic conditions are so diverse that it is impossible to enumerate all the mixtures suited to different conditions and localities for any extensive region or for different purposes. Prominence should be given, however, to those grasses that are best adapted to local conditions and best meet the needs. One or more species that will make quick growth and give early pasture should be included in such a mixture. The following general suggestions are offered:

In regions adapted to Kentucky blue grass, add white clover, red clover and timothy.

On wet soils adapted to redtop, add white clover and alsike clover.

On poor upland soils use redtop, Canada blue grass and white clover. Under certain conditions brome grass may be included.

Where Bermuda grass thrives best, add Lespedeza clover, bur clover and Italian rye grass.

In addition to the grasses mentioned, orchard grass is desirable, because it furnishes early pasture.

If there is any doubt relative to the purity of the grass and clover seeds to be used, a sample should be submitted to the state experiment station for examination and test. One familiar with grass and clover seeds may make his own inspection by the use of a hand lens, and may also make his own germination test by the use of white blotting paper moistened and placed in an ordinary dinner plate covered with another to retain moisture. One or two hundred seeds placed between the blotters and kept at favorable temperature will enable one to determine the percentage of germination. Careful inspection every day or two should be made to keep the blotters continuously moist.

Seeding Grasses and Clovers.—A full crop of grass, whether for a meadow or pasture, necessitates a full stand of plants. The first essential to this is the requisite number of viable seeds, well distributed on every part of the field. There are many factors that influence the stand besides the rate of seeding.

Rates of seeding for the different grasses and clovers when used alone are given in the chapter on "Grasses and Clovers." A few species only enter into the average meadow mixture. As a rule, the ratio of the amount of seed for the different species entering into a meadow mixture will be a little larger than the amount when seeded alone. For example, timothy seeded at the rate of 15 pounds alone and red clover at the rate of 12 pounds, when seeded together would require on an average of about 9 pounds of timothy and 7 pounds of clover, making a total of 16 pounds as compared with one-half of the sum of the two individual rates, which would be 13½.

The depth of seeding has already been discussed under several of the species of grasses and clovers. The depth in case of mixtures should be regulated with even more accuracy than in seeding one species only. It should meet as accurately as possible the needs of the leading grasses and clovers in the mixture. In special cases it may be found advantageous to drill the clovers and broadcast the smaller grass seeds, such as timothy, redtop and blue grass. The depth is also controlled largely by character of soil and weather conditions. In midsummer, when the soil is dry and the temperature high, seeds should be covered rather deeply. In the cool, moist portion of the year, very shallow covering is better. In no case can grass and clover seeds be covered more than two inches without suffering much loss. With the smaller grass seeds, one-half inch to an inch is generally sufficient.

The time of seeding is subject to considerable latitude, but there are two seasons of the year that generally give best results. These are very early in the spring or rather late in the summer. These two seasons will be subject to some modification, depending upon weather conditions. It is wise to seed when the soil is in a good moisture condition so as to insure quick germination. As a rule, it is not advisable in case of summer seeding to seed just before a heavy rain. Such a rain compacts the soil and the hot weather that is likely to follow will form a crust that the small plants cannot penetrate. Seeds deposited in a dry soil may be germinated by a light shower followed by dry weather that will cause the small plants to perish.

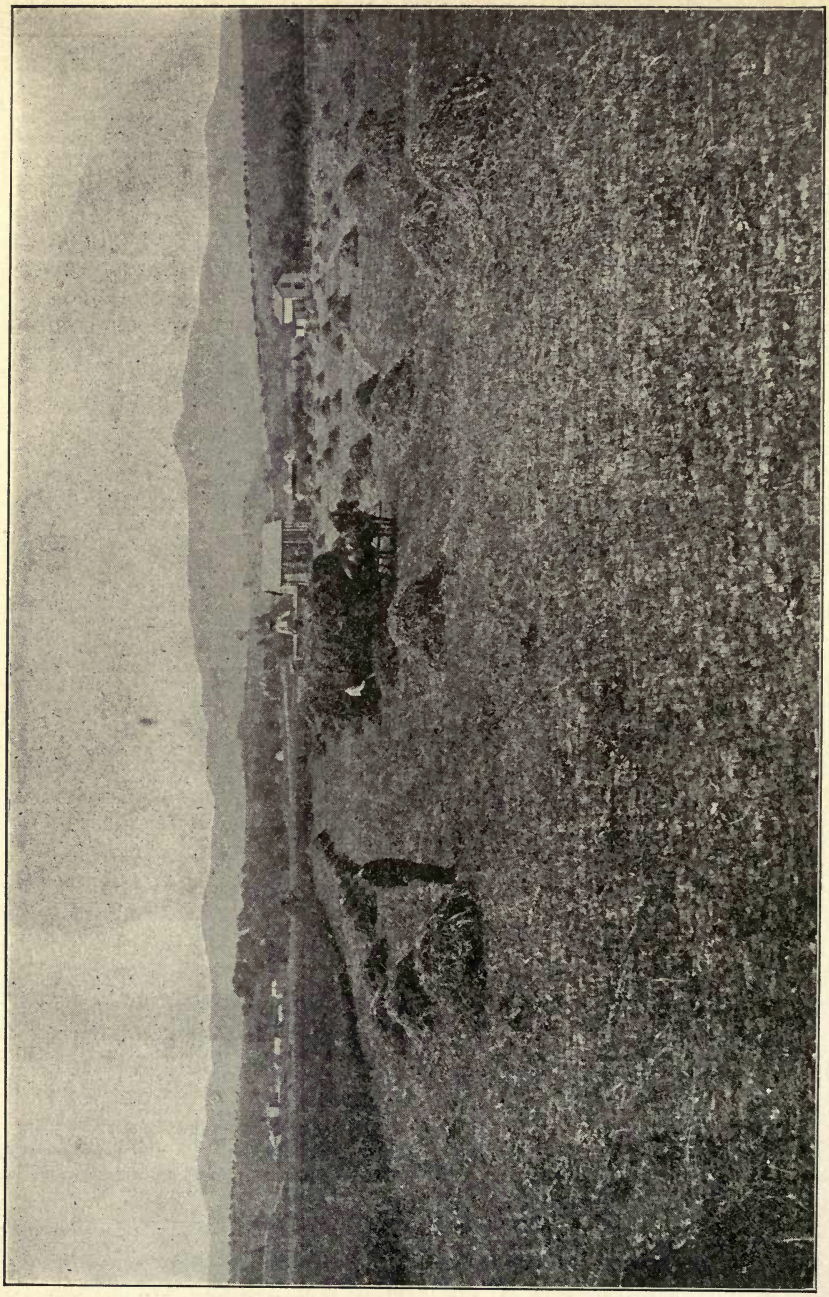
Grasses seeded in summer may be broadcasted on a well-prepared seed-bed immediately following the harrow. One additional harrowing will sift the seeds down into the soil and effect a satisfactory covering. If the soil is dry the first harrowing may be followed by the plank drag. This will mash the small clods, compact the soil, bring the moisture nearer the surface and germinate the seed.

The manner of seeding depends largely on seasonal condition of the soil and character of grass-seed mixture. Grasses and clovers are generally sown broadcast. There are a number of forms of seeders. The grass-seed attachment to the grain drill predominates where fall seeding with wheat occurs. It is also extensively used where the drill is used for spring seeding of oats. The wheelbarrow seeder and the hand seeder are extensively used when seeded alone or on grain fields where drills are not employed. Slant-toothed spike harrows are most generally used for covering the seed when broadcasted in this way. Brush harrows are sometimes used when the seed is very small and the seed-bed very mellow. This avoids covering too deeply. In any case, implements should be used that do not tend to drag trash or soil and result in bunching the seed. Much seeding is done in the winter and very early spring which calls for no covering. In this case the seed is covered by the freezing and thawing of the soil and by rains and winds.

Late fall and early spring seeding usually takes place with a nurse crop. In this way the cost of seed-bed preparation is charged chiefly to the grain. This is the cheapest possible way of seeding grass other than that of sowing it in the spring to be covered by the freezing and thawing and rains. The nature of the nurse crop is important. Moderately thin seeding and the use of early varieties generally favor a good catch of grass.

Seeding without a nurse crop calls for especially well-prepared seed-bed and freedom from weeds. Such seeding generally does best in the late summer.

Treatment of Meadows and Pastures.—Of all the farm crops, the meadows and pastures are probably the most neglected. Meadows usually receive more care and attention than pastures. The treatment accorded meadows will consist chiefly: (1) in the application of manures



HAY-MAKING SCENE—MILLET.[1]

[1] Courtesy of Virginia-Carolina Chemical Company, Richmond, Va. From V.-C. Fertilizer Crop Books.

and fertilizers, (2) re-seeding of the grasses and clovers in case of failure (3) cultivation to maintain a good physical condition of the soil, and (4) cutting of weeds when they become serious.

The cultivation given to meadows, while rather unusual, will consist mainly in disking and harrowing. These operations will frequently be demanded wherever re-seeding is required and may be used for the destruction of weeds and the loosening of the soil. There are now on the market certain forms of spiked disks designed especially for this type of work.

Cultivation is even more applicable to pastures than it is to meadows Pastures are more permanent, or at least remain for a long series of years without being disturbed. Certain grasses frequently become sod-bound As a result of close grazing, weeds also frequently become numerous. The tramping of the animals tends to compact the soil. Cultivation is beneficial for all of these difficulties. Harrowing spreads the droppings of the animals and affords a more effective distribution of the manure for the benefit of the grass.

Meadows should not be maintained for too long a period. Better results have been secured by plowing and re-seeding than to continue too long in consecutive crops of grass. In pastures the situation is much different. There are records of pastures forty and fifty years in grass without being disturbed. This applies, however, to those regions in which the soils and climate are especially adapted to the typical pasture grasses and clovers, such for example as Kentucky and Canada blue grass and white clover. Where pastures are prone to run out in a few years, it is better as a rule to re-seed. This, of course, applies only to lands that are capable of cultivation and devotion to other crops.

Care of Meadows and Pastures.—The life of a meadow and the maintenance of its productivity may be prolonged by exercising certain precautions in connection with its care and the harvesting of the crops. It is unwise to pasture animals or to haul manure onto a field when the soil is too wet. The more permanent the nature of the meadow the greater should be the care exercised. Meadows should go into the winter well protected by either sufficient second growth or proper mulching with manure. It is, therefore, unwise to closely pasture the aftermath of meadows late in the season. In favorable years a moderate amount of pasturing will not be undesirable. If weeds occur in considerable numbers, late summer or fall clipping to prevent seeding is advised.

Pastures should not be grazed too early in the spring. It is undesirable: (1) from the standpoint of not giving the grass a sufficient start, and (2) through injury by tramping and compacting the soil when it is wet. It is also unwise to pasture closely too late in the fall, since pastures, like meadows, should have winter protection. It is never wise to pasture too closely at any time of the year. Close pasturing reduces the vitality of the plants and their subsequent producing capacity. The packing of the soil

by animals under favorable conditions will be overcome in temperate climates by the freezing and thawing during the winter.

In grasses the growth takes place at the base of the leaves and lower portions of the internodes, so that grazing does not destroy the plants unless the plants or portions thereof are injured below the point of growth.

The grazing capacity of a pasture will be determined by the care given to it and the manner in which it is grazed. Its grazing capacity should be fully utilized, and it is believed that the pasture will be maintained fully as well, and sometimes better, in this way than when not fully grazed. In pastures that are not fully utilized many weeds occur that go to seed and result in weedy pastures within a few years. No animals are better for destroying weeds than sheep, although all classes of livestock will eat most kinds of weeds when there is a shortage of grasses. There are few experiments in America on pastures and pasturing.

Improvement of Meadows and Pastures.—"An ounce of prevention is worth a pound of cure" applies especially to meadows and pastures. This is pretty thoroughly covered in the treatment and care of meadows and pastures discussed in the preceding topics. Brush pastures may be improved by removing the brush by clearing, by firing or by pasturing with goats. The latter is perhaps the most economical method, provided goats can be secured and disposed of without loss. This not only cleans the pastures, but utilizes the removed product in the form of brush, weeds, etc.

Wet pastures may be improved by underdrainage. This not only encourages the growth of the more nutritious and better grasses and clovers, but protects the pasture against injury through tramping by animals when too wet. The expense of drainage for pasture land must not be too great.

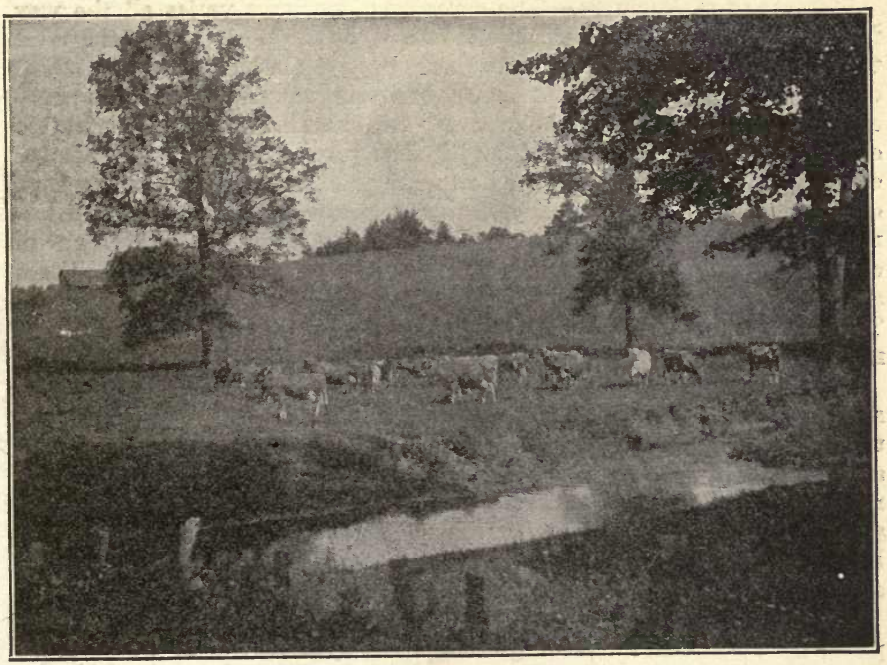
Manuring, Fertilizing and Liming.—Sour soils should be liberally limed when prepared for meadows or pastures. Meadows that are to be continued for several years may be top-dressed with lime to good advantage, and pastures may be top-dressed at intervals of six to ten years. The benefits from liming will be determined chiefly by the acidity of the soil and the proportion of clovers that enter into the meadow and pasture mixtures.

Barnyard and stable manure is advantageously used in the establishment of meadows and pastures. It is often advisable to apply the manure to the crop preceding the one in which the grass is seeded. On the other hand, meadows that are to remain for several years may be advantageously top-dressed with light applications of manure, greatly to the benefit of the grass. Such top-dressing has been found profitable wherever manure is available, or may be purchased at low cost. The better sod resulting is also beneficial to the crops which are to follow the meadow.

It is unusual to apply manure to pastures once established, since the droppings of the animals, if properly distributed, go far towards meeting

the needs of the soil. In all probability the manure can be more advantageously used on the meadows and other crops.

Experiments at several of the state experiment stations have demonstrated that moderate amounts of complete commercial fertilizers can be economically used on meadows. The more perfect the stand of grass, the larger the increased yields resulting from such treatment. While the composition of the fertilizer will differ somewhat for different soils and grasses, that for the grasses proper should contain about equal percentages of the



GOOD PASTURE LAND.[1]

three fertilizing constituents. Nitrogen is essential in increasing vegetative growth. A home-made mixture consisting of 150 pounds per acre each of nitrate of soda and acid phosphate, and 50 pounds of muriate of potash, is recommended. This should be applied broadcast very early in the spring just as the grass is beginning to start.

Since nitrogen is so expensive, clovers should be used in both meadows and pastures for the benefit of the grasses. They also increase the protein content of both the hay and grazed product.

Utilizing Aftermath.—The amount of aftermath or second growth on meadows depends on the nature of the grasses, the time of cutting the first

[1]Courtesy of The Macmillan Company, N. Y.

crop and the weather conditions which prevail. With early cutting of the first crop and favorable subsequent weather conditions, the second crop may be as large and well worth harvesting for hay. Certain precautions in this connection are necessary, namely, not cutting so late as to prevent further growth for winter protection. There is no objection to pasturing the aftermath if not pastured too closely and if the character of grasses is such as not to be seriously injured by the tramping of animals. The future life and use of the pasture will be a factor in this connection.

Capacity of Pastures.—The capacity of pastures varies all the way from fifty acres to the animal unit in case of the range pastures of the West to one acre per animal unit on first-class pastures in humid regions. The capacity is also measured by the length of grazing season, and this is dependent chiefly upon latitude and elevation. It is also influenced by the nature of the pasture grasses, some prolonging their growth into the cooler portion of the year. Experiments show that more product is secured as hay than can be secured when the same grasses are pastured. This has been determined by comparing the relative yield of cuttings at short intervals with cutting once at maturity. Such experiments have given nearly three times as much dry matter in the form of hay as was secured in frequent cuttings. The protein content of the new growth was much higher and aggregated nearly as much in frequent cuttings as in the matured product.

Pasture experiments in Missouri showed average daily gains of 1.65 and 1.85 pounds for yearlings and two-year-old steers respectively during the summer season. At the usual charge for pasturage in that state, the estimated cost per hundred pounds of live weight was $1.60 and $1.90 respectively. Pasture experiments in Virginia covering several years gave gains in live weight of 150 pounds per acre annually. This was on average blue grass pasture in that state. The average pasture in the humid region should produce 150 pounds live weight in cattle per acre annually.

Composition and Palatability of Pasture Grass and Hay.—The composition of various kinds of grasses and hay is given in Table I, in Part III. The composition of grass mixtures will be determined by the relative portions of the species entering into it, and also by the stage of growth when harvested, and the conditions under which grown. Nitrogenous fertilizers have been found to somewhat increase the protein content of the grasses.

The palatability and digestibility of grasses as grazed are doubtless much greater than those for mature hay. The labor required for harvesting the hay is also saved.

Temporary Pastures.—Temporary pastures are generally provided to meet early needs and are designed for short periods. They consist of annual plants, of which there are many species. These will be determined by soil and climatic adaptation and the character of animals to be grazed. Oats, sorghum and red clover make a good combination. Oats make rapid growth during the early part of the season, while sorghum grows more

rapidly with the approach of warm weather. As these two crops are becoming exhausted, the clover takes their place. This mixture is suited to spring seeding and can be pastured from the latter part of June to the close of the season. Another mixture consists of spring wheat, barley and oats, using about one-third of the usual sowing of each. These may be pastured as soon as they attain sufficient size to afford a good supply of pasturage. Another mixture frequently used consists of rye, winter wheat and winter vetch sown in the fall. This will afford pasture in the spring earlier than the spring-sown grains, and if seeded fairly early may furnish some winter pasture. In pasturing the annual crops, waste by tramping may be prevented by restricting the area grazed by means of hurdles or temporary fences. Such pastures require knowledge relative to the date crops must be sown to afford pasture when needed. In this respect it resembles the provision for soiling crops which are to be cut and fed from day to day.

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CHAPTER 11

Miscellaneous Annual Hay and Forage Crops

Of the miscellaneous annual hay and forage crops the legumes take first place. They are important both from the standpoint of high feeding value and of the benefit derived from them by the soil. In regions adapted to alfalfa or the clovers, annual legumes find a minor place, chiefly as substitutes when for any reason the clovers fail.

Cowpeas and soy beans are by far the most important annual legumes. The former are especially adapted to the cotton belt, while the latter may be grown wherever corn is successfully raised. For northern latitudes, Canada field peas and winter vetch are hardy and promising.

Of the non-legumes, the millets and sorghums rank first as annual hay and forage crops.

COWPEAS

The cowpea is a warm-weather crop, and is the best annual legume for the entire cotton belt. It is suited for the production of both hay and seed. It is seldom grown above 40 degrees north latitude, and in the northern limits of its production only early-maturing varieties should be used. There are more than sixty varieties of cowpeas, differing greatly in size, character of growth, color of seeds and time of maturity. Only a few of them are extensively grown.

Varieties.—Whippoorwill is the best known and most extensively grown variety. It is of medium maturity and well adapted for making hay. It may be recognized by seed which has a mottled chocolate on a buff or reddish ground color. It makes a vigorous growth, quite erect and produces a large amount of vine. It can be handled readily by machinery.

Iron is also a well-known variety, and is especially valuable because it is practically immune to root knot and wilt, diseases which cause much trouble with cowpeas in many parts of the cotton belt.

New Era is one of the earliest of the cowpea varieties and is adapted to the southern portion of the corn belt. Its habit of growth is erect with few prostrate branches, thus making it easy to cut with machinery. It produces a heavy crop of small seed, characterized by innumerable minute blue specks on a gray ground color. Because of the small seed, less quantity is required for seeding.

Unknown or Wonderful is one of the most vigorous and largest growing varieties and is late in maturing. It is quite erect and is handled readily by machinery, either for hay or grain production. The seed is large and of a light clay color. It is not adapted north of North Carolina and Tennessee, except in a few localities at the lower altitudes.

Clay is the most variable of any of the varieties, and the name is given commercially to any cowpeas having buff-colored seeds, except the Iron. For this reason there are doubtless many varieties that masquerade under this name. This variety is vigorous, but of a trailing habit. It fruits sparingly and is consequently rather unpopular either for seed or hay purposes. It is especially valuable for pasturing and for soil improvement.

Groit is very similar to New Era, but makes a slightly larger growth and fruits more heavily.

Black is a variety characterized by its large black seeds that do not decay rapidly after ripening, even after lying on the warm, moist earth.

FIELD OF IRON COWPEAS PLANTED IN ONE-FIFTH-ROD ROWS AND CULTIVATED THREE TIMES.[1]

It is especially adapted to the sandy, coastal plain soils of Virginia and North Carolina. It is also popular in the sugar-cane section of Louisiana.

Time, Manner, Rate and Depth of Seeding.—Cowpeas should not be seeded until the soil is thoroughly warm. In most localities the date of seeding will be one or two weeks later than the best time for planting corn. The plants are tender and are injured by the slightest frost.

In the cotton belt, the time of seeding should be regulated so that when harvested for hay, the proper stage of maturity will occur when the weather conditions are favorable for hay making. This will usually be sometime in September.

The seed-bed for cowpeas should be prepared the same as for corn. The planting may be in drills or by broadcasting. When grown for seed it is generally best to plant in drills not less than thirty inches apart and

[1] From Farmers' Bulletin 318, U. S. Dept. of Agriculture.

cultivate the same as for corn. Good results, however, have been secured by seeding with the ordinary grain drill, which, of course, permits of no cultivation. When seed is costly, the saving of seed by drilling in rows thirty inches or more apart may offset the labor of cultivation. When grown chiefly for hay, broadcasting or drilling in rows close together is best.

The rate of seeding varies from one to eight pecks per acre, depending on the manner of seeding, the character of seed and the purpose for which grown. When seeded with the wheat drill, with all of the holes open, one bushel of seed per acre will give good results for hay and still provide for fair yields of seed. Small seed requires less in planting than large, and less seed is required for seed production than when grown for forage.

The depth of seeding will depend on the character and condition of the soil. It may vary from one to four inches. The looser the soil or the drier the seed-bed, the deeper should be the planting. The cowpea is really a bean and, like all beans, should not be planted too deeply.

Cowpea seed usually costs from $2 to $3 per bushel.

Seeding with Other Crops.—There are two principal advantages in seeding cowpeas with other crops, namely, the production of a better balanced ration when used as forage, and the increased facility with which the crop may be harvested and cured when supported by upright growing plants.

The best crops to seed with cowpeas are corn, sorghum and millet. These are all similar to the cowpea in soil and climatic requirements. It is never wise to seed cowpeas with oats, as the one requires warm weather and the other cool weather for best results.

The upright growing varieties of cowpeas may be grown with corn, preferably by planting both corn and peas in rows at the same time. By selecting the proper variety with reference to habit of growth and time of maturity, the cowpeas may be harvested at the same time with a corn harvester and used for making ensilage.

In the southern portion of the corn belt and in the cotton belt cowpeas are frequently drilled between the corn rows after the last cultivation. The pods are gathered for the peas and the vines turned under for the benefit of the soil. When planted with corn, the cowpeas should be four or five inches apart in the row and the corn about twelve inches apart. Best results are secured by using a cowpea attachment to the corn planter.

When grown for hay, seeding with sorghum or millet gives best results. Sorghum is generally preferable to millet, because it has a somewhat longer growing season and makes a more palatable hay. Best results are secured by mixing the seed at the rate of two bushels of peas to one bushel of sorghum and seeding with a wheat drill at the rate of one and one-half bushels per acre. The large varieties of millet may be used with the early maturing varieties of cowpeas.

Fertilizers, Tillage and Rotation.—Cowpeas respond to moderate applications of phosphorus and potash, but do not need nitrogen.

When planted in drills sufficiently far apart to enable cultivation, cowpeas do best when given frequent, shallow and level cultivation. The earth should not be thrown on the foliage and tillage should cease as soon as the vines begin to run.

Cowpeas are adapted to short rotations. They may frequently follow an early-maturing crop, such as wheat, oats and early potatoes, thus providing two crops from the land in one season. A rotation of wheat or oats and cowpeas is giving excellent results in portions of Tennessee, Arkansas and Missouri.

Time and Method of Harvesting.—For hay purposes cowpeas should be cut when the first pods begin to ripen. A large growth of vines is somewhat difficult to cure. The cut vines should lie in the swath for one day. They should then be placed in windrows where they may remain until fully cured. If weather conditions are not most favorable the vines, after remaining one or two days in the windrow, should be put into tall, narrow cocks and left to cure for a week or more. If rains threaten, canvas covers are advised.

The leaves are the most palatable and nutritious portion of the forage, and every effort should be made to prevent their loss. When so dry that no moisture appears on the stems when tightly twisted in the hands, the hay may be put into stack or mow.

Harvesting for seed is most cheaply done by machinery. The crop should be cut with the mowing machine or self-rake reaper when half or more of the pods are ripe. When thoroughly dry they may be threshed with the ordinary threshing machine by removing the concaves and running the cylinder at a low speed to prevent breaking the peas. Better results are secured by using a regular cowpea threshing machine.

Feeding Value and Utilization.—Well-cured cowpea hay is superior to red clover and nearly equal to alfalfa hay. It is very high in digestible protein. Experiments relative to its feeding value show that one and one-quarter tons of chopped cowpea hay is equal to one ton of wheat bran. It is a satisfactory roughage for work stock and for beef and milk production.

SOY BEANS

Soy beans are adapted to the same soil and climatic conditions as corn. They are most important in the region lying between the best clover and cowpea regions. This is represented by Delaware, Maryland, West Virginia, Virginia, Tennessee and the southern portion of the corn belt. They do well on soils too poor for good corn production, but are not so well adapted to poor soils as the cowpea. They stand drought well.

Varieties.—There are several hundred varieties of soy beans, but only about fifteen are handled by seedsmen. The most important of these are described in the accompanying tabulation. The selection of a variety should be based upon time of maturity as related to the length of season for growth and the purpose for which grown. For seed production, good

seed producers should be selected, and for hay and ensilage the leafy varieties are better.

Time, Method, Rate and Depth of Seeding.—The seed-bed for soy beans should be prepared the same as for corn, and the seed may be sown broadcast or drilled, according to the purpose for which grown. On land that is not weedy the seed may be drilled solid with a grain drill. About one bushel of soy beans should be used per acre and they should be covered with one to two inches of soil. If land is weedy or if crop is grown for seed the corn planter may be used, the rows narrowed to three feet if possible

LEADING VARIETIES OF SOY BEANS AND THEIR CHARACTERISTICS.

VARIETY.	COLOR OF SEED.	NUMBER OF SEEDS PER LB.	TIME OF MATURITY.	PURPOSE TO WHICH ADAPTED.	HABITS OF GROWTH.
Mammoth.	Yellow.	2100	Late, 120 to 150 days.	Roughage and grain for entire South.	Large and bushy; 3 to 5 feet high. Will not mature seed north of Virginia and Kentucky.
Hollybrook.	Yellow.	2100	Medium, 110 to 130 days.	Principally for seed. South.	Three feet or less; coarse; poor for hay. Not so valuable as Mammoth.
Haberlandt.	Yellow.	2400	Medium-early, 100 to 120 days.	Principally for seed. South.	Stocky; seldom more than 30 inches tall.
Medium Yellow or Mongol.	Yellow, with pale hilum.	3500	Medium-early, 100 to 120 days.	Forage.	Erect; bushy; 2½ to 3 feet.
Guelph or or Medium Green.	Green.	2600	Early, 90 to 100 days.	Principally for seed. North.	Coarse; not satisfactory for hay; stout and bushy; 1½ to 2 feet. Seed shatters easily.
Ito San.	Yellow, with pale hilum.	3200	Early, 90 to 110 days.	Hay and seed. North.	Bushy, with slender stems; 2 to 2½ feet. Much grown in North.
Wilson.	Black, yellow germ.	2400	Medium-early, 100 to 120 days.	Hay and seed.	Tall, slender; 3 to 4 feet. Excellent for hay.
Peking.	Black, yellow germ.	6300	Medium, 110 to 130 days.	Hay and seed.	Bushy with slender, leafy stems; 2½ to 3 feet. Shatters very little.
Sable.	Black.			Hay and silage.	

and the seed drilled two inches apart in the row. This should require not more than one-half bushel per acre. The drill will accomplish the same result if every fifth drill hoe is used and the planting is made in rows for cultivation.

Seeding should not take place until danger of frost is past. In the Central states it is safe to seed as late as July 1st, and further south seeding may take place later. Soy beans are adapted to seeding with corn to be used as ensilage, in which case varieties should be used that mature about the same time as the corn with which planted. This mixture is also well adapted for hogs and they may be turned into the field as soon as the corn reaches the roasting-ear stage.

Inoculation, Tillage and Fertilizers.—On land which has not before grown soy beans it is advisable to inoculate, either by soil transfer or by artificial cultures. When sown in rows, inoculated soil may be put into the fertilizing box and distributed with the beans at time of planting. This reduces the amount of soil required and gives perfect inoculation. The precautions pertaining to inoculated soils and artificial cultures are the same as those given for alfalfa.

The fertilizers for soy beans are the same as for cowpeas.

When planted in rows far enough apart to permit of cultivation, cultivation should begin early and be sufficiently frequent to keep down all weeds and maintain a soil mulch. Soil should not be thrown on the plants when they are wet. Cultivation should cease when the plants come into bloom.

Time and Method of Harvesting.—Beans grown for hay may be cut with the mowing machine and cured in the same manner as cowpeas. For this purpose it is best to cut when the leaves first begin to turn yellow and the best developed pods begin to ripen. When harvested for seed it is best to wait until the leaves have fallen and at least half of the pods have turned brown. If much value is attached to the straw, harvesting for seed may take place a little earlier. The method of threshing is the same as that for cowpeas.

When grown with corn for silage purposes, the beans should be a little more mature than when harvested for hay.

Composition, Feeding Value and Utilization.—Well-cured soy bean hay is superior to clover hay and equal to alfalfa. It is more palatable than cowpea hay. Whether used for hay, grain, straw or ensilage, it is very valuable as a feed for nearly all kinds of livestock. It is especially valuable in all kinds of rations where high protein content is desired. The whole plant is high in protein and the beans are very high in both protein and fat.

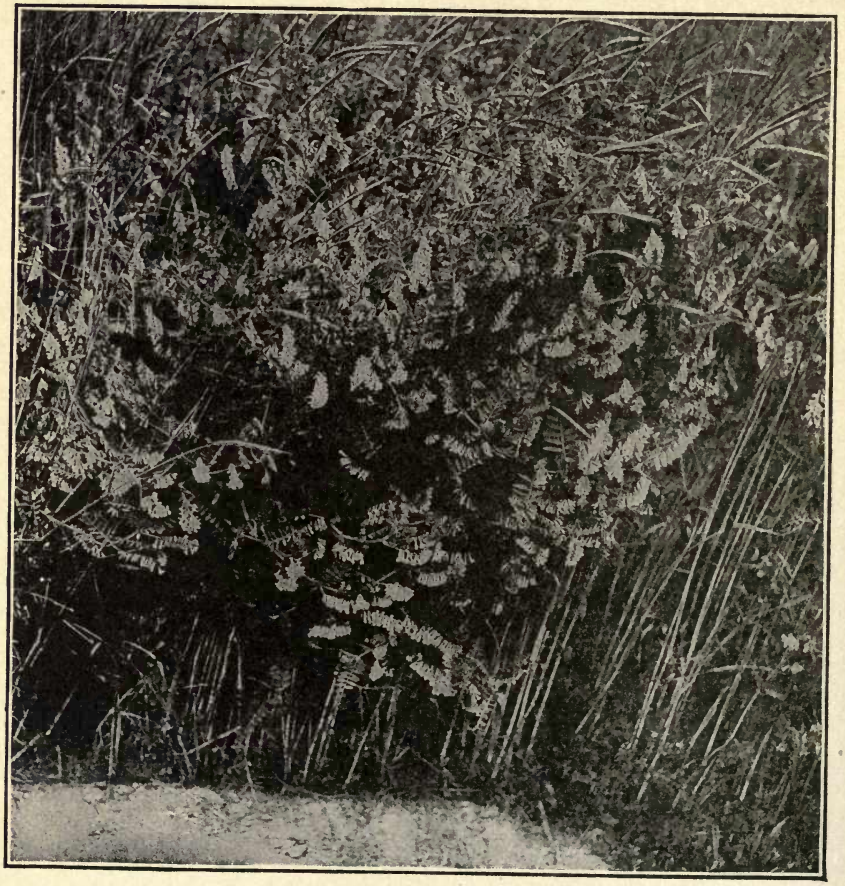
Vetches.—The hairy vetch is a winter annual and is important as a forage and soil improvement crop in the United States and Canada. It belongs to the same family of plants as cowpeas and soy beans. It is best adapted to a cool, moist climate and succeeds best in the northern half of the United States and southern portion of Canada. Although it may be seeded any time during the summer, it does best when seeded in the late summer or autumn. It generally blossoms in May and matures seeds in June or July.

It is valuable as a winter cover crop. The plant has a reclining habit. It is, therefore, best to seed rye and vetch together. About twenty-five pounds of vetch and one-half bushel of rye per acre makes a suitable mixture. The crop may be turned under early in the spring for the benefit of the soil, or pastured or cut green for soiling purposes, or made into hay.

Canada Field Peas.—This term is used for field peas regardless of their variety. The plant is adapted to a cool, moist climate and succeeds best when seeded early in the spring. When used for haying or soiling

purposes, it is best to seed it with oats. The oats support the peas and facilitate the harvesting of the crop.

The amount of seed to use will vary with the size of the pea and the character of the soil. It will vary from two bushels per acre in case of small



HAIRY VETCH AND RYE GROWING TOGETHER.[1]

seed to three and one-half bushels of the large seed. When seeded with oats, two bushels of peas and one bushel of oats per acre is about the right proportion.

On light soils peas may be sown broadcast and plowed under to a depth of three to four inches. Peas should not be buried so deeply on stiff clays. Best results will be secured by drilling the seed with a grain drill. Some of the peas will be broken in passing through the drill, but the loss

[1] From Farmers' Bulletin 515, U. S. Dept. of Agriculture.

will not be serious. When oats and peas are drilled together, it is best to drill the peas first, after which the oats may be drilled at right angles to the peas and not so deeply. Since the oats come up more promptly than the peas, some advocate deferring drilling the oats until three or four days after drilling the peas.

Harvesting.—Peas are ordinarily cut with a mowing machine when the first pods are full grown but not yet filled. At this time they make an excellent quality of hay. They are cured in the same manner as clover or timothy. Care should be taken to prevent loss of leaves by shattering and injury from rain.

Other Annual Legumes.—The Velvet Bean is a rank growing vine requiring seven to eight months to mature seeds, and is especially adapted as a cover crop in Florida and along the Gulf Coast.

The Beggar Weed is also well adapted to the extreme South and is utilized both as forage and for cover crop purposes. It is adapted to light, sandy soils, and when seeded thickly, can be converted into hay or silage. It grows six to ten feet high and is relished by all kinds of livestock.

Sorghum.—The non-saccharine sorghums were discussed under the head of Kaffir corn. The sweet sorghums, of which there are a number of varieties, are utilized for forage purposes as well as for the manufacture of molasses. The sweet sorghums are not so drought resistant as the non-saccharine sorghums, and a small acreage may be advantageously grown on many livestock farms east of the semi-arid region.

The season of growth is similar to that of corn and the plant demands the same kind of soil and methods of treatment. When used for hay, it should be seeded thickly either by broadcasting or by drilling with a wheat drill, using 70 to 100 pounds of seed per acre.

The Early Amber is considered the best variety for general purposes.

Sorghum should be cut for hay when the seeds turn black. It may be cut with a mowing machine the same as any hay crop. Best results are secured by putting it into large shocks and allowing it to remain until thoroughly cured. If cut too early or stacked before the weather becomes quite cool, it is likely to sour and make a poor quality of hay.

Millet.—There are three common varieties of millet: German, Hungarian and common millet. The common millet is drought resistant and grows well on rather poor soil. It matures in from two to three months. It makes a good quality of hay and can be fed with less loss than the coarser varieties.

The German variety is the largest and latest maturing variety. It will outyield common millet, but is not so drought resistant.

Hungarian millet is about midway between the common and German millet as regards time of maturity, drought resistance and yield. Its tendency to produce a volunteer growth has brought it somewhat into disfavor.

The millets may be seeded any time after the soil is thoroughly warm. In latitude 40 degrees north, German millet should be seeded the last week

in May or the first week in June. Hungarian millet may be seeded two or three weeks later, while common millet will frequently produce a crop when seeded as late as the middle of July.

Millet is used chiefly as a catch crop for hay. It is well adapted for this purpose and may be substituted where a catch of clover or timothy fails. It is also excellent to fill in where areas of corn have failed.

The preparation of the seed-bed should begin as early in the spring as conditions will permit. This gives an opportunity to rid the soil of weeds by occasional harrowing prior to seeding. Millet is seeded broadcast at the rate of one peck per acre when grown for seed, and one-half bushel per

Millet Makes an Excellent Catch Crop and is Profitable Either for Hay Purposes or for Seed Production.

acre when grown for hay. Three pecks of seed is advised by some for hay. This results in smaller plants with a finer quality of hay.

Where extensively grown for seed, millet should be harvested with the self-binder when the seed is in the stiff dough stage. The after-treatment is similar to that for wheat and oats. The best quality of hay is secured by cutting before the seeds begin to ripen. The seeds act as a diuretic to animals and it is not safe to feed too much of it to horses. Hay that is to be used for horses should be harvested before seeds form.

Rape.—Rape belongs to the same family of plants as cabbage and turnips. There are two varieties, annual and biennial. The latter bears seed in the second year. The best known variety of biennial is the Dwarf Essex. This gives best results for soiling and pasture purposes. Cattle and sheep are fond of rape. It is especially fine for hog pasture.

Catch Crops for Pasture and Hay.

Crop.	Time of Seeding.	Variety.	Amount of Seed per Acre.	Cost per Bushel.	Cost per Acre.	Method of Seeding.	Time to Harvest.	Yield.	Value.
Field Peas and Oats.	Same time as spring small grain.	Golden Vine or Canadian Beauty field peas; any late oats.	1½ bushels oats, 1½ bushels field peas.	Field peas $2.75, oats 60 cents.	$5.00	Drill in together 3 inches deep.	Oats in milk and pea pods forming.	2 tons.	Almost equal to clover hay.
Succotash.	Same time as small grain.	Any mixture of small grains.	2½ bushels.	$1.00	$2.50	Drill or broadcast.	Use for pasture if needed, or cut in the milk for hay.	Good pasture to middle of July or 2 tons of hay.	Not quite equal to field peas and oat hay, but equal to timothy.
Rape.	From early spring to August 1st.	Dwarf Essex.	5 pounds.	$4.20	$0.40	Drill or broadcast alone or harrow in on small grain.	Pasture 8 or 10 weeks after seeding, 12 or 15 inches high; not much good during hot weather.	Large yield of good pasture.	Furnishes splendid pasture, especially for hogs and sheep, early in season and late.
Millet.	Late May, June or early July.	Common (early), Hungarian (medium), German (late).	3 pecks.	$1.75	$1.30	Drill or broadcast.	Just after blossoming, but before the seeds form.	3 tons.	A fair quality of hay, but not nearly equal to clover; dangerous for horses.
Sorghum.	Soon after corn planting or same time as millet.	Amber.	80 to 100 pounds broadcast; 40 pounds of germinable seed if drilled.	$1.50	$3.00	Drill or broadcast.	Early fall just before frost and when the heads are in dough.	4 tons.	Palatable hay, much the same as corn fodder; deteriorates in spring.
Cowpeas.	Same time as sorghum.	New Era (early), Whippoorwill (medium), Black (late), Clay (late).	1½ bushels, less if in rows.	$2.75	$3.40	Drill thickly, broadcast or sow in rows three feet apart.	When pods are partly ripe and lower leaves turning.	2 tons.	Fully equal or superior to clover; good late summer pasture.
Soy Beans.	Same as cowpeas or a little earlier.	Ito San, medium brown, medium yellow, medium green.	Same as cowpeas.	$3.00	$3.75	Same as cowpeas.	Same time as cowpeas.	2 tons.	About same as cowpeas.
Sorghum and Cowpeas.	Late May, June or early July.	Any of the varieties mentioned in foregoing.	30 pounds sorghum, 1 bushel peas.		$3.55	Drill or broadcast.	When sorghum is in dough stage.	3 tons.	Not quite equal to clover hay.

