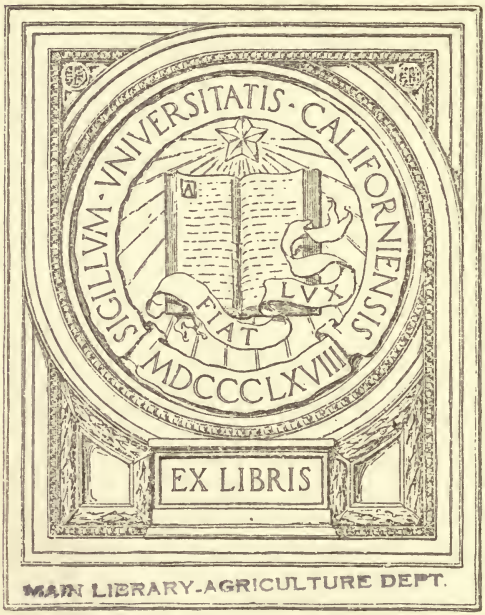
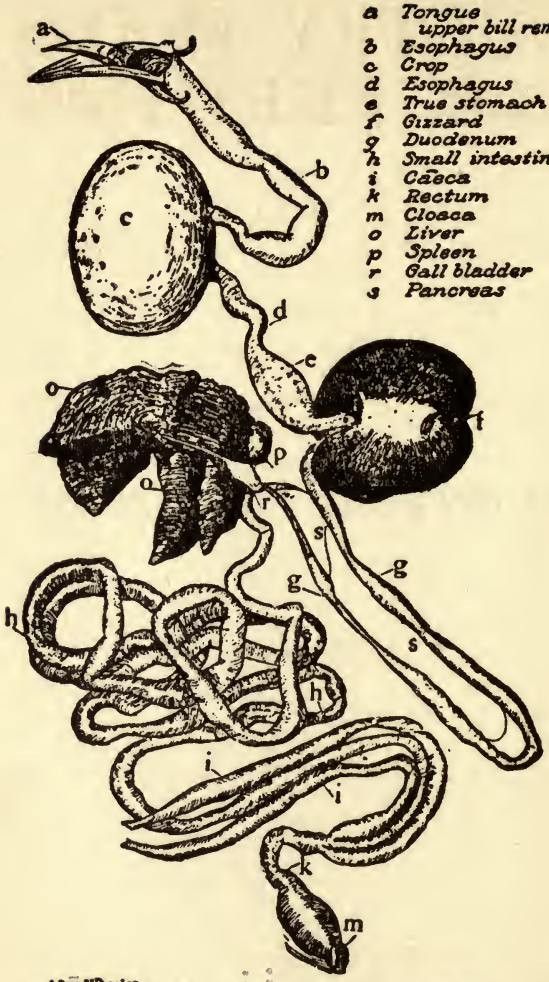


POULTRY FEEDS AND FEEDING



After Wheelock.

The digestive tract of a fowl.

POULTRY FEEDS AND FEEDING

HARRY M. LAMON

FORMERLY SENIOR POULTRYMAN, UNITED STATES DEPARTMENT OF AGRICULTURE

AND

ALFRED R. LEE,

POULTRYMAN IN CHARGE, UNITED STATES DEPARTMENT OF AGRICULTURE

ILLUSTRATED

NEW YORK
ORANGE JUDD PUBLISHING COMPANY
LONDON
KEGAN PAUL, TRENCH, TRUBNER & CO., LIMITED
1922

PRINTED IN U. S. A.

TABLE OF CONTENTS

INTRODUCTION

PART I. PRINCIPLES OF FEEDING POULTRY

CHAPTER I

CHAPTER II

CHAPTER III

CHAPTER IV

CONTENTS

PART II. DESCRIPTION OF FEED STUFFS

CHAPTER V

CHAPTER VI

CHAPTER VII

CHAPTER VIII

PART III. PRACTICAL FEEDING OF POULTRY

CHAPTER IX

CONTENTS

LIST OF ILLUSTRATIONS

All illustrations are by the courtesy of the Bureau of Animal Industry, United States Department of Agriculture.

PREFACE

"Poultry Feeds and Feeding" is designed to meet the needs of both poultry keepers and students by furnishing detailed information on all feeds and methods of feeding used with poultry. Grains, rations and methods of feeding used in every section of the United States are taken up and discussed to make this book of value in all sections.

Part I is devoted to the principles of feeding, explains which elements have been found essential in feeding poultry and tells why certain combinations are made. This part of the book is of special value to the student of poultry but the authors have tried to present this in a plain style which can be grasped by every intelligent poultry keeper and the subject is worthy of careful consideration by all progressive poultry feeders.