This plant is best adapted to cool, moist climates and does best in the Northern states and Canada. South of latitude 38 degrees it is best to sow it in the fall. This allows it to make most of its growth during the cooler part of the year. North of this, rape should be seeded in the spring so that it may make most of its growth before hot weather.

Three to six pounds of seed per acre are required. It may be either broadcasted or seeded with a drill on a well prepared seed-bed.

Rape is usually ready to pasture in six or eight weeks after seeding. If not pastured too closely, it continues to grow until freezing weather.

MAKING HOGS OF THEMSELVES.[1]

Rape makes an excellent late fall and early spring pasture for growing hogs.

Care must be taken in pasturing cattle and sheep in rape. They should be allowed on the rape only a short period at a time, until they become accustomed to it. Very bad cases of bloat may result if this caution is unheeded.

The preceding tabulation taken from "Wallace's Farmer" summarizes the requirements for catch crops when used for pasture and hay. It gives the approximate requirements for average corn-belt conditions, but is subject to modifications as regards time of seeding and amount of seed, depending on climatic conditions.

[1] Courtesy of Dept. of Animal Husbandry, Pennsylvania State College.

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CHAPTER 12

Annual Legumes, Grown Principally for Seeds

The annual legumes most grown in North America for seed are the white or navy bean, the common pea and the peanut. They are used extensively as food for man. In addition to these, cowpeas and soy beans are grown for seed, some of which is used for human food, some for stock food, but still more for seeding purposes.

The production of crimson clover, vetch and castor bean for their seed is of minor importance in North America.

Field Bean.—Is extensively grown under field conditions for the production of dried beans. These become the baked beans of New England fame. According to the census of 1910 the production in the United States was 11,250,000 bushels of 60 pounds from 803,000 acres. Michigan, California and New York lead in bean production. During the same year Canada grew about 1,000,000 bushels from 50,000 acres.

Field beans do best in a cool, moist climate. They are not adapted to conditions south of 40 degrees north latitude. Field beans are adapted to loamy soils of a calcareous nature, but may be grown fairly well on clay loams and silt loams when well supplied with organic matter. The underdrainage must be good and cultural methods such as will produce a fine, mellow seed-bed.

Time, Rate, Manner and Depth of Seeding.—Beans are tender plants and seeding, therefore, should be deferred until danger from frost is past. This makes it convenient to plant them immediately after planting corn.

They give best results when planted in rows far enough apart to permit horse cultivation. The beans may be drilled or planted in hills. Drilling usually gives best results, distributing the seed from three to six inches apart in the row. With rows thirty inches apart about one-half bushel of seed per acre will be required.

Great care must be taken not to plant too deeply. The habit of growth is such that the plant cannot reach the surface if planted deeply. An inch and one-half to two inches is the maximum depth on any except sandy soils. On sandy soils they may be three inches deep.

The beans should be thoroughly and frequently cultivated during their early stages of growth to destroy weeds and conserve soil moisture. They should not be cultivated when dew is on the plants. This precaution must be taken to guard against certain diseases, the spores of which may be in the soil. Disturbing the plants while they are wet tends to scatter the spores and spread the disease.

Harvesting.—The ripe beans are harvested with a bean harvester. This implement cuts two rows at a time, leaving the vines in a single windrow. If the vines are practically dead when harvested they may be placed at once in small piles, and later built into large cocks around poles five feet or more in height.

Threshing and Cleaning.—Beans grown commercially are threshed with a machine especially adapted to the purpose. It is operated in a manner similar to the ordinary threshing machine. If only a few beans

HARVESTING FIELD BEANS WITH A HARVESTER.[1]

are grown an ordinary threshing machine may be used. All except four teeth should be removed from the concaves and the speed of the machine should be such as not to break the beans. Most satisfactory results will be secured by having all the beans uniformly dry.

Beans fresh from the thresher generally contain fragments of straw, stones and particles of earth which must be removed before being placed upon the market. This calls for the use of a special cleaning machine, which removes most of the foreign matter. After this the remaining broken and discolored seeds must be removed by hand.

[1] Courtesy of U. S. Dept. of Agriculture, Bulletin 89.

Yield.—Variations in weights of measured bushels range from fifty-seven to sixty-five pounds. The standard weight is sixty pounds. Beans yield all the way from five to thirty-five bushels per acre. There is usually no profit in a ten-bushel crop. According to the last census the average yield per acre was fourteen bushels.

Field Peas.—The Canada field peas, described in the preceding chapter, are extensively grown in Canada and a few of the Northern states for the dried peas. These are adapted to a wide range of uses as feed for livestock. They also furnish the supply of seed for all localities where the crop is grown for forage purposes.

Peas are very high in protein and are especially adapted as feed for young stock and for the production of milk and butter. When given with oats and bran to cows in milk, they may constitute from one-third to one-half of the concentrates fed.

When harvested for seed, the vines are cut with a mowing machine to which special guards are attached for lifting them from the ground. There is also a device attached to the rear of the cutting bar, which leaves the vines in a swath far enough from the standing peas to enable the team and machine to work without tramping the peas. It is customary to cut when two-thirds of the pods are yellow.

When dry the peas should be stacked under cover or threshed immediately with a pea huller or with an ordinary threshing machine in the same manner as described for field beans.

The legal weight of field peas is sixty pounds to the bushel. They are quite prolific and under favorable conditions will yield forty bushels to the acre. At Guelph, Ontario, eight varieties during eleven years gave an average yield of 31.5 bushels per acre. Four varieties at Ottawa averaged 34.4 bushels for five years, while six varieties grown for five years in three other localities averaged 40, 41 and 41.2 bushels respectively per acre.

The most suitable varieties to grow depend somewhat on soil and climatic conditions. Three good all-around varieties are Prussian Green, Canadian Beauty and White Marrowfat.

Cowpeas.—The seed of cowpeas has been very little used as feed, because the price has been too high to justify its use in this way. The introduction of suitable harvesting and threshing machinery should make it possible to produce grain of the more prolific varieties at prices that will put it in reach for feeding purposes. At present practically all of cowpea seed is used for seeding purposes, the price ranging from $2 to $4 per bushel.

The dried shelled peas contain 26 per cent of protein, 1.5 per cent of fat and 63 per cent of nitrogen free extract. A comparatively low rainfall is favorable to seed production. Continuous wet weather causes a development of vines at the expense of seed. At one of the southern experiment stations during a series of five years, the yield of peas with a yearly rainfall of 62 inches was only 12 bushels per acre, whereas, with only 22 inches of

rainfall, the yield was 28 bushels per acre. The yield of hay in both cases was practically the same.

The methods of seeding and harvesting for seed production are treated in the foregoing chapter.

Soy Beans.—The growing of soy beans for grain to be used as feed is profitable if the yield is sixteen bushels or more per acre. The seed is very rich in oil and protein and occupies the same place in concentrates as cottonseed meal and oil meal. The seed should be ground before being fed. Some of the varieties with highest fat content are being utilized for the manufacture of oil. This is used as a substitute for linseed oil in the manufacture of paints. The best varieties under proper cultivation yield from

SOY BEANS, BRADFORD COUNTY, PENNSYLVANIA.[1]

This annual legume is excellent for both forage and seed production. May be grown nearly as far north as dent corn.

thirty to forty bushels of seed to the acre. Hollybrook, Mammoth and Haberlandt are three especially good varieties for seed production. Tall varieties that bear pods some distance from the ground are most desirable and most easily harvested.

The methods for harvesting and threshing are given in the preceding chapter. The threshed beans should be thoroughly dried when stored. Otherwise they are likely to heat and spoil. They should be carefully watched when first stored and at once spread out to dry if there are signs of heating.

Soy bean seed is especially exempt from weevils.

[1] Courtesy of Department of Agricultural Extension, Pennsylvania State College.

Castor Bean.—There are two classes of castor beans, one a perennial, bushy plant with large seeds; the other a small seeded variety which yields oil of superior quality. The plant grows within a wide range of climate, from the tropics to the north temperate zone. In Florida it is a perennial plant growing from fifteen to thirty feet high. Further north, it becomes an annual, matures seed in a short season and grows only four or five feet high.

The castor bean thrives in sandy soils and its culture is simple. The seeds germinate with difficulty and it is advised to place them in hot water twenty-four hours before planting.

It is customary to plant them in hills two inches deep, eight to ten beans to a hill. They are afterwards thinned to one or two plants per hill. The rows should be five or six feet apart and the plants from two to three feet apart in the North, and from five to six feet apart in the South, where the plant grows more luxuriantly. They require about the same tillage as corn.

Crimson Clover, a Good Winter Cover Crop Where Winters are Mild.

Well suited to the lighter soils in the Coastal Plain Region south of Philadelphia.

Planting should be done as early in the spring as possible, but must escape injury from frost.

As soon as the pods begin to open the fruit branches should be removed. This process must be repeated at least once a week as soon as seeds ripen. The branches are spread out to dry on the floor of a suitable building.

In the United States most of the castor beans are produced in Kansas, Oklahoma, California, Oregon and Wisconsin.

The chief use of the beans is for the manufacture of castor oil. This oil is one of the best lubricants for machinery and is used in the manufacture of many articles.

Vetch.—Common vetch and hairy vetch are the two most important varieties of vetches. Common vetch seed is produced in large quantities in the United States only in parts of Oregon. Hairy vetch has a wider range of growth, but is grown mostly for forage, most of the seed being imported from Russia. Both of these varieties seed freely wherever grown and the prevailing high price of the seed ($5 to $8 per bushel) should induce farmers to grow more of it for seed purposes. Yields ranging from twenty to twenty-five bushels per acre have been reported for common vetch, the average estimated yield being ten bushels. Hairy vetch is somewhat less

prolific, but yields ranging from two and one-half to twenty-one bushels per acre have been reported by different experiment stations, the average yield being seven and one-half bushels.

The method of harvesting for seed is similar to that of cowpeas. It is threshed with the ordinary threshing machine.

Crimson Clover.—The chief demand for seed of crimson clover is for seeding purposes. The seed is larger than that of red clover, one pound containing 125,000 to 150,000. The weight is sixty pounds to the bushel. It yields better than red clover, averaging about six bushels to the acre. Most of the seed is produced in Delaware and nearby states.

Crimson clover should be harvested for seed as soon as perfectly ripe. The seeds shatter badly. For this reason it should be cut promptly, preferably in the morning or evening when the plants are damp. The mowing machine with a clover buncher or the self-rake reaper are best adapted for harvesting the crop. If the clover becomes wet the seeds sprout, causing serious loss. For this reason threshing should promptly follow the harvest.

Fresh seed is shiny and of a pinkish color. Seed two years old loses its bright color, becoming dark brown. It is then worthless for seeding purposes.

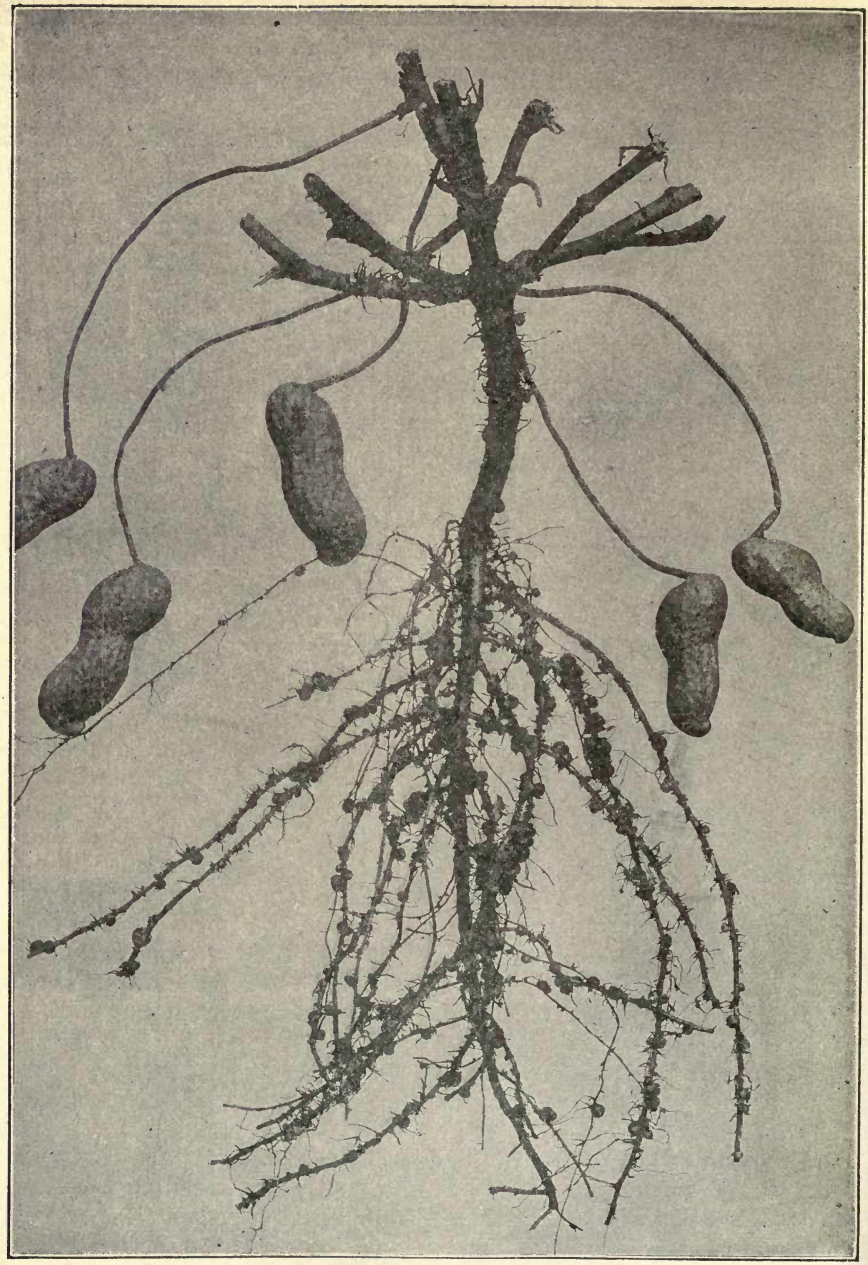
The cultural methods for crimson clover are given in the preceding chapter.

PEANUTS

During the last decade there has been a great increase in the production and use of peanuts in the United States. Their annual commercial value in the United States, according to the last census, was $18,272,000. The states leading in production are North Carolina, Virginia, Georgia and Florida, three-fourths of the marketable nuts being produced in these states. They are valued for forage as well as for a money crop, having a feeding value equal to that of clover hay. Peanut products, such as peanut butter, oil and meal, also have a market value. The peanut kernel has a high percentage of fat. After the oil has been extracted the meal is noted for its high percentage of protein. Being nitrogen gathering like other legumes, they are valued as a soil improvement crop.

In parts of the South where corn is not a successful crop, its place is being taken by the peanut, the entire plant being fed. It also enters usefully into the cropping system, on the cotton and tobacco lands of the Southern states. In parts of the South where the cotton-boll weevil is troublesome, peanuts are more advantageously cultivated than cotton.

Soil and Climatic Conditions.—A light, loamy, sandy soil is best suited to peanuts. A dark soil will produce the forage crop satisfactorily, but is apt to discolor the nuts for market purposes. Heavier soils may be used for forage purposes, but if grown for nuts, a loose soil is necessary, owing to the fact that the nuts must burrow into the soil in order to develop.



A Peanut Plant.[1]

[1] Farmers' Bulletin 431, U. S. Dept. of Agriculture.

A compact soil does not facilitate this very necessary process. The peanut is more susceptible to frost than the bean plant. It requires a long season without frost in order to develop nuts. The small Spanish peanuts require about 115 days to mature and the large varieties need a still longer period. For this reason they are most successfully grown in the frost-free regions, such as the South Atlantic and Gulf states and westward into California. When grown for forage, however, a wider range of climate is possible, peanuts being successfully grown as far north as Maryland and Delaware.

Fertilizers and Lime Required.—Soils that are adapted to peanuts will not require much commercial fertilizer, although the peanut responds readily to a moderate use of it. On river bottom lands no fertilizer will be needed, but in hillside regions applications of fertilizers and lime are advisable. Practically the same fertilizer that is suitable for potatoes is suitable for peanuts. The peanut responds well to the application of manure, but the manure should be applied to the crop preceding the peanuts. For this reason, peanuts should follow a cultivated crop if possible. This also aids materially in freeing the peanuts from weeds. Too much manure causes a heavy growth of tops to the detriment of the pods. If the forage is fed and returned to the land in the form of manure, the peanut is not an exhaustive crop, but if the entire crop is removed it soon robs the soil of fertility.

Peanuts also require an abundance of lime in the soil. Soils that show any indications of sourness should receive from 600 to 1000 pounds of lime (preferably fresh burned) to the acre. This treatment should be given at least every five years. The sorrel weed is an indication of a sour soil.

The fertilizer may be distributed in the row to be planted and thoroughly mixed with the soil. Lime should not be applied at the same time, but some time previous, either during the fall before or just after plowing.

Time, Rate, Depth and Manner of Planting.—Peanuts should be planted as soon as the ground is thoroughly warm and all danger from frost is over. This insures quick germination. The larger varieties must be planted somewhat earlier than the Spanish variety, as more time is needed to mature.

The soil is prepared much the same as that for potatoes. The peanuts are planted in furrows about three feet apart. The nuts may be dropped by hand or a one-horse peanut planter may be used. The running varieties should be planted from twelve to sixteen inches apart in the row but the bunch varieties somewhat closer, from nine to twelve inches apart. The richer the soil, the greater should be the distance between plants, in order to allow for growth.

Only one seed in a place is necessary, but in order to insure a good yield, two seeds are preferable. Two pecks of shelled peanuts are generally sufficient to plant an acre, while two bushels of the Spanish peanut in the pod are required.

Peanuts should be covered from three-quarters of an inch to two inches deep, depending upon character of soil. Light, sandy soils require a deeper

planting, while on heavy soils from three-quarters to one and one-quarter inches is sufficient.

Seed Selection and Preparation.—Selecting a good grade of seed is just as important in peanut culture as it is with corn or any other crop. Seed should be selected only from mature plants and from those producing the largest number of pods. It must be properly cured and kept thoroughly dry during the winter. It is not safe to use seed older than the preceding crop.

Seed from the large pod varieties should always be shelled before planting. Shelled seed is surer and more rapid of germination than seed in the pod, and insures a better stand. Machine-planted seed must be shelled.

The small or Spanish varieties may be planted in the pod with but little disadvantage. Some growers make a practice of soaking the pods for a few hours before planting in order to soften them and hasten germination. Soaked seed must be planted at once, however, or it becomes useless. Shelled seed should not be soaked.

Preparing the large varieties for seed entails much work, as they must be shelled by hand. The smaller varieties, however, are usually shelled by machinery, although some loss is experienced by this process.

Varieties.—Peanuts are divided into large-podded and small-podded varieties, according to their size. The Virginia bunch and the Virginia runner are the two most grown large varieties. These varieties are the most used when roasted and sold for human consumption. They have about the same weight per bushel.

The Spanish peanut is much used for forage and for shelled purposes. Its range of growth is wider than that of the Virginia variety.

Other varieties are the African, the Tennessee Red and the Valencia. They are all small varieties.

Cultivation, Harvesting and Curing.—Peanuts should be cultivated in much the same manner as beans, corn or similar crops. Cultivation should begin as soon as the crop is up and continue until the vines spread over the ground. The soil should be kept loose and free from weeds. Peanut pods have the peculiar habit of burrowing in the ground when they begin to form. For this reason the dirt should be worked towards the vines in the last cultivation and the vines should not be disturbed after the process of burrowing begins.

The same implements may be used as for cultivating corn and beans. A one-horse weeder is the general form of cultivator used.

Harvesting should occur just before frost, as frost will injure the forage as well as the peanuts. Peanuts may be plowed from the ground with a common turning plow, but the use of a potato-digging machine is a much better method. The initial expense of such a machine is about $75, but it lasts many years and does the work much more efficiently than it can be done otherwise. If dug by plow the soil must be shaken from the roots by hand, whereas the machine shakes off the soil as it digs.

A few hours after harvesting the peanuts should be stacked about a pole. These poles should be driven firmly into the ground and pieces nailed at right angles to them just above the ground in order to keep the vines from the ground as much as possible. The stacks should be small and conical and stacked as loosely as possible so that air will pass through. It is not advisable to store peanuts in the barn until thoroughly cured. Then the forage part may be stored after the nuts are picked.

The nuts should not be picked from the vines until they are thoroughly dry and solid, else they will shrivel and become unfit for market purposes.

HARVESTING AND CURING PEANUTS.[1]

On the other hand, picking should not be delayed too late in the season on account of ravages from crows and mice.

Hand-picked peanuts command the highest price, but owing to the dusty, irksome labor involved, picking machines are coming into general favor. There are two kinds on the market: one is a cylinder type used mostly for Spanish peanuts; the other machine drags the vines over a horizontal wire mesh, thus removing the nuts without breaking them.

Peanuts must be kept continually dry or they become discolored. After picking they are usually covered with dust and kept in a dry, well-ventilated place until stored in bags ready for market.

[1] Courtesy of U. S. Dept. of Agriculture, Farmers' Bulletin 431.

Preparing for Market.—Threshed peanuts contain much trash, necessitating a thorough cleaning before marketing. This can be done on a small scale by the grower, but if large quantities are involved, the process is more economically done in a cleaning factory, which is equipped with all necessary fanning and grading machinery.

Yields.—An average yield of peanuts is about thirty-four bushels an acre, although it is quite possible on fertile soil and by expert methods to increase this to sixty bushels an acre, with from one to two tons of forage. Peanut forage is worth from $8 to $10 per ton. Sixty bushels of nuts are worth from $40 to $60, according to quality. Estimating upon this basis, allowing an expenditure of from $12 to $25 per acre to grow the crop, the grower would realize a profit of from $36 to $45 per acre. This is a conservative estimate and, all conditions being favorable, might be much larger.

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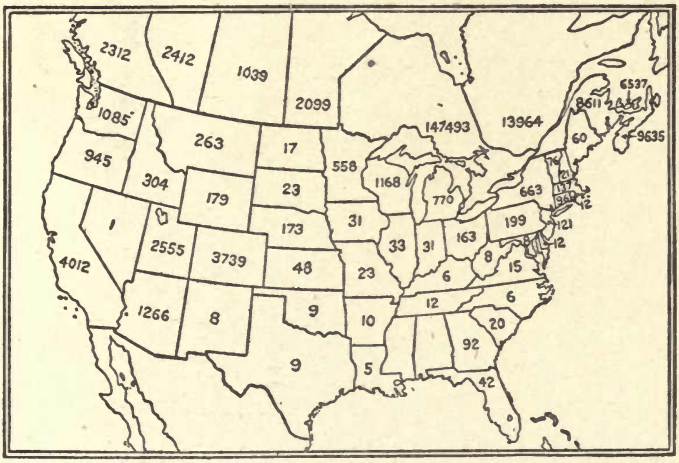
CHAPTER 13

ROOTS AND TUBERS FOR FORAGE

In the United States roots and tubers are grown principally as vegetables or for sugar production, but in Canada they are quite extensively grown for forage purposes. In such root crops as the beet, turnip, parsnip and carrot, the edible part is really an enlargement of the upper portion of the root and the lower portion of the stem merged together. Roots, such as cassava and chufa, are enlargements of the roots.

According to the last census Canada produced nearly 200,000 acres of root crops, while those grown in the United States for forage purposes



ROOT CROPS, 1909-1910. FIGURES=ACRES.[1]

aggregated only about 15,000 acres. Mangels, rutabagas, turnips, beets, carrots and cabbage are best adapted to cool, moist climates. Of these the rutabaga and turnip may be successfully grown further south than the others. The accompanying map gives the acreage of root crops in the United States and Canada by states and provinces according to the latest census figures.

Relation to Other Crops.—The economy in growing root crops for forage purposes depends chiefly on whether or not other succulent crops suited to feeding livestock can be more cheaply produced. It also depends on the relative yields of the different crops.

[1] Courtesy of The Macmillan Company, N. Y. From "Forage Plants and their Culture," by Piper.

The longer the winter period, the greater the need for succulent food for livestock during the stabling period. For this reason there is more need of such foods in the northern part of the United States and in Canada than farther south where the season for plant growth is longer. Many of the root crops are adapted to a short growing season where corn cannot be successfully grown.

Numerous experiments on the relative cost of producing corn and roots show that corn is the cheaper source of feed wherever it can be successfully

A Load of Mangels, Note Size and Character of Roots.[1]

grown. The root crops require more labor than corn in culture, harvesting and feeding. Less of the work can be done by labor-saving machinery. It is for this reason chiefly that they are the more expensive source of succulent food. Roots have the advantage in that they may be grown in small quantities for small numbers of livestock when it would not be practicable to have a silo. They also fit well into crop rotations and the tillage required by them leaves the soil in excellent condition for crops that follow.

Utilization and Feeding Value.—The root crops are best utilized for dairy cattle, especially during the winter period. The various roots differ considerably in their percentage of dry matter and feeding value. Sugar

[1] Courtesy of Webb Publishing Company, St. Paul, Minn. From "Field Crops," by Wilson and Warburton.

beets rank first, as they have about 20 per cent of dry matter, three-quarters of which is sugar. Mangels, rutabagas and turnips frequently have no more than 10 to 12 per cent of dry matter, not more than one-half of which is sugar.

Some of the flat-topped turnips that grow principally on the surface of the ground may be grown for pasturage and are readily eaten by sheep.

The dry matter in roots is slightly lower in feeding value, pound for pound, than that in cereals. It is about equal in digestibility to the dry matter in cereals.

The yield of some of the more important root crops, as grown at a number of experiment stations, is as follows: mangels, average yield in tons per acre during five years in five localities, 31; rutabagas, same localities and same number of years, 26.5 tons per acre; carrots, same localities and same number of years, 23.6 tons per acre; sugar beets, same localities, average five years in two of them and three years in other three, 20.6 tons per acre; turnips, three localities average of five years, 21.3 tons per acre.

Sugar-Beets.—While sugar-beets have a high feeding value they are not extensively grown as forage because the yield is generally much less than can be secured from mangels and rutabagas. The by-products of the sugar factories in the form of beet pulp are quite extensively used as roughage for livestock. Beet pulp is a food that can be easily stored and kept, and instead of losing its value it really improves with age. The pulp may be simply thrown on the ground and preserved for three or four years without deterioration except in the outer part. For cultural methods of beets see the article on "Sugar Crops."

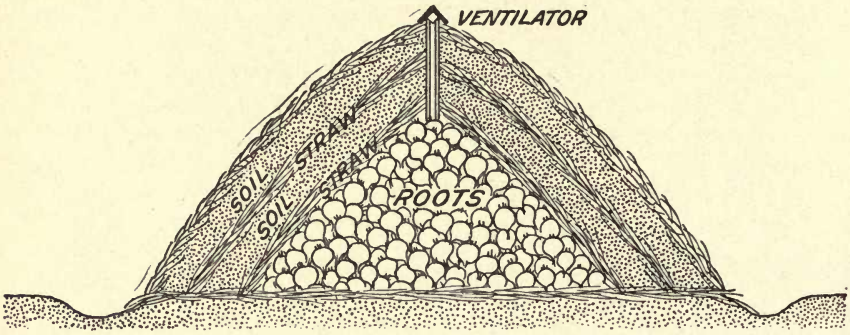
Mangels.—Mangels differ quite materially from sugar-beets in form, color and size. Sugar-beets grow mostly in the ground, are tapering in form, and both the skin and flesh are white. Mangels average four times as large, are more cylindrical in form, and a considerable portion of the root grows above ground. The flesh of the mangel is usually reddish or yellow, while the skin may be white, red, golden, purplish or even black. Mangels are planted in rows twenty-eight to thirty-six inches apart. The rate of seeding ranges from six to eight pounds of seed per acre. The seed should be covered about one inch deep and as soon as the plants are well established they should be thinned by use of a hoe to little groups of plants at intervals of twelve inches. These should be thinned later by hand to one plant to each place. They should be cultivated to destroy weeds and maintain a good soil mulch. They are generally harvested by plowing a furrow on one side of the row, and are pulled by hand. On account of their large size they require much cutting before being fed. They may be stored in root cellars or in pits, and call for a low, uniform temperature and fair ventilation during the storage period.

Turnips and Rutabagas.—There are a great variety of turnips. Rutabagas or Swedes are but a few of the large growing varieties that are espe-

cially adapted for forage purposes because of the large yields they give. From two to three pounds of turnip seed and four to five pounds of rutabaga seed per acre are required. The seed may be either drilled or broadcasted, although in case of rutabages drilling is decidedly preferable. The preparation of the ground, planting and method of tillage is very similar to that given mangels. As turnips make their growth in two or three months, they may be seeded late in the summer and yet mature before frost. Rutabagas require more time for maturity and should be sown in May or June.

Turnips do not keep well and should be fed in the fall and early winter. Rutabagas, on the other hand, keep through the winter without difficulty. The methods of storage are similar to those for rutabages.

Carrots.—This crop is less extensively used for forage purposes, chiefly because it yields less abundantly than rutabagas and mangels. It makes



Cross Section of an Easily Constructed Pit for Roots.[1]

an excellent quality of feed and calls for about the same soil conditions and cultural methods as the other root crops. The roots are much smaller and consequently there should be more of them in a given area. From four to six pounds of seed per acre are required. It should be drilled in rows, and the plants should ultimately stand two or three inches apart in the row.

Parsnip.—This crop requires a rich, fertile soil, and demands the same cultural methods as the carrot. The roots of the parsnip may be dug late in the fall and stored or allowed to remain where grown and dug as required for use. Whether they are allowed to remain in the field will be determined largely by winter conditions and the possibilities of digging them in the winter time. When used as human food, the freezing of the roots improves their flavor.

Cabbage.—While this crop is grown chiefly for human consumption, in some sections of the country it is extensively grown for forage purposes. The usual method of storing cabbage is to dig a trench about eighteen inches

[1] From Farmers' Bulletin 465, U. S. Dept. of Agriculture.

deep and three feet wide in which the cabbage is set with the heads close together and the roots bedded in soil. As cold weather approaches they are covered with straw and a few inches of earth. Slight freezing does not injure them, but they should not be subjected to alternate freezing and thawing. They should be well ventilated while in storage. Cabbage makes a good roughage for dairy cows and young stock.

Kale.—Thousand-Headed kale is the variety best adapted for forage purposes because of its large, rank growth and heavy yield. It somewhat resembles cabbage and makes a succulent forage which can be fed from October until April in regions where the winter is mild. It is best fed fresh or allowed to wilt, but should not be cut more than four or five days before feeding; neither should it be fed while frozen.

The methods of growing are similar to those for cabbage, the plants being grown in a seed-bed and transplanted in the field early in the spring.

Cabbage and any of the root crops that tend to give a peculiar taste to milk should always be fed soon after the milking period and never for several hours just prior to it. This precaution in feeding is said to obviate the disagreeable flavor which is frequently imparted to the milk.

Artichokes.—This crop, of which there are several varieties, belongs to the sunflower family, and both the tops and tubers are relished by livestock. They are cultivated much after the manner of potatoes, although planted somewhat farther apart. Yields of 200 to 500 bushels of tubers per acre have been reported.

Artichokes are valuable as forage, chiefly for hogs, which may be turned into the fields and allowed to harvest the crop themselves. The tubers keep in the ground all winter and usually enough of them are left by the hogs to produce a new crop for next year.

Cassava.—This plant is a native of the tropics and is adapted to Florida and the Gulf Coast portion of the states bordering on the Gulf of Mexico. It is a large growing, bushy plant attaining a height of four to ten feet and produces horizontal, fleshy roots or tubers three to five feet long and from one to two and one-half inches in diameter. While it will grow on quite a variety of soils, it can be economically produced only on loose, sandy soils which will enable the easy harvesting of the roots. On fertile soils and with good cultural methods, yields of five to ten tons per acre of roots are reported. The roots are very high in starch and sugar content and make an excellent food for all kinds of livestock. The crop is quite extensively used in the manufacture of starch.

Cassava is propagated by means of portions of the roots or stems which are stored in the dry during the winter. The roots or seed canes are cut into pieces of the desired length and planted in the spring after danger of frost is past. They are usually planted four feet apart each way and covered with a few inches of moist earth.

Chufa.—This is a sedge-like plant with creeping root stocks which produce great numbers of edible tubers. These are small, sweet and

frequently used as human food or pasture for hogs. The yield varies greatly ranging from 50 to 300 bushels of tubers per acre. The plant is propagated by planting the tubers in the spring in rows sufficiently far apart to permit cultivation. The rate of planting is about the same as for potatoes.

Taro.—Thi plant, commonly grown for its edible roots in the tropics, is more familiar to persons in the United States as seen in the large-leaved, ornamental plant sometimes called "elephant's ear." The tubers are similar to potatoes in composition. It requires a long season for its growth and is adapted only to Florida and the lower portions of the Gulf states. The bulbs are from six to twelve inches long and three to four inches in diameter. It is grown chiefly for human food, but in semi-tropical districts may be used as a forage for livestock.

Youtia.—This plant closely resembles the taro and is similar in its requirements and uses. The yield of tubers under favorable conditions may be ten to fifteen tons per acre. They are harvested by pulling, supplemented by the use of the hoe. No doubt machinery such as is used for the harvesting of sugar-beets could be utilized for the harvesting of this crop and the one preceding.

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CHAPTER 14

THE POTATO

BY ALVA AGEE
Director, Agricultural Extension, Rutgers College, N. J.

The potato is one of the world's most important products for human food. The United States have been producing between 350,000,000 and 400,000,000 bushels, and Canada between 70,000,000 and 85,000,000 bushels annually. Adaptability to this crop gives high value to land near good markets, and good transportation facilities have made the crop profitable

THE POTATO CROP.[1]

in sections of the country that must ship their products long distances. The Southern states, growing their crop in the cool months of the spring, supply Northern markets during the summer, and in the fall scores of millions of bushels are sent southward from the Northern states. The crop is important not only for the reason that it produces a large amount of human food per acre, but on account of the reward it offers to the grower's skill. The limit to production per acre is unknown, but it is a conservative statement that the present average yield in this country could be doubled.

[1] From Farmers' Bulletin 365, U. S. Dept. of Agriculture.

The Soil.—The potato is a tuber developing below the surface of the ground and displacing soil particles as it grows. Therefore, a mellow soil is essential. The best potato lands are naturally loose, but somewhat heavy soils have been brought into profitable production by the free use of organic matter from sods and cover crops. A good potato soil is retentive of moisture, and rotted organic matter in it serves as the best insurance against drought. Some light, sandy soils of the seaboard states are put into productive condition by means of cover crops and manure which give them body and excellent physical condition. Soils naturally too compact for the potato may be made loose, friable and retentive of moisture by the same means.

Crop Rotation.—The history of potato production in other countries as well as our own teaches clearly that this crop should be grown in rotation with others and that when the crop rotation is shorter than four years there is great danger of ultimate failure. The practice of growing potatoes year after year on the same land, using a winter cover crop, or of using a rotation of two years only, may prevail for a number of years in a region peculiarly adapted to the crop, but it is only a matter of time until yields will be badly cut by disease and lack of vegetable matter in the soil. One excellent crop rotation is clover, corn, potatoes and grain, followed by clover. The manure is put on the field for corn, and both it and the sod are thoroughly rotted for the potato the following year. Another rotation of some reputation is clover, potatoes and wheat. The clover sod rots more readily than a grass sod and feeds the potato and at the same time keeps the soil mellow. A fresh-turned grass sod does not favor this crop. When it is necessary to follow grass with potatoes the sod should be broken in the fall, and if there is danger of undue leaching, a winter cover crop of rye or wheat should be grown.

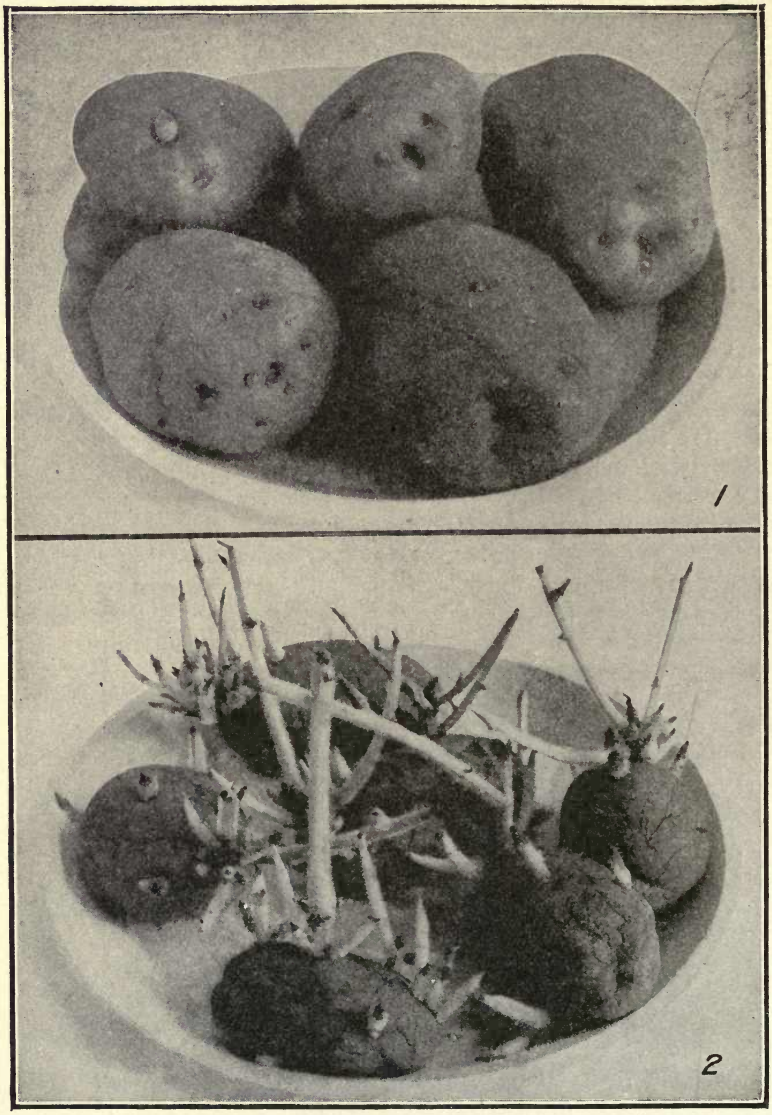
Soil Preparation.—A deep soil holds moisture better than a shallow one, and our more productive potato lands have been made and are kept deep by proper plowing. A shallow soil should be deepened gradually, and the best part of the sod never should be thrown into the bottom of the furrow. A breaking-plow having a short, straight mold-board is to be preferred for all land that is at all deficient in humus, as it is essential that some organic matter be in the surface soil. The time of plowing is a local question. Wherever leaching is not to be feared and early planting is practiced, fall plowing is advised. When land is broken in the fall or very early in the spring, it is less subject to summer drought than late-plowed ground. We should bear in mind all the time that a supply of moisture is a big consideration and in the preparation of the ground that should be kept chiefly in view. The use of a heavily weighted, sharp, disk harrow on sod land before it is broken does much to hasten decay after the plowing and to insure prime physical condition. It is easy to do harm by tramping plowed land with horses in the spring, and disking before plowing reduces the amount of required preparation after the plowing.

The Seed.—The potato thrives in a relatively cold climate and loses vigor when grown during midsummer in warm latitudes. The best seed is obtained from our northernmost states, grown in midsummer, or from more southern states when grown in the cool months of autumn. As a rule, the northern seed is preferred, partly because it is in abundant supply.

Successful growers prefer potatoes of marketable size for planting. The tubers are enlarged underground stems, and their vitality may be measured by that of the vines which produce them. A small potato, known as a second, may have been set late by a vine of strong vitality which produced also a big crop of merchantable tubers. In that case the small potato makes fairly good seed, and would be just as desirable as a section of a large potato if it did not put out any more sprouts than the cut portion of a large tuber. On the other hand, many seconds are small because the vines producing them lacked in vitality. Experience has taught that growers depending upon seconds soon have a large percentage of plants that lack full productive power. Potato yields in the warmer latitudes of the Northern states are kept low by the use of home-grown seed which necessarily has had vitality impaired.

The amount of seed per acre depends somewhat upon variety, but relatively heavy seeding is profitable. The grower wants sufficient foliage to cover and shade the soil thoroughly, and ordinarily, that requires the use of thirteen or fourteen bushels of seed per acre. The seed piece should be a block of potato sufficiently large to average two eyes to the piece. The size of the seed piece is important in insuring a good stand, and the cutting should be related more to size of the piece than to number of eyes. In some instances there will be only one bud which may produce two or three good stalks, and in other cases a seed piece of right size may have three eyes. Close cutting and any skimping of the amount of seed result in loss under ordinary conditions, however successful they may be in a very fine and fertile soil having the right amount of moisture immediately after planting.

Fertilization.—Large areas of sandy loams are planted with potatoes because they have right physical condition and partly because they mature a crop early in the season. Sandy soils are badly deficient in potash, and it has come about that most growers think of the potato as a plant requiring unusually heavy applications of potash. Manufacturers of fertilizers have fostered this idea, but the results of careful experiments have shown within recent years that phosphoric acid should be the controlling element in the potato fertilizer, just as it is in the fertilizer for corn and most other staple crops. In normal soils of great natural strength no commercial fertilizer may be used, but when need first develops, phosphoric acid is the requirement. This occurs even where clover and stable manure are freely used. Commercial growers, as a rule, make no use of stable manure direct to potatoes, as it furnishes ideal conditions for the development of disease, and especially of the scab. In the case of naturally fertile land the manure applied for corn and the legumes in the rotation may furnish the most of



THE CONDITION OF SEED POTATOES DEPENDS ON CHARACTER OF STORAGE.

1—Stored in cool place. 2—Stored in warm place, tubers shrunken and vitality impaired.

the needed nitrogen, and the decay of the vegetable matter may free all of the potash required, but we now have relatively small areas in which phosphorus does not add materially to crop yields. As potato production continues, a need of nitrogen develops, and as has been said, potash is a requirement for most sandy soils. A lack of fertility may be met by use of a fertilizer containing 3 per cent of nitrogen, 10 per cent of phosphoric acid and 5 or 6 per cent potash excepting, naturally, areas where the percentage of nitrogen must be increased. The amount of fertilizer used per acre varies greatly. Some growers in the seaboard states apply one ton of a high-grade complete fertilizer per acre, and many growers on naturally

A Potato Planter.[1]

fertile soil in the Central states use none at all. It is a common practice to apply all of the fertilizer in the row, and when the amount is in excess of 1000 pounds per acre, there is danger of injury to the plants as they start growth

Lime is not applied to land immediately before potatoes are planted, as it favors the development of potato scab. Acid soils are more free from this disease than alkaline ones, but clover demands lime and is needed in a rotation with potatoes. The best practice is to use finely pulverized limestone rather than burned lime and to make the application immediately after the potato crop in the rotation.

The Planting.—As the potato thrives best in cold latitudes the planting should be made as early as possible in the spring in the Southern states and

[1] From Farmers' Bulletin 365, U. S. Dept. of Agriculture.

the southern tier of the Northern states. The only exception is in the case of midsummer planting with the aim of securing a crop in the fall. Farther north the planting may be later in the spring, although the tendency in recent years has been away from June planting.

The depth of planting depends upon the character of the soil and the variety. Where an early crop is wanted, the planting is shallow, but for a main crop in loose soils the depth should be at least three inches below the dead level of the surface.

A planter does more satisfactory work than can be done by hand, dropping the seed in a more direct line. The width between rows may vary from thirty to thirty-five inches and the distance between the seed pieces in the row should be sufficient to require about fourteen bushels of seed per acre. This is a surer rule than any fixed number of inches, as much depends upon the cutting.

Cultivation.—A soil that is sufficiently retentive of moisture for the potato usually inclines to become more compact than is desired. The preparation of the soil and the planting compacts some of the ground beneath the surface. A few days after the planting is finished it is good practice to give a very deep and close cultivation, the shovels being guided by the furrows made in covering. Later the weeder or harrow should be used to level the ground and kill all weeds so that the potato plants will come up in a fresh, clean soil. Close and deep tillage should be given when all the plants are above ground, and later the cultivation should be more shallow so that the roots of the plants will not be unduly disturbed. Level culture enables the grower to keep the maximum amount of moisture in the soil, but dependence upon mechanical diggers has led practical growers to ridge the rows and, when the growing is on a large scale, this is the only practical method of controlling grass and weeds. Cultivation should continue until the vines fill the middles, and the last cultivation should be given by a light one-horse cultivator that will slip under fallen vines. The early cultivation should keep the soil loose and later cultivation should keep the surface well mulched with loose earth and should prevent any growth of weeds.

Diseases.—The number of virulent potato diseases is increasing in this country, and the grower should study the latest bulletins from his state experiment station. He will be informed regarding the formalin treatment for the seed before planting, that gives control of some diseases. All potato seed should be given this treatment, which consists of soaking the seed for two hours in a solution of formaldehyde made by diluting one pint of 40 per cent formaldehyde in 30 gallons of water. This should be done before the seed is cut and under no circumstances should scabby seed be planted without this treatment.

Close examination of the seed pieces when cutting is an aid. Mechanical cutters are not advised and partly for this reason. All tubers showing discoloration of any sort should be rejected.

Spraying with Bordeaux mixture increases the yield of potatoes through stimulation, and is profitable, except in case of very highly fertilized soil, even when no blight prevails. The early blight which is prevalent in the southern tier of our Northern states is not well controlled by spraying, but in cooler latitudes where the late blight prevails spraying should never be omitted. Directions for making the Bordeaux mixture and applying it are furnished by the experiment stations. The only point to be emphasized here is that the spraying should be thoroughly done, insuring a perfect coating of the plants, and that is possible only by use of strong pressure and two nozzles to the row when the plants have reached some size.

Insect Pests.—For white grubs and wire-worms, which may render a potato crop unmarketable, there is no remedy. There is no soil treatment that will kill these pests. The grower should know the life history of these insects and plan his rotation as far as possible for their control. Examination will show whether a soil is infested or not at planting time, and potatoes should not be planted where serious injury is sure to come.

The potato beetle is easily controlled by use of arsenical poisons and these should be on the plants when the larvæ of the potato beetle are hatching. Two pounds of Paris green or four pounds of arsenate of lead in fifty gallons of Bordeaux will prevent injury by this insect.

The flea-beetle does great injury not only by impairing the vitality of the plant, but by opening the way for disease attacks. Control is very difficult. The Bordeaux mixture repels for twenty-four to forty-eight hours and to that extent is a help.

Harvesting the Crop.—An early crop of potatoes when dug for market in hot weather must have careful handling. All cut and bruised tubers should be discarded. If there is reason for not marketing promptly, the crop is safer in the ground than out of it, although excessive wet weather may cause rot. Later varieties, dug usually in the fall when nights are cool, will bear placing in large bulk.

The best diggers elevate the soil of the row with the tubers and, having sifted the soil back, drop the tubers on top of the fresh surface. Such diggers are relatively expensive and small growers use low-priced diggers that do fairly good work. When good seed is planted in highly fertilized soil the percentage of seconds may be so small that little grading is required, but it never pays to send to market any tubers below merchantable grade.

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CHAPTER 15

Sugar Crops (Cane, Beet and Maple Sugar, and Sorghum)

By W. H. Darst
Assistant Professor of Agronomy, The Pennsylvania State College

The world's sugar supply is manufactured from two plants, namely, the sugar-beet (*Beta vulgaris*) and the sugar-cane (*Saccharum officinarum*). The amount of sugar secured from the maple tree is insignificant.

SUGAR-BEETS

The development of the sugar-beet industry dates back to March 18, 1811, when the French Emperor dictated a note to his Minister of the Interior, instructing him to see that 90,000 acres of beets were planted. He then appropriated 1,000,000 francs with which to establish schools of instruction, and to be given in bonuses to those who erected factories. Even though sugar-beet was an unknown crop, the farmers were compelled to grow them. At the end of two years France was producing 7,700,000 pounds of sugar. By 1836 the production of sugar in France amounted to 40,000 tons. At this time Germany observed that sugar-beets in France had revolutionized French agriculture. By growing beets in the rotation the yield of all the cereals was increased to an even greater extent than where turnips were grown, as in England. Up to this time Germany had not been able to induce her farmers to grow beets of their own accord. Germany then adopted the French plan of governmental aid to establish the industry. Other European countries soon followed the same plan, with the result that today one-half of the world's supply of sugar is derived from European sugar-beets.

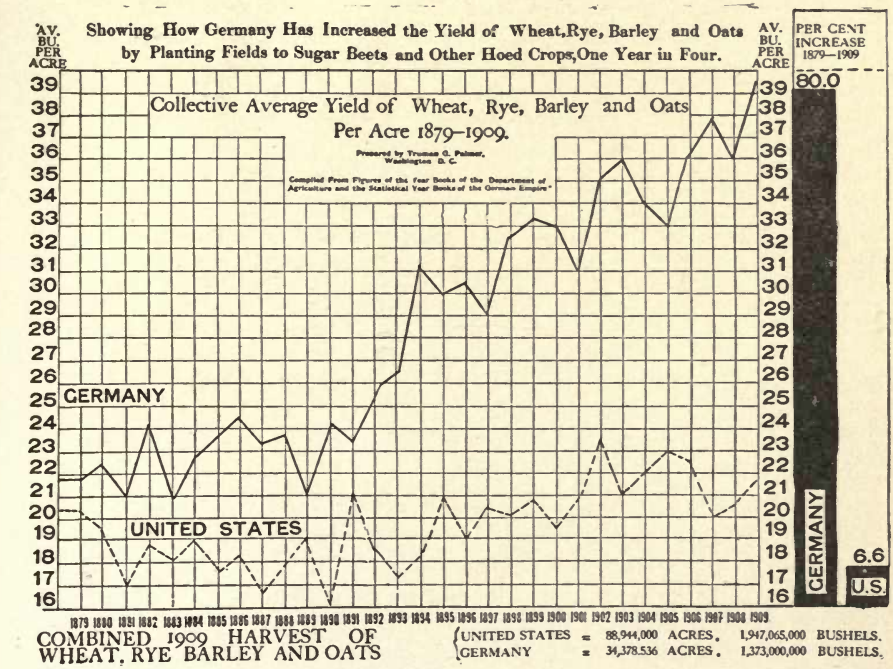
The following table gives the total world's production of beet and cane sugar compared:

World's Production.	Short Tons.		
	1911–12.	1912–13.	1913–14.
Cane sugar	10,253,000	10,699,000	11,118,000
Beet sugar	7,072,000	8,365,000	9,765,000
Total production	17,325,000	19,064,000	20,883,000

The countries leading in the production of both beet and cane sugar in 1914 were as follows:

Beet Sugar.		Cane Sugar.	
Country.	Short Tons.	Country.	Short Tons.
Germany	2,886,000	Cuba	2,909,000
Russia	2,031,000	British India	2,534,000
Austria-Hungary	1,858,000	Java	1,591,000
France	861,000	Hawaii	612,000
United States	733,000	Porto Rico	364,000
Italy	337,000	United States (Louisiana and Texas)	300,000

The development of the sugar-beet industry in the United States is of comparatively recent date. It was not until 1906 that the production of



AGRICULTURAL PROGRESS IN THE UNITED STATES AND GERMANY.

sugar from beets exceeded that from sugar-cane. At present the production of beet sugar has more than doubled that of cane sugar in the United States. (See above table.)

The leading states in the production of beet sugar, in the order of their production, are: Colorado, California, Michigan, Utah, Idaho and Ohio.

In the past and even at present, many farmers think beet culture injures the soil. This, with the high cost of extracting the sugar from the beet, has made progress in beet culture in this country very slow.

Results obtained in Germany and other European countries, when beets are introduced into the rotation, suggest that the farmers of the United States, having the proper conditions for production, would do well to introduce them into their rotations. European farmers do not find the beet crop in itself highly profitable, but the extra cultivation and fertilization necessary to grow them, has greatly increased the yields of all other crops, in the rotation, especially the cereals.

Sugar-Beet.[1]

For the most part the profit is made indirectly from the beet crop. The preceding chart from the loose-leaf service of the United States Sugar Manufacturers' Association compares the average yields of cereals in Germany, a beet-raising country, with those of the same crops in the United States, where very few beets or roots are grown.

Adaptation.—The soil and climatic conditions are very important factors in growing beets with high sugar content. They are not as widely adapted as other farm crops commonly grown in this country. Plenty of moisture and sunshine, particularly during early growth, are essential to the production of beets with high sugar content. Ideal conditions are found most commonly in the irrigated districts of the Rocky Mountains and the Pacific Coast, although many Northern states have favorable conditions for sugar-beet growing.

Sugar-beets require deep, well-drained soils. They do best on rich loam or sandy loam and are not adapted to clays, muck or peaty soils.

Preparation of Land.—The root of the sugar-beet grows entirely or mostly underground, the smaller roots often reaching a depth of four to six feet. For this reason, a deep soil and a deeply prepared seed-bed are necessary. Beet ground should be plowed eight to twelve inches deep, and where possible a subsoiler may be used with good results. Fall plowing is advised where conditions will permit. It is very important that the seed-bed be well prepared. The land should be worked often enough to secure a fine, firm, moist seed-bed. It is necessary to obtain a soil free from weeds or weed-seeds. Beets grow slowly at first, and if weeds are allowed to start, considerable hand labor will be required to eradicate them. Beets should never be grown in continuous culture. The rotation will depend on the

[1] Courtesy of California Agricultural College.

crops common to the region where grown. A three, four or five-year rotation, including a legume crop, should be used when growing beets.

Fertilization.—Barnyard manure and high-grade fertilizer are used with profit on beets. The manure should be well rotted when applied, so as to lessen the chances of weed-seed. High-grade fertilizers, selected to meet the needs of the soil, should be used.

In European countries beets are fertilized very heavily. This produces a large tonnage of beets and the residual effect of the fertilizer is taken up by the crops that follow.

Seeding and Cultivation.—The beet plant produces seed in balls or capsules containing one to five seeds. It is impossible, therefore, to regulate the rate of seeding so as to get a satisfactory distribution of plants in the row. The seed is drilled rather thickly, and when the plants are large enough, they are thinned to the required distance in the row. The seed is ordinarily sown with a beet drill, which sows several rows at a time. The distance between rows varies from twenty to twenty-eight inches. To insure a full stand of plants, about twenty pounds of seed are sown to the acre. In irrigated sections, beets are often sown in double rows one foot apart and twenty-four to twenty-eight inches between each pair of rows. Beet-seed should be sown early in May or after the ground warms up. Cultivation should begin as soon as the rows can be followed and continued at intervals of six to ten days, until the tops nearly meet between the rows. A special beet cultivator is used that will cultivate several rows at a time.

The thinning of the plants should be done about the time the fifth leaf is formed. Thinning is done by first blocking or bunching with a hoe. This consists of cutting out the plants in the row, leaving small bunches eight to ten inches apart. After blocking, further thinning is necessary, leaving but one plant in each bunch. The blocking and thinning, hoeing, pulling and topping of the beets are done by hand labor. On the larger beet farms this work is generally done by foreigners under contract.

Harvesting.—Beets should be harvested before danger of frost in the fall; if not worked up immediately, the roots should be protected from freezing. Harvesting consists of lifting, pulling, topping, piling and hauling away the roots. Lifting is done by a special implement that loosens the roots in the soil. The pulling, topping and piling are done by hand. In topping, the leaves are sometimes simply twisted off. A much better method of topping, from the standpoint of the manufacturer, is to remove the tops with a sharp knife at the lowest leaf scar on the root. The part of the beet that grows above ground is not desirable. The sugar content of this part is low, and there is a high percentage of minerals that may crystallize the sugar at the wrong time in the process of manufacture.

Seed Production.—The sugar-beet is a biennial, producing seed the second year. Almost all of the seed used in this country is imported. When grown for seed, only beets with high sugar content should be saved. This selection is based on the percentage of sugar as determined in a small sample

taken out of the side of the root with a trier. The hole made by the trier is filled with charcoal or clay to prevent rotting. The selected beets are stored over winter in sand, in a dry cellar or pit. The next spring these roots are planted in rows to produce seed. From three to five plants will produce a pound of seed.

Manufacture of Beet Sugar.—At the factory the beets are washed in sluiceways, then sliced into long strips called "cosettes" The juice is

A Good Stand and Vigorous Growth of Sugar-Beets.[1]

removed by applying hot water to the sliced beets, leaving a product known as beet pulp. This juice is purified by adding small quantities of lime. The lime combines with the foreign matter and is filtered out. The purified juice is then placed in vacuum pans and boiled until the sugar crystallizes. The sugar is removed by placing the product in a large centrifugal machine, lined with fine sieves. The whirling motion drives off the molasses through the sieves, and the sugar is retained. The sugar is then dried and is ready

[1] U. S. Dept. of Agriculture, P. I. Bulletin 238.

for market. The molasses, to which is added a little fresh juice, is again boiled in vacuum pans until the remaining sugar crystallizes. The sugar is separated out as before, the product being known as second sugar. The molasses, after the second boiling, is sold as stock feed.

By-Products of Beet Farming.—Beet tops left on the field after harvesting may be cured as forage to be fed to livestock. If not fed, they should be spread evenly over the ground and plowed under as a fertilizer.

Beet pulp, a by-product of the sugar factory, is an excellent substitute for corn silage. Wet beet pulp contains about 90 per cent of water and 10 per cent of solids, which compares favorably with mangels as a feed. Many factories dry the pulp. Dried pulp makes a better feed, in that it remains in better condition for a longer time and is worth about eight times as much as the wet pulp.

Beet molasses, another by-product, is not palatable when fed alone; but when mixed with dried pulp, chopped hay or straw, has considerable feeding value.

CANE SUGAR

Sugar-cane has been cultivated for many centuries in the tropical and semi-tropical portions of the world. According to the best authorities, sugar-cane appears to have originated in India. From there it was taken to China and other parts of the Old World, where it has been extensively cultivated from time immemorial. After the discovery of the New World sugar-cane was introduced first in San Domingo, then into Mexico, Martinique, Guadaloupe, Cuba, the Guianas and the warmer states of South America.

The State of Louisiana produces almost all of the cane sugar produced in the United States. Texas and Florida produce some. Sugar-cane was first introduced into Louisiana in 1751, but sugar was not manufactured from it until about 1792.

Description and Mode of Reproduction.—Sugar-cane is a perennial grass, growing from eight to fifteen feet tall. The stalks are thick and heavy, being filled with a sweet, juicy pith. The flowers are borne in silky-like panicles. Seed is never formed in this country, and is not abundantly produced in Egypt or India. Cane in its wild and native state reproduces vegetatively more often than by seeds.

The stalk of cane is divided into joints or nodes and internodes. At each joint is a bud which under proper conditions develops into a stalk. Around each bud, on the stalk, are semi-transparent dots which develop into roots that feed the bud when planted.

Soils.—Sugar-cane requires a large quantity of water during the growing season; consequently, it grows best on soils well supplied with humus and having a high water-holding capacity. Well-drained alluvial bottoms and muck soils are very good soils for sugar-cane. The more fertile clay uplands produce cane higher in sugar, but do not supply the required amount of water for large yields.

Sugar-cane is adapted to tropical or semi-tropical latitudes, the two predominating essentials to growth being warmth and moisture. A mean annual temperature of 70° F. and a minimum annual rainfall of about 60 inches are essential to the successful growth of sugar-cane. One of the difficulties in growing sugar-cane is in the control of water. In Louisiana as much as five to seven inches of water may fall during one rain. The problem, then, is to get rid of the excess water before it damages the crop. Good tile drainage is necessary on most of these sugar plantations. If for any reasons, tile drainage is not possible, it is then necessary to depend on surface drainage.

There are times when irrigation is necessary. The ideal sugar-cane plantation should be equipped with underdrainage as well as irrigation ditches. In Louisiana, scarcely a year passes that irrigation water cannot be used at some time. Irrigation may be used to help prepare the seed-bed, as well as to supply water when needed for the growing crop.

Varieties of Cane.—Many varieties of cultivated cane are grown in this country. These have been and are being introduced from various parts of the world. The Louisiana Agricultural Experiment Station has arranged the varieties into groups and then under classes as follows:

Class one—white, green and yellow canes.
Class two—striped canes.
Class three—solid colors other than class one.

In the Louisiana Bulletin No. 129, the variety known as D.74, a light-colored cane, is recommended very highly. It is very high in sugar and outyields by 20 per cent the green or ribbon canes.

Rotation and Preparation of the Land.—It is not desirable to grow sugar-cane continuously. A common rotation is two years cane and one of corn and cowpeas. The cowpeas are sown in the corn to be plowed down for the benefit of the cane crop which follows. The plowing is generally done in the fall of the year. The land must be plowed very deep, the deeper the better, up to twenty to twenty-four inches. Traction plows are quite generally used, as the work is too heavy for horses. On small plantations, heavy mules and disk plows are used to break the soil.

After the land is plowed it is bedded with a two-horse mold-board plow. This gives surface drainage between each two rows of cane. When ready to plant, the rows are opened with a double mold-board plow. Two or more running stalks are deposited in this furrow and covered by a disk cultivator.

It has been demonstrated in Louisiana that fall planting gives best results when winter freezing is not too severe and when the seed-bed is properly prepared and drained. Planting may take place any time from the middle of September to the first of April.

Fertilizers.—Cane is a rank-growing plant and demands the liberal use of fertilizers. Since most of the potash and phosphoric acid removed

by the crop is returned in the ash and the waste from sugar factories, as explained later, nitrogen is the only element of fertility that need be purchased in large quantities. The humus of the soil must be kept up by the application of barnyard manure and by plowing down legumes. When nitrogen is used as a fertilizer it should be applied in the organic form. The nitrogen in cottonseed meal becomes available more slowly than in nitrate of soda, hence this carrier is better adapted to the long-growing season required for sugar-cane.

Cultivation.—Sugar-cane is cultivated frequently to keep down weeds and to insure rapid growth by conserving the moisture. Considerable hand hoeing is necessary as the cane rows can be cultivated only one way. The disk is a favorable type of cultivator; however, the tooth or shovel types are also used.

Harvesting.—The sugar in the plant increases up to a certain stage of ripeness. While the maximum amount of sugar can be determined only by chemical means, the grower learns to determine the proper stage quite accurately by the appearance of the stalks and inflorescence or flower cluster. For economy of production, it is desirable to continue the grinding of cane over as long a period as possible. The season may be extended by planting at different times and by using varieties that vary in time of maturity on different types of soil.

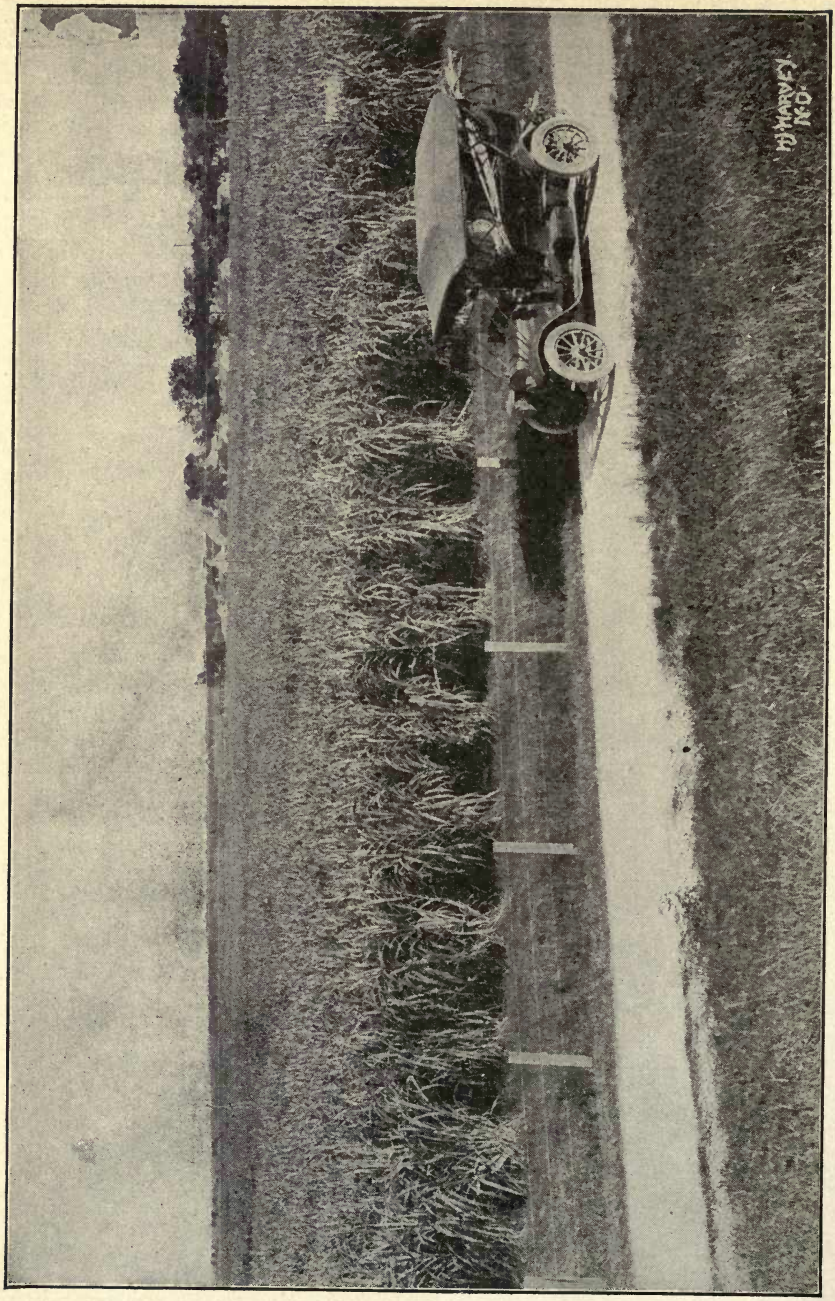
In Louisiana the harvesting begins the first of November. The cane is cut by hand and is a very slow process. The plant is first stripped with the back of the cane knife, then topped and cut close to the ground. The stalks are thrown in piles for loading. As the canes begin to lose sugar rapidly in twenty-four hours after cutting, they are usually hauled immediately to the mill.

Cane Sugar Manufacture.—At the factory the stalks are first shredded. The juice is then pressed out by running this shredded material through three sets of heavy steel rollers. After passing through the first set of rollers, the pressed material is sprayed with hot juice, then passed through the second set of rollers. In turn, this material is sprayed with hot water and again pressed. In this way from 90 to 95 per cent of the juice is removed. The pressed material is used as fuel and is converted into the heat and power necessary to operate the mill.

The juice is heated and purified by adding milk of lime. The lime combines with the impurities and is filtered out. The purified juice is then concentrated by boiling in vacuum pans and is finally crystallized.

The principal by-products of the sugar-cane factories are the impurities combined with lime, the different grades of syrup and molasses and the ashes from the pressed cane.

Since the impurities taken out in combination with lime contain a large part of the phosphorus and potash removed by the crop, this product with the ashes is returned to the soil as a fertilizer.



A Field of Sugar-Cane.[1]

[1] Courtesy of Virginia-Carolina Chemical Company, Richmond, Va. From V.-C. Fertilizer Crop Books.

MAPLE SUGAR

The making of maple sugar, like every other farming industry, has changed greatly within the last fifty years. In this country maple sugar has become more and more a luxury, and less a necessity, owing to the low price of cane and beet sugar.

The maple sugar production of the United States during the year 1909 was 14,060,206 pounds, valued at $1,380,492. The following states lead in the production of maple sugar: Vermont, New York, Pennsylvania and New Hampshire.

Sugar is made from the saps of several varieties of maple trees. The two most important are the Rock Maple (*Acer saccharinum*) and the Red Maple (*Acer rubrum*). Ideal sugar weather occurs in the late winter or early spring when the days are warm and sunny and the nights cold and frosty. This weather starts a rapid flow of sap in the tree. The tree is then tapped and the sap collected in covered buckets made for the purpose. The sap as it comes from the tree is colorless and contains on the average about three per cent of sugar.

Sugar Making.—In the process of sugar making, the sap is first boiled down in evaporators; then boiled to a much greater density in concentrating pans.

In making maple syrup the sap is boiled until the temperature reaches about 219° F.; in making sugar, the temperature must reach 234° to 245° F. The boiling of maple sap for syrup must be done over a hot fire. Boiling over is prevented by adding cream or skim milk from time to time. While the thermometer is used to determine the amount of boiling necessary, an experienced individual can tell simply by the way the syrup boils.

The brown syrupy fluid is then cooled, during which it must be stirred vigorously until graining begins. The soft mass is then poured into molds.

SORGHUM

Sugar from sorghum has never been manufactured on a commercial scale, although it has been made in small quantities and in an experimental way. The difficulty in making sugar from sorghum lies chiefly in the fact that there is only a very short period in the life of the plant when it is possible to crystallize sugar from its juices. The period is so short and the possibilities of detecting the right period are so difficult that it makes sugar making from this plant impracticable.

The plant is quite extensively used, however, in the manufacture of molasses or syrup. It is best known as sorghum molasses, and is used for cooking purposes more extensively than for the table.

The requirements and cultural methods for sorghum are given in the chapter on "Annual Forage Crops." When used for molasses the crop should be planted in drills and given thorough cultivation. The plants should be about six inches apart in the row.

There are many varieties of sorghum, but the Early Amber is the only

early variety given any particular preference. There is much uncertainty as to the quality of molasses that will be secured, and it does not seem to depend either upon the variety used or the method of making. Experiments indicate that there are frequently impurities in the juice which interfere with the making of a good quality of molasses.

In general, the best quality of molasses is secured in the northern region of production and in seasons of comparatively low rainfall and abundant sunshine. It is essential that the canes be harvested at the right stage of maturity and that there be uniformity in maturity. Carelessness in the selection of seed and the manner of planting often give rise to canes varying greatly in maturity at harvest time. It is very important to have all the canes about the same height and of the same maturity. This facilitates the removal of the seed heads and is more likely to produce good molasses.

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CHAPTER 16

Cotton Production

By Prof. E. F. Cauthen
Associate in Agriculture, Alabama Agricultural Experiment Station

Cotton, the second most valuable crop produced in the United States and the first most valuable export, is grown in that part of the country lying south of 36 degrees north latitude and east of western Texas. This section is known as the "Cotton Belt." The climate and soil are peculiarly adapted to its growth. The warm, moist spring and hot, humid summer favor the growth of the plant and its fruit; the dry, warm autumn matures and opens the bolls and permits the picking of the cotton.

Species.—The genus (*Gossypium hirsutum*) includes the common long and short staple varieties grown in the United States. The length of lint varies from one-half inch to one and a half inches.

Sea Island cotton (*Gossypium barbadense*) grows on the narrow Sea Islands along the coast of South Carolina and in some of the interior counties of south Georgia and north-central Florida. It makes the longest, finest and most valuable of all cotton fibers. Sea Island cotton may be distinguished from the ordinary upland cotton by: (1) its long, slender bolls bearing usually three locks, (2) deeply lobed leaves, (3) yellowish flowers with a red spot on each petal, and (4) many black seeds almost necked, with long slender, silky fiber. Its fiber may be two inches long, and is separated from the seed by the roller-gin, which does not cut the fiber from the seed, but pushes the seed out of the fiber. This cotton is used in the manufacture of fine fabric and laces and in the finer grades of spool cotton thread.

Characteristics of the Plant.—Cotton is a tap-root plant. In loose soils this root penetrates to considerable depth, even into the subsoil. When the subsoil is hard, poorly drained or near the surface, the tap-root is forced aside and the plant becomes dwarfed. Most lateral roots branch from the tap-root near the surface and feed shallow, hence the need of shallow cultivation.

On fertile soil cotton may grow five or six feet high. From its nodes spring two kinds of branches, vegetative and fruit-bearing. The lowest branches or vegetative ones are often called base limbs; they may bear short fruit-limbs. As the top of the plant is approached, the branches shorten, giving it a conical shape. The bolls of cotton are borne only on fruit-limbs.

Some varieties, like Russell and Triumph, produce bolls from one and

one-half to two inches in diameter, and require from 60 to 70 to make one pound of seed cotton; others, like King and Toole, having smaller bolls, require from 100 to 120 to make a pound.

Some varieties are much more easily picked than others. If the parts of the boll open wide, the locks of cotton are easily picked out by hand or blown out by wind or beaten out by rain; but if the parts of the boll do not open wide, the locks may cling to the burs and suffer less damage from wind and rain.

Cotton fiber varies in length from three-quarters of an inch in the upland varieties to two inches in Sea Island cotton, and may be likened to a long, slender, flattened tube with two-thirds of its length slightly curled. It is this curled condition of a fiber that makes it valuable, for without it the fiber could not be spun into thread.

A Good Cotton Plant Showing Good Base Limbs; Variety, Cook.

Seed. — The number of seed in a boll varies from twenty-five to fifty. The size of seed in some varieties is larger than in others. Some varieties have green seed, some gray and still others have blackish or necked seed. In the upland varieties most seed are covered with a short fuzz. A bushel of seed weighs 33¾ pounds.

Varieties of Upland Cotton Grouped. — The cotton plant is a native of the tropics; but under the influence of man, its growth has been extended far into the temperate zones and its habit changed from a biennial to an annual. Climate, soil, selection and cultivation have wrought many changes in the plant. The true and so-called varieties now number several hundred.

To facilitate the study of so many varieties, a system of grouping, worked out by the Alabama Experiment Station, is followed. According to form of plant, size of boll, time of maturing and other characteristics, they are classified into six groups: cluster, semi-cluster, Peterkin, King, big-boll and long-staple upland. There is no striking demarcation between any two groups, but a gradual blending of the characters of one into the next group.

Cluster Group.—The distinguishing characteristics of the cluster group are the one or two long base limbs near the ground and above them the many short fruit-limbs that bear the bolls in clusters of two or three. The plants are usually tall, slender and bend over under the weight of the green bolls; the bolls of most varieties are small, pointed and difficult to pick.

The leading varieties of the cluster group are Jackson and Dillon. The Dillon variety is important where cotton wilt (*Neocosmospora vasinfecta*) exists, because of its considerable immunity to this disease.

Semi-Cluster Group.—This group somewhat resembles the cluster group, except that its fruit-limbs are longer and the bolls do not grow in clusters. Its varieties have medium to large bolls and large, white, fuzzy seed.

Two well-known varieties of this group are Hawkins and Poulnot. Bolls of both are medium size, slightly pointed and easily picked. One hundred pounds of seed cotton yields about thirty-four pounds of lint.

Peterkin Group.—The fruit and vegetative branches of the varieties of this group are long and nearly straight; its leaves are small and have rather sharp-pointed lobes; its bolls are medium to small in size; its seed is small and many of them are without much fuzz. A striking characteristic of the members of this group is the high percentage of lint that they yield—often as high as 40 per cent.

Some of the well-known varieties of this group are Peterkin, Toole, Layton and Dixie. Layton and Peterkin are very much alike, except that Layton does not have as many necked seed and is probably more uniform in type. Toole and a selection from it called Covington Toole, resemble both King and Peterkin groups. Toole has small bolls, is early and very productive. Some selections from Covington Toole are fairly immune to cotton wilt and are extensively grown in sections affected by this disease. Dixie is a variety that is being bred up by the United States Department of Agriculture to resist cotton wilt.

King Group.—This group embraces the earliest varieties. The plants do not grow large; the leaves and bolls are usually small. Its base limbs are often wanting, and its fruit limbs are usually long and crooked. A distinguishing mark of the group is the red spot on the inner side of the petals of many plants. Most varieties drop the locks of cotton on the ground when they are rained on or blown by hard wind.

The leading varieties are King, Simpkins, Bank Account, Broadwell, etc. On the northern border of the cotton belt these varieties are well adapted because of their earliness.

Big-Boll Group.—This group is marked by the size of its bolls. When seventy or less will yield a pound of seed cotton, the bolls are considered large and classed as a big-boll variety. Some varieties have long limbs; others have short ones, giving the plant a semi-cluster appearance. As a general rule, all big-boll varieties have rank stalks, large, heavy foliage and mature their fruit late.

Some of the widely grown big-boll varieties are Triumph, Cleveland, Truitt, Russell, etc. Triumph originated in Texas and is grown extensively there. It shows considerable storm resistance, has big bolls, is easy to pick and yields well under boll-weevil conditions. Cleveland has medium size bolls and is medium early, but it lacks storm resistance. Russell is late in maturing, has many large green seed and turns out a low percentage of lint.

Cook Improved is a leading variety whose bolls are scarcely large enough to belong to the big-boll group. The type of plant is variable. This variety yields a high percentage of lint, is early and easily picked and has stood at the top in yield of seed cotton in many experiments. However, it has two faults—a tendency to boll-rot (*Anthracnose*), and a lack of storm resistance.

Long-Staple Upland Group.—The chief characteristic of this group is the length of its fiber, which measures from $1\frac{1}{8}$ to $1\frac{1}{2}$ inches long. Most long staple varieties are late and, therefore, are not suited for that part of the country infested with boll-weevils. The percentage of lint is lower than the other upland varieties, but it commands a premium of three or four cents a pound. Some of the better known long-staple varieties are Webber, Griffin and Allen Long-Staple.

Desired Qualities of a Variety.—By careful selection, the type of plant or yield of seed cotton of any common variety may be greatly improved in a few years.

Some of the desirable qualities of a variety are:

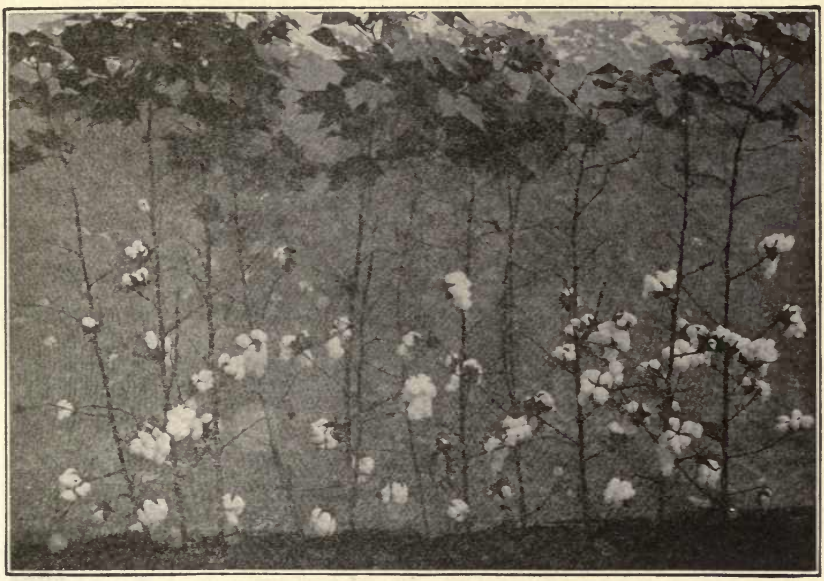
(1) Large yield of lint.
(2) Medium to large size bolls that are easy to pick.
(3) Plants that are true to type and healthy.
(4) Medium earliness with some storm resistance.

Selection.—Field selection is the one method most frequently employed to improve a variety of cotton. It consists in sending a picker, who is familiar with the points to be improved, ahead of the other pickers to select the best plants and to pick the well-matured bolls on them. In this way a few hundred pounds of well-selected seed cotton is gathered and then carefully ginned. The next year the selected seeds are planted in a well-prepared and fertilized field away from the other varieties for a seed patch. From the seed patch selection is made in the same way as the year before in the field. By repeating this operation for several years a variety may be greatly improved. However, no variety will continue pure if the seeds are handled at the public gins in the usual careless way.

Soils Adapted to Cotton.—Cotton is grown on all types of soil from the light sandy to the heavy clays, from the badly eroded hills to the rich alluvial bottoms. However, in this wide range of soils are planted many acres that would yield a better income if they were planted in some other crop. It is the low yield of the poorly adapted acres that makes cotton an unprofitable crop on so many farms.

The type of soil influences the earliness of the cotton plants. As a general rule, cotton grown on light, sandy soil makes a rapid growth and matures the fruit early—a decided advantage where boll-weevils exist; while that on heavy clay soil may grow until frost stops it, if the season is favorable. Light soils are not naturally productive, but by the use of 500 to 1000 pounds of complete commercial fertilizer per acre, the yield is increased from one-third of a bale to one or two bales an acre.

Special Types of Soil.—Of the different types of soil, the heavier members of the Orangeburg series are the best adapted to cotton culture.



COTTON GROWN BY SINGLE STALK METHOD.[1]

They are marked by a reddish-brown to gray color and open structure soil with a friable, sandy-clay subsoil.

The Greenville series is very much like the Orangeburg in its adaptation to cotton.

The Norfolk soils are not so productive; but when there is an abundance of humus and a liberal supply of commercial fertilizer, they will produce a heavy early crop of cotton.

The Houston series east of the Mississippi and the Victorian west, with good cultivation and proper seasons, produce above an average crop. However, the cotton plants often suffer from rust.

In the Piedmont regions are located the Cecil soils. Where there is not a deficiency of humus, these soils are productive, but the plant grows

[1] From P. I. Bulletin 279, U. S. Dept. of Agriculture.

slowly in the spring and late in the fall—a condition favorable to boll-weevils.

Along the rivers and smaller streams are strips of alluvial land called bottoms. They are usually fertile, well watered and produce a rank growth of plants that do not make fruit in proportion to their size. On such land, hay or corn is a more profitable crop.