Every grain or feed-stuff used for poultry is discussed in Part II and references are given to experiments conducted in the feeding of poultry. The information in this section on the comparative feeding value of the different grains is of considerable importance to all poultry keepers in order to help them make an intelligent selection of feeds and to adapt their rations to prices and available supplies of feeds, which are constantly changing. The student will also find the references to experiments in feeding poultry and also the material in the Appendix of this book of great value.

Part III is devoted to the practical feeding of poultry and tells how to feed poultry, and is the part of greatest importance to everyone who keeps any chickens. The readers who do not care to study into the purpose of feeding or to learn why certain things are done can turn direct to this part of the book and select a ration which will give them good results and secure information on feeding which is of immediate practical application. Successful rations are given which are in actual use in different sections of the country. Rations for every class of poultry keepers are included: for the farmers with whom poultry is a side issue, for the suburban or city family who have only enough available space to keep a few fowls and for the poultryman who keeps chickens on a large scale. Complete information and rations on the commercial fattening of poultry as it is conducted in the poultry fattening stations are also included.

The authors have endeavored to supply a book on poultry feeding that will do for poultrymen and poultry students what the well-known book on "Feeds and Feeding" by Henry and Morrison has so successfully done for stockmen and students of livestock. The object throughout this book has been to present all the scientific and practical facts relating to poultry feeding in so simple a manner that anyone can understand and readily use them in his own feeding problems.

ALFRED R. LEE
HARRY M. LAMON.

Washington, D. C., 1922

INTRODUCTION

PLACE AND IMPORTANCE OF POULTRY IN AGRICULTURE

Poultry occupies a more important place in the life and nourishment of the American people than any one kind of livestock. The keeping of poultry is not confined to extensive ranches or even to farms, but is adapted to all sorts of conditions, ranging from the small flock of hens kept in a backyard or a city lot with only a few square feet of available land, through varying sizes of flocks kept on practically all of the general farms in all sections of the United States, to large poultry farms, each keeping from 500 to 10,000 or more hens. It provides pleasure, profit and the opportunity to get absolutely fresh table products at all seasons of the year, to every class of people.

THE VALUE OF POULTRY PRODUCTION

The estimated value of poultry products in the United States exceeds a billion dollars and the industry is steadily growing. The population of the United States increased about 21 per cent during the census period of 1900 to 1910 while the products from most lines of livestock were actually decreasing. Poultry products, however, increased materially during that time, fowls showing an increase in numbers of 17 per cent while their value increased 48 per cent. During this period eggs increased in numbers

23 per cent and in value 112 per cent. In other words, poultry and eggs are steadily occupying a more important place in the diet of the American people as the amount of poultry products either imported or exported is not large. The place which poultry products occupy in our diet combined with the growing population of this country and its constantly increasing demand for food products guarantees a steady demand at good prices for future poultry and egg production and allows for a healthy growth of the poultry industry and continued steady expansion of poultry farms. Quality in poultry products is being appreciated and paid for more and more especially in the value of strictly fresh eggs. The importance and value of eggs for human consumption have been greatly emphasized in recent experiments in which a soluble fat absolutely essential to human life and growth has been found in eggs, milk and certain glandular organs of animals.

The large poultry farms cannot compete in cost of production with the general farmer who keeps poultry as a side issue but they can get a much higher price for their eggs by supplying eggs to the consumer while they are strictly fresh and in prime condition. It is this difference in price obtained for strictly fresh eggs above the price of average receipts which gives the commercial egg farmer a sound practical basis on which to operate successfully. There is not the same relative profit in the production of high grade fresh poultry on the commercial poultry farm as poultry can also be produced more cheaply on the general farm from which it goes to the poultry packing sta-

tions and is fattened, held in storage for any reasonable length of time, and then sold at nearly the same price as fresh killed poultry products will command.