FERTILIZER AND CULTIVATION

Plant Food Removed by Cotton.—There is probably no cultivated crop that draws so lightly upon the fertility of the soil as cotton. The average crop per acre in the United States is slightly less than 600 pounds seed cotton yielding 200 pounds lint. This amount of lint removes from the land only.42 pound nitrogen, .15 pound phosphoric acid and 1.32 pounds potash. When both seed and lint are removed, the loss is 13 pounds nitrogen, 4.74 pounds phosphoric acid and 5.70 pounds potash. The roots, stems, leaves and burs contain about as much nitrogen and phosphoric acid, and about three times as much potash, as the seed cotton. These parts of the plants are seldom removed from the field.

Need of Humus.—In the cotton belt the amount of humus in the soil is small. The warm, moist conditions that prevail during a large part of the year favor rapid nitrification; and the heavy winter and spring rains rapidly leach out the soluble plant-food. As a general practice, cotton follows cotton year after year and receives clean cultivation and furnishes little organic matter to replenish the humus. There is needed on every farm some system of crop rotation in which one crop is plowed under to renew the humus.

Need of Nitrogen.—The small size of the cotton plants over large areas is evidence of the deficiency of nitrogen in the soil. In many fields the plants are large enough to make only two or three bolls. To make a profitable crop they should be two or three feet high, full of fruit and have a rich black color during the growing season. The only lands that do not need a supply of nitrogen are the rich bottoms or those that have received a heavy crop of clover or some other legume for soil improvement.

The chief sources of nitrogen in commercial fertilizer are cottonseed meal, which also furnishes some phosphoric acid and potash, nitrate of soda, tankage and calcium cyanamid. If quick results are desired, as in the case of a side application to a growing crop, some soluble form like nitrate of soda is used.

Need of Phosphoric Acid.—The need of phosphoric acid is almost universal. Most fertilizer experiments show an increased yield whenever it is used. The only soils that do not show an increased yield from its use are the rich alluvial lands and Houston and Victoria clays. A liberal application of acid phosphate on heavy clay soil often hastens the maturing of a crop of bolls that would not ripen and open before frost. When a crop of 200 or 300 pounds lint cotton is expected, it is usual to

apply 150 or 200 pounds acid phosphate either before planting or as a side dressing.

Need of Potash.—Loose, sandy soils and the Houston clays show an increased yield when kainit or some other potash fertilizer is used; but most red clay and some silty soils do not seem to need artificial potash to make an average crop. The red clay soils, as a rule, have a great deal of potash, but it is slowly available.

When used alone, an excess of potash tends to delay the maturity of the fruit. When used in connection with other materials making a complete fertilizer, the tendency to lateness is obviated. Some soils subject to cotton rust are greatly improved by the use of 150 to 200 pounds kainit or 35 to 50 pounds of muriate of potash per acre.

Commercial Fertilizers Profitable.—Commercial fertilizers usually pay a good profit, when the season is favorable and they are intelligently used. Lands that formerly produced a half a bale of cotton, now by the use of $8 or $10 worth of high-grade commercial fertilizer adapted to the needs of the land, produce a bale per acre without much additional expense. There is a strong tendency all over the cotton belt to increase the amount of fertilizer and especially the amount of nitrogen. Many farmers are using 400 to 600 pounds of a formula that analyzes 5 per cent phosphoric acid, 4 per cent ammonia and 3 per cent potash for sandy soils and the same with less potash for the clay soils.

Three-Year Rotation Suggested.—The long practice of planting cotton continuously on the same land has destroyed nearly all the humus in the soil. To increase the humus and to maintain soil fertility in the cotton states, the following three-year rotation is recommended:

First year.—Cotton, following in the fall with crimson clover or some other winter cover crop.

Second year.—Corn with cowpeas sowed or drilled between the rows at the last cultivation.

Third year.—Oats or wheat followed by cowpeas sowed broadcast for hay or soil improvement.

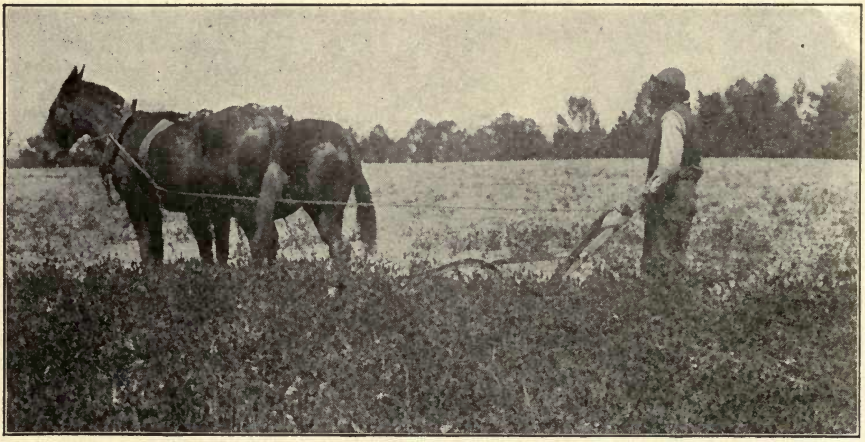
Preparation of Land.—The only preparation a great deal of the cotton land receives before planting is one plowing, which consists in throwing up beds or ridges on which the seed is planted. Many farmers are beginning to recognize the need of better preparation and are plowing the land flat and then bedding it before planting.

Much of the plowing is done with a one-horse plow to a depth of four or five inches. However, the lands that are producing a bale of cotton to the acre are plowed with a team to a depth of six or eight inches. Subsoiling, as a special operation, is not recommended, but deeper plowing is proving beneficial in many parts of the cotton belt.

Time of Plowing.—Late fall or winter plowing is commendable for heavy soils and those that have a great deal of litter on them, if such lands are not subject to severe erosion. Light, sandy soils are liable to winter

leaching if plowed early. All fall-plowed lands, especially if they are sandy or subject to erosion, should have some winter cover crop like crimson clover or grain so that their roots may take up the plant food as fast as it becomes available and prevent washing of the surface. In the early spring the cover crop is plowed under in the final preparation for planting. In a large measure the date of the first plowing should be governed by the labor on hand, the amount of litter and stiffness of soil.

Seed-Bed.—Land that was plowed broadcast in the winter or early spring is marked off in rows by a furrow that receives the fertilizer. Where cotton follows cotton without any previous plowing, as is too often the practice in a large part of the cotton belt, a furrow with a middle-buster is run in the row of old stalks or in the middle of the previous rows, and the



TURNING UNDER CRIMSON CLOVER FOR COTTON.

fertilizer is distributed in this open furrow with a one-horse machine that has a shovel-plow to mix soil and fertilizer together. By throwing over the fertilizer four or five furrows with a turning plow, a bed or ridge is formed four or five inches high and two feet wide. When no fertilizer is used, many farmers omit even the center furrow and "list" or bed without running the center furrow as a preparation for the row.

Planting.—Just before planting a drag or spring-tooth harrow is drawn across the beds or lengthwise to smooth them down and freshen the surface. On well-drained land some farmers are discarding the high beds and planting on a level surface. In the western part of the cotton belt, where the rainfall is below twenty-two inches, much planting is done in a water-furrow made with a two-horse lister.

In the southern part of the cotton belt, planting begins in March and is usually completed in the northern part of the cotton belt by the end of May.

Most of the crop is planted in April. Where boll weevils are present, planting should be made as soon as the danger from frost is past.

The seeds are sown or dropped in a shallow furrow and covered one or two inches deep in soil. If the soil is dry the seed should be planted deeper and the soil slightly packed on the seed. When the seed is drilled, one-half to one bushel of seed is required to plant an acre; when planted in hills, one or two pecks are required. If the land is rough, the planting should be thicker to secure a stand without replanting.

Tillage.—Prompt germination is desirable. If a rain packs the surface or a crust forms before the seed comes up, the surface should be stirred with a spike-tooth harrow or weeder to help the young plants to break through the crust. The harrow or weeder may be drawn across the rows after the plants come up to destroy small weeds and to cultivate the cotton plants. When the cotton begins to show its true leaves, it should be cultivated with a scrape or turner, which leaves the plants on a narrow ridge. The cotton is then thinned to one plant in a hill about one foot apart on poor land and about one and one-half to two feet apart on fertile land. Soon after thinning a little soil should be pushed up round the young plants. This may be done with a small scrape, sweep or spring-tooth cultivator.

Flat, shallow, frequent cultivation should be given the growing crop until about the first of August, when it may cease, unless the crop is very late.

HARVESTING AND MARKETING

Picking.—Cotton is picked by hand. A picker hangs a bag over his shoulder, picks the cotton out of the open bolls and drops it in his bag. He picks 150 to 200 pounds seed cotton a day and receives from forty to seventy-five cents per hundred pounds.

Picking begins in the latter part of August or early in September and ends about the first of December. When labor is scarce, the time of harvest may be prolonged until midwinter. Cotton should be picked out as fast as it opens to prevent damage from storms or rotting of fiber.

Picking is an expensive operation because it has to be done by hand. However, it does not require much skill and much of it is done by the cheapest of labor—women and children. Many cotton picking machines have been invented, but none of them have proven successful. They damage the plant and gather much trash with the cotton.

Cotton should not be picked when it is wet, nor should locks fallen on the ground and badly stained be picked up and mixed with the white cotton. The damaged cotton should be placed in a separate bale. If cotton is picked when it is slightly wet, it should be dried before ginning, as damp cotton cannot be ginned without injury to the fiber.

Ginning.—When 1200 or 1500 pounds of seed cotton have been picked, it is usually hauled to a public ginnery. A suction pipe draws the seed cotton into a screen where a great deal of the dirt and trash is blown out, and then drops it into a feeder. The feeder picks up locks or small wads

of cotton and drops them into the gin-breast, where they form a revolving roll of seed cotton. On the under side of this roll are many small circular saws rapidly revolving in opposite directions and cutting the lint off the seed. A rapidly revolving brush takes the lint off the saws and drives it into a condenser. The lint is then dropped into a large box and packed into a bale of cotton, which is now ready for the market or warehouse.

Cotton Seed.—The seed is usually sold to a cottonseed-oil mill. The short lint or fuzz is cut off the seed and is called "linters." The seed is then run through a mill that takes off the hulls, which are used for cattle food; the kernels, or meats as they are called, are ground and cooked, after

A Field of Cotton.

which they are put in a powerful press that removes the crude oil and leaves a hard yellow cake.

The crude oil is refined and from it are obtained: (1) "summer white oil," which is used in the manufacture of a compound of lard; (2) stearin, used in making solid oils, etc.; and (3) a residue that is used in making soap. On the dry western stock ranches, a great deal of the yellow cake is fed to cattle and sheep in the winter; the cake is ground, forming what is known as cottonseed meal, and is used as stock feed and commercial fertilizer. Recent experiments show that specially prepared meal mixed with wheat flour makes an excellent nutritious bread.

Not many decades ago, cottonseed was a waste product on the farm, but now the commercial value of the seed equals one-seventh the value of the lint.

On an average 1500 pounds of seed cotton make a 500-pound bale and 1000 pounds of seed. When the seed passes through an oil-mill, it produces about 150 pounds crude oil, 337 pounds meal, 500 pounds hulls and 13 pounds linters.

Storing.—After the cotton is ginned, the bales may be marketed at once, or stored on the farm or in a public warehouse. The bales of cotton are often left lying about the ginhouse or homes, exposed to the weather. As a result of the weather, their covering becomes badly damaged and the lint tinged with a bluish color, and the buyer "docks" them to cover the damage.

Bales of cotton should be stored under a shed on timber to prevent their touching the damp ground and absorbing moisture. In many markets are large public warehouses where cotton can be weighed, stored and insured at a small cost per bale.

Before selling a bale, a sample of lint is drawn from each covered side and placed together as a sample of the bale. The buyer judges its grade and makes a bid. The price is based on the grade and the demand for that grade of cotton in the markets. Most farmers do not know the grade of their cotton, as it takes expert knowledge to classify cotton correctly. They accept the highest price bid on the cotton as the top of the market for that grade. Where a large number of bales are offered in the market, often an expert grader is employed to classify the cotton, which method usually gives satisfaction to seller and buyer.

When a foreign or domestic mill wishes a quantity of a given grade, an order is placed with an agent, and this agent goes to the warehouses or dealers and buys the grades desired. If the bales have to be shipped far, they are sent to the compress, where the size is greatly reduced by a powerful press and thereby the cost of transportation is reduced.

Grades of Cotton.—The grades of cotton depend mainly on (1) color of fiber, (2) amount of trash, and (3) quality of ginning. A high grade requires that the fiber be white, with a slightly creamy tinge, strong and free from trash or dirt. When the cotton shows a yellowish or bluish tinge, the fiber usually is not strong; immaturity or exposure to the weather are the usual causes for this condition. To get a high grade, the farmer should pick the cotton from only the fully opened and matured bolls, and pick it free from trash and dirt.

There are seven primary grades in the commercial classification of lint cotton. They are named in the order of value: (1) "fair," (2) "middling fair," (3) "good middling," (4) "middling," (5) "low middling," (6) "good ordinary," (7) "ordinary." The half grades, which lie between the primary grades are named by prefixing the word "strict" to the name of the next lower grade, as "strict good middling," which is a half grade better than "good middling." The telegraphic dispatches from the cotton exchanges quote prices on "middling," and the prices of better and lower grades are calculated on the basis of "middling."

The larger part of the cotton crop of the United States falls under the following grades: strict good middling, good middling, strict middling and middling. Storms and early frost increase the quantity in the lower grades.

The diseases and insect enemies of cotton are discussed in Part II of this book.

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CHAPTER 17

TOBACCO

By George T. McNess
Tobacco Expert, Texas Experiment Station

Types and Their Commercial Uses.—The commercial tobaccos of North America are divided into three principal types, known as cigar leaf, manufacturing and export. These types are again subdivided according to their market grades and commercial use. The cigar type consists of three grades: wrapper, binder and filler leaf. The wrapper is a fine-textured leaf used for covering the outside of the cigar, and must have good appearance, length and width, be uniform in color and have fine veins. Cigar wrapper leaf is the highest priced tobacco produced in North America. The binder is that part of a cigar which holds the filler leaf or bunch together. This grade of tobacco must have fair size and possess good burning qualities. It is generally selected from the poorer grades of wrapper leaf. The filler is that part which constitutes the bulk of the cigar, and varies in quality according to the kind of tobacco used for this purpose. Filler tobacco should possess good aroma, taste and perfect combustion.

There are quite a number of tobaccos used for cigar purposes, each having distinctive characteristics and grown in different parts of the country. The kind of seed used, the influence of climate, soil conditions and methods of culture and curing determine the ultimate use of the leaf.

The tobaccos used in the manufacturing of cigars are: the Havana Seed, Broadleaf, Cuban Seed, Florida Sumatra, Georgia Sumatra, Texas Hybrid, Wisconsin Seed, Pennsylvania Seed, Zimmer Spanish, Gebhardt and Little Dutch. Several types of tobacco are used in the manufacture of smoking and chewing tobaccos, the principal type used in this country being the White Burley, which is grown in Kentucky and parts of Ohio. Cigarette tobacco is manufactured from the bright flue-cured leaf of the Carolinas and southern Virginia. About 60 per cent of the crop is used for home consumption. The heavy or fire-cured tobaccos are mostly exported to Europe, although some of the finer grades are used for plug wrappers.

Principal Tobacco Districts.—The finest cigar tobaccos are grown in the New England states of Connecticut and Massachusetts, and in the South in Florida, Georgia and Texas. These states produce the fine grade cigar wrapper leaf. In the New England states it is grown under cloth shades, while in the Southern states a slat shade is used. These shade-grown tobaccos rival the fine tobaccos imported from Sumatra and Cuba both in quality of burn and taste and in wrapping capacity. The binder

tobaccos are produced in the states of Connecticut and Wisconsin; while filler leaf of the various types comes from the Miami Valley of Ohio, and from Pennsylvania, Florida, Texas, Georgia and Connecticut.

The manufacturing tobaccos, air, sun, flue and fire-cured, are grown in Kentucky, Ohio, Virginia, Tennessee and North and South Carolina. Maryland also produces a fine grade of pipe tobacco, but most of this tobacco is exported to England and France. Nearly all of the fire-cured

Field of Virginia Heavy Tobacco.

tobaccos produced in the above states are exported to the various parts of the world.

Tobacco Soils.—It might be well to mention briefly a few of the principal soils upon which tobacco is grown. The heavy tobaccos of Virginia are grown in the Piedmont District on soil known as the Cecil clay or Cecil clay loam. This soil is a heavy, red clay soil and produces a heavy-bodied dark-colored tobacco. This type of soil is also found in the tobacco districts of Tennessee and part of Kentucky. The soil of the Carolinas is a very light-gray, sandy soil and belongs to the Norfolk series of soils as classified by the U. S. Bureau of Soils. This soil produces a light-colored, thin-textured leaf which is used in the manufacture of cigarettes and granulated tobaccos. The soil upon which the burly tobacco is grown is also a light soil, as is also the tobacco soil of Maryland. The tobacco soil

of Connecticut and Massachusetts is a light, gravelly soil belonging to the Hartford series of soils, and when well fertilized produces a fine quality of tobacco.

The principal tobacco soils of the South Atlantic and Gulf states are light sand to sandy loam, underlaid by either a yellow or red sandy clay. These soils run from gray to red in color, and where they have the yellow clay subsoil they belong to the Norfolk series, while the red clay subsoil places them in the Orangeburg series. The Orangeburg soils are more productive than the Norfolk and the better grades of cigar leaf are produced upon the former soil. These southern soils are responsive to fertilization,

FIELD OF CIGAR LEAF TOBACCO.

and as high as one ton of commercial fertilizer is used to the acre by the best growers.

The soils of Ohio are of limestone formation, and produce a heavy-bodied cigar filler leaf having good aroma, but on account of the lime content are apt to flake. The Pennsylvania soils are a little heavy for the production of wrapper leaf, but the standard cigar filler leaf used in this country is produced upon these soils. The soils of Texas are the Orangeburg and Norfolk, which produce the same grade of tobacco as Florida and Georgia. They are found in the eastern portion of the state. For additional information on soils, see Chapter 1 on "Soil Classification and Crop Adaptation."

Preparation and Care of Seed-Bed.—The preparation of the seed-bed varies in the different tobacco districts, owing to some extent to the varied climatic conditions, financial condition of the grower and type of tobacco being grown. The most expensive and complete seed-beds are to be found

in the New England states, while less pretentious ones are to be found in the Carolinas. The object, however, is the same, that is, to produce a supply of good, healthy, vigorous plants; for a failure of the seed-bed means a failure of the crop.

In Connecticut and Massachusetts the young plants are grown under glass in steam-heated beds, and the tobacco seed is sprouted before being sown in order to produce plants by the time danger of frost is over. It is only in the Northern states that it is necessary to go to this expense and trouble. In most of the heavy tobacco-growing districts, as well as in the

Tobacco Plant-bed, or Tobacco Seed-bed.

South Atlantic and Gulf states, the open seed-bed is used, the only covering being a thin cheesecloth to keep out the cold and conserve the heat and moisture in the bed.

In locating a good seed-bed for any type of tobacco the prospective grower should select a piece of ground near to water, having a southern exposure and protected on the north either by buildings or timber. The best plan is to select a piece of woodland near a small stream having the desired exposure. The timber should be cut off the land in the fall of the year, split into desired lengths and sizes and stacked to dry. January is the best time to burn a seed-bed, excepting in the Northern states. In these states this form of bed is not used. The first operation is to rake from the bed all leaves and trash, then lay across the bed skids of green pine poles, upon which the cut timber with a good supply of small brush is placed. This pile of wood and brush should extend clear across the bed, but not over

the entire length. The fire should then be started and let burn until the soil directly under the fire has been burnt to a depth of three inches. It is then dragged on the skids and another section of the bed burnt. This operation is repeated until the entire bed is burnt. As soon as the ground has cooled off, the coals should be raked off the bed and the fine ashes spaded or plowed under.

The bed is now ready for the frame to be placed around it. In some states logs are used for this purpose, but one-inch planks twelve inches wide and any desired length, best serve the purpose. The most convenient size to make a seed-bed is six feet wide and fifty feet long, which will make 300 square feet of bed. In building the frame to go around the beds the planks should be set upon edge and where the ends meet they are nailed to a stake which has previously been driven in the ground (see preceding page). After the frame is complete a No. 9 wire should be stretched from the center of one end of the frame to the other, supported at intervals by stakes, the tops of which are about two inches higher than the top of the frame. When the cloth is stretched over the frame this will cause a peak or ridge to the cloth roof.

Prior to stretching the cloth over the frame, fertilizer should be applied to the bed. Best results have been obtained by using twenty-five pounds of cottonseed meal and ten pounds of acid phosphate to every fifty square yards of seed-bed. This should be thoroughly mixed with the soil, and should be applied several days before the tobacco seed is sown. This form of seed-bed is now used in nearly all of the tobacco districts of the United States with the exception of the New England states, where, on account of their severe climatic conditions and short growing season, glass frames and steam heat are used in order to obtain early seedlings.

In sowing a seed-bed it is very important to secure a uniform stand of seedlings and in order to have a stocky growth they must not stand too thick in the bed. On account of the small size of tobacco seeds, it is necessary to mix them with some foreign substance in order to facilitate uniform distribution in the bed. The best material to use for this purpose is fine-sifted dry ashes. One ounce of tobacco seed mixed with one gallon of sifted wood-ashes will plant three hundred square feet of bed. More than this amount of seed sown to three hundred square feet of bed will cause the plants to grow too thick; consequently, they will not have that desired stocky growth. The seed should not be raked in, but simply pressed into the surface of the soil either by a small roller or by a board placed upon the bed and pressure applied. As soon as the seeds have been pressed into the soil the bed should be watered and the cloth covering placed in position.

If the seed-bed has been well burnt and otherwise prepared very little attention will be needed except the daily watering, and this must not be neglected if a good germination is desired, for the grower must remember that the seed is upon the surface of the soil and that it takes moisture and

heat to cause the seed to germinate. Tobacco seed germinates in from ten to fourteen days under normal conditions.

In the Southern states it may be necessary to weed the plant beds, and wherever weeds or grass appear in the bed they should immediately be pulled out. From six to seven weeks after sowing the seed the young plants will be ready to transplant to the field. The cloth cover should be removed for a few days prior to transplanting so as to harden the plants, and the beds should be well watered before the plants are pulled in order to lessen the injury to the roots. Plants should be taken from the plant-bed in the early morning and placed in a shady place until used.

Preparation of the Soil.—Tobacco requires a good seed-bed, therefore, the preparation of the soil is one of importance, and although the minor details of soil preparation may differ in the various tobacco districts, the ultimate object should be the same. Fields intended for tobacco culture should be plowed the previous fall to a depth of at least ten or twelve inches, and, if it is desirable, as in some localities,to apply stable manure,this should be applied at the rate of from fifteen to twenty loads to the acre, broadcasted over the field before plowing. Lime has been found beneficial upon some tobacco soils and should be applied after the land is plowed, and disked in during the preparation of the seed-bed.

The spring preparation of the soil depends largely upon the method to be used in transplanting the seedlings, either by machinery or by hand. In most of the Northern states, especially where cigar leaf tobacco is grown, machine setting is practiced, while in the Central Atlantic and Southern states most of the tobacco is transplanted by hand.

In the North where machinery is used the fertilizer is applied broadcast after the spring plowing and harrowed in by means of a disk harrow. Smoothing harrows, such as the Acme or Meeker, are then run several times over the fields, pulverizing the soil and leaving it in good condition for the planter.

In the Central Atlantic and Gulf Coast states most of the tobacco is transplanted by hand and the fields require entirely different treatment than where the machine is used. The field to be used for tobacco culture is bedded up during February, the beds varying from three to three and one-half feet apart for cigar tobaccos. The commercial fertilizer is applied in the drill and mixed with the soil by having a single-shovel plow furrow run in the drill, after which two furrows are made with a one-horse turning plow forming a list.

The field is left in this condition until the plants are large enough on the plant-bed to transplant to the field. At this time this list is leveled off either by a small harrow or with a log. Where the land has been listed for some time, it is good practice to re-list and then log off, as the small plants will take root much quicker in fresh-plowed mellow soil.

Fertilizers.—Tobacco responds to good fertilization and feeds heavily on nitrogen and potash. Larger amounts of commercial fertilizer are used

in the production of cigar leaf tobacco than with tobacco used for other purposes. The principal source of nitrogen is from cottonseed meal, although where the heavy tobaccos are grown, castor pumace or ground blood is used to some extent. Potash is needed in the production of all tobaccos in order to improve the burning qualities of the leaf. Only sulphate or carbonate of potash should be used, as the salt contained in the muriate of potash is detrimental to the burning quality of the leaf. Phosphoric acid is also necessary in small amounts.

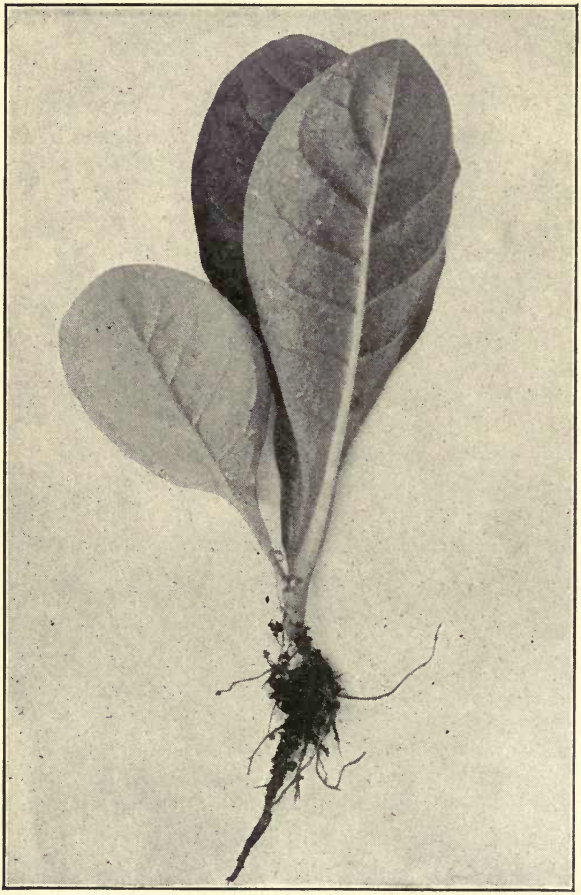
In the tobacco-growing regions of Florida, Georgia and Texas a vast amount of money is spent each season for commercial fertilizers. In addition to a liberal application of stable manure, as high as 2000 pounds of cottonseed meal, 400 pounds of sulphate of potash and 200 pounds of acid phosphate are used to the acre in the production of cigar wrapper leaf. Like amounts are used in the New England states. Smaller amounts are used in the production of heavy and export tobacco, and in such states as Virginia a crop rotation in which clover appears as one of the crops in the rotation, reduces the amount of commercial fertilizer, especially that which is used as a source of nitrogen.

Transplanting and Cultivation.—When the seedlings in the plant-bed have reached a height of from four to six inches, they are ready to be transplanted to the field. Great care is necessary in taking the seedling from the bed that the roots are not injured; therefore, it is necessary to water the bed well before pulling up the plants. Plants should be taken from the bed early in the morning and placed in a cool, shady place until they are to be used. If pulled during a rainy season there is no use in watering the bed and they can be used at once. Plants should be pulled one at a time with the finger and the thumb taking hold of the plant close to the ground. They should be shaken off or, if water is near, the soil washed from the roots, and then packed with the roots down in a basket or box.

Where a machine is used for transplanting, the field is usually left flat, having been previously harrowed so as to present a fresh surface. Two men are required to feed the machine and one to do the driving. There are several makes of transplanters, the most popular being the Beemis and the Tiger. These machines open the furrow, set the plants and place any amount of water desired around the roots. Tobacco transplanted by means of these machines appears to recover from the shock of being transplanted, and grows off much sooner and with more uniformity than when planted by hand. Another advantage of machine transplanting is that the transplanting can be done just as well, if not better, during dry weather as during wet, or when the soil is in favorable condition. These machines have been in use in the northern tobacco states for years, and they are gradually finding favor with the southern grower. The cheap negro labor of the South has been the principal cause of their restricted use, but as the price of labor has risen in the last few years, tobacco trans-

planters are now being used with success where formerly hand setting was practiced.

When hand setting of tobacco is practiced, the field is bedded instead of flat, the beds are marked off the distance required to plant the seedlings, and if the soil is at all dry, water is applied at these places. The plants are then dropped at each mark and a laborer sets them at these places with a dibble. Transplanting by hand should be done only when the soil is in a good moisture condition, or during cloudy or rainy weather. The distance at which the plants are set in the rows depends entirely on the type and commercial use of the tobacco. The heavy tobaccos of Virginia and Tennessee and the flue-cured tobaccos of the Carolinas are usually checked at a distance of thirty-six inches, while cigar leaf tobaccos are set in the drill from twelve to eighteen inches, according to their type.



A Plant Ready to Set in Field.[1]

Tobaccos of all types require frequent and thorough cultivation. No weeds or grass should ever be allowed to grow in the field. Cultivation usually begins about eight days after transplanting, when the young plants should be hoed and given a reasonably deep plowing. This is the only time that a deep cultivation should be given. In the North, riding and walking cultivators are used, having an attachment of shallow running

[1] Courtesy of The Pennsylvania Farmer.

plows, while in the Southern states single stocks with sweeps are mostly used. Cultivation usually ceases when the plants have received their final topping. As soon as the seed-head appears it should be taken out along with about three or four leaves with cigar type tobaccos, while the heavy and export types are topped down to eight or ten remaining leaves, according to the growth of the plant and the style of leaf desired. The Maryland and Burley tobaccos have more leaves left on the plant after topping, but not as many as the cigar types. All types of tobacco will send out shoots or suckers after being topped, and these should be broken off, so that all the strength of the plant will go into the leaves on the main stalk.

Tobacco is subject to insect pests from the time it germinates in the plant-bed to the time it is harvested. The flea beetle which lives on the young plants in the bed can be controlled by using kerosene and wood ashes. In the field the bud worm, horn worm and grasshopper destroy the leaves. These can be controlled by the use of Paris green, either applied dry mixed with cornmeal or ashes for the bud worm and in a solution at the rate of one pound of Paris green to 100 gallons of water, for the horn worm. More detailed instructions for controlling these pests will be found in the chapter on "Insect Pests."

Methods of Harvesting.—Various methods are used in the different tobacco districts in harvesting tobacco. In the heavy and export districts the entire plant is cut. The stalk is first split down the middle about two-thirds its length; then cut off close to the ground. The plant is then hung across a stick about four feet in length holding from six to eight plants, according to their size. When a stick is filled it is placed upon a wagon and taken to the curing barn. In the Burley and Maryland tobacco districts the plant is simply cut close to the ground and speared upon the stick, the stalk not being cut as in the former method. This method of harvesting is also used in Ohio, Pennsylvania, Wisconsin and to some extent in the New England states with the binder and filler grade of cigar leaf tobacco.

For the cigar wrapper tobaccos of Florida, Georgia, Texas and the New England states, the leaves are picked off the growing plants as they ripen, beginning with the sand or bottom leaves. The leaves are placed in baskets and taken to the curing barn, where, by means of a needle, they are strung upon strings attached to sticks, each string holding about thirty-five leaves. The ends of the string are fastened to each end of the stick, which is then hung upon the tier poles in the barn where they remain until cured. The bright flue-cured tobaccos of North and South Carolina, also Virginia, are harvested by a similar method, differing in that the leaves are tied upon the string in pairs and sometimes in triplets instead of the individual leaves being strung upon the string by means of a needle. Cigar leaf tobacco, harvested by the priming or single-leaf method, will cure much quicker than when the whole plant is cut and will produce tobacco of more uniform color and finer texture; besides, there will be less

waste of the bottom leaves and every leaf can be harvested at the desired stage of ripeness.

Barn Curing.—There are four methods of barn curing practiced: air curing, fire curing, flue curing and sun curing. All cigar leaf, Burley and Maryland smoking tobaccos are air cured. The tobacco, either primed or cut on the stalk, is hung upon the tier poles in the curing barn and there allowed to cure out by a gradual dying of the leaf tissues and evaporation of moisture. Favorable curing conditions exist when the tobacco will come and go "in kase" several times during the period of curing. Barns for air curing are provided with ventilators which can be opened or closed according to the climatic conditions and the stage of the cure. For the first few days the barn should be kept closed until the tobacco has wilted and taken on a yellow shade of color; then the ventilators should be opened so as to admit a free circulation of air until the tobacco assumes the brown color. During dry, windy weather the ventilators should be kept closed during the day and opened at night.

Fire-curing Barn.

The heavy and export tobaccos of Virginia, Tennessee and Kentucky are fire cured. As soon as the barn has been filled with green tobacco, small wood fires are started to wilt the leaf until the yellow color appears; then the amount of heat is gradually increased until the leaf turns brown. When the tobacco reaches this stage the heat is again increased to cure the midrib or stem of the leaf, after which the fires are allowed to die and the tobacco cool off. During the curing process the heat should never be allowed to fall until the final cure is obtained, as a fall of temperature during the curing process will injure the color and texture of the tobacco. Small log barns with tight walls are used for fire curing without any ventilation except the door.

The bright tobaccos of Virginia and North and South Carolina are cured by flues. The barns used in this process are similar to those used in the open fire process, except that the fires are built on the outside of the barn in brick fireplaces, having a metal flue running around the inside of the barn about two feet from the bottom. There are usually two fireplaces, the flues of each uniting at the opposite end of the barn, and merging into

a single return flue coming out at the same end of the barn as the fireplaces. Some barns have the two flues independent of each other, in which case both flues return to the front end of the barn.

The tobacco, after being hung in the barn, is first given a low heat so as to wilt the leaf and produce the yellow color. The temperature is then rapidly increased so as to set the yellow color in the leaf and prevent the leaves turning brown. As soon as the color is set the temperature is again increased to cure the midrib, when the temperature is allowed to fall and the tobacco to cool off. Three days and nights is the usual time taken to cure a barn of tobacco by this process.

The sun-curing process is similar to the air curing, the difference being that the tobacco is allowed to wilt on scaffolds before being placed in the barn and when climatic conditions are favorable it is also sunned before being placed in the barn. This process gives the tobacco a delicate flavor when smoked in the pipe.

FLUE-CURING BARN, VIRGINIA.

Preparation for Market.—The first damp season after tobacco is cured is usually the best time to take it from the tier poles and prepare it for the market, especially with cigar leaf tobacco. At this time the tobacco is soft and pliable, and can be handled without injury to the leaf. The only grading done by the grower in preparing cigar leaf for the market is to separate the leaves into three groups, namely, sand or bottom leaves, middle leaves, and top leaves. Where the tobacco has been cured on the stalk the leaves are stripped off and tied into hands containing about forty leaves. Where the tobacco has been primed, or leaves picked off the stalk in the field, the cured leaves are simply bunched on the string and the string wrapped around the butt-end of the leaves. The tobacco is then packed in boxes and hauled to the packing house or kept in the barn until a buyer comes.

With the heavy, export and bright tobaccos, the grower usually grades the tobacco into the commercial classes as sand lugs, lugs and wrappers, the finer classification being performed by the buyer, who is usually a rehandler of tobacco.

These tobaccos are packed in hogsheads and remain for some time in the warehouses to undergo an ageing process which mellows the tobacco

and brings out its best qualities. All cigar tobaccos have to go though a fermentation process, after which they are graded out according to color, texture and size. The tobaccos of Ohio, Wisconsin, Pennsylvania and certain grades of the New England tobaccos are packed in boxes, while the wrapper grades of Connecticut and Massachusetts are packed in mat bales weighing about 160 pounds. The cigar leaf tobaccos of the southern tobacco states are all packed in bales, either the Cuban or Sumatra style.

Methods of Selling.—All cigar tobaccos are sold by the grower in their unfermented condition to dealers in leaf tobacco, who either buy the tobacco from the curing barn, or upon delivery by the grower at the warehouse. In some cases the tobacco is grown upon contract at a stipulated price per pound for the various grades. All transactions are upon a cash basis upon delivery of the tobacco.

The heavy, export, manufacturing and bright tobaccos are sold at public auction, either in the hogshead or as loose tobacco. The place of sale is a public warehouse and all transactions are cash at the close of each auction. The sales are attended by buyers not only of this country, but of foreign governments where the regi system (government monopoly) exists; such countries as Spain, Italy, France and Japan having buyers attending these auctions.

Danville, Virginia, is the largest market for loose tobacco, especially the bright tobaccos; while Richmond, Lynchburg and Petersburg, Virginia, handle mostly dark, fire-cured tobaccos. Public auctions are held at various places in Tennessee, Kentucky, Ohio and the Carolinas.

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CHAPTER 18

Weeds and Their Eradication

Weeds are the farmer's most active and persistent enemy. If he would keep them under control, he must wage a continual warfare against them. Seldom is there soil so poor that it will not grow weeds, and the richer the soil, the greater the weed crop. They seem to have been equipped by nature to hold their own in the struggle for existence, for they manage to thrive despite heat or cold, drought or flood.

Some may ask: Why do weeds exist? They undoubtedly have a place in nature's great plan. They are her agents in restoring fertility to the soil. If unmolested they will cover the soil as a blanket, first as weeds, then as brush and finally as a forest. In fact, in some parts of our country, land is farmed until crops are no longer profitable, and then abandoned. Weeds then take possession, and by returning nitrogen to the soil, they become restorative agents. Give nature time enough and she will restore any land to its normal fertility.

Damage Done by Weeds.—It is impossible to calculate the damage done yearly in the United States by weeds. Investigators roughly estimate it to be hundreds of millions of dollars.

Weeds Reduce Crop Yields.—Weeds are more rapid of growth and more tenacious of life than cultivated plants. They crowd out the rightful occupants of the soil, depriving them of air and sunshine. Being more vigorous, they absorb from the soil the plant food that should be used by the crops, thus reducing the yield. A ton of dried pigweed contains as much phosphoric acid, twice as much nitrogen and five times as much potash as a ton of ordinary manure.

Weeds also absorb moisture in greater quantities and more rapidly than crop plants. They are more drought resistant, for, having appropriated all the moisture to themselves, they continue to thrive while the plant beside them dies. Experiments prove that some weeds transpire 250 to 270 pounds of water to develop a pound of dry matter.

In addition to this, it is a well-established fact that weeds exert an injurious effect upon crop yields by giving off from their roots substances which are poisonous to crop plants.

Weeds cause a direct money loss by reducing land values. A would-be purchaser is not so apt to buy a farm where the fields are thickly covered with mustard, wild carrot or the ox-eye daisy. Naturally, the loss in value should be borne by the man who has allowed his land to be so abused.

Weeds increase the expense of harvesting the crop. A field overrun with weeds calls for extra labor and entails extra strain on the machinery.

It sometimes necessitates hand labor, which is most expensive. Also the cost of threshing and cleaning the grain is increased by the presence of weed seeds.

Market values are lessened by impure grain. Many crops are docked full half their value on account of noxious weed seeds. It is estimated that the State of Minnesota alone suffers a loss annually of over $2,000,000, because of weed seeds in the wheat.

But the loss does not stop here. Some weeds harbor and encourage harmful fungi and insects. For example, the very common clubroot of cabbage thrives on the various members of the wild mustard family. Stubble overgrown with weeds harbors cut worms, beetles and other insect pests. Mildew, smut and rust are often transferred from friendly weeds to the grain crop.

Furthermore, livestock and even human beings lose their lives as the result of eating poisonous berries or roots. The water hemlock or cowbane is fatal to sheep and cattle. The deadly loco-weed on the western plains has caused the death of many horses and cattle.

How Introduced and Spread.—Weeds are great travelers. They travel by means of the wind and water. They are carried by birds, beasts and human beings. They are disseminated by means of manure, feedstuffs, machinery and grain seeds.

Such weeds as the thistle, milkweed and the dandelion have downy plumes attached to each seed. The faintest breeze will carry them miles away, where they begin life anew. Members of the dock family have seeds supplied with wings which enable them to float upon the water as well as upon the breeze. Some weed seeds have sharp barbs and stickers by which they attach themselves to the hair of animals and to the clothing of human beings, and are thus carried into new localities.

When it is known how many thousand seeds one weed-plant produces, it can readily be seen how great a calamity it is to let a weed bloom and go to seed. One thistle head contains enough seeds to start several thousand plants the next year. It is estimated that one wild mustard plant produces 10,000 seeds, and one pigweed 115,000 seeds. If only a few of these seeds germinated, the situation would not be alarming, but the chances are that if allowed to seed a very high percentage of them will find opportunity to propagate their kind.

One of the most prolific sources of weed dissemination is in the buying and sowing of impure seeds. Especially is this true of clover and grass seeds. In an analysis of several samples of commercial seed at one of the experiment stations, one sample of red clover seed was found to contain 36,000 weed seeds to the pound. A pound sample of timothy seed contained 79,000 weed seeds.

Care should be taken to procure seeds only from uninfested districts. A farmer should have sufficient knowledge of seeds to enable him to detect impurities. It is a wise precaution to send first for samples of seed under

consideration for purchase. If the farmer cannot determine with reasonable certainty as to their purity and germinating power, he should submit his sample to the experiment station of his state, that the weed seeds may be identified. These institutions gladly test samples of seeds for farmers free of charge.

Careful screening will overcome much of the difficulty with weed seeds.

Classification of Weeds.—It is not enough to know the name of a weed. In order to win in the struggle against a weed enemy, one must know its habits of life and its methods of propagation. There is no weed so vicious that it cannot be subdued or even entirely eradicated if its habits are understood.

Weeds may be divided into three classes according to their life cycle: annuals, biennials and perennials. Annuals complete their growth and ripen seed in one season, such as wild mustard and ragweed. These weeds must depend upon seed in order to grow again the following year. It can readily be seen that if the plant is destroyed before seeds form, the source of next year's crop is much lessened.

Unfortunately, some of these seeds are encased in an oily covering, enabling them to resist decay. Wild mustard seed, for instance, has such power of vitality that it has been known to germinate after having lain in the ground for many years.

Biennials are not so easily disposed of. They require two years in which to complete their growth. Some of them have long tap roots in which they store up plant food during the first year. This food is used to produce seed during the second summer. Burdock and wild carrot are common examples of this class. These weeds are seldom seen in cultivated fields, for the plow and cultivator are disastrous to their roots. If these weeds are cut off even with the ground, they branch out and become thicker than before. Cutting two or three inches below the surface so as to destroy the crown of the plant is effective.

Perennials grow year after year and produce seed indefinitely. Some of them reproduce by seed only, such as the ox-eye daisy and dandelion. Others have roots running under ground from which they send up new plants yearly. Common examples of this kind of weed are Canada thistle and bindweed. This class of weeds is the most difficult to eradicate, for wherever these roots are cut or bruised new stalks are sent forth and the difficulty increased. There is one time, however, during the growing season when these weeds are most effectively attacked; that is, when they are in full growth, but before seeds form. No plant can live long without a leaf system. If the plants are cut off and plowed under at this time, many of them will be eradicated.

Repeated and persistent attacks, however, on the part of the farmer will be necessary for ultimate success. The poorer the land becomes, the greater the number of biennial and perennial weeds. They seem to be best adapted to the poor conditions and will thrive where other crops fail.

Weed Habitats.—Bindweed, Canada thistle and horse nettle are entirely at home in any field, whether it be corn field, meadow or feed lot. However, it is a well-established fact that certain weeds seem to follow certain crops. For instance, corn fields are mostly infested by such weeds as foxtail, cockle-bur and butter-print. These can be overcome by persistent cultivation. Milkweeds and the large family of mustards, of which shepherds' purse and wild radish are members, seem to follow the small grains. The mustard family is easily overcome by cutting before it goes to seed. The milkweed, however, is more difficult to eradicate, as it spreads by means of underground roots. Meadows and pastures have a different

THE MANNER IN WHICH CANADA THISTLES SPREAD BY UNDERGROUND ROOTSTOCKS.[1]

When the rootstocks are brought to the surface by plowing at the right depth they may be raked up and destroyed.

type of weed from corn and small grains. Three of the worst meadow weeds are dock, ragweed and buckhorn. They spread by seed only and can be kept down by mowing before they go to seed. The ground must also be kept well seeded to grass or clover, for if bare spots appear, the weeds are quick to appropriate them. Sorrel is a pasture weed which is hard to eradicate, as it spreads by means of underground roots. It cannot compete with red clover, however, for a place in the meadows. For this reason it is usually found in meadows where the acidity of the soil does not encourage red clover. Plowing and sowing to cultivated crops is the best method of eradication. If the land will not admit of cultivated crops, common salt put on the plants will kill them and keep them from spreading.

Principles Governing Control.—The foregoing discussion suggests

[1] Courtesy of U. S. Dept. of Agriculture.

the necessity of working out a system of farm management that will afford weeds the least opportunity to gain a foothold. The problem is not how to rid a farm of weeds, but how to prevent weeds in the first place. This can be solved by a system of cropping which takes into consideration the needs of the different fields as regards weed eradication. This phase of the problem has been discussed under the chapter on "Rotations."

A few general principles for weed prevention and eradication are here given:

1. Cut all weeds before seeding, if possible.
2. Burn all weeds with mature seeds. Do not plow them under.
3. Practice crop rotations.
4. Sow clean seed.
5. Watch for new weeds in your locality. If you can not identify them, send them to your experiment station for identification.
6. See that the laws in your state dealing with control of weed plagues are enforced.

A few of the most common weeds are here considered.*

Canada Thistle.—The Canada thistle is a perennial of European origin, and is the most dreaded of all weed pests. It is a common weed of the northern half of the United States. The stems of Canada thistle grow from one to three feet tall; they are much smaller and smoother than other thistles. The leaves are very spiny and the margin has a ruffled appearance. The upper side of the leaves is smooth and bright green in color, while the lower side is downy or hairy. The flowers are rather small, about one-half inch in diameter and of a rose-purple color. The Canada thistle flowers from June to September, maturing the first seed by the middle of July. The seed is smooth and light-brown in color, measuring one-eighth of an inch in length. The seed is easily carried by the wind and is most commonly found in medium red and alsike clover seed.

Propagation.—The Canada thistle propagates by underground rootstocks as well as by seed. The underground rootstocks grow rather deeply in the soil and run parallel with the surface. They are the storehouse of the plants, and are capable of sending up young shoots for some time after the parent plant has been destroyed. This fact explains the persistency of the Canada thistle. As long as the plant is permitted to form green leaves, it will manufacture plant food, which is stored in the rootstocks. As long as plant food is present in the rootstocks they are capable of sending up new plants, and will continue to thrive as long as they grow leaves at the surface.

Control.—The Canada thistle occurs in all crops in the rotation, consequently no one method of control will be effective. The details of control had best be worked out for each particular condition.

To thoroughly subdue the pest it is necessary to starve out the root-

*Taken, with modifications, from The Pennsylvania Farmer, prepared by Professor Darst, of The Pennsylvania State College.

stocks by cutting off all green parts above ground. This requires destroying the plants in some manner every week at first, and then every two weeks until the rootstocks die of starvation.

In a small grain crop keep them cut with scythe or hoe, so as not to let them go to seed. After harvest the land should be plowed rather deeply and then worked down with the drag harrow. All roots harrowed out should be piled, dried and burned. The land should be disked regularly about every ten days, so as to destroy stray plants. In the late fall the land should be re-plowed, but not worked down, so as to expose the remaining roots to frost action. In the early spring the ground should be worked with a disk and a smother crop sown, such as oats and Canada field peas, millet or buckwheat.

THE CANADA THISTLE (*Circium arvense*).[1] B—Seed enlarged.

Canada thistles occurring in pastures must be cut out below the ground every ten days until starved out. After cutting the plants, it is well to pour a little kerosene on the stem and roots. Often spraying with strong concentrated salt solution will be effective in pastures and waste places. The spraying should be done thoroughly and repeated when young shoots reappear. Spray materials should be applied under high pressure, and in a vapor spray, to be effective.

After all, sprays used as a substitute for the scythe and mower will not kill the roots below the ground.

When the thistle occurs in a cultivated crop, knives or sweeps should be used on the cultivator instead of the ordinary shovels. The sweeps will be more effective in cutting off the plants. The thistles that grow within the row should be kept cut out with the hoe.

Quack Grass.—Quack grass is perennial and propagates both by seeds and creeping underground rootstocks. The stems grow from one to two feet tall. The leaves are ashy green in color, rough on the upper side and smooth beneath. The plant flowers in June and seeds in July.

The plant sends out underground rootstocks which are jointed, each joint capable of budding a new plant. Quack grass grows an enormous root system, which soon crowds and smothers out other plants.

Control.—Quack grass may be subdued if no green leaves are allowed to develop. Since quack grass makes fair pasture, a good plan, where possible, is to pasture it close to the ground during the midsummer; then plow deeply in the early fall. The ground should be worked down immedi-

[1] Courtesy of The Pennsylvania Farmer.

ately with the spike-tooth harrow. This will drag out a great many of the roots. These should be dragged or raked to one end of the field, to be dried in piles and then burned. The ground should be plowed the second time, late in the fall. This should be done crossways of the first plowing. The ground should be worked down again with the harrow and as many of the rootstocks dragged out, piled and burned as possible.

QUACK GRASS (*Agropyron repens*).[1]

The next spring cultivation should begin as early as possible, the ground being worked every few days. Then a cultivated crop should be planted, preferably corn. The corn should be planted in hills so that cultivation can be given both ways of the field. The corn should be cultivated thoroughly and a close watch kept for any stray quack grass which may come up.

If there is any doubt as to whether the quack grass is completely killed, a mixture of hairy vetch and rye should be sown in the last cultivation of the corn. This cover crop should be plowed down the next spring and a heavy seeding of millet sown. The cover crop and the millet following the corn will surely smother out the last of the quack grass.

A thick covering of straw or manure a foot or so thick and well packed down, will smother out the grass. It will take from two to three months to smother out quack grass, as the roots remain alive for some time even though the tops above ground be dead.

GREEN FOXTAIL (*Getaria viridis*).[1]

1—Concave side of seed.
3—Convex side of seed.
Both enlarged.

Foxtail.—The green and yellow foxtails are very similar in appearance and in habit. They are both annuals and propagate by seed alone, seeding from August to October. The yellow foxtail is a common weed all over the world, while the green foxtail is found mostly in North America. The seed of the foxtails are common impurities in many grass and legume seeds. Once in the

[1] Courtesy of The Pennsylvania Farmer.

ground, they retain their vitality for many years, germinating only when brought near the surface of the ground. The stems of the foxtails grow from one to four feet tall. The leaves are three to six inches long and are rather wide, flat and smooth. The seed heads are from two to four inches long. The seed is yellowish-brown in color, about one-tenth of an inch in length and ovoid in shape.

Control.—In grain fields the stubbles should be given surface cultivation or, if the soil is dry enough, burning over will destroy the seeds that have fallen on the ground.

In cultivated crops tillage should be continued very late, in order to prevent the development and distribution of seed from late-grown plants. Sheep may be turned in to graze down the aftermath of infested meadows.

A FIELD DODDER. Seeds enlarged. B FLAX DODDER. C ALFALFA DODDER.[1] Blossom of Alfalfa Dodder.

Dodders.—There are several kinds of dodders; those found in this country are known as common dodder, field dodder, clover dodder and alfalfa dodder.

They are annuals and propagate by seed, and are very peculiar weeds because they live upon other plants. From their habit of growth they are known as parasites.

The seeds of the dodder germinate in the soil and the young plants soon perish unless they come in contact with a clover or alfalfa plant. Once in contact with a suitable host plant, the roots of the weed soon decay. The fine yellowish and reddish stems twine about the host and spread from plant to plant; a single dodder plant often growing on several different host plants at the same time.

This weed derives its nourishment by sending little suckers out into the stems of the plant on which it grows. Dodders appear lifeless to the casual observer as the leaves are reduced to mere scales.

The white or pink flowers occur in clusters along the slender stems. During the latter part of summer the cluster may contain flowers in bloom and the matured seed at the same time.

Small patches of dodder may result from a single seed. A patch can

[1] Courtesy of The Pennsylvania Farmer.

be distinguished at quite a distance on account of its distinct yellowish cast.

Dodder seed is very difficult to remove from clover and alfalfa seed.

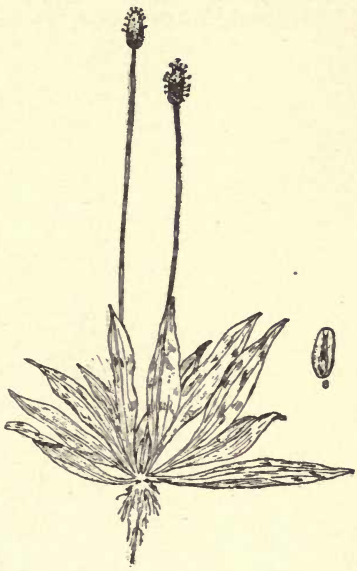
Eradication.—The first step in the control of dodder is to sow clean seed. Clover and alfalfa seed should be carefully examined for the pest before it is sown.

When a field is badly infested the crop should be plowed under before the seeds form. Dodder seed, plowed under, may remain in the soil for seven or eight years and then germinate. After plowing, plant a cultivated crop for a year or two; as the weed is an annual, it yields readily to cultivation.

When dodder occurs in small patches it may be successfully eradicated by digging up the infested areas. To avoid scattering the seed, dry and burn the plants on the spot.

The dried plants may be burned by covering them with straw or shavings soaked with kerosene. After the first burning, stir the surface with a rake, then burn over for the second time, so as to destroy any seed that may have matured and fallen to the ground.

After a patch has been dug up, burned and re-seeded, it will be well to watch for stray plants which may come. If such plants appear, destroy them before flowering time.



Buckhorn or Narrow-leaved Plantain (*Plantago lanceolata*).[1]
B—Two times natural size of seeds.

When dodder seed is allowed to mature in clover or alfalfa hay it should not be removed from the field, but should be dried and burned.

Weed sprays are sometimes recommended for killing dodder in clover and alfalfa. The spraying should be done before or at blooming time in order to prevent the seed formation. A twenty per cent solution of iron sulphate is found effective on alfalfa fields. The spray will kill the parasite and apparently destroy the crop, but a new growth of alfalfa will spring from the roots as soon as the plant is relieved of the pest.

Buckhorn.—Buckhorn is a perennial of European origin. The weed propagates by seed, which matures any time from May to November. The plant has a short, thick root-stem which enables it to exist over winter. Buckhorn leaves are long and slender, borne in rosette-like clusters at the surface of the ground. The plant does not produce stems as other weeds

[1] Courtesy of The Pennsylvania Farmer.

commonly do, but sends up a stiff, slender flower stalk one to two feet long, at the end of which there is a short, compact head or spike. The figure shows the plant in bloom. After blooming, the heads elongate somewhat and turn a dark brown color. The seeds are shaped like a coffee grain, but very much smaller, measuring about one-tenth of an inch long. The seeds are a shiny amber to rich brown color. A dark-colored scar is present on the concave surface, while a narrow yellowish stripe is generally present on the back of the seed.

Control.—Buckhorn is a very common and persistent weed in meadows, pastures and lawns. It is without doubt the most common of all weed seed in clover and alfalfa seed. In fact, it is very difficult to buy seed, even from the best of seedsmen, that is entirely free from this weed. The first step in controlling the weed on the farm is to sow nothing but clean seed.

Common or Broad-leaved Plantain (*Plantago major*).[1]
B—Two times natural size of seeds.

Where meadows and pastures are badly infested they should be plowed and a cultivated crop grown for one or two years. By thorough cultivation and the use of hoes, all plants may be destroyed before going to seed. The seed remaining in the soil will be induced to germinate by frequent cultivation, thus making it possible to rid a field of the pest in one or two seasons.

Small areas in lawns may be controlled by cutting out with a spud or narrow-bladed hoe. This method is more effective during hot, dry weather. Buckhorn can be destroyed with carbolic acid without injuring or defacing the lawn. Stab each plant in the center, down to the fibrous cluster of roots, with a pointed stick and squirt into the opening a few drops of the acid with a common machine oil can.

Plantain.—The common plantain is a very persistent weed in lawns and yards. The plant is a perennial and propagates by seed. Plantain does not produce a true stem as most other plants. The leaves, which grow in a tuft near the ground are large, coarse and oval in shape. The weed flowers from May throughout the summer and ripe seed may be found by July.

The seeds are dark brown to black, slightly flattened, with acute edges. They are variable in shape, measuring one-twentieth of an inch in length.

Control.—Common plantain when occurring in fields will yield readily

[1] Courtesy of The Pennsylvania Farmer.

to thorough cultivation. The control is the same as recommended for buckhorn.

In lawns the most practical method of eradicating it is by hand digging. If the plant is cut off several inches below the ground during dry weather, it will give no more trouble.

Carbolic acid may be used in the same manner as recommended for buckhorn, where digging roughens the lawn.

Pigweed.—Pigweed is an annual and is commonly found growing in cultivated fields and waste places. While the weed itself is not hard to eradicate, yet it produces abundantly seeds which have long vitality. The seed has been known to survive in the ground for more than twenty years.

The pigweed has a long, fleshy, red taproot. The main stem is erect, stout, woody and slightly branched. The stem and branches are covered with stiff, short hairs.

Usually the plant will grow from one to four feet tall, but under more favorable conditions it will often reach six feet.

The leaves are long and ovate in shape, measuring from three to six inches in length. The small greenish flowers are crowded into thick, compact heads which are borne at the ends of the branches or in the axils of the leaves. The pigweed flowers from July to September and produces enormous quantities of small, shiny seeds. The seed is a jet black color, oval and flat in shape. It propagates by seeds only.

PIGWEED (*Amaranthus retroflexus*).[1]
C—Root.

Control.—Pigweed seed is commonly found in commercial seeds of different kinds. The first step in its eradication is to guard against buying seed containing this weed.

Thorough cultivation will suppress the weed. In case cultivation cannot be continued late into the summer the weed should be pulled or cut out with a hoe before going to seed. Plants which are pulled or cut while blooming should be destroyed, as they frequently mature seed after cut.

Pigweed may be destroyed in small grain crops by the use of the weeder or the spike-tooth harrow. By going over the grain field when the crop is but a few inches tall the small seedlings may be dug out without injuring the grain. If the weed makes its appearance later on in the growth of a small grain crop, it may be killed with an iron or copper sulphate spray.

[1] Courtesy of The Pennsylvania Farmer.

The spray to be effective must be applied before the grain begins to head and before the weeds bloom.

Lamb's-Quarters.—Lamb's-quarters is sometimes known as smooth pigweed or white goosefoot. This weed is a very common annual throughout the world. It is commonly found in cultivated fields, orchards and gardens.

Lamb's-quarters is distinguished by its upright grooved and many branched stem. The stems are often striped with purple. The plant is a rapid grower and attains a height of from two to four feet. The leaves are quite variable as to size and shape, the lower ones on the stock being comparatively large and irregular, while the upper ones are rather small and narrow.

LAMB'S-QUARTERS, OR SMOOTH PIGWEED (*Chenopodium album*).[1]

A—Root.
B—Seed enlarged three times natural size.

The small greenish flowers are borne on the ends or in the axils of the branches. The entire plant presents a silvery gray or mealy appearance which distinguishes it from the true pigweed. The seed is about one-twentieth of an inch in diameter, lens-shaped and a dull black color. The seeds have long vitality, lying dormant in the soil for many years.

The control of lamb's-quarters is similar to that of pigweed. In hoed crops the weed is very persistent and cultivation should be continued until late in the season. In gardens and other small areas the weed should be pulled or chopped out while young.

Since the plants are very succulent while young, sheep may be used to pasture them where conditions will permit. Cultivation in the late summer or fall will germinate seed remaining in the soil which will eliminate the seed that may germinate the next year.

Wild Mustard or Charlock.—The cruciferæ or mustard family contains a large number of weeds, of which the wild mustard and tumbling mustard are the most troublesome. The plants of this family may be recognized by the shape of the flowers, which consist of four petals arranged like arms of a cross. This character was used as the basis for naming the family.

Wild mustard, because of its immense productiveness and the exceedingly long vitality of its seeds, is one of the most difficult weeds to dislodge.

It is an annual plant, which in its earlier stages of growth bears some resemblance to the radish or yellow-fleshed varieties of the turnip. It

[1] Courtesy of The Pennsylvania Farmer.

produces erect branching stems from one to three feet in height which are somewhat roughened by short stiff hairs.

The leaves are quite variable; the lower ones are slender-stalked and deeply pinnatifid, forming one large terminal lobe with two to four smaller lateral lobes.

The upper leaves are irregularly toothed, somewhat hairy and have very short petioles; the lobes are not very pronounced, while the terminal one is much narrower than the terminal lobe of the lower leaves.

The plant flowers from June to September and mature seeds may be found as early as August. The bright yellow, fragrant flowers which are about one-half inch in diameter are borne in elongated clusters at the end of the stem and branches.

The flowers begin to open at the bottom of the cluster, which lengthens as the season advances, and the pods form and empty so that there may be emptied pods below and forming pods above. One of the pods may contain from four to twelve seeds.

The round dark reddish-brown seeds are about one-sixteenth of an inch in diameter. They are a common impurity of grass and clover seeds.

Wild mustard grows in all kinds of grain crops that are sown in the spring and usually matures its seeds before the grain in which it grows is ripe. Where spring grains are chiefly grown the contest with this weed will be a difficult one.

WILD MUSTARD
(*Brassica arvensis*).[1]

A—Pod, natural size.
B—Blossom, one-third natural size.
C—Seed enlarged four times.

Wild mustard is distributed by different agencies. Some of the small seeds are carried from place to place by the birds, but usually the weed finds its way to new centers in grain seed. The threshing machine is also a potent means of carrying it from farm to farm.

It is further distributed over farms on which it grows by means of manures. It is also very frequently distributed by spring floods; when this is the case the farmer has a difficult job.

Control.—Wild mustard seed is a common impurity of small grain, clover and alfalfa seed. The first step in its eradication is to avoid sowing seed containing the pest. As the seeds are small, they are easily removed from wheat, oats and barley by screening. Wild mustard is most common in grain fields and generally disappears in grass and cultivated crops.

[1] Courtesy of The Pennsylvania Farmer.

A good short rotation will in time reduce the seed in the soil. In grain fields, young seedlings may be harrowed out when the grain is but a few inches high. Later on the mustard may be destroyed by the use of iron sulphate or copper sulphate spray. Iron sulphate is probably the most efficient and cheapest spray. The spraying should be done before the grain heads are out and when the mustard is just beginning to flower. The spraying at this time will kill practically all the mustard with little or no injury to the grain. Spraying for weeds should be done on a bright, still day when there are no immediate prospects of rain. For spraying, use a solution made by dissolving 100 pounds of iron sulphate in 52 gallons of water. This solution should be used at the rate of 50 gallons to the acre and put on at a high pressure of 100 or more pounds to the square inch. The spraying can be done at a cost of approximately $1.25 per acre.

SHEPHERD'S-PURSE (*Capsella bursapastoris*).[1]

A—Enlarged seed pod.
B—Enlarged seed.

Shepherd's-Purse.—Shepherd's-purse is sometimes known as Case weed, St. James' weed and Mother's Heart. "With the exception of the chickweed, it is probably the most common weed on earth," being found in all cultivated regions of the world.

Shepherd's-purse is very prolific and its seeds have long vitality. This weed often harbors the club-root fungus, so common on cabbage, cauliflower, turnips and radishes, and will infect soil where those plants are cultivated.

Shepherd's-purse is an annual, or winter annual. It is one of the first plants to make its appearance in the spring and it is not uncommon to find it making a good growth in March.

The seeds, as a rule, germinate in the fall and form a rosette of leaves, close to the ground. From this rosette the following spring, arise the stems which vary from three inches to two feet in height. The leaves growing close to the ground are rather long and deeply cut, while those on the stem are small and arrow shaped. The small white flowers are borne in elongated heads or racemes. On the flowering stalks will be found all graduations from a small bunch of flowers in bloom at the end, down to mature pods below.

Shepherd's-purse is propagated by seeds only, which germinate either in the fall or spring. This weed flowers and produces seed throughout the

[1] Courtesy of The Pennsylvania Farmer.

season. An average size plant will produce about 2000 seeds. The seeds are very small and covered with a transparent, mucilaginous material which preserves them in the soil for several seasons.

Control.—Shepherd's-purse may be controlled in the field or garden by thorough cultivation and use of the hoe.

In meadows or small grain fields the weed may be destroyed by spraying. Spray while the weed is still young, and if possible before it blooms. Seventy-five pounds of iron sulphate to fifty gallons of water is recommended as a good weed spray. The spray material should be applied under high pressure and in mist. It will take about fifty gallons to the acre.

If one intends to spray weeds in pastures or small grain crops on a large scale, it will pay to purchase a weed sprayer, which is better adapted for the work and will be more effective and economical than ordinary sprayers.

Weeds can be sprayed in grass fields, but not in alfalfa or clover fields, as the spray will kill the clover as well as the weeds.

Peppergrass.—Peppergrass is a native of this country; an annual, and propagates by seed. It seeds from June to October and will be found in small grains and clover fields. The seed is often found in timothy and red clover seed on the market.

Peppergrass grows from six inches to two feet tall and is much branched. The weed sometimes becomes a tumble weed because of its spreading growth.

The flowers are white and very small, borne on racemes or elongated heads. The seeds are formed in round but flattened pods. They are small, measuring about one-sixteenth of an inch in length.

Birds are very fond of the seed and dispose of large quantities.

Control.—The control is similar to that of shepherd's-purse. Care should be taken in plowing under plants that are nearly mature, since part of the seeds will germinate.

Badly infested land should be planted to a cultivated crop and thoroughly cultivated; thorough cultivation being all that is necessary to control the weed.

Cocklebur.—Cocklebur is known by several other common names, *i.e.*, "Clotbur," "Sheepsbur," "Buttonbur" and "Ditchbur." This weed is an annual and native of this country. The plant is coarse, rough and branched, growing from one to four feet tall. The stems are angled and often reddish, spotted with brown. The leaves are broad, bristly rough on both sides and placed alternately on the stems.

Cocklebur bears the male and female flowers at different places on the plant. The male flowers are borne above and near the end of the main stem, while the female flower clusters are borne below in the axils of the leaves.

The seeds of the cocklebur are borne in reddish-brown, two-peaked burs which are covered with stout hooked prickles. Each bur contains

two seeds. It is claimed that one of the two seeds germinate the first year and the other the following year, thus insuring at least seed for two years.

Control.—Clean cultivation and the rotation of crops are recommended for this obnoxious weed. Infested corn fields should be put into a small grain crop, followed by clover or grass. The harvesting of these crops will kill or behead the weed before it has time to grow much or develop burs. Plants that have formed burs should be cut, raked and burned.

Field Bindweed or Wild Morning Glory.—It is most commonly found in grain fields, meadows and waste places. "It is a most obnoxious weed, spreading chiefly by means of its long, creeping, cord-like roots, which at any part of their length may bud new plants." Small bits of the roots may be broken off and carried quite a distance by a cultivator and produce new plants.

Cocklebur (*Xanthium canadense*).[1] A—Bur two-thirds natural size.

"The stems are smooth, slightly angled, slender, one to three feet long, twining about and over any plants within reach," tending to smother them. The leaves are cordate or heart-shaped, one to one and one-half inches long, with backward pointing lobes at the base. The flowers are pink, sometimes nearly white, funnel-shaped, about one inch in diameter at the mouth of the tube.

This plant is propagated by seed and the underground fleshy root-stocks. It flowers from June throughout the summer and mature seed may be found in July.

The seeds, which are borne in globular, two-celled capsules, are dull, dark brown, about one-eighth inch long, rough, oval, with one side flat and the other rounded.

Control.—If the land is planted to crops that can be cultivated very often throughout the growing season, field bindweed can be completely eradicated in two years.

When this weed grows in pastures and waste places, its growth may be checked by allowing sheep to have access to the places where it grows. Three years of pasturing with a large number of sheep will greatly weaken this pest, if not kill it entirely.

Infested land should be plowed in the late summer after a crop has been removed and hogs which have not been ringed turned in for the purpose of turning out and eating the succulent roots, of which they are

[1] Courtesy of The Pennsylvania Farmer.

very fond. If hogs are again turned into the field as soon as possible in the spring and left until planting time the weed will be considerably weakened in vitality.

Hedge Bindweed.—This weed is very similar to field bindweed and about as hard to eradicate; its rootstocks are larger and not so difficult to remove from the soil. The trailing or twining stems are three to ten feet or more in length and have the same method of destroying other plants. The leaves are smooth, long, triangular and pointed at the end instead of rounded as the field bindweed. The base of the leaves forms pointed lobes. The funnel-shaped flowers are about two inches long, pink with white stripes or clear white. They are borne singly on slender flower stocks in the axils of the leaves. The seed capsules are globular and may contain four seeds, but often only three are fertile; the dark-brown, kidney-shaped seeds are angular and about one-eighth inch long. They retain vitality for several years.

Control.—The rootstalks should be starved persistently by the frequent cutting of the stems. The weed loves the mellow soil of a cornfield. If the land is planted to corn, this will mean that as soon as the corn is too large to be cultivated by a cultivator the field should be gone over with a hoe and all young shoots cut off as soon as they make their appearance. Keeping them cut prevents the pest from maturing seed and leaves to re-stock the underground storehouse with food for another year.

FIELD BINDWEED (*Convolvulus arvensis*).[1]

After F. S. Matthews in Manual of Weeds, by Ada E. Georgia.

Fifty Worst Weeds.—The following table gives an alphabetical list of the fifty worst weeds of the United States, with such information as will enable the reader: (1) to identify them; (2) to determine the nature and place of their greatest injuriousness; (3) to determine their duration or natural length of life, that is, whether annual, biennial or perennial; and (4) some methods of eradication. With this knowledge one will be able to attack much more intelligently any troublesome weed.

[1] Courtesy of The Pennsylvania Farmer.

Descriptive List of the Fifty Worst Weeds in the United States.*

(A—Annual. B—Biennial. P—Perennial.)

Common Name, Botanical Name, Duration of Life.	Color, Size and Arrangement of Flowers.	Sections where Injurious.	Method of Seed Distribution; Vegetative Propagation of the Perennials.	Place of Growth and Products Injured.	Methods of Eradication.
Bermuda grass, wire grass (*Capriola dactylon*), P.	Purple, $\frac{1}{12}$ inch, spikes.	Maryland to Missouri and southward.	Seeds sparingly, rootstocks.	Fields and lawns; hoed crops.	Plowing and planting cowpea, sorghum or millet to smother the wire grass.
Bindweed, field bindweed (*Convolvulus arvensis*), P.	White or pink, 1 inch, solitary.	Entire United States, especially California.	Grain and flax seeds, creeping roots.	Rich, moist soils; grain and hoed crops.	Cultivation; if very bad, close grazing with sheep.
Bindweed, wild morning glory (*Convolvulus sepium*), P.	White or rose, 2 inches, solitary.	Mississippi Valley region.	Grain and flax seeds, rootstocks.	Rich prairie and river bottoms; corn and small grains.	Starvation of rootstocks by close cutting.
Bitterweed, fennel, yellow dog fennel (*Helenium tenuifolium*), A.	Yellow, $\frac{3}{4}$ inch, head.	Virginia to Kansas and southward.	Wind, hay, animals.	Meadows and pastures; injures livestock and taints milk.	Close cutting or hand pulling before seeding time.
Broom sedge (*Andropogan virginicus*), P.	Green, $\frac{1}{4}$ inch, racemes.	Massachusetts to Michigan, Florida and Texas.	Wind, short rootstocks, plants in tufts.	Fields and waste places; pastures and meadows.	Prevent seeding, burn mature plants, cultivate infested ground.
Buffalo bur, sand bur (*Solanum rostratum*), A.	Yellow, $\frac{1}{2}$ inch, solitary.	Illinois and Colorado to Texas.	Plants rolled by wind, seeds in hay and by animals.	Fields; grain and hoed crops, wool.	Heavy seeding, close cultivating.
Bull nettle, horse nettle (*Solanum carolinense*), P.	Purple, 1 inch, solitary.	Entire United States.	Plants rolled by wind, running roots.	Everywhere; grain and hoed crops, pastures.	Alternate cultivating and heavy cropping.
Bur grass, sand bur (*Cenchrus carolinianus*), A.	Green, $\frac{1}{2}$ inch, bur.	Maine to Florida and westward to Colorado.	Animals, especially sheep.	Sandy land, pastures and waste places; pastures and wool.	Cultivation and burning.
Chess, cheat (*Bromus secalinus*), A.	Green, spikelets in panicles.	All grain sections.	Grain seed, especially wheat.	Everywhere; grain fields.	Clean seed, cultivation.
Chickweed, common chickweed (*Alsine media*), A.	White, $\frac{1}{3}$ inch, cymes.	Entire United States.	Grass and clover seed; animals; has a long seeding period.	Meadows, lawns; winter crops.	Cultivation in late fall and early spring.
Cocklebur, clotbur (*Xanthium americanum*), A.	Green, $\frac{1}{4}$ inch, head.	Entire United States.	Carried by animals.	Cultivated fields and waste places; hoed crops and wool.	Prevention of seeding, cultivation.
Crab-grass (*Syntherisma sanguinale*), A.	Green, spikes.	Entire United States, especially the South.	Clover and grass seed, hay; animals.	Cultivated fields, gardens, lawns; hoed crops.	Prevention of seeding, closer cultivation.

*Taken from Farmers' Bulletin No. 660, United States Department of Agriculture; with remedies added.

DESCRIPTIVE LIST OF THE FIFTY WORST WEEDS IN THE UNITED STATES (*Continued*).

COMMON NAME, BOTANICAL NAME, DURATION OF LIFE.	COLOR, SIZE AND ARRANGEMENT OF FLOWERS.	SECTIONS WHERE INJURIOUS.	METHOD OF SEED DISTRIBUTION; VEGETATIVE PROPAGATION OF THE PERENNIALS.	PLACE OF GROWTH AND PRODUCTS INJURED.	METHODS OF ERADICATION.
Daisy, ox-eye daisy (*Chrysanthemum leucanthemum*), P.	White with yellow center, 1 inch, heads.	Maine to Virginia and Kentucky.	Clover seed, hay; woody, rather short rootstocks, but largely by seed.	Pastures, meadows, roadsides; hay, pasturage.	Prevention of seeding, close cultivation.
Dandelion (*Taraxacum officinale*), P.	Yellow, 1½ inches, head.	Entire United States.	Wind; taproot, which spreads but little.	Lawns, meadows, waste places; hay and lawns.	On lawns, continued cutting below surface; in fields, cultivation.
Dock, yellow dock, sour dock (*Rumex crispus*), P.	Green, ¼ inch, panicle.	Entire United States.	Hay and straw, clover and grass seed; taproot, which spreads but little.	Hay, small grain and hoed crops.	Prevent seeding, continued cutting to destroy leaf system.
Dodder, alfalfa dodder, field dodder (*Cuscuta arvensis*), A.	Yellow, ⅛ inch, clusters.	All clover and alfalfa regions.	Hay, clover and alfalfa seed.	Clover and alfalfa fields.	Clean seed, cultivation of crops other than clover or alfalfa.
Dogbane, Indian hemp (*Apocynum cannabium*), P.	Greenish white, ¼ inch, terminal clusters.	Upper Mississippi Valley.	Wind; creeping root.	Fields with sandy soil; pasture, grain and hoed crops.	In small spots, strong hot brine; in fields, plowing up roots during hot summer.
Fern, brake (*Pteridium aquilinum*), P.	No flowers.	Northwestern States and the Pacific Coast.	Spores scattered by wind; running roots.	Logged-off land, meadows and pastures.	Heavy seeding, cultivation.
Fleabane, horseweed (*Erigeron canadensis*), A.	White, ¼ inch, heads in cymes.	Entire United States.	Hay, grass and clover seeds.	Meadows, pastures and grain fields.	Prevent weeds seeding, close cultivation.
Foxtail, yellow foxtail, pigeon grass (*Chaetochloa glauca*), A.	Green, spikes.	Entire United States.	Animals, hay, grain and grass seeds.	Land cultivated in early part of season; young grass and clover seedlings.	Clean seed, cultivate land late in season.
Hawkweed, orange hawkweed, devil's paintbrush (*Hieracium aurantiacum*), P.	Orange, 1 inch, heads.	Maine to Ohio.	Wind, grass and clover seeds; runners similar to strawberry.	Untillable pastures and meadows.	Sheep pasturing, heavy cropping, cultivation.
Iron weed (*Vernonia noveboracensis*), P.	Purple, ½ inch, heads.	Maine to Maryland and Iowa to Kansas.	Wind; short, thick rootstocks making plant grow in bunches.	Pastures and meadows.	Repeated close cutting to destroy leaf system, thus starving the roots.
Jimson weed (*Datura stramonium*), A.	Purple, 3 inches, solitary.	Maine to Minnesota and Texas.	Pods and plants blown by wind.	Pastures, barnyards and waste lands; seeds, flowers and leaves poisonous.	Prevention of seeding.
Johnson grass (*Holcus halepensis*), P.	Green, ½ inch, panicle.	Virginia to Texas and California.	In hay, grain, and grass seed; running rootstocks.	All crops except hay.	Alternate cultivating and heavy cropping.

DESCRIPTIVE LIST OF THE FIFTY WORST WEEDS IN THE UNITED STATES (*Continued*).

COMMON NAME, BOTANICAL NAME, DURATION OF LIFE.	COLOR, SIZE AND ARRANGEMENT OF FLOWERS.	SECTIONS WHERE INJURIOUS.	METHOD OF SEED DISTRIBUTION; VEGETATIVE PROPAGATION OF THE PERENNIALS.	PLACE OF GROWTH AND PRODUCTS INJURED.	METHODS OF ERADICATION
Lamb's-quarters, pigweed (*Chenopodium album*), A.	Green, very small, panicle.	Entire United States.	Grain and grass seed.	Grain fields and hoed crops.	Prevention of seeding.
Lettuce, prickly lettuce (*Lactuca virosa*), A.	Yellow, ½ inch, heads in panicles.	Ohio to Iowa, Utah to California.	Wind.	Everywhere; all crops.	Prevent seeding, burn all mature seeds.
Milkweed, common milkweed (*Asclepias syriaca*), P.	Purple, ½ inch umbels.	New York to Minnesota.	Wind; creeping roots.	All crops and in pastures.	Prevent seeding, cultivation and heavy cropping.
Morning-glory (*Ipomea hederacea*), A.	White, purple or blue, 1½ inches, solitary.	New York to Missouri.	Corn stover, straw and wind.	Cultivated fields, especially corn and small grain.	Prevent seeding, thorough cultivation.
Mustard, wild mustard, charlock (*Brassica arvensis*), A.	Yellow, ½ inch, racemes.	Maine to Washington.	Grain, grass, clover, and rape seeds.	Small grain fields and meadows; grains.	Prevent seeding, cultivation, hoed crops.
Nut-grass, coco (*Cyperus rotundus*), P.	Brown, $\frac{1}{16}$ inch, spikelets.	Maryland to Florida and Texas.	Wind, nursery stock, hay and grass seed; tubers.	All soils; hoed crops.	Alternate cultivation and smothering crops.
Penny cress, Frenchweed (*Thlapsi arvense*), A.	White, ⅛ inch, racemes.	North Dakota and Minnesota.	Wind.	Grain fields and pastures; grain and dairy products.	Burning and thorough cultivation.
Pigweed, redroot, careless weed (*Amaranthus retroflexus*), A.	Green, quite small, spikes in panicles.	Entire United States.	In grain and grass seeds; plants blown by wind.	Plowed land; hoed crops.	Prevention of seeding, thorough cultivation.
Plantain, buckhorn, ribgrass (*Plantago lanceolata*), P.	White, $\frac{1}{16}$ inch, spike.	Entire United States.	Hay, clover and grass seed; spreads but slowly from a crown.	Everywhere; meadows, pastures and lawns.	Clean seed, cultivation.
Poison ivy, poison oak (*Rhus toxicodendron*), P.	Greenish white, ⅛ inch, panicles.	Entire United States.	Does not spread fast by seeds; running rootstocks.	Moist, rich land along fences; poisonous by contact.	Cultivation, repeated grubbing.
Purslane, pusley (*Portulaca oleracea*), A.	Yellow, ¼ inch, solitary.	Entire United States.	Tillage implements; has a long seeding period.	Rich, cultivated land, especially gardens; hoed crops.	Close cultivation.
Quack-grass, witchgrass (*Agropyron repens*), P.	Green, spike.	Maine to Pennsylvania and Minnesota.	Seeds of grain and coarse grasses; creeping rootstocks.	All crops on the better soils; hoed crops.	Alternate cultivation, heavy cropping; close grazing.
Ragweed, smaller ragweed (*Ambrosia elatior*), A.	Yellow, ¼ inch, small heads on spike.	Entire United States.	Wind carrying matured plants; in grain and red clover seed.	Everywhere, especially grain stubble; hoed crops and young grass seeding.	Prevent seeding, burning.
Russian thistle, tumble weed (*Salsola pestifer*), A.	Purplish, ¼ inch, solitary.	Minnesota to Washington and southward.	Wind rolling matured plants.	Everywhere; small grain and hoed crops.	Cultivating, close grazing; burning developed seeds.

DESCRIPTIVE LIST OF THE FIFTY WORST WEEDS IN THE UNITED STATES (*Concluded*).

COMMON NAME, BOTANICAL NAME, DURATION OF LIFE.	COLOR, SIZE AND ARRANGEMENT OF FLOWERS.	SECTIONS WHERE INJURIOUS.	METHOD OF SEED DISTRIBUTION; VEGETATIVE PROPAGATION OF THE PERENNIALS.	PLACE OF GROWTH AND PRODUCTS INJURED.	METHODS OF ERADICATION.
St. John's-wort (*Hypericum perforatum*), P.	Yellow, ¾ inch, cymes.	Maine to North Carolina and Iowa.	In hay and grass seed; rootstock.	Meadows, pastures and waste places.	Frequent cutting to destroy leaf system.
Smartweed (*Polygonum pennsylvanicum*), A.	Light rose, $\frac{1}{16}$ inch, racemes.	Maine to Minnesota, Florida and Texas.	Wind carrying matured plants.	Moist, rich soils; hoed crops and young grass seedings.	Turn under badly infested meadows for hoed crops.
Smartweed, marsh smartweed, devil's shoestring (*Polygonum muhlenbergii*), A.	Rose color, $\frac{1}{16}$ inch, spikes.	Indiana to Iowa.	Wind and farm machinery; rootstocks.	Wet land, prairie and muck soils; hoed crops, hay, pasture.	Prevent seeding, cultivation.
Sorrel, sheep sorrel, horse sorrel (*Rumex acetosella*), P.	Red, ⅛ inch, panicles.	Entire United States.	In clover seed; creeping roots.	Meadows and pastures.	Cultivation, smothering crops.
Sow thistle, perennial sow thistle, field sow thistle (*Sonchus arvensis*), P.	Yellow, ¾ inch, heads.	Maine to Minnesota.	Wind; running rootstocks.	Grain fields and hoed crops.	Thorough cultivation and smothering crops.
Squirreltail grass, squirrel grass, foxtail, wild barley (*Hordeum jubatum*), A.	Green, spike with long bristly glumes.	Minnesota to Texas and California.	Hay, animals, wind.	Meadows and pastures; barbed seeds produce sores on livestock.	Prevention of seeding, cultivation.
Thistle, Canada thistle (*Cirsium arvense*), P.	Purple, ¾ inch, heads.	Maine to Pennsylvania and Washington.	Wind, in hay and straw and in clover and grass seed; creeping roots.	All crops.	Alternate cultivating and heavy cropping.
Thistle, common thistle, bull thistle (*Cirsium lanceolatum*), B.	Reddish purple, 1 inch, heads.	Maine to Virginia and Washington.	Wind, in alfalfa, clover and grass seeds.	Pastures, meadows and winter wheat.	Prevent seeding, cut in the fall.
Wild carrot (*Daucus carota*), B.	White, very small, umbels.	Maine and Virginia to the Mississippi.	In foreign clover and alfalfa seed; carried by animals and wind.	Meadows and pastures.	Fall grubbing, cultivation.
Wild oats, (*Avena fatua*), A.	Green, panicles, similar to oats.	Wisconsin to Washington.	In seed oats.	Oat fields; lawns, injurious to stock.	Clean seeding, burning and pasturing.
Wild onion, garlic (*Allium vineale*), P.	Flowers rare, umbels, with bulblets.	Rhode Island to Georgia and west to Missouri.	Seeds rare; bulblets carried in wheat, underground bulbs.	Everywhere; wheat and dairy products.	Alternate cultivation and heavy cropping.
Winter cress, yellow rocket (*Barbarea vulgaris*), P.	Yellow, ¼ inch, racemes.	Maine to Virginia and westward.	In grain, clover and grass seeds.	Grain fields, pastures and meadows.	Prevent seeding, hoe grubbing beneath surface.

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PART II

DISEASES OF FARM CROPS

CHAPTER 19

Diseases of Farm Crops and Their Remedies

By Dr. Mel. T. Cook
Plant Pathologist, New Jersey Agricultural Experiment Station

When any of the various parts of a plant are not doing their work properly the plant is said to be diseased. The disease frequently causes poor growth or poor fruit, or both; and in case of our cultivated plants, an unsatisfactory crop.

The most important causes of plant diseases are fungi, bacteria, slime moulds, parasitic flowering plants, insects, mites, nematodes, unsatisfactory soil, too much or too small amount of moisture, unfavorable temperature, gas fumes and smoke. Some plant diseases occur for which there are no satisfactory explanations.

Plant diseases may be detected by characteristic symptoms which readily distinguish the disease upon the healthy plants. The most common of these symptoms are: (*a*) a discoloration of the foliage and sometimes of the new growths; (*b*) wilting, frequently followed by yellowing and browning; (*c*) dropping of the foliage; (*d*) the formation of spots on foliage, stems or roots; (*e*) perforation of the foliage commonly called "shot hole;" (*f*) variegation of the foliage commonly called mosaic; (*g*) the "damping off" or dying which is especially common on seedling plants; (*h*) the blight or dying of leaves, twigs or stems; (*i*) the dwarfing of parts; (*j*) the increase in size of parts; (*k*) formation of galls, pustules or corky growths; (*l*) cankers on fruit, stems or roots; (*m*) abnormal fruits; (*n*) the formation of masses of small shoots called "witches' brooms;" (*o*) the curling of leaves; (*p*) the formation of leaf rosettes; (*q*) abnormal root growths commonly known as hairy root; (*r*) exudations of gums, resins, etc.; (*s*) the rotting of fruit, stems or other parts; and (*t*) sunburn of fruits and foliages.

Some diseases of the soil, such as "damping off," are very severe in seed-beds and in greenhouses, and can be controlled by sterilizing the soil. Diseases that occur in the soil in fields are frequently overcome by a rotation of crops, by improved drainage and sometimes by stimulating the plants with suitable fertilizer.

Many diseases are controlled by spraying, but in most cases spraying is used for the protection of plants against disease and not for curing them; therefore, it is a kind of insurance and must always be supplied in advance of the appearance of the disease. Spraying cannot be conducted in a satisfactory manner unless the grower is sufficiently familiar with the disease

to understand when, why and how to give the necessary treatments. In recent years it has been found possible to overcome some diseases by growing plants that are disease-resistant and, therefore, do not need treatments.

In this chapter only the most common and important plant diseases in the United States and Canada are considered. Brief descriptions and condensed directions for treatment are given.

Farmers should always report the presence of disease on crops to the agricultural experiment station of the state in which they reside, and ask advice as to treatment. The treatment of some diseases will vary somewhat, dependent upon the part of the country in which it occurs.

The annual losses occasioned by insects to farm products are enormous and demand the attention of all farmers.

ANTHRACNOSE OF BEAN.[1]

The brown spots occur on both the pods and plants. They are caused by spores coming in contact with the tender plant tissues, where they germinate and give rise to serious damage.

[1] Cornell Agricultural Experiment Station Bulletin 255.

BEAN

Anthracnose (*Colletotrichum lindemuthianum* [Sacc. and Magn.], B. and C.).—This disease is most severe on the wax beans. It occurs on the pods, causing unsightly, dark-colored, sunken, canker-like spots. It also attacks the leaves and stems, producing similar spots and frequently causing the death of the plants. The fungus is carried in the seed and one diseased seed in a thousand is enough to infect a large number of growing plants.

Treatment.—Select clean seed.

Rust (*Uromyces appendiculatus* [Pers.], Link).—This fungus causes minute rusty spots or blisters on the under surface of the leaves and occasionally on the pods. These blisters break and set free great quantities of the reddish or rust-colored spores. It is not so severe as the anthracnose.

Treatment.—Practice clean cultivation and burn all old vines in the fall.

Blight (*Pseudomonas phaseoli*, Smith).—This disease attacks leaves, stems and pods, causing large watery areas, which later become dry, brown and papery. It is carried from year to year in the seed.

Treatment.—Use seed from healthy plants.

Downy Mildew (*Phytophthora phaseoli*, Thaxt.).—This disease is unlike the mildew on the fruits. It attacks the pods of lima beans, causing irregular areas of dense, woolly-white growth. It also occurs on other parts of the plant, causing dwarfing and irregular growths.

Treatment.—Spray with Bordeaux mixture.

Leaf Spot (*Phyllosticta sp.*).—This disease is most severe on the pole lima beans. It causes an irregular spotting of the leaves and to some extent of the pods. It is carried from season to season in the seed.

Treatment.—Spray with Bordeaux mixture.

PEA

Spot (*Ascochyta pisi*, Lib.).—This disease causes spots on stems, leaves and pods which are most conspicuous on the latter. On the pods they are circular, sunken with dark borders and pale centers, becoming pink when mature. The spots on the leaves are oval and usually show concentric circles. When severe on the stems it causes wilting and death of the plant.

Treatment.—Select clean seed and rotate crops.

BEET

Leaf Spot (*Cercospora beticola*, Sacc.).—This fungus causes the very common circular, brown, purple-bordered spots with ash-colored centers.

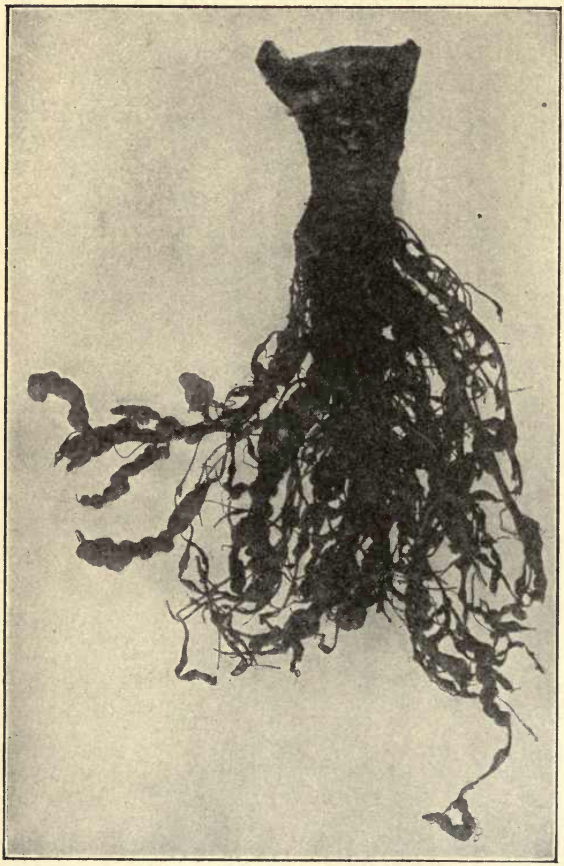
Treatment.—Spraying with Bordeaux mixture will control this disease.

Root Rot (*Rhizoctonia betæ*, Kuhn).—This disease causes the outer leaves to turn black and fall. The roots crack and then rot.

Treatment.—Use lime and rotate crops.

CABBAGE, CAULIFLOWER, TURNIP, ETC.

Black Rot (*Pseudomonas campestris*, Pammel).—This is a bacterial disease which attacks all of the above and many related plants. It starts at the edges of the leaves, causing a blackening of the veins, gradually working downward to the main stalk and then upward and outward until the entire plant is affected. The affected leaves become yellow, wilt and then dry. In advanced stages the disease is accompanied by other rot organisms which cause a pronounced odor.



ENLARGED ROOTS OF CABBAGE CAUSED BY NEMATODES.[1]

Treatment.—When once in the soil it is extremely difficult to eradicate. Prevent infection by using clean seed, which as a precautionary measure should be soaked for fifteen minutes in formaldehyde (1 part formalin to 30 parts water).

Club Root or Finger and Toe Disease (*Plasmodiophora brassicæ*, Wor.).—This very destructive and well-known disease attacks cabbage and related plants, causing unsightly knotted roots. The diseased plants are dwarfed and fail to develop heads.

Treatment.—Use nothing but absolutely clean soil in the seed-beds; use lime in the fields; rotate crops.

[1] From Farmers' Bulletin 488, U. S. Dept. of Agriculture.

CARROT

Soft Rot (*Bacillus carotovorus*, Jones).—This is a bacterial disease which causes a soft rotting of the roots. It also attacks turnips, radishes, parsnips, onions, celery, beets and many other plants. The only satisfactory treatment lies in the rotation of crops.

POTATO

Late Blight or Downy Mildew (*Phytopthora infestans* [Mont.], De By.).—This disease usually starts near the tip or margin of the leaf, but causes the infected area to die and blacken. In cool, wet, cloudy weather it spreads very rapidly and causes an offensive odor. The diseased tubers may show slightly depressed, dark-colored areas and a dirty brown color within. The disease is frequently the cause of heavy losses by rotting.

Treatment.—Spray with Bordeaux mixture, beginning when the plants are about six inches in height and repeat about every two or three weeks throughout the growing season.

Early Blight (*Alternaria solani* [E. and M.], J. and G.).—This disease appears earlier in the season than the late blight. It causes brown, brittle, irregular, more or less circular leaf spots with rather definite concentric circles. These spots frequently unite and the plant dies very much as though from natural causes.

Treatment.—Same as for late blight.

Wilt, Stem Rot and Dry Rot (*Fusarium oxysporum*, Schlecht).—The plant assumes an unhealthy appearance, the leaves roll and curl and the plant falls and dies prematurely. The stems are partly or entirely black and dead near the base and frequently show a white or pink mould. When stems are cut across below the ground they show discolorations just below the surface. This field form of the disease is known as "wilt" or "stem rot."

In storage the tubers undergo a "dry rot" beginning at the stem end, which causes them to shrivel and become light in weight. When cut across, these tubers show black discolorations just below the surface. The disease can be carried on the seed and will also persist in the soil.

Treatment.—Select seed potatoes which are free from surface cankers and are perfectly white when cut. When the soil becomes infected use rotation of crops for from three to five years.

Black Leg (*Bacillus phytophthorus*, Appel).—This disease causes the plants to be dwarfed, erect, pale in color and to die early. The stems become brown or black near the ground and the disease works downward. It is carried in the seed.

Treatment.—Soak the seed in formaldehyde or corrosive sublimate as recommended for potato scab.

Scab (*Oospora scabies*, Thaxt.).—This well-known disease is readily recognized by the rough, pitted character of the tubers and is the cause of heavy losses. It can be carried on the seed and will persist in the soil for several years.

Treatment.—Soak the seed potatoes for two hours in formaldehyde (1 pound in 30 gallons of water) or in corrosive sublimate (4 ounces in 30 gallons of water) for one and one-half hours. When the land becomes infected, avoid the use of stable manure and lime, and rotate crops for three to five years.

Little Potato, Rosette, Stem Rot, Scurf (*Rhizoctonia* or *Corticium vagum*, B. and C., *var. solani*, Burt.).—This disease assumes different forms, varying with the climatic conditions, soils and varieties. In very severe cases many of the young plants fail to get through the ground. Many that do get through are dwarfed and show a peculiar crinkling of the foliage. The part of the stems below ground shows peculiar brownish or black cankers.

Treatment.—Soak seed potatoes in corrosive sublimate as recommended for scab.

Bacterial Wilt (*Bacillus solanacearum*, Smith).—The plants wilt prematurely, become yellow, then black and dry. This disease attacks tomatoes, tobacco, peppers and eggplants.

Treatment.—Rotate crops, avoiding those that are susceptible.

Tipburn.—This disease is due entirely to hot, dry weather. It causes the leaves to dry at the tips and margins, roll up and break off.

NOTE.—There are a number of other diseases of the potato which cannot be included in this brief discussion.

PEANUT

Peanuts are subject to several foliage and root diseases of more or less importance. Growers of this crop should consult with their state agricultural experiment station.

TOBACCO

Granville Tobacco Wilt (*B. solenacerarum*, Smith).—This is due to the same organism as the wilt of the potato, tomato, peppers and eggplants. (See Potato.)

Mosaic, Calico or Mottle Top.—The cause of this disease is still somewhat uncertain. The leaves of the diseased plants show dark and light areas and frequently irregular thickenings or twistings.

Treatment.—Remove the diseased plants. Be careful not to touch healthy plants while working with the diseased plants. The disease can be communicated by contact.

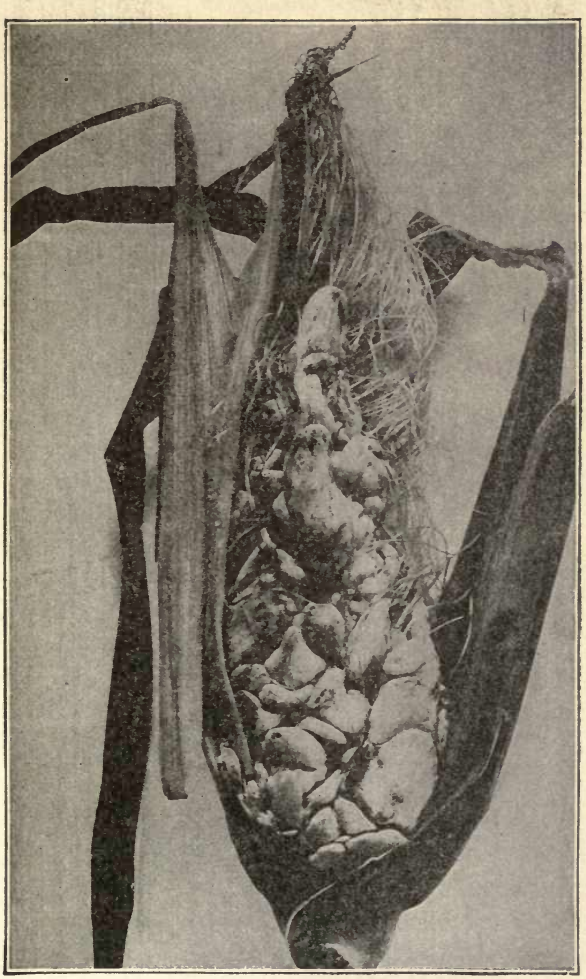
Leaf Spots.—There are a number of leaf spot diseases and also mildews which cause more or less trouble.

Root Rots (*Thielavia basicola*, Zopf.).—This disease is a rotting of the roots, accompanied by the production of numerous new roots. The affected plants are dwarfed and frequently killed.

Treatment.—Sterilize seed-bed. Rotate crops. Avoid liming and acid fertilizers.

CORN

Smut (*Ustilago Zeae* [Beckm.], Ung.).—Corn smut on ear, tassel and leaves is so common that it is not necessary to give a description. It is frequently very destructive, especially on sweet corn.



SMUT OF CORN.[1]
Showing a young smutted ear.

Treatment.—The treatment will depend largely on the severity of the disease. Do not use manure from animals which have been fed on smutted cornfodder. Rotate crops. If growing sweet corn on the same land year after year, it is advisable to remove the smut balls as soon as they appear.

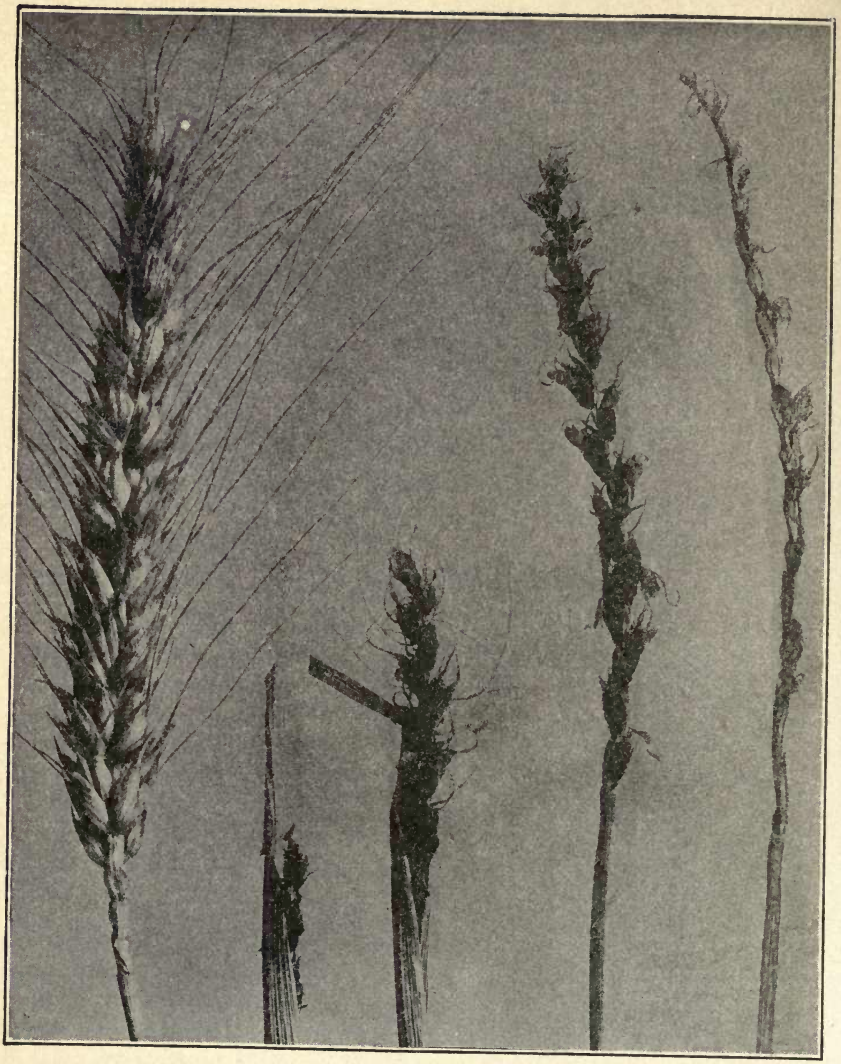
WHEAT

Rust (*Puccinia graminis*, Pers., *P. rubigovera*, Wint.).—This crop is affected with the familiar rust diseases, all of which appear to be very much the same to the inexperienced student of plant diseases. They are very difficult to control and in fact comparatively little effort is made to protect the crop. Resistant varieties should be used and if possible spring wheat should be sown early.

Loose Smut (*Ustilago tritici* [Pers.], Jens.).—This very common and familiar disease is the cause of much greater loss than the growers realize.

Treatment.—It can be controlled by treating with hot water. Clean

[1] From Farmers' Bulletin 507, U. S. Dept. of Agriculture.



LOOSE SMUT OF WHEAT.[1]

Showing four smutted heads of various stages of development, and for comparison a sound wheat head.

[1] From Farmers' Bulletin 507, U. S. Dept. of Agriculture.

the seed and soak for five to seven hours in water at a temperature of 63° to 72° F. Then put into loose bags or wire baskets holding about one peck each and plunge into water ranging between 126° and 129° F. for ten minutes. Care should be taken to keep the water at the proper temperature and to keep the grain well stirred. The seed can be dried on a barn floor or canvas.

SMUT OF OATS.[1]
Showing a smutted head, and for comparison a sound oat head.

Stinking Smut or Bunt (*Tilletia fœtans* [B. and C.], Trel.).—This disease is very different from the loose smut. The diseased grains are shriveled, greenish tinted, filled with a mass of black spores and have a disagreeable odor. Badly infested crops are worthless for milling or for stock feed.

Treatment.—Put one pound of formaldehyde in fifty gallons of water and sprinkle on the grains at the rate of one gallon to each bushel of grain. Shovel the wet grain into a pile and cover with canvas or burlap for six to twelve hours. Spread and dry. (See Chapter on Wheat.)

OATS

Rust (*Puccinia coronata*, Cda.).—Also the two species found on wheat.

Treatment.—Same as for wheat.

Smut (*Ustilago avena* [Per.], Jens.).—Very similar in appearance to the loose smut of wheat.

Treatment.—Formaldehyde treatment same as for stinking smut of wheat.

[1] From Farmers' Bulletin 507, U. S. Dept. of Agriculture,

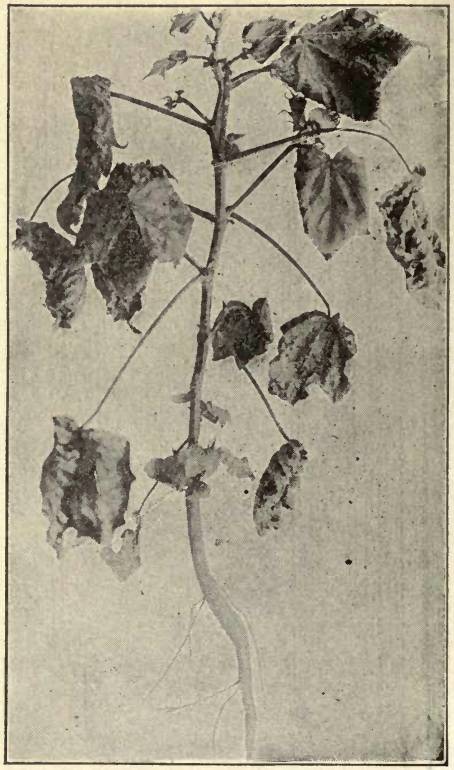
SUGAR CANE

Red Rot (*Colletotrichum falcatum*, Went.).—This is one of the most destructive diseases of the sugar cane. It causes the plants to wilt and finally a yellowing of the upper leaves. This is followed by a blackening and dying of the eyes and a gradual discoloration on the outside extending from the nodes. Upon splitting the canes, the fibro-vascular bundles are found to show reddish discolorations.

Rind Disease (*Trichosphaeria sacchari*, Massee).—Although this disease is not so severe as the preceding one, it causes a premature yellowing and dying of the plants. The joints become discolored and shrunken and the entire plant loses weight. Finally, small black eruptions which are thread-like in appearance appear over the canes.

The Pineapple Disease (*Thielaviopsis ethacetica*, Went.).—This disease is of comparatively little importance, but it sometimes attacks the cuttings which have been prepared for planting and prevents their growth or causes weak, unhealthy plants.

Treatment.—The most satisfactory treatment for these three diseases is care in selection of good healthy plants for cutting and the treatment of these cuttings with Bordeaux mixture before planting.



A Young Cotton Plant Affected by Cotton Wilt.[1]

When the grower has any reason to suspect the appearance of these or other diseases, he should consult with the plant pathologist of the experiment station in the state in which he is located.

Other Diseases.—There are a number of other diseases of minor importance.

COTTON

Anthracnose (*Golmerella gossypii*, Southworth Edg.).—This disease attacks stem, boll and leaves, causing dull, reddish-brown spots which are

[1]Courtesy of Bureau of Plant Industry, U. S. Dept. of Agriculture

slightly depressed. In advanced stages these spots are covered with a dirty gray or pinkish powder which is the spores of the fungus. This disease is carried in the seed and is the cause of heavy losses.

Damping Off, Sore Shin, Seeding Rot.—These diseases may be due to any one of several organisms. They attack the young plants at or just below the surface of the ground, causing them to rot off and die. They are sometimes the cause of heavy losses.

There are a number of other diseases of the cotton. The most satisfactory remedy for most diseases is the selection of seed from healthy plants. Where growers experience much difficulty, they should consult with the authorities at the state agricultural experiment station.

FLAX

Wilt (*Fusarium lini*, Bolley).—This is one of the most severe diseases of the flax. Sometimes the organism causing this disease is so abundant in the soil that it leads to the term "flax sick soil." The new plants affected with this disease wilt and die and fields are very frequently seen in which there are large bare spots due to the ravages of this disease. When the older plants are attacked they wilt and gradually turn yellow and die.

The grower who has any difficulty with this or other diseases should consult with the state agricultural experiment station.

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618. "Leaf Spot: A Disease of the Sugar Beet."
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CHAPTER 20

Insect Pests and Their Control

By W. B. Wood

Scientific Assistant, Bureau of Entomology, U. S. Department of Agriculture

Insects are, without doubt, the greatest enemies of the farmer, for they destroy the crops of field and garden and render the fruit on the trees unfit for use; they injure the domestic animals by constant irritation, causing them to lose weight and even to die. Stored grains, tobacco and other farm products also suffer from their attacks.

After studying their life histories and habits, methods of control have been devised by which they can be combated with a reasonable amount of success. Many species can be held in absolute control by thorough and timely applications of the proper remedies, while others are only partially held in check.

In order to intelligently apply a treatment for the control of an insect, something of its habits must be known, especially in regard to its manner of feeding. Most of the important pests fall within two great groups, namely, biting or chewing insects and sucking insects, depending on whether the mouth parts are chisel or pincher-like in the first class, or beak-like and made for piercing and sucking in the second class. A number of these pests will fall in certain special groups which require a definite treatment, indicated by their manner of living or by the injury they do. Some of these special classes are internal feeders, as boring insects, subterranean insects and insects affecting stored products.

The external feeders, which have biting mouth parts, usually feed upon plants by gnawing out small pieces of the plant tissue which are swallowed. This group includes the larvæ or caterpillars of moths and butterflies, the larvæ of beetles and the adults, grasshoppers and crickets, and the larvæ of some species of *Hymenoptera* or the wasp group. Such insects may usually be controlled by applying a poison to the plant, either as a fine spray or as a powder dusted or blown over its surface. The arsenicals have been found to be the best remedy for this group.

The sucking insects feed by piercing the skin or epidermis of plants with their sharp beaks and sucking the sap. This group of insects is represented by the tree bugs or *Hemiptera*, to which order belong the squash bug, scale insects, plant lice and leaf hoppers. It is evident that a stomach poison on the surface of the plant would not affect insects of this class, so it is necessary to use what is known as a contact insecticide, which should be applied as a spray or wash directly to the insect's body. Such

remedies kill by their suffocating or corrosive action. The most common of these insecticides are nicotine solutions, kerosene or oil emulsions, lime-sulphur wash and fish-oil soap.

In the following pages will be found listed the principal insect pests of farm crops under the class of crops to which they are most injurious. Only a very brief description of each insect can be given, and in most cases nothing of their life histories, in the limited space devoted to the subject. The treatments which have given the best results in each individual case are indicated briefly and reference is made to publications which give a more extended account of the insects. The abbreviations which are used in the references are as follows:

Bur. Ent. Bull.—U. S. Department of Agriculture, Bureau of Entomology Bulletin.
Bur. Ent. Cir.—U. S. Department of Agriculture, Bureau of Entomology Circular.
Farm. Bull.—U. S. Department of Agriculture, Farmers' Bulletin.
Dept. Bull.—U. S. Department of Agriculture Bulletin.

GENERAL CROP INSECTS

Caterpillars (leaf-eating).—Many plants are attacked by caterpillars which feed upon the leaves. These worms are the larvæ of *Lepidopterous* insects, or moths and butterflies.

Treatment.—Spray with an arsenical, preferably arsenate of lead, or dust with powdered arsenate of lead or Paris green. If the spray gathers in drops and does not adhere well to the surface of the leaves, use a resin fish-oil soap sticker.

Cutworms.—Various species of the family *Noctuidæ*, usually feeding at night upon the roots, crowns or foliage of plants. The worms may be found in daytime lying curled up in ground about an inch below surface.

Treatment.—Broadcast poison bran mash about the garden in the spring just before the plants come up. Make other applications later if the cutworms are still found. Cultivate the ground thoroughly in late summer and early in the spring to prevent the growth of grasses and weeds, thus starving out worms if present.

Grasshoppers or Locusts.—A number of species feed on corn, wheat, sorghum and other field crops, also on many garden crops and at times on fruit trees.

Treatment.—Cultivate the fields and stony fence rows in the fall to break up the egg masses deposited one to two inches below the surface of the ground. Broadcast Criddle mixture or poison bran mash flavored with juice of orange or lemon in fields where grasshoppers are plentiful.

Leaf Beetles (*Chrysomelidæ*).—Crops of many kinds are injured by beetles which feed upon the leaves as adults and sometimes as larvæ.

Treatment.—Spray or dust the affected plants with arsenicals.

Plant Lice (*Aphididæ*).—Many species of plant lice are found attacking field, garden and orchard crops. They feed by sucking the juices of the host plant and cannot be controlled by a poison spray.

Treatment.—Use sprays of nicotine or tobacco extract, kerosene emulsion (5 to 10 per cent strength) or fish-oil soap just after the aphids appear and at such other times as may be necessary. Spray thoroughly, being sure to wet all plant lice. If spray does not adhere to the bodies of insects, add 2 or 3 pounds of laundry soap to 50 gallons of spray solution, or preferably an equal amount of resin fish-oil soap as a sticker. For underground forms practice rotation of crops or use soil fumigants.

White Grubs (*Lachnosterna spp.*).—White grubs or grubworms are the larvæ of the common brown beetles known as May beetles or June bugs, commonly seen around lights and on the screens in the spring and summer. Their natural breeding place is grass lands, but they are found in fields and gardens feeding upon the roots of many plants.

Treatment.—No successful treatment is known. Practice crop rotation when necessary. Fall plowing will be of some benefit. Do not plant crops liable to be injured, as strawberries, on recently broken sod land.

Wire Worms (*Elateridæ*).—Slender, brown, hard, shining larvæ, ½ inch to 1½ inches long, body divided into several segments which show plainly three pairs of small legs near front end of body. Their natural breeding place is grass lands, but they feed on or in the roots of many garden and field crops. Two years or more are required for development.

Treatment.—No satisfactory treatment has been found. Rotation of crops, preventing ground from remaining long in grass, and late fall plowing followed by repeated harrowing for a month or two are the best means of preventing their increase. Seeds might be protected by the use of some substance as a repellent which would not injure germination.

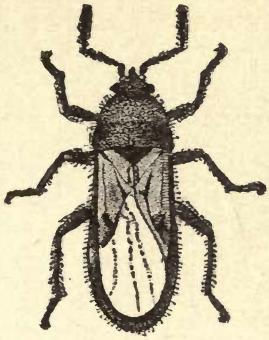
GENERAL CROP INSECTS

The Army Worm (*Leucania unipuncta*, Haworth).—In general appearance it resembles cutworms. About 1½ inches long, dark in color, with three yellowish stripes down the back. The adult insect is a dull brown moth, often seen about lights in the spring. The worm feeds naturally on wild grasses, but when it is abundant marches across fields, destroying many crops, including corn, wheat, oats and related crops, as well as many truck crops.

Treatment.—The march of the worms to uninfested fields may be checked by a deep dust furrow through which a log is dragged occasionally to crush the worms and to maintain a thick coat of dust on the sides. Scattering poison bran mash through infested fields will often prove very effective. Late fall plowing and cultivating will help in destroying overwintering worms.

The Alfalfa Leaf Weevil (*Phytonomus posticus*, Fab.).—This insect, which has been accidentally introduced into the United States from Europe, now threatens the alfalfa industry of the country. From a small field near Salt Lake, where it was first found, it has spread through the surrounding country until it has gone as far as Wyoming and Idaho. In the spring

the adult insect punctures the stems of the plants as they are coming up, and deposits its eggs in the wounds. The grubs hatch and feed upon the tender leaves until they are fully developed. Transformation then takes place and the adult beetle begins to destroy the foliage.



CHINCH BUG (*Blissus leucopterus*).[1]
Adult of long-winged form, much enlarged.

Treatment.—Breaking up the ground in the spring with a disk harrow to stimulate a rapid growth has been found to be beneficial. Clean up all trash and rubbish which might form hiding places for the insect. Immediately after first cutting use a spike-tooth harrow, followed closely by a brush drag to knock off and kill the grubs.

Bur. Ent. Bull. 112; Utah Exp. Sta. Bull. 110.

The Chinch Bug (*Blissus leucopterus*, Say.).—Throughout the Middle states this is the worst enemy of all kinds of grains. It hibernates for the most part in clumps of grass, but may be found in weeds and rubbish along fence rows. The bug injures the plant by sucking the sap from the stalks.

Treatment.—Concerted action by the farmers in a large area, in burning the bunch grass late in the fall or in early winter, is the best means of control. The grass should be burned close to the ground when it is perfectly dry, thus destroying many of the insects and leaving others unprotected against the storms of winter. When bugs are migrating from small grains to corn or other crops in summer, they may be stopped by dusty ditches with post holes in bottom, by dust ridges or coal tar barriers.

Farm. Bull. 657.

CHINCH BUG (*Blissus leucopterus*).[1]
Adults of short-winged form, much enlarged.

[1] Bur. Ent. Cir. 113.

Clover Mite (*Bryobia prætensis*, Garm.).—A common red mite on many plants, including clover, alfalfa and a number of varieties of fruit.

Treatment.—Dust the plants with sulphur and lime at rate of 1–4, or spray with either 10 per cent kerosene emulsion or sulphur in water, 1 pound to 4 gallons. Destroy eggs on fruit trees in winter with 20 per cent kerosene emulsion or with lime-sulphur.

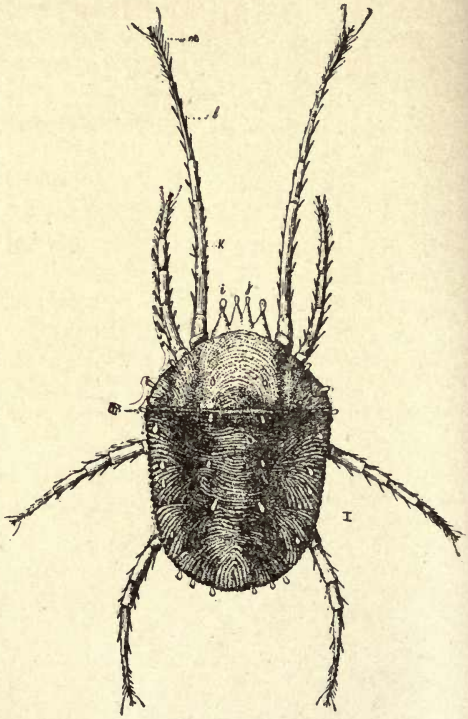
Bur. Ent. Cir. 158.

Clover Root Borer (*Hylastinus obscurus*, Marsham).—The beetle winters over in clover roots; emerges in the spring and lays eggs in the larger roots. The grubs, on hatching, bore through central part, destroying plants.

Treatment.—Plow the fields after haying, allowing the roots to dry. Pasturing checks the injury. Infested field should not be allowed to stand over the second season.

Bur. Ent. Cir. 119.

Corn Ear Worm (*Heliothis obsoleta*, Fab.).—This insect is also known as the cotton boll worm, the tobacco bud worm or the tomato fruit worm. It has a long list of other food plants, but on many causes no serious injury. On corn the eggs are laid by the moths upon the silk. The larvæ upon hatching enter the ear and begin to feed on the immature grains. Cotton is not seriously attacked until the corn silks are drying up, as corn is much preferred by the worms. The adults lay their eggs upon the cotton leaves and the larvæ, after feeding for a short time upon the foliage, enter the bolls. They attack tobacco by eating into the buds, and tomatoes are injured by attacks upon the fruit.



Clover Mite (*Bryobia prætensis*).[1]
Enlarged; natural size shown by line at right.

Treatment.—For all crops the injury is materially lessened by late fall plowing and cultivation which crushes many pupæ in the soil and exposes others to the winter. On cotton the insect may be well controlled by two applications of an arsenical dust or spray at the time the eggs are hatching. Tobacco may be protected by dropping into the buds a little

[1] Bur. Ent. Cir. 158.

corn meal, poisoned with powdered arsenate of lead, using 2 or 3 spoonfuls to a quart of meal. Early maturing varieties of corn or cotton will not be so seriously injured as the later kinds.

Farm. Bull. 290; Bur. Ent. Bull. 50.

The Corn Root Aphis (*Aphis maidi-radicis*, Forbes).—A bluish-green plant louse found on the roots of corn, broom corn, sorghum and on several weeds. It weakens the plant, causing it to be stunted and poorly nourished.

Treatment.—One year rotation to other crops than corn, clean cultivation and liberal use of fertilizers, winter plowing to break up nests of ants where aphis eggs are stored.

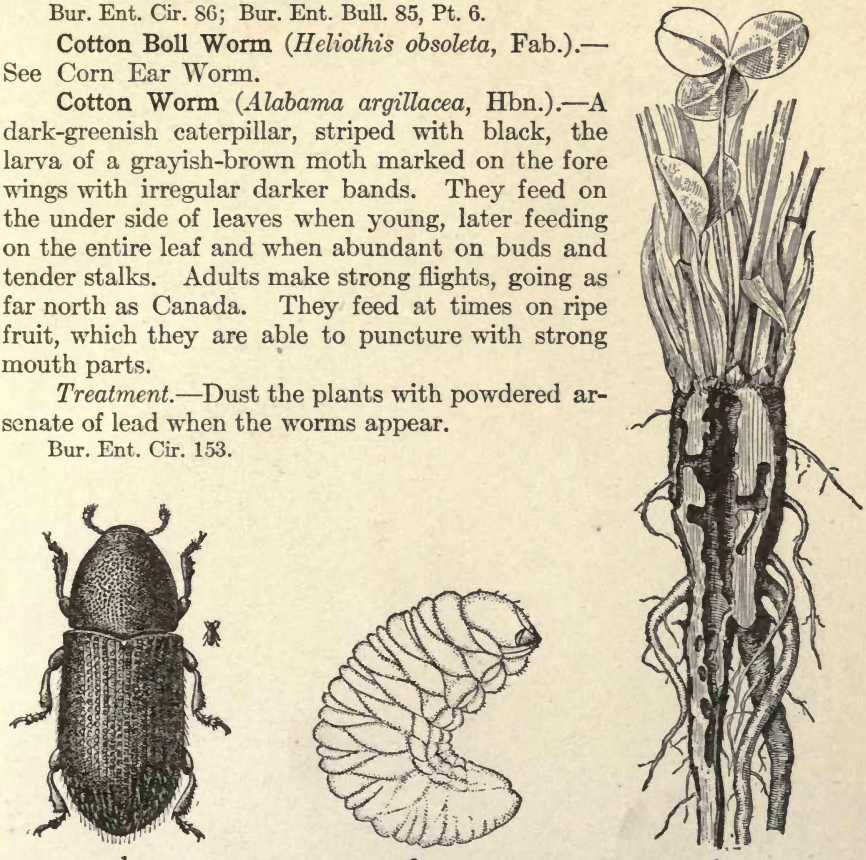
Bur. Ent. Cir. 86; Bur. Ent. Bull. 85, Pt. 6.

Cotton Boll Worm (*Heliothis obsoleta*, Fab.).—See Corn Ear Worm.

Cotton Worm (*Alabama argillacea*, Hbn.).—A dark-greenish caterpillar, striped with black, the larva of a grayish-brown moth marked on the fore wings with irregular darker bands. They feed on the under side of leaves when young, later feeding on the entire leaf and when abundant on buds and tender stalks. Adults make strong flights, going as far north as Canada. They feed at times on ripe fruit, which they are able to puncture with strong mouth parts.

Treatment.—Dust the plants with powdered arsenate of lead when the worms appear.

Bur. Ent. Cir. 153.



1 2 3

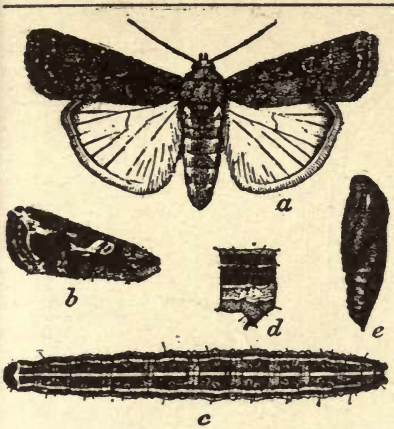
Clover Root Borer (*Hylastinus obscurus*).[1]

1—Adult beetle, natural size at right. 2—Larva or grub, much enlarged. 3—Showing work of the borer.

[1]Bur. Ent. Cir. 119.

COTTON WORM (*Alabama argillacea*).[1]
Stages and work.

[1]Bur. Ent. Cir. 153.



FALL ARMY WORM
(*Laphygma frugiperda*).[1]

A—Moth, plain gray form. B—Fore wing of prodenia-like form. C—Larva extended. D—Abdominal segment of larva, lateral view; twice natural size. E—Pupa, lateral view.

army worm, but with different plants, including many forage and truck crops.

Treatment.—Practice fall plowing to break up the pupæ cells in the ground. Scatter poison bran mash when the caterpillars appear, or spray or dust with arsenicals.

Bur. Ent. Bull. 29.

The Green Bug, or Spring Grain Aphis (*Toxoptera graminum*, Rond.).—A small green plant louse which attacks oats, wheat, barley and other grains. It appears very early in the spring.

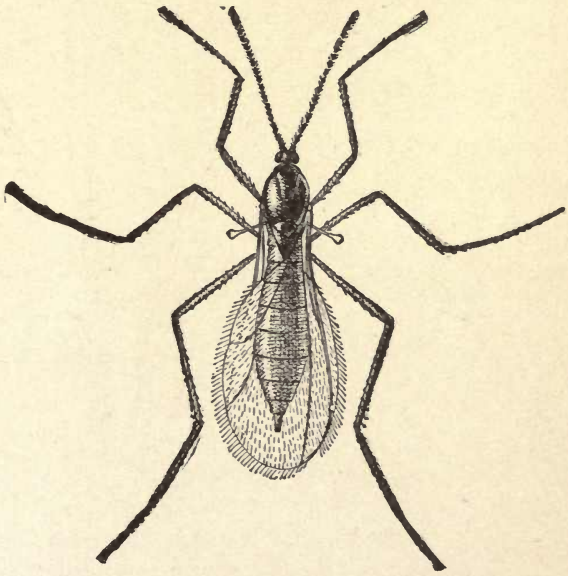
Treatment.—No satisfactory method of control is known. Attacks may be partially pre-

The Cotton Red Spider (*Tetranychus bimaculatus*, Harvey).—This small red mite is common on cotton and on several other plants, especially pokeweed and violet. It causes the leaves of cotton to turn red and fall off. It kills plants if abundant.

Treatment.—Prevent the mites from starting on the cotton by clean culture, being sure to eradicate all pokeweed and violets near the fields. If found in cotton fields, spray the affected plants with potassium sulphide 3 pounds and water 100 gallons; make two applications one week apart.

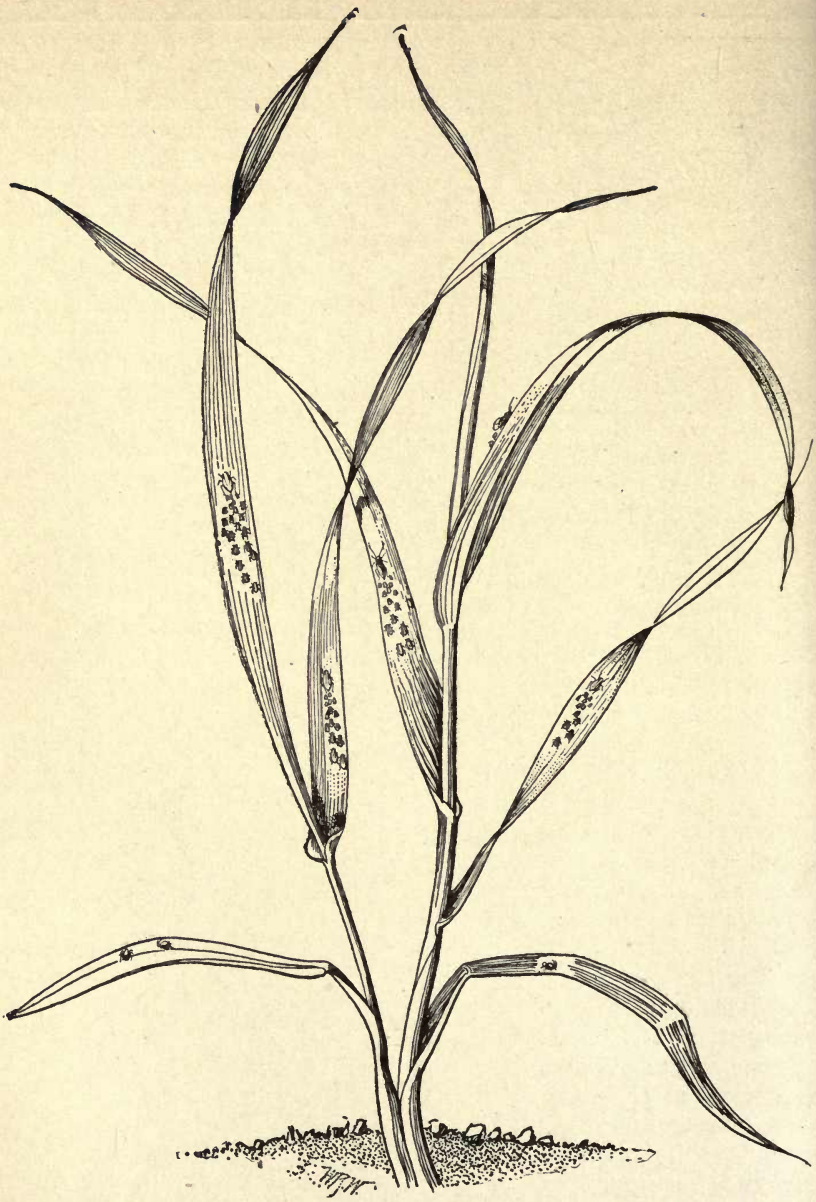
Bur. Ent. Cir. 172.

The Fall Army Worm (*Laphygma frugiperda*, S. and A.).—In general appearance is similar to the common markings. It has wide range of food



HESSIAN FLY (*Mayetiola destructor*).[2]
Adult female, much enlarged.

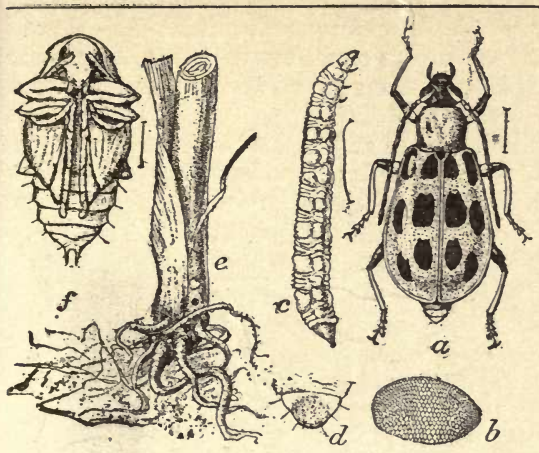
[1] Bur. Ent. Bull. 29. [2] Farm. Bull. 640.



GREEN BUG, OR SPRING GRAIN APHIS (*Toxoptera graminum*).[1]

Wheat plant showing winged and wingless viviparous females with their young clustered on leaves, and a few parasitized individuals on lower leaves. About natural size.

[1] Bur. Ent. Bull. 110.



SOUTHERN CORN ROOT WORM
(*Diabrotica duodecimpunctata*).[1]

A—Beetle. B—Egg. C—Larva. D—Anal segment of larva. E—Work of larva at base of corn stalk. F—Pupa. All much enlarged except E, which is reduced.

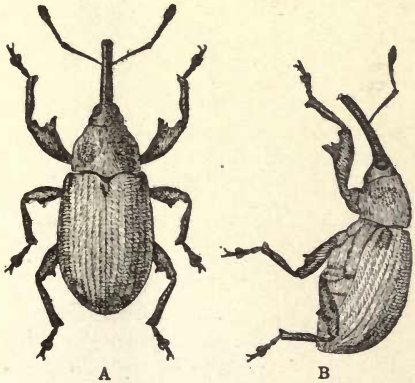
vented by late planting and by the destruction of volunteer wheat and oats in the fall.

Bur. Ent. Bull. 110.

The Hessian Fly (*Mayetiola destructor*, Say.).—This small two-winged fly is one of the most destructive insects of growing wheat, causing the plants to be stunted and to break down near harvest time.

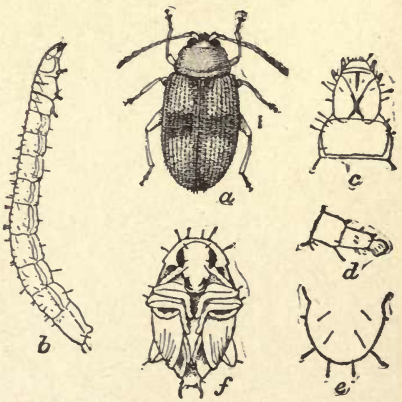
Treatment.—Burn the stubble or plow it under as soon after harvest as possible. Destroy all volunteer wheat just before sowing. Delay the sowing until ten days or two weeks after usual time. The two latter precautions should prevent most of usual injury.

U. S. Dept. Agri. Cir. 51, Office of Secretary; Farm. Bull. 640.



COTTON BOLL WEEVIL
(*Anthonomus grandis*).[2]

A—Beetle, from above. B—Same from side. About five times natural size.



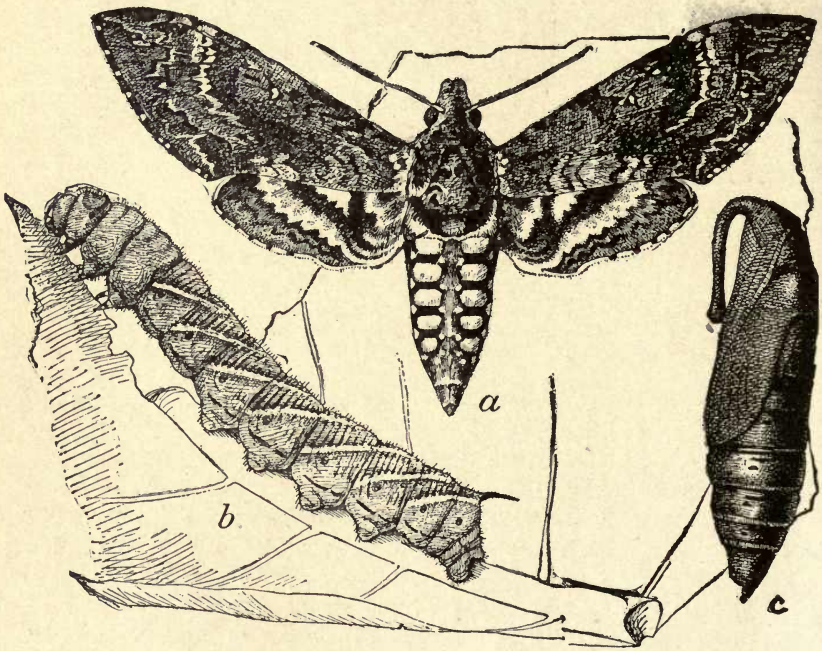
TOBACCO FLEA BEETLE
(*Epitrix parvula*).[3]

A—Adult beetle. B—Larva, side view. C—Head of larva. D—Hind leg of same. E—Anal segment of same. F—Pupa. A, B, F—Enlarged about fifteen times. C, D, E—More enlarged.

[1] Bur. Ent. Bull. 43. [2] Farm. Bull. 344. [3] Bur. Ent. Cir. 123.

Mexican Cotton Boll Weevil (*Anthonomus grandis*, Boh.).—No pest of cotton has caused so much injury as this small brown beetle. Both the adult insects and the larvæ feed upon the squares and the bolls, injuring the fiber.

Treatment.—Clean up and destroy all stalks, dead bolls and crop remnants as soon as cotton is picked, either by burning or burying. Plow under or burn in the fall and winter all trash in neighboring fields and



Southern Tobacco Horn Worm (*Phlegethontius sexta*).[1]
A—Adult. B—Larva. C—Pupa.

hedgerows where the insect might hibernate. Prepare the land early, plant early and fertilize heavily to secure an early crop.

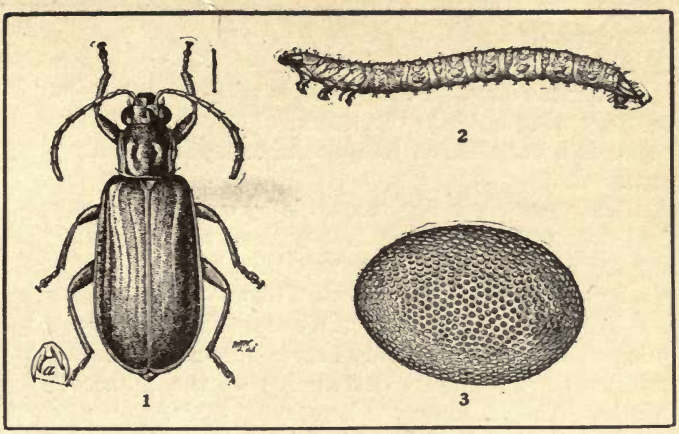
Farm. Bull. 344, Senate Document No. 305, 62d Congress.

Spring Grain Aphis (*Toxoptera graminum*, Rond.).—See Green Bug.

Southern Corn Root Worm, or Bud Worm (*Diabrotica duodecimpunctata*, Oliv.).—Greenish-yellow beetle marked on the back with twelve black spots. Feeds on a variety of plants. Larva or grub feeds on roots of corn after boring into roots and stem.

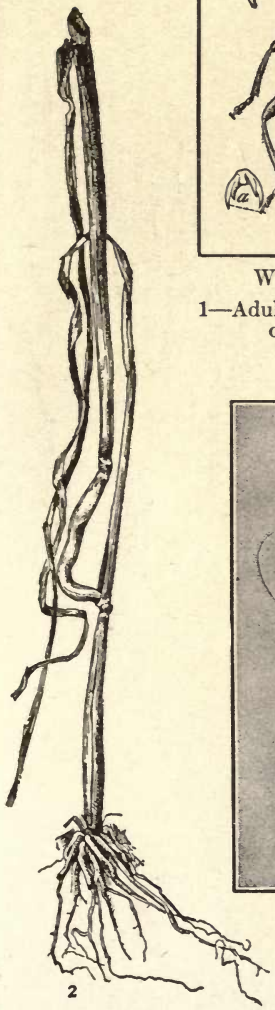
Treatment.—No satisfactory insecticidal treatment is known. The worst of the injury may be prevented in Southern states by planting about

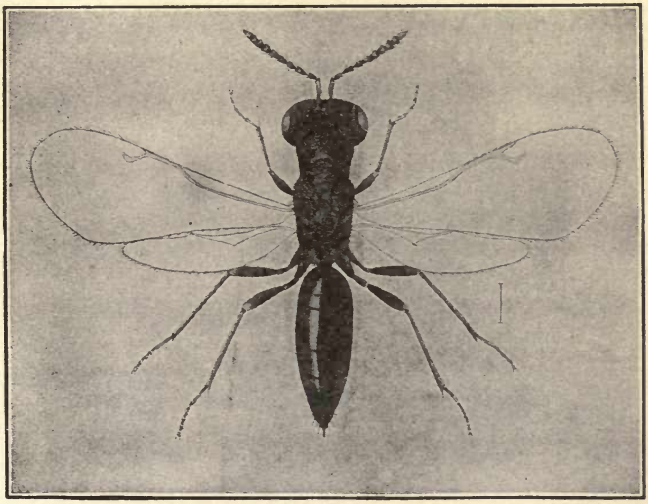
[1] Bur. Ent. Cir. 123.



WESTERN CORN ROOT WORM (*Diabrotica longicornis*).[1]

1—Adult, or beetle; *a*, claw of hind leg; much enlarged. 2—Larva, or worm, much enlarged. 3—Egg, highly magnified.





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WHEAT JOINT WORM (*Isosoma tritici*).[2]

1—Adult of the joint worm much enlarged. 2—One effect of the joint worm in wheat straw.

[1] Dept. Bull. 8. [2] Bur. Ent. Cir. 66.

three weeks later than usual or after most of the first brood eggs have been deposited.

Dept. Bull. No. 5.

Tobacco Flea Beetle (*Epitrix parvula*, Fab.).—A small dark-colored beetle, eating holes in the leaves of tobacco. The beetle is a very active jumper and cannot be readily captured.

Treatment.—Apply arsenicals by spraying or as dust when the injury is first noticed and again a few days later, if the beetles are still present.

Bur. Ent. Cir. 123; Year-Book 1910, pp. 281–296.

Tobacco Worms, or Horn Worms (*Phlegethontius quinquemaculata*, Haw., and *P. sexta*, Johan.).—These two pests are the most destructive of the tobacco insects. They feed on the leaves and buds.

Treatment.—Hand picking or the use of arsenicals will prevent serious injury.

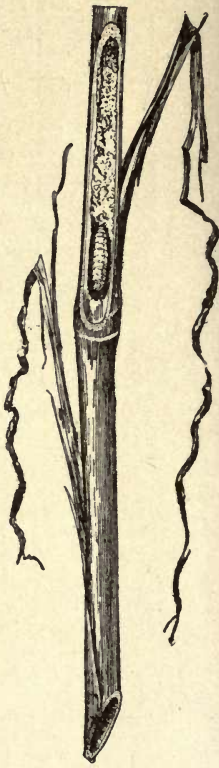
Bur. Ent. Cir. 123; Bur. Ent. Cir. 173

Western Corn Root Worm (*Diabrotica longicornis*, Say.).—A yellowish green beetle, the larva of which feeds on the roots of corn. There is only one generation of the insect each year.

Treatment.—The only successful way of combating the pest is to rotate crops from corn to one of the small grains.

Dept. Bull. No. 8.

Wheat Joint Worm (*Isosoma tritici*, Fitch).—Most of the injury from this insect has been found in the wheat-growing regions east of the Mississippi River. The adult is a small black insect somewhat resembling a small winged ant. Eggs are laid in the straw of growing wheat after several joints have been formed. The larvæ develop in the joints and emerge in the following spring.



LARVA OF *Isosoma grande* IN WHEAT STRAW.[1]

Treatment.—Burn or plow under all stubble in the fall. Burn all outstanding straw in spring. Do not scatter green manure in fields to be planted in wheat in spring if infested straw was used for bedding. Fertilize liberally. Practice rotation of crops.

Bur. Ent. Cir. 66.

Wheat Straw Worm (*Isosoma grande*, Riley).—West of the Mississippi River this insect is often a very serious enemy of wheat. The larva works inside the young shoots early in the spring and the later generation in straw.

Treatment.—Injury can be largely prevented by a rotation of crops

[1] Bur. Ent. Cir. 106.

according to Prof. F. M. Webster. Wheat should not be planted on the same ground two years in succession.

Bur. Ent. Cir. 106.

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634. "The Larger Corn Stalk Borer."
636. "The Chalcis-Fly in Alfalfa Seed."
637. "The Grass Hopper Problem and the Alfalfa Culture."
640. "The Hessian Fly."
671. "Harvest Mites or Chiggers."

CHAPTER 21

Insecticides and Fungicides

By H. Garman
Professor of Entomology, University of Kentucky

The word insecticide has come to mean any chemical or other substance used to destroy insects that are hurtful or objectionable in any way to man. This definition excludes substances such as sticky fly-paper that may be employed to entrap pests and would, according to some entomologists, exclude also simple deterrents, such as oil of citronella, used to keep insects away by their offensive odors. In a general way, however, every substance employed to prevent the injuries of insects is an insecticide and in this view it does not matter whether or not they kill, deter or entrap.

The insecticides most used and valued by practical men either kill as poisons when eaten with food, or else destroy when brought in contact with the bodies of insects, in which case they are sometimes called contact insecticides.

A group of insecticides of which the effective ingredient is arsenic has proved especially popular and useful in suppressing insects which feed by gnawing away and devouring the leaves of plants.

Paris Green.—Of these the one best known and most used is Paris green, Schweinfurth green, or Imperial green, French green and Emerald green. It was first used in the arts, and because of its cheapness and poisonous properties was early tried on the Colorado potato beetle (about 1868) proving a very satisfactory means of suppressing the pest when used either as a dry powder or when stirred into water. It contains a little soluble arsenic however, and in water this is liable to burn leaves to which it is applied, hence care must be exercised not to use too much. Four to five ounces of the powder in a barrel of water is commonly regarded as enough; if more is used a pound or two of freshly-slaked lime may be added to neutralize its caustic effect.

Arsenate of Lead.—Paris green has two defects: Its burning action is often hard to guard against, and its weight causes it to settle quickly when used in water, rendering the spray produced uneven in strength. Stirrers connected with spray pumps obviate the latter trouble, but sometimes increase the labor of operating pumps. The addition of lime, as already suggested, lessens the burning action, though the lime may, if care is not exercised, increase the labor of applying.

Arsenate of lead has neither of these defects. It is practically insoluble in water, does not burn foliage, and it is so finely subdivided that it

remains suspended much better than Paris green. It has the additional advantage of adhering to leaves longer than Paris green, and thus fewer applications are required. A single spraying with this substance, if applied at the right time, is for some plants sufficient for a whole season. The arsenate of lead paste is commonly used with water in the proportion of 2½ to 3 pounds in 50 gallons. As found in the market it contains about 50 per cent of water.

It requires more by weight to destroy insects than Paris green, but the cost per pound is less and hence the actual cost for materials amounts to about the same, whichever poison is used. Its advantages are so decided in other directions that it is now supplanting Paris green in popular favor. For the injuries of most gnawing insects working on foliage this insecticide may be safely recommended.

To meet the objections sometimes made to arsenate of lead paste, a powdered arsenate of lead has recently been offered to the public by manufacturers of insecticides. The paste when dried out is lumpy and is not in this condition easy to mix with water. In the powdered form it is not open to this objection and may, besides, be dusted over plants without the addition of water.

There are serious objections to the use of poisonous dusts, however, though in practice they have advantages that always commend them to workmen. The weight of the water to be carried when using liquid sprays increases the labor, of course, and this ought to be lessened if it can be done without diminishing the effectiveness of the applications, and also without increasing the danger to those making the applications. The inhaling of either dry Paris green or arsenate of lead is a serious matter, and if continued long is certain to lead to ill health. Liquid sprays go more directly and evenly to the plants and stay there. They may be made just as promptly effective as the dusts if used when the injury is beginning. They are not so likely to be inhaled.

Arsenite of Zinc.—This poison has somewhat recently been recommended as a substitute for Paris green and arsenate of lead, and appears to be about equally good and somewhat cheaper than either. It is a finely divided white powder as put on the market and remains in suspension about as well as arsenate of lead, having thus some advantage over Paris green. It contains a little water-soluble arsenic and has been claimed to be less injurious to foliage even than arsenate of lead, possessing at the same time about the same killing power. For use it is stirred first into a little water and allowed to soak for a time, then is stirred into the water in which it is to be used, about one pound of the powder being added to 50 gallons of water. It contains nearly the same quantity of arsenic as Paris green. Like arsenate of lead, it remains in suspension better if a little soap is dissolved in the water into which it has been stirred. It has of late been quoted by dealers at from 20 to 25 cents per pound.

London Purple.—This arsenite came into use for injurious insects

somewhat later than Paris green (about 1878), but is less used now than formerly because of its lack of uniformity in composition and its excessive burning of foliage. Its affective ingredient as an insecticide is arsenic in the form of lime arsenite and lime arsenate, of which it contains about 40 per cent, nearly half of which is soluble. It is the soluble arsenious and arsenic oxides that make this insecticide so injurious to the foliage and render necessary the addition of lime. The amount of pure arsenic present has been found to be about 29 per cent. For use it is customary to recommend about one-quarter pound each of London purple and fresh lime in from 50 to 75 gallons of water.

White Arsenic.—The use of this poison has been recommended from time to time for gnawing insects, but the time and labor required in boiling it with milk of lime (thus producing an arsenite of lime) in order to avoid its burning effect on foliage has prevented its general employment as an insecticide. It can be made to accomplish the same purpose as Paris green and arsenate of lead, without injury to foliage, by boiling for a half hour 1 pound of commercial arsenic and 2 pounds of fresh lime in 4 gallons of water, diluting with water finally to make 100 gallons.

Sulphur.—Flowers of sulphur has been used for many years as an insecticide, especially for mites infesting hothouse plants. When dusted on plants it does no harm to the leaves, but is not as effective as could be desired. When burned in hothouses it may do severe injury to plants. These defects have led to its neglect by entomologists. When sulphur is boiled with lime, however, it produces a lime sulphide, in which condition it becomes one of the best of insecticides for use in winter against scale insects.

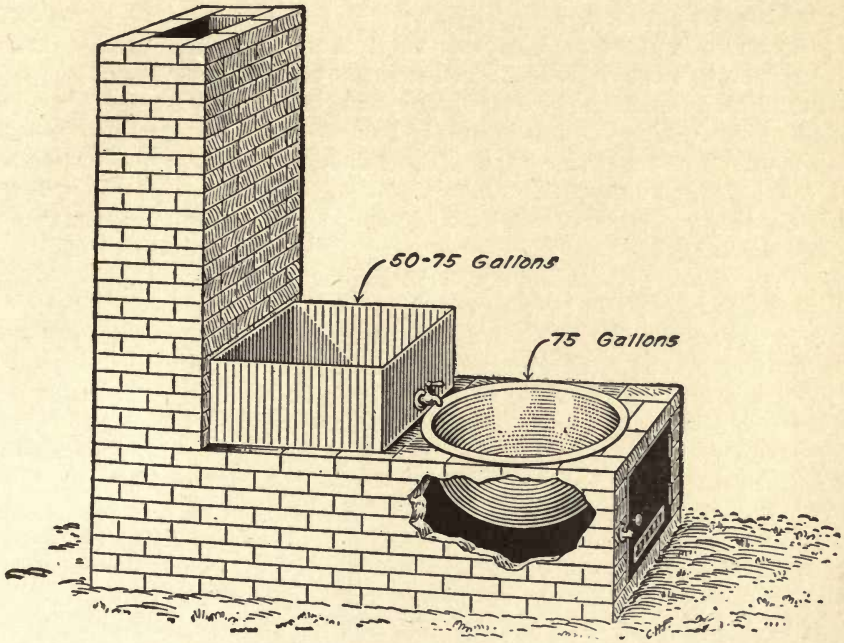
Lime-sulphur Wash.—In this condition thousands of barrels of the boiled sulphur and lime are sold to fruit growers every year, who use it largely as a remedy against San José scale. A concentrated solution is prepared by boiling in large iron kettles, tanks or other vessels, 50 pounds of fresh lime, 100 pounds of sulphur and 50 gallons of water. Part of the water is heated, then the lime is added and is followed by the sulphur, the whole being stirred continually while boiling, the time employed being from fifty minutes to an hour. Finally, after adding enough hot water to make 50 gallons, the solution is strained and set aside until ready to use. Home-made solutions may not test higher than 27 to 30° Baumé, but when carefully made go higher and may even reach 34 or 35° Baumé, the differences being apparently due to differences in the quality of limes used.

The manufacturers now follow about the same formula in producing their concentrated products, but because of having better facilities will perhaps average higher in concentration than the fruit grower, although analysis of samples bought in the market have sometimes shown that they did not test as high as good home-made lime-sulphur.

These concentrated solutions are of a deep reddish-yellow color and for use must be greatly diluted with water. It is customary in spraying

for San José scale to use one part of the solution to eight or ten of water and to apply during open weather in February or March, while the trees are still dormant. For summer use they must be diluted with from 30 to 50 parts of water to avoid injury to the foliage, but lose much of their value as insecticides when thus weakened. The concentrated solution is regarded as the most effective remedy for scale injury now in use.

It should be added that there has somewhat recently appeared a so-called "soluble sulphur" which is recommended for the same uses as



A Lime-sulphur Cooking Outfit.[1]

lime-sulphur. It promises well, but has not been tested long enough and carefully enough to justify very positive statements as to its merits.

Tobacco Extracts.—For use against soft-bodied insects such as plant lice there is no more useful insecticide than extracts made from the midribs of tobacco leaves. These extracts contain as their effective ingredient nicotine and differ widely in the percentage of nicotine they contain. Home-made extracts or decoctions are made by placing a couple of pounds of the midribs in a wooden bucket full of boiling hot water, allowing it to stand over night. The percentage of nicotine under such treatment will probably not be more than 0.07 per cent, but it is a very useful wash for plants infested with aphides, does no harm at all to leaves, and where

[1] From Farmers' Bulletin 650, U. S. Dept. of Agriculture.

tobacco is grown and the midribs can be easily secured is one of the very best insecticides for uses of this sort. The whole leaf makes a somewhat stronger extract (0.12 per cent) as determined by tests recently made at the Virginia Station. Soaking seems to extract as much of the nicotine as boiling. When plants are to be treated on a larger scale it becomes important to know just how much nicotine is present in a wash, and manufactured extracts, some of them containing 40 per cent of nicotine, are demanded. For the apple leaf louse, the lettuce louse, the rose aphis and other similar pests, these extracts are safe and effective. For thick-skinned insects they are not so satisfactory.

Tobacco is often used in other ways as a remedy for insect injuries, but is open to some objections when so employed. Florists have long used the midribs (often called "stems") for making a smudge for the destruction of plant lice. The tobacco is simply burned in a perforated iron vessel. The smoke leaves a strong smell of tobacco on flowers, which is sometimes objected to by buyers. The odor can be avoided by using the extract diluted with water and driven off as a vapor by dropping a hot iron into a pan containing it.

Pyrethrum.—Under the name Persian insect powder or simply insect powder this insecticide is to be obtained from most dealers in drugs. It is a brown powder made from the flowers of a rather handsome plant of the sunflower family (*Compositæ*). Its beauty leads florists to propagate it, though few who grow the plant know that it has any relation to the powder sold in drug stores. It comes to us from the East, and the powder commonly sold here is imported, though an effort has been made in the west coast states to manufacture the powder in this country.

The powder is thought to give off a volatile oil which penetrates the breathing tubes of insects and thus by some irritating or suffocating effect overpowers them. It is effective either dry, in water or when burned to produce a smudge, but must be fresh. It loses much of its effectiveness if kept in open packages. Though rather costly for use on field crops, it has a place in the household at times, and may sometimes be profitably resorted to for limited outbreaks of garden pests. Unlike most other insecticides, this one is not hurtful to man; at any rate, not more so than snuff.

White Hellebore.—This is another vegetable product, being the pulverized rootstocks of a plant (*Veratrum album*) of the lily family, occurring in Europe and northern Africa. It is used in this country for the rose slug, either dry or in water, in the latter case about two heaping tablespoonfuls being stirred into a wooden bucketful (2½ gallons) of water. It is a stomach poison and also a contact insecticide.

Old samples when not kept in airtight receptacles lose their virtue and tend to discredit this vegetable poison as a remedy for pests.

Coal Oil.—This oil has become well known as an insecticide in the form of an emulsion. It is a good contact insecticide, serving the same purpose as lime-sulphur wash in the destruction of scale insects, and having

the advantage of remaining effective when diluted. It can, therefore, be used on foliage in summer for both scale insects and plant lice, and being quicker in its action than tobacco extract, has advantages under some circumstances over the extract for the prompt destruction of soft-bodied insects. It is, however, more likely to do injury to plants, especially if the emulsion is badly prepared, and this, together with the work required in making it, leads practical men to neglect it whenever they can use something else.

The standard emulsion is made of one-half pound of whale oil or laundry soap dissolved in a gallon of boiling hot water, this to be added to two gallons of coal oil, and the whole churned for ten minutes by passing rapidly through a force pump. As thus made it can be diluted for use, one part to ten of water.

Crude Oils.—These are sometimes used for the same purposes as the refined oil, and to render them easily mixed with water are sometimes mixed with caustic potash, fish oil and crude carbolic acid, producing a so-called miscible or soluble oil, which can be diluted with water for use like the coal oil emulsion.

Soaps.—Many of the soaps sold in our market can be used at times as a means of lessening the injuries of insect pests. A good soapsuds frequently and freely used on plants infested with aphides or scale insects has a good effect, though not a very prompt one. Stronger solutions must be used with some caution to avoid injury to foliage. When trees are dormant very strong solutions (one or two pounds to a gallon of water) are sometimes used on the trunks for scale and other insects.

Whale oil soap or fish oil soap, as it is sometimes called, is to be preferred to most others because of its more even composition. It is particularly good for use in making coal oil emulsion.

Coal Tar.—In the early days of fruit growing in America this substance was much used on the trunks of trees to prevent the ascent in the spring of the wingless female canker worm moth. It proved to have an injurious effect on the trees after a time, and hardened on exposure, so that the insects could pass over the barrier. It was then used on bands of tin, and by frequent renewal proved a useful check on the insect. But with the introduction of arsenites and spraying machinery, it was given up for the more convenient treatment. It is still used as a barrier, poured along the ground, for chinch-bugs which are migrating from small grains to corn. Seed corn may be treated with it before planting to deter wire worms and the seed corn maggot from attacking the germinating seeds. The corn is first immersed in warm water for a minute or two, then a couple of teaspoonfuls of the tar are stirred quickly among the grain so as to bring a little in contact with each seed. It dries over night so as to be ready for planting the following day. The application does no harm to the germ, as has been determined by germination tests of treated seeds.

Borax.—This substance has often been recommended for roaches in

dwellings, and is sometimes found with an arsenite as an ingredient of proprietary roach pastes. Recent work done with a view to destroying the larvæ of house flies in manure indicates that this is one of the best of insecticides for the purpose, excelling for this use, coal oil, pyroligneus acid, formalin and Paris green. Sodium borate and crude calcium borate were both found effective in killing the larvæ, either when used dry or in solution. It was recommended as a result of the work done that about 0.62 pound of borax be used in 8 bushels of manure. Larger amounts of borax are believed to be injurious to plants when the manure is spread on land. The cost was estimated at one cent per horse per day.

Other Insecticides.—Numerous other insecticides have been recommended, and have had a limited use, but, excepting the fumigants considered later, they have not been generally adopted by practical men. Among them may be mentioned benzene, which is sometimes applied to fabrics to destroy clothes moth; carbolized plaster, sometimes recommended as a remedy for fleas about stables; fir-tree oil, lemon oil and oil of citronella, the latter often employed as a deterrent against the attacks of mosquitoes and also as a preventive of injury to seed corn in the soil. Quassia, the effective ingredient of which is quassiin, is obtained from the wood of the Jamaican *Picrasma excelsa*. It is an old insecticide that has been perhaps most used in solutions for the hop aphis in the West. The extract is made from the "chips" by either soaking or boiling.

Bisulphide of Carbon.—As sold by druggists and manufacturers, this is a brownish fluid which quickly disappears in the air when exposed in an open vessel. Its disagreeable odor is due to impurities, since the odor of pure bisulphide of carbon is not unpleasant. The fumes are not only poisonous, but are inflammable, so that some care must be exercised in handling the fluid. It has proved of special service as a remedy for grain weevil, bean weevil and other insects attacking stored seeds, and for the phylloxera of grapevines in Europe, for the woolly aphis, for ants, and even for the clothes moth. Its great value for such purposes comes not only from its effectiveness in destroying all insects, but also because it is not corrosive and is otherwise not injurious to seeds, fabrics and other objects fumigated. The offensive odor is soon gone if objects that have been exposed to the fumes are thoroughly aired. It cannot be used for fumigating plants infested with insects because of its destructive effect on the plants themselves.

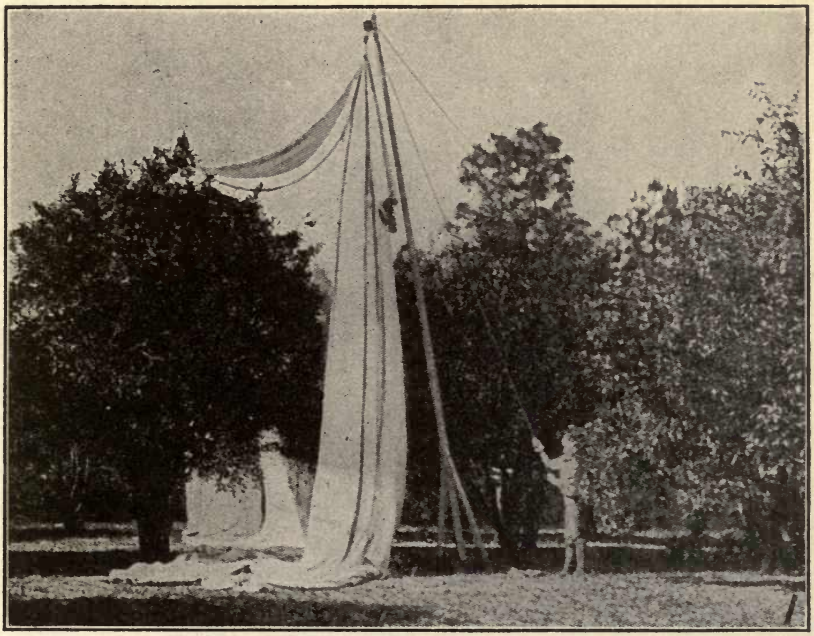
About one fluid ounce should be used on each bushel of seed, and may be poured over the seeds or simply placed in a saucer or other open vessel set on their surface. It is absolutely necessary that the seeds be enclosed in a tight box or bin to get satisfactory results, and the time of exposure should not be less than two nours.

Carbon Tetrachlorid.—The disagreeable odor of commercial bisulphide of carbon renders it objectionable to some people for use on fabrics infested with moth, and has led to the suggestion that carbon tetrachlorid, which

has a rather pleasant odor, be used in its stead. This also is a fluid, and is used in the same way as carbon bisulphide, namely, by pouring it into open dishes or crocks and allowing it to evaporate in a box, bin or room.

It is not nearly as effective in small quantities as either cyanide of potassium or carbon bisulphide, and the large quantities that must be used increase the cost of treatment.

Para-dichlorobenzene.—This is a recently proposed fumigant and is not yet in general use, because of its cost. It is not evil-smelling like



MAKING PREPARATIONS TO FUMIGATE WITH HYDROCYANIC GAS.[1]
Front edge of sheet tent and top of derrick ready to be pulled over tree.

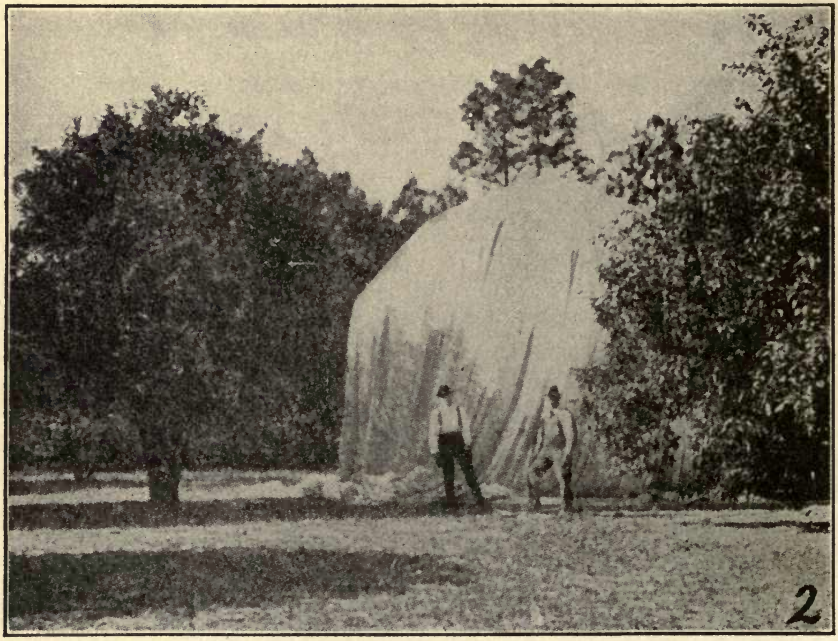
carbon bisulphide, and appears to be quite effective in destroying weevils in grain and clothes moth. Since it is not inflammable, it can be more safely used about dwellings, though its fumes have wonderful penetrating power and escape in some quantity even from tightly stoppered bottles. From a limited experience with it the writer is disposed to regard it very favorably for fumigating seeds and fabrics, though more extended tests may show it to have defects that are not now apparent.

Hydrocyanic Acid Gas.—This gas is made from cyanide of potassium (98 per cent), commercial sulphuric acid of good grade and water. The

[1] Courtesy of U. S. Dept. of Agriculture.

gas produced is very poisonous, as are also the cyanide of potassium and sulphuric acid. When fumigating it is well to place a notice on the room or house warning people not to enter. After the fumigating is accomplished it is advisable to open up doors and windows and air out for ten minutes or more before entering.

The dose to be used depends upon the space to be fumigated and upon the character of the plants to be treated. Dormant trees can be exposed for



FUMIGATING WITH HYDROCYANIC GAS.[1]
Sheet tent ready for introduction of chemicals.

a time to very strong fumes. Growing plants must be treated cautiously with very mild doses. Some of them are very sensitive to the gas and will be slightly burned with any dose calculated to be of value in destroying insects. The condition of the air as to moisture may influence the results, since dampness favors injury from the gas.

For nursery stock it is customary to employ for each 100 cubic feet enclosed, the following:

Cyanide of potassium	1 ounce
Sulphuric acid	1.25 fluid ounces
Water	3 fluid ounces

[1] Courtesy of U. S. Dept. of Agriculture.

FUNGICIDES

When all has been said the number of fungicides approved by the experience of practical and scientific men is very small. Many have been recommended, but comparatively few have stood all the tests as to effectiveness, convenience of application and cheapness.

Copper Sulphate.—At the head of the list stands copper sulphate, a cheap, effective fungicide, commonly known as bluestone. This is the active and most essential ingredient of Bordeaux mixture. Concentrated solutions of it cannot be used alone on foliage because of their caustic action. In winter on dormant trees it is sometimes used for fungous troubles, about two pounds being dissolved in a barrel of water. A weaker solution—1

EFFICIENCY OF BORDEAUX MIXTURE ON POTATOES. ONE ROW NOT SPRAYED.[1]

pound in 200 gallons of water—may be used on foliage in summer when fruit is well matured and it is not desirable to use sprays like Bordeaux mixture, which leave a residue. The bluestone may be quickly dissolved by pouring boiling hot water over it. When one is not hurried it may be dissolved by suspending in a loose sack in the water. It dissolves slowly if simply thrown in the water and allowed to settle.

To avoid to some extent the delays involved in dissolving bluestone it is well to buy a finely powdered grade now manufactured for the making of fungicidal preparations.

Bordeaux Mixture.—A standard formula for the preparation of this valuable mixture is the following:

Bluestone	4 pounds
Fresh lime	4 pounds
Water	50 gallons

[1] Courtesy of New York Agricultural Experiment Station, Geneva, N. Y.

Dissolve the bluestone in 25 gallons of water, slake the lime separately, and add water to make 25 gallons; then pour the two, bucket by bucket, into a third barrel so as to mix thoroughly. For peach and plum, which are more tender than apple and grape, the above formula may be changed to the following:

Bluestone	2.5 pounds
Fresh lime	2.5 pounds
Water	50 gallons

These are the best preparations known for mildews, rots, scabs, smuts and the like, and where one is dealing with a fungous trouble and is uncer-

Treating Grain with Formalin for Smut.[1]

tain as to how to proceed, the chances are that he will accomplish as much by using this preparation as with anything that could be recommended. It is the best general-purpose fungicide we have at present.

Copperas, or Iron Sulphate.—While this is less often used than bluestone, yet it has decided fungicide and antiseptic value, and because of its cheapness may sometimes be found serviceable. As now used it generally comes to the market as a waste product in the manufacture of steel wire, and may be bought for a cent or less per pound.

Formalin, or Formaldehyde.—This very valuable preservative and antiseptic has been much used of late as a remedy for potato scab and to some extent for wheat smut. It is sold as a fluid containing forty per cent of formalin. In this condition it is very acrid, and gives off fumes that affect the eyes and nostrils unpleasantly. Used on the hands, it quickly

[1] Courtesy of H. L. Bolley and M. L. Wilson, North Dakota Agricultural Experiment Station.

destroys the outer skin. It cannot, therefore, be employed except when greatly diluted. But since it retains its active fungicide and bactericidal properties even when very greatly diluted, and is not so dangerous a poison in this condition as are corrosive sublimate and other antiseptic agents, it becomes very useful in the hands of those who wish to disinfect quarters in which have been lodged people, or animals, affected with communicable diseases. The wash or spray of the dilute formalin has always seemed to the writer much better for such uses than the fumes of formalin as generally produced.

On plants the action of even dilute sprays is very quickly destructive, and I doubt if it has a value for their treatment. But for seed wheat, likely to produce smutted heads and for potato scab it has proved very convenient and useful. A pint of the 40 per cent formalin may be poured into a barrel containing 30 gallons of water, stirred thoroughly, and the potatoes in a sack can be set in the barrel for disinfection. They should be left in the fluid for two hours and may then be removed and spread out on grass or on a clean plank floor to dry, when another sack may be placed in the barrel. The treated potatoes must not be put in barrels or sacks that have not been treated with the formalin. By having a number of barrels at hand, the work proceeds rapidly.

Oats and wheat liable to smut may be treated by sprinkling the seed with dilute formalin (1 pint in a barrel of water) until every seed is moist, not wet, then leaving for several hours in a heap, finally spreading out to dry.

Fumes of formalin produced either by heat or by the use of permanganate of potash have been recommended as a remedy for potato scab, but the writer's experience with the fumes has not been such as to warrant him in recommending them for this or for other purposes.

Bichloride of Mercury.—A very poisonous chemical, valuable in dilute solutions (1 part in 1000) as a disinfectant, and particularly good as a remedy for potato scab. The whitish, crystalline, very heavy material is very dangerous to have about, since it may attract the attention of children or animals. It should of course always be kept labeled as a poison. It dissolves slowly in cold water, and it is best, therefore, to make use of heat, afterward turning the dissolved poison into the larger quantity of water required, best kept in a barrel. Good results have been obtained in checking potato scab with this disinfectant, using 4 ounces in 30 gallons of water and soaking the seed potatoes one hour. They were placed in the fluid in gunny sacks and afterward spread out on a barn floor to dry.

It is very essential that poisoned potatoes be not left where stock will eat them, and the poisonous fluid must be disposed of after treating the seed, so that it will do no harm.

Lime-Sulphur Wash.—This preparation of sulphur and lime has already been mentioned under insecticides. It has undoubted fungicide value both in concentrated and dilute preparations. For foliage the latter

must always be used. Even the sulphur alone thickly strewn over leaves is a fairly good remedy for mildew. A very small quantity of the sulphur dissolved in the presence of lime renders it more effective both as an insecticide and as a fungicide.

COMBINED INSECTICIDES AND FUNGICIDES

The cost of treatment for pests is greatly increased by the necessity for frequent spraying when insecticides and fungicides are used separately. They have been combined in some cases with no loss in the effectiveness of either, and one of the important problems of both entomologists and plant pathologists at the present time is the finding of ways and means of reducing the number of sprayings still further.

Some work in determining the compatibility of different mixtures has already been done, and it may be said that the following mix without loss and in some cases with a gain in effectiveness:

Arsenate of lead (acid) and Bordeaux mixture.
Arsenate of lead and tobacco.
Arsenate of lead and acids.
Arsenate of lead (neutral) and Bordeaux mixture.
Arsenate of lead (neutral) and lime-sulphur.
Arsenate of lead (neutral) and tobacco.
Paris green and Bordeaux mixture.
Arsenite of lime and Bordeaux mixture.
Arsenite of lime and tobacco.
Lime-sulphur and tobacco.
Soaps and Bordeaux mixture.
Soaps and tobacco.
Soaps and emulsions.
Tobacco and lime-sulphur.
Tobacco and soaps.
Tobacco and emulsions.
Tobacco and alkalies.

Some dangerous combinations are the following:

Arsenate of lead (acid) and soaps.
Arsenate of lead (acid) and emulsions.
Arsenate of lead (acid) and alkalies.
Arsenate of lead (neutral) and acids.
Arsenite of zinc and lime-sulphur.
Arsenite of zinc and soaps.
Arsenite of zinc and emulsions.
Arsenite of zinc and alkalies.
Arsenite of zinc and acids.
Hydrocyanic acid gas and Bordeaux mixture.

PART III

TABLES OF AGRICULTURAL STATISTICS AND WEIGHTS AND MEASURES

TABLE VI.—PERCENTAGE COMPOSITION OF AGRICULTURAL PRODUCTS.

Crop.	Water.	Ash.	Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.
Corn, dent	10.6	1.5	10.3	2.2	70.4	5.0
Corn, flint	11.3	1.4	10.5	1.7	70.1	5.0
Corn, sweet	8.8	1.9	11.6	2.8	66.8	8.1
Corn meal	15.0	1.4	9.2	1.9	68.7	3.8
Corn cob	10.7	1.4	2.4	30.1	54.9	0.5
Corn and cob meal	15.1	1.5	8.5	6.6	64.8	3.5
Corn bran	9.1	1.3	9.0	12.7	62.2	5.8
Corn germ	10.7	4.0	9.8	4.1	64.0	7.4
Hominy chops	11.1	2.5	9.8	3.8	64.5	8.3
Germ meal	8.1	1.3	11.1	9.9	62.5	7.1
Dried starch and sugar feed	10.9	0.9	19.7	4.7	54.8	9.0
Starch feed, wet	65.4	0.3	6.1	3.1	22.0	3.1
Maize feed, Chicago	9.1	0.9	22.8	7.6	52.7	6.9
Grano-gluten	5.8	2.8	31.1	12.0	33.4	14.9
Cream gluten	8.1	0.7	36.1	1.3	39.0	14.8
Gluten meal	8.2	0.9	29.3	3.3	46.5	11.8
Gluten feed	7.8	1.1	24.0	5.3	51.2	10.6
Wheat, all analyses	10.5	1.8	11.9	1.8	71.9	2.1
Wheat, spring	10.4	1.9	12.5	1.8	71.2	2.2
Wheat, winter	10.5	1.8	11.8	1.8	72.0	2.1
Flour, high grade	12.2	0.6	14.9	0.3	70.0	2.0
Flour, low grade	12.0	2.0	18.0	0.9	63.3	3.9
Flour, dark feeding	9.7	4.3	19.9	3.8	56.2	6.2
Bran, all analyses	11.9	5.8	15.4	9.0	53.9	4.0
Bran, spring wheat	11.5	5.4	16.1	8.0	54.5	4.5
Bran, winter wheat	12.3	5.9	16.0	8.1	53.7	4.0
Middlings	12.1	3.3	15.6	4.6	60.4	4.0
Shorts	11.8	4.6	14.9	7.4	56.8	4.5
Wheat screenings	11.6	2.9	12.5	4.9	65.1	3.0
Rye	11.6	1.9	10.6	1.7	72.5	1.7
Rye flour	13.1	0.7	6.7	0.4	78.3	0.8
Rye bran	11.6	3.6	14.7	3.5	63.8	2.8
Rye shorts	9.3	5.9	18.0	5.1	59.9	2.8
Barley	10.9	2.4	12.4	2.7	69.8	1.8
Barley meal	11.9	2.6	10.5	6.5	66.3	2.2
Barley screenings	12.2	3.6	12.3	7.3	61.8	2.8
Brewers' grains, wet	75.7	1.0	5.4	3.8	12.5	1.6
Brewers' grains, dried	8.2	3.6	19.9	11.0	51.7	5.6
Malt sprouts	10.2	5.7	23.2	10.7	48.5	1.7
Oats	11.0	3.0	11.8	9.5	59.7	5.0
Oat meal	7.9	2.0	14.7	0.9	67.4	7.1
Oat feed	7.7	3.7	16.0	6.1	59.4	7.1
Oat dust	6.5	6.9	13.5	18.2	50.2	4.8
Oat hulls	7.3	6.7	3.3	29.7	52.1	1.0
Rice	12.4	0.4	7.4	0.2	79.2	0.4
Rice meal	10.2	8.1	12.0	5.4	51.2	13.1
Rice hulls	8.2	13.2	3.6	35.7	38.6	0.7
Rice bran	9.7	10.0	12.1	9.5	49.9	8.8
Rice polish	10.0	6.7	11.7	6.3	58.0	7.3
Buckwheat	12.6	2.0	10.0	8.7	64.5	2.2
Buckwheat flour	14.6	1.0	6.9	0.3	75.8	1.4
Buckwheat hulls	13.2	2.2	4.6	43.5	35.3	1.1
Buckwheat bran	10.5	3.0	12.4	31.9	38.8	3.3
Buckwheat shorts	11.1	5.1	27.1	8.3	40.8	7.6
Buckwheat middlings	13.2	4.8	28.9	4.1	41.9	7.1
Sorghum seed	12.8	2.1	9.1	2.6	69.8	3.6

TABLE I.—PERCENTAGE COMPOSITION OF AGRICULTURAL PRODUCTS (*Continued*).

Crop.	Water.	Ash.	Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.
Broom-corn seed	11.5	3.4	10.2	7.1	63.6	3.0
Kaffir seed	9.3	1.5	9.9	1.4	74.9	3.0
Millet seed	14.0	3.3	11.8	9.5	57.4	4.0
Hungarian grass seed	9.5	5.0	9.9	7.7	63.2	4.7
Flaxseed	9.2	4.3	22.6	7.1	23.2	33.7
Flaxseed, ground	8.1	4.7	21.6	7.3	27.9	30.4
Linseed meal, old process	9.2	5.7	32.9	8.9	35.4	7.9
Linseed meal, new process	10.1	5.8	33.2	9.5	38.4	3.0
Cotton seed	10.3	3.5	18.4	23.2	24.7	19.9
Cotton seed, roasted	6.1	5.5	16.8	20.4	23.5	27.7
Cottonseed meal	8.2	7.2	42.3	5.6	23.6	13.1
Cottonseed hulls	11.1	2.8	4.2	46.3	33.4	2.2
Cottonseed kernels (no hulls)	6.2	4.7	31.2	3.7	17.6	36.6
Cocoanut cake	10.3	5.9	19.7	14.4	38.7	11.0
Palm nut meal	10.4	4.3	16.8	24.0	35.0	9.5
Sunflower seed	8.6	2.6	16.3	29.9	21.4	21.2
Sunflower seed cake	10.8	6.7	32.8	13.5	27.1	9.1
Peanut kernels (no hulls)	7.5	2.4	27.9	7.0	15.6	39.6
Peanut meal	10.7	4.9	47.6	5.1	23.7	8.0
Rape seed cake	10.0	7.9	31.2	11.3	30.0	9.6
Pea meal	10.5	2.6	20.2	14.4	51.1	1.2
Soy bean	10.8	4.7	34.0	4.8	28.8	16.9
Cowpea	14.8	3.2	20.8	4.1	55.7	1.4
Horse bean	11.3	3.8	26.6	7.2	50.1	1.0
Corn fodder, field cured	42.2	2.7	4.5	14.3	34.7	1.6
Corn stover, field cured	40.5	3.4	3.8	19.7	31.5	1.1
Corn husks, field cured	50.9	1.8	2.5	15.8	28.3	0.7
Corn leaves, field cured	30.0	5.5	6.0	21.4	35.7	1.4
Corn fodder, green	79.3	1.2	1.8	5.0	12.2	0.5
Dent varieties, green	79.0	1.2	1.7	5.6	12.0	0.5
Dent, kernels glazed green	73.4	1.5	2.0	6.7	15.5	0.9
Flint varieties, green	79.8	1.1	2.0	4.3	12.1	0.7
Flint, kernels glazed green	77.1	1.1	2.7	4.3	14.6	0.8
Sweet varieties, green	79.1	1.3	1.9	4.4	12.8	0.5
Leaves and husks, green	66.2	2.9	2.1	8.7	19.0	1.1
Stripped stalks, green	76.1	0.7	0.5	7.3	14.9	0.5
HAY FROM GRASSES:						
Mixed grasses	15.3	5.5	7.4	27.2	42.1	2.5
Timothy, all analyses	13.2	4.4	5.9	29.0	45.0	2.5
Timothy, cut in full bloom	15.0	4.5	6.0	29.6	41.9	3.0
Timothy, cut soon after bloom	14.2	4.4	5.7	28.1	44.6	3.0
Timothy, cut when near ripe	14.1	3.9	5.0	31.1	43.7	2.2
Orchard grass	9.9	6.0	8.1	32.4	41.0	2.6
Redtop, cut at different stages	8.9	5.2	7.9	28.6	47.5	1.9
Redtop, cut in full bloom	8.7	4.9	8.0	29.9	46.4	2.1
Kentucky blue grass	21.2	6.3	7.8	23.0	37.8	3.9
Kentucky blue grass, cut when seed is in milk	24.4	7.0	6.3	24.5	34.2	3.6
Kentucky blue grass, cut when seed is ripe	27.8	6.4	5.8	23.8	33.2	3.0
Hungarian grass	7.7	6.0	7.5	27.7	49.0	2.1
Meadow fescue	20.0	6.8	7.0	25.9	38.4	2.7
Indian rye grass	8.5	6.9	7.5	30.5	45.0	1.7
Perennial rye grass	14.0	7.9	10.1	25.4	40.5	2.1
Rowen (mixed)	16.6	6.8	11.6	22.5	39.4	3.1

TABLE I.—PERCENTAGE COMPOSITION OF AGRICULTURAL PRODUCTS (*Continued*).

Crop.	Water.	Ash.	Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.
HAY FROM GRASSES (*Continued*):						
Mixed grasses and clovers	12.9	5.5	10.1	27.6	41.3	2.6
Barley hay, cut in milk	15.0	4.2	8.8	24.7	44.9	2.4
Oat hay, cut in milk	15.0	5.2	9.3	29.2	39.0	2.3
Swamp hay	11.6	6.7	7.2	26.6	45.9	2.0
Salt marsh hay	10.4	7.7	5.5	30.0	44.1	2.4
Wild oat grass	14.3	3.8	5.0	25.0	48.8	3.3
Buttercups	9.3	5.6	9.9	30.6	41.1	3.5
White daisy	10.3	6.6	7.7	30.0	42.0	3.4
Johnson grass	10.2	6.1	7.2	28.5	45.9	2.1
FRESH GRASS:						
Pasture grass	80.0	2.0	3.5	4.0	9.7	0.09
Kentucky blue grass	65.1	2.8	4.1	9.1	17.6	1.3
Timothy, different stages	61.6	2.1	3.1	11.8	20.2	1.2
Orchard grass, in bloom	73.0	2.0	2.6	8.2	13.3	0.9
Redtop, in bloom	65.3	2.3	2.8	11.0	17.7	0.9
Oat fodder	62.2	2.5	3.4	11.2	19.3	1.4
Rye fodder	76.6	1.8	2.6	11.6	6.8	0.6
Sorghum fodder	79.4	1.1	1.3	6.1	11.6	0.5
Barley fodder	79.0	1.8	2.7	7.9	8.0	0.6
Hungarian grass	71.1	1.7	3.1	9.2	14.2	0.7
Meadow fescue, in bloom	69.9	1.8	2.4	10.8	14.3	0.8
Italian rye grass, coming in bloom	73.2	2.5	3.1	6.8	13.3	1.3
Tall oat grass, in bloom	69.5	2.0	2.4	9.4	15.8	0.9
Japanese millet	75.0	1.5	2.1	7.8	13.1	0.5
Barnyard millet	75.0	1.9	2.4	7.0	13.1	0.6
HAY FROM LEGUMES:						
Red clover	15.3	6.2	12.3	24.8	38.1	3.3
Red clover in bloom	20.8	6.6	12.4	21.9	33.8	4.5
Red clover, mammoth	21.2	6.1	10.7	24.5	33.6	3.9
Alsike clover	9.7	8.3	12.8	25.6	40.7	2.9
White clover	9.7	8.3	15.7	24.1	39.3	2.9
Crimson clover	9.6	8.6	15.2	27.2	36.6	2.8
Japan clover	11.0	8.5	13.8	24.0	39.0	3.7
Alfalfa	8.4	7.4	14.3	25.0	42.7	2.2
Cowpea	10.7	7.5	16.6	20.1	42.2	2.2
Soy bean	11.3	7.2	15.4	22.3	38.6	5.2
Pea vine	15.0	6.7	13.7	24.7	37.6	2.3
Vetch	11.3	7.9	17.0	25.4	36.1	2.3
Serradella	9.2	7.2	15.2	21.6	44.2	2.6
Flat pea	8.4	7.9	22.9	26.2	31.4	3.2
Peanut vines (no nuts)	7.6	10.8	10.7	23.6	42.7	4.6
Sainfoin	15.0	7.3	14.8	20.4	39.5	3.0
FRESH LEGUMES:						
Red clover, different stages	70.8	2.1	4.4	8.1	13.5	1.1
Alsike clover	74.8	2.0	3.9	7.4	11.0	0.9
Crimson clover	80.9	1.7	3.1	5.2	8.4	0.7
Alfalfa	71.8	2.7	4.8	7.4	12.3	1.0
Cowpea	83.6	1.7	2.4	4.8	7.1	0.4
Soy bean	75.1	2.6	4.0	6.7	10.6	1.0
Serradella	79.5	3.2	2.7	5.4	8.6	0.7
Horse bean	84.2	1.2	2.8	4.9	6.5	0.4
Flat pea	66.7	2.9	8.7	7.9	12.2	1.6

TABLE I.—PERCENTAGE COMPOSITION OF AGRICULTURAL PRODUCTS (*Continued*).

Crop.	Water.	Ash.	Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.
STRAW:						
Wheat	9.6	4.2	3.4	38.1	40.4	1.3
Rye	7.1	3.2	3.0	38.9	46.6	1.2
Oat	9.2	5.1	4.0	37.0	42.4	2.3
Barley	14.2	5.7	3.5	36.0	39.0	1.5
Wheat chaff	14.3	9.2	4.5	36.0	34.6	1.4
Oat chaff	14.3	10.0	4.0	34.0	36.2	1.5
Buckwheat straw	9.9	5.5	5.2	43.0	35.1	1.3
Soy bean	10.1	5.8	4.6	40.4	37.4	1.7
Horse bean	9.2	8.7	8.8	37.6	34.3	1.4
SILAGE:						
Corn	79.1	1.4	1.7	6.0	11.0	0.8
Sorghum	76.1	1.1	0.8	6.4	15.3	0.3
Red clover	72.0	2.6	4.2	8.4	11.6	1.2
Soy bean	74.2	2.8	4.1	9.7	6.9	2.2
Apple pomace	85.0	0.6	1.2	3.3	8.8	1.1
Cowpea vine	79.3	2.9	2.7	6.0	7.6	1.5
Cow and soy bean vines mixed	69.8	4.5	3.8	9.5	11.1	1.3
Field pea vine	50.1	3.5	5.9	13.0	26.0	1.6
Barnyard millet and soy bean	79.0	2.8	2.8	7.2	7.2	1.0
Corn and soy bean	76.0	2.4	2.5	7.2	11.1	0.8
Rye	80.8	1.6	2.4	5.8	9.2	0.3
ROOTS AND TUBERS:						
Potato	78.9	1.0	2.1	0.6	17.3	0.1
Common beets	88.5	1.0	1.5	0.9	8.0	0.1
Sugar beets	86.5	0.9	1.8	0.9	9.8	0.1
Mangels	90.9	1.1	1.4	0.9	5.5	0.2
Turnip	90.5	0.8	1.1	1.2	6.2	0.2
Rutabaga	88.6	1.2	1.2	1.3	7.5	0.2
Carrot	88.6	1.0	1.1	1.3	7.6	0.4
Parsnip	88.3	0.7	1.6	1.0	10.2	0.2
Artichoke	79.5	1.0	2.6	0.8	15.9	0.2
Sweet potato	71.1	1.0	1.5	1.3	24.7	0.4
MISCELLANEOUS:						
Cabbage	90.5	1.4	2.4	1.5	3.9	0.4
Spurry	75.7	4.0	2.0	4.9	12.7	0.8
Sugar beet leaves	88.0	2.4	2.6	2.2	4.4	0.4
Pumpkin, field	90.9	0.5	1.3	1.7	5.2	0.4
Pumpkin, garden	80.8	0.9	1.8	1.8	7.9	0.8
Prickly comfrey	88.4	2.2	2.4	1.6	5.1	0.3
Rape	84.5	2.0	2.3	2.6	5.4	0.5
Acorns, fresh	55.3	1.0	2.5	4.4	34.8	1.9
Apples	80.8	0.4	0.7	1.2	16.6	0.4
Cow's milk	87.2	0.7	3.6	...	4.9	3.7
Cow's colustrum	74.6	1.6	17.6	...	2.7	3.6
Mare's milk	91.0	0.4	2.1	...	5.3	1.2
Ewe's milk	81.3	0.8	6.3	...	4.7	6.8
Goat's milk	86.9	0.9	3.7	...	4.4	4.1
Sow's milk	80.8	1.1	6.2	...	4.4	7.1
Skim milk, gravity	90.4	0.7	3.3	...	4.7	0.9
Skim milk, centrifugal	90.6	0.7	3.1	...	5.3	0.3
Buttermilk	90.1	0.7	4.0	...	4.0	1.1

TABLE II.—FERTILITY IN FARM PRODUCE.

Produce.	Amount.	Nitrogen. pounds.	Phosphorus, pounds.	Potassium, pounds.
Corn, grain	100 bushels	100	17	19
Corn, stover	3 tons	48	6	52
Corn crop		148	23	71
Oats, grain	100 bushels	66	11	16
Oats, straw	2½ tons	31	5	52
Oat crop		97	16	68
Wheat, grain	50 bushels	71	12	13
Wheat, straw	2½ tons	25	4	45
Wheat crop		96	16	58
Soy beans	25 bushels	80	13	24
Soy bean straw	2¼ tons	79	8	49
Soy bean crop		159	21	73
Timothy hay	3 tons	72	9	71
Clover seed	4 bushels	7	2	3
Clover hay	4 tons	160	20	120
Cowpea hay	3 tons	130	14	98
Alfalfa hay	8 tons	400	36	192
Cotton, lint	1000 pounds	3	0.4	4
Cotton, seed	2000 pounds	63	11	19
Cotton, stalks	4000 pounds	102	18	59
Cotton crop		168	29.4	82
Potatoes	300 bushels	63	13	90
Sugar beets	20 tons	100	18	157
Apples	600 bushels	47	5	57
Leaves	4 tons	59	7	47
Wood growth	1 tree	6	2	5
Total crop		112	14	109
Fat cattle	1000 pounds	25	7	1
Fat hogs	1000 pounds	18	3	1
Milk	10,000 pounds	57	7	12
Butter	400 pounds	0.8	0.2	0.1
Rye, grain	1470 pounds	28	12	9
Rye, straw	3500 pounds	12	4	27
Rye crop	4970 pounds	40	16	36
Beets, roots	36,800 pounds	88	22	158
Beets, tops	9200 pounds	26	11	69
Beets, crop	46,000 pounds	114	33	227
Grass	4000 pounds	53	13	58
Cotton cake, decoraticated	1000 pounds	66	31.2	15
Rape cake	1000 pounds	48	24.6	13.2
Linseed cake	1000 pounds	45	19.6	14.7
Cotton cake, undecorticated	1000 pounds	39	22.9	20.1
Linseed	1000 pounds	36	15.4	12.3
Palm kernel meal, English	1000 pounds	25	12.2	5.5
Malt dust	1000 pounds	38	17.2	19.5
Bran	1000 pounds	22	32.3	14.8
Mangels	1000 pounds	1.9	0.7	3.9
Swedes	1000 pounds	2.4	0.6	2.0
Carrots	1000 pounds	1.6	1.0	3.2
Turnips	1000 pounds	1.8	0.6	2.9

TABLE III.—WEIGHT PER BUSHEL, SEEDING RATE PER ACRE, NUMBER OF SEEDS PER POUND AND DEPTH TO COVER FARM SEEDS.

Crop.	Weight per Bushel, pounds.	Rate of Seeding.	Number of Seeds per Pound.	Depth to Cover, inches.
GRASSES.				
Bermuda	36	5 pecks	180,000	¼–½
Canada blue	14–20	15 pounds	2,583,000	¼–½
Creeping bent	15–20	.....	8,000,000	¼–½
Crested dog's tail	26–30	.....	897,000	¼–¾
Erect brome	14–15	4–6 pecks	162,000	½–1
Fowl meadow	12–15	30 pounds	.....	¼–½
Hard fescue	10	.....	578,000	¼
Italian rye	17–24	30 pounds	275,000	¼–¾
Johnson	28	4–6 pecks	.....	½–1½
Kentucky blue	6–28	25 pounds	2,637,000	¼–½
Meadow fescue	12–28	12–15 pounds	264,000	½
Meadow foxtail	6–14	40 pounds	769,000	½
Orchard	12–21	20 pounds	457,000	¼
Perennial rye	18–30	30 pounds	280,000	¼–½
Redtop	12–40	12–15 pounds	4,135,000	.....
Reed canary	14–48	20–25 pounds	632,000	.....
Rough stalked meadow	12–28	26 pounds	2,706,000	¼
Sheep's fescue	12–28	30 pounds	802,000	¼
Smooth brome	12–14	15–20 pounds	120,000	½–1
Sweet vernal	6–15	30 pounds	837,000	½
Tall meadow fescue	14–25	12–20 pounds	246,000	¼
Tall meadow oat	7–14	30–40 pounds	151,000	½–¾
Timothy	44–50	15 pounds	1,146,000	¼
Velvet	6–7	20 pounds	1,268,000	¼–½
Yellow oat	12–14	30 pounds	1,540,000	¼
LEGUMES.				
Alfalfa	60–63	15–25 pounds	210,000	½–1½
Alsike clover	60–66	4–8 pounds	692,000	½
Bird's foot trefoil	60	11 pounds	367,000	¼–½
Bur clover	60	15 pounds	.....	½–1
Common vetch	60	60 pounds	.....	.....
Cowpeas	60	4–6 pecks	.....	1–2
Crimson clover	60	12–15 pounds	129,000	½–1½
Field peas	52–68	2½–3½ bushels	2,400–4,000	1½–3
Garden peas	60	3 bushels	800–2,400	1–3
Hairy vetch	60	40–60 pounds	75,000	1½–2
Horse bean	56	4 bushels	.....	.....
Japan clover	25	15–25 pounds	370,000	¼–¾
Kidney beans	60	.....	3,200–4,000	1–2
Kidney vetch	60–64	18–22 pounds	169,000	½–1½
Red clover	60–64	8–14 pounds	304,000	½
Soy beans	60	2–3 pecks	2,000–7,000	1–2
Sweet clover	.....	2–4 pecks	.....	½–1
Velvet beans	60	2–6 pecks	.....	.....
White clover	60–63	3–6 pounds	739,000	¼
White lupine	50–60	1½–2 bushels	.....	1–2
Yellow trefoil	64–66	4–6 pounds	305,000	¼–½
ANNUAL FORAGE CROPS.				
Barnyard millet, Japanese	35	1–2 pecks	212,000	.....
Broom corn millet	60	2–4 pecks	212,000	½–1½

TABLE III.—WEIGHT PER BUSHEL, SEEDING RATE PER ACRE, NUMBER OF SEEDS PER POUND AND DEPTH TO COVER FARM SEEDS (*Continued*).

Crop.	Weight per Bushel, pounds.	Rate of Seeding.	Number of Seeds, per pound.	Depth to Cover, inches.
ANNUAL FORAGE CROPS (*Continued*).				
Millet, common Millet, Hungarian Millet, German Millet, Golden Wonder	50	2–3 pecks	212,000	¼–½
Rape	50–60	3–8 pounds	.....	½–1
Sainfoin	26	40 pounds	22,500	¾–1
Serradella	28–36	40–50 pounds	.....	1–2
Sorghum	56	1½–2 bushels	23,000–35,000	½–1½
Sunflower	24–50	10–15 pounds	.....	1½–2½
CEREALS.				
Barley	48	7–9 pecks	.....	1–2½
Buckwheat	42–50	3–5 pecks	.....	1–2
Flax	56	2–8 pecks	.....	½–1
Kaffir corn	50–60	3–12 quarts	.....	1–2
Milo	50–60	5 quarts	.....	1–2
Maize, shelled Maize, on cob	56 70	5–16 quarts	.....	1½–4
Rice	43–45	1–3 bushels	.....	1½–3
Rye	56	5–10 pecks	.....	¾–2
Spelt	40–60	.....	.....	1–3
Wheat	60	5–8 pecks	.....	1–3
Oats	32	8–10 pecks	.....	1–2½
VEGETABLES AND ROOTS.				
Artichokes	.....	6–8 bushels	.....	.....
Beets	50–60*	4–6 pounds	25,000	.....
Carrots	50*	3–4 pounds	384,000	¼–¾
Mangels	50–60*	5–8 pounds	.....	½–1
Parsnip	45–50*	4–8 pounds	112,000	½–1
Potato	60	8–15 bushels	.....	2–4
Turnip	55–60*	2–4 pounds	208,000	½–1
Rutabaga	50–60*	3–5 pounds	.....	½–1
Sugar beets	50–60*	15–20 pounds	.....	½–1
Sweet potato	50–55	1½–4 bushels	.....	2–4
FIBER.				
Broom corn	30–48	3 pecks	.....	1–2
Cotton, Sea Island Cotton, upland	44 30	1–3 bushels	.....	1½–3
Hemp	44	3½–4 pecks	.....	1–2

* Roots.

TABLE IV.—WATER REQUIREMENTS OF VARIOUS STANDARD CROPS.

Crop.	Location.	Experimenter.	Pounds Water per Pound Dry Matter.		
			Maximum.	Minimum.	Mean.*
Wheat	Germany	Sorauer	708	...	708
	Germany	Hellriegel	390	328	339
	Germany	Von Seelhorst	333	...	333
	India	Leather	544	...	544
	Akron, Col	Briggs and Shantz	534	468	507
	England	Lawes	235	...	235
	Logan, Utah	Widstoe	489	427	458
	Davis, Cal	Fortier and Beckett	359	286	326
	Bozeman, Mont	Fortier and Gieseker	334	226	271
	Reno, Nev	Fortier and Peterson	395	309	360
Oats	Germany	Wollny	...	...	665
	Germany	Sorauer	...	...	600
	Germany	Hellriegel	464	339	401
	India	Leather	...	...	469
	Wisconsin	King	526	502	514
	Akron, Col	Briggs and Shantz	639	598	614
Barley	England	Lawes	262	258	260
	Germany	Wollny	...	...	774
	Germany	Sorauer	...	...	490
	Germany	Hellriegel	366	263	297
	Germany	Von Seelhorst	454	295	365
	India	Leather	...	...	468
	Wisconsin	King	401	375	388
	Akron, Col	Briggs and Shantz	544	527	539
Corn	Germany	Wollny	...	...	233
	India	Leather	...	...	337
	Wisconsin	King	390	305	348
	Akron, Col	Briggs and Shantz	420	319	369
Rye	Germany	Hellriegel	438	315	377
	Germany	Von Seelhorst	700	343	469
	Akron, Col	Briggs and Shantz	...	...	724
Peas	England	Lawes	...	...	235
	Germany	Wollny	...	...	416
	Germany	Hellriegel	353	231	292
	India	Leather	...	...	563
	Wisconsin	King	...	...	477
	Akron, Col	Briggs and Shantz	...	...	800
Potatoes	Germany	Von Seelhorst	294	268	281
	Wisconsin	King	...	...	423
	Akron, Col	Briggs and Shantz	...	...	448
Alfalfa, 1 year	Davis, Cal	Fortier and Beckett	1265	1005	1102
Alfalfa, 2 years			971	522	761
	State College, N. M.		889	757	823
	Akron, Col	Briggs and Shantz	...	...	1068
Clover, red	England	Lawes	...	...	251
	Germany	Hellriegel	363	297	330
	Wisconsin	King	564	398	481
Sugar beets	Logan, Utah	Widstoe	...	...	497
	Akron, Col	Briggs and Shantz	...	...	377
Rice	India	Leather	...	...	811

* This column represents the average of all reliable and comparable tests.

TABLE V.—COST PER ACRE, PRODUCING CROPS.*

Crop.	Average Cost.
Barley, fall plowed	$8.21
Clover, cut for seed	6.50
Corn, ears husked from standing stalks	10.44
Corn, cut, shocked and shredded	15.30
Corn, cut, shocked and hauled in from field	10.26
Corn, grown thickly and siloed	19.89
Flaxseed, threshed from windrow	7.50
Flaxseed, stacked from windrow	7.85
Flaxseed, bound, shocked, stacked, threshed	7.28
Fodder corn, cut and shocked in field	9.65
Fodder corn, cut, shocked and stacked	12.36
Hay, timothy and clover, first crop	5.59
Hay, timothy and clover, two cuttings	7.18
Hay, millet	7.10
Hay, wild grasses	4.04
Hay, timothy	3.39
Hemp	6.74
Mangels	32.68
Oats, fall plowed	8.86
Oats, on disked corn stubble	8.88
Potatoes, machine production	26.37
Potatoes, machine production, use of fertilizer	37.72
Timothy, cut for seed	4.43
Wheat, fall plowed	7.25

*Minnesota Experiment Station, Bulletin No. 117, page 29.

TABLE VI.—COST OF FARM HORSE POWER.*

Agricultural Region.	Total Annual Cost of Keeping One Horse. Average 5 Years, 1908–12.	Actual Cost per Hour of Work for One Horse. Average 9 Years, 1904–12.
Southeastern Minnesota	$103.27	9.72 cents
Southwestern Minnesota	100.64	8.64 cents†
Northwestern Minnesota	84.67	8.05 cents

NOTE.—The cost figures shown in this table have been selected from the statistical data of the Division of Farm Management of the Minnesota Agricultural Experiment Station. These figures are not estimates, but actual records from a large number of Minnesota farms. The averages are based on records of about 450 horses in each region. The annual cost includes interest on investment, depreciation, harness depreciation, shoeing, feed, labor and miscellaneous expense. Feed is the largest item in the cost of farm horse power, representing on the average ⅔ to ¾ of the total cost. The cost of horse power per hour is computed by dividing the total annual cost by the actual number of hours worked.

* Taken from "Field Management and Crop Rotation," by Parker.
† Seven-year average.

Table VII.—Weights and Measures.

AVOIRDUPOIS WEIGHT.

16 ounces (oz.)	= 1 pound (lb.).
100 pounds	= 1 hundredweight (cwt.).
20 cwt	= 1 ton (T.).
1 ton	= 20 cwt. or 2000 lbs. or 32,000 oz.

DRY MEASURE.

2 pints (pt.)	= 1 quart (qt.).
8 qts	= 1 peck (pk.).
4 pks	= 1 bushel (bu.).
1 bu	= 2150.42 cu. in.

LIQUID MEASURE.

4 gills (gi.)	= 1 pint (pt.).
2 pints	= 1 quart (qt.).
4 quarts	= 1 gallon (gal.).
31½ gallons	= 1 barrel (bbl.).
U. S. gallon	= 231 cu. in.
7½ gallons water	= 1 cu. ft. approximately.

LINEAR MEASURE.

12 inches (in.)	= 1 foot (ft.).
3 feet (ft.)	= 1 yard (yd.).
5½ yds. or 16½ ft	= 1 rod (rd.).
320 rds	= 1 mile (mi.).

1 mile or 320 rds. or 1760 yds. or 5280 ft. or 63,360 ins.

SQUARE MEASURE.

144 square inches (sq. in.)	= 1 square foot (sq. ft.).
9 square feet (sq. ft.)	= 1 square yard (sq. yd.).
30¼ sq. yds	= 1 square rod (sq. rd.).
160 sq. rds	= 1 acre (a.).
640 acres	= 1 square mile (sq. mi.).
1 sq. mi	= 1 section.
36 sections	= 1 township (twp.)
43,560 sq. ft	= 1 acre.

SOLID OR CUBIC MEASURE.

1728 cubic inches (cu. in.)	= 1 cubic foot (cu. ft.).
27 cu. ft	= 1 cubic yard (cu. yd.).
1 cu. yd	= 27 cu. ft. or 46,656 cu. in.
1 cu. yd	= 1 load.
24¾ cu. ft	= 1 perch.
128 cu. ft. or 8 ft. × 4 ft. × 4 ft	= 1 cord.
1 ft. x 12 in. x 1 in	= 1 board foot.

SURVEYOR'S LINEAR MEASURE.

7.92 inches	= 1 link.
100 links	= 1 chain.
80 chains	= 1 mile.

Gunter's chain is the unit and is 66 feet long.

SURVEYOR'S SQUARE MEASURE.

10,000 sq. links	= 1 square chain.
10 sq. chains	= 1 acre.
10 chains square	= 10 acres.