POULTRY RAISING IS PROFITABLE

The bulk of the poultry is produced, and the greatest opportunity for profit exists, on general farms especially in the Central West section. The leading states given in the order of their value of poultry products is as follows: Illinois, Missouri, Iowa, Ohio, Indiana, Pennsylvania, New York, Kansas, Texas, Michigan and California. Poultry is kept in good sized flocks on most every farm in these states, these flocks containing from 25 to 200 hens. The states of California, New York, New Jersey, and Pennsylvania contain also a considerable number of good sized commercial poultry farms which aid materially in bringing up the value of the poultry products in these states. Nearly every general farm could carry 100 hens profitably, while on many farms where some member of the family likes poultry, a much larger number of fowls than this can be kept profitably. Poultry kept on farms can be fed to some extent on unmarketable grains and will secure a considerable part of their living during the growing season from products which would otherwise be largely wasted. Better feeding and management of the hens and care in handling the poultry products would give a greater increase of profit from the farm flock than from most any other branch of poultry raising. Although the bulk of the poultry products will always come from the

flocks kept on general farms where the range is unlimited, good opportunities to keep poultry profitably exists for families which have only a small amount of available space. These families can keep fowls profitably for their own use and in addition sell any surplus products in their immediate vicinity at the highest retail price. Garbage or table scraps or waste products from the garden will materially aid in keeping down the cost of feeding hens kept under these conditions.

Most of the farms devoted entirely to poultry are located in the northeastern section of this country within easy shipping distance of the large cities and in central or southern California. Enough eggs are produced in California so that during the past few years a considerable number of carloads of eggs have been shipped to New York City during the winter. The constant and growing demand for a high quality of fresh eggs has made it possible to operate these poultry farms at a good profit although not over 10 per cent of the poultry and eggs produced in this country come from such farms. The most essential factor in the location of these commercial farms is nearness to a good market where goods of high quality are appreciated and paid for. The soil, climate and other factors must be considered but are really secondary in importance.

PART I
PRINCIPLES OF FEEDING POULTRY

CHAPTER I

COMPOSITION OF PLANTS

How Plants Make Food. Plants supply the feed for poultry and a brief description of their composition and growth is of value in the study of the principles of poultry feeding. Fourteen elements are commonly found in plants, namely, carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur, calcium, potassium, iron, magnesium, sodium, chlorin, silicon and manganese. The water which is obtained from the soil through the roots of plants makes up from 75 to 90 per cent of the weight of freshly cut plants. In addition to the water which they use plants live largely on carbon dioxid drawn from the air.

Plants use an enormous volume of air in getting this carbon dioxid as only 3 to 4 parts of carbon dioxid are found in 10,000 parts of air. Practically all plants except the legumes secure their nitrogen from the soil either in the form of nitrates or as ammonia. The legumes including such plants as clover, alfalfa, soybeans and cowpeas are able to take nitrogen gas from the air through nodular growth on their roots which contain bacteria. Therefore, the growing of these legumes adds fertility directly to the soil in the form of nitrogen. The mineral substances of plants given in this list of elements are taken from the soil in the form of phosphates, sulphates, car-

bonates, nitrates, chlorides and silicates. Phosphates are present in the leaf cells and in the proteins of seeds and sulphur is found in plant proteins.

PRODUCTION OF CARBOHYDRATES AND VEGETABLE FATS

The carbohydrates consisting of carbon and water is the term used to cover all the starches and sugars including the celluloses and pentosans. Chlorophyll which gives the green color to plants, assisted by light and sunshine, transforms carbon dioxid and water into compounds resulting in the formation of these starches, sugars and mineral matter, all of which represent stored up energy.

Carbohydrates constitute the bulk of all the dry matter of plants. The sugars are soluble in the plant juices and pass freely to all parts of the plant while starch is not directly soluble in plant juices but is stored up in the different parts of seeds and roots. Starch is subject to change by a ferment or enzyme called diastase which works with water and changes the starch to sugar, in which condition it can be passed freely throughout the plant structure.

The walls of the cell constituting the framework of the plant are made of cellulose with which is also found some mineral matter or ash. The pentosans are found with the cellulose in the more fibrous or woody parts of the plants and make up a considerable part of the roughages and feeds containing a high per cent of fiber. Vegetable fats and oils which are stored especially in the seeds of certain plants are made of these same elements as the carbohy-

drates but with a larger proportion of carbon and a larger number of atoms in the compounds. They give off more heat or energy than the carbohydrates on account of their greater carbon content.

PRODUCTION OF NITROGENOUS AND MINERAL COMPOUNDS

The carbohydrates and fats are combined in the plant with nitrogen, sulphur and phosphorus, elements obtained from the nitrates and mineral salts in the soil, to form more complex compounds called crude proteins. Crude proteins consists of two general groups—proteins and amids, and include all nitrogenous compounds of the plants. There is approximately 16 per cent of nitrogen in crude protein. The amids are the simpler forms of crude proteins from which the more complex proteins are constructed. They are soluble in plant juices and circulate freely throughout the plant. Our knowledge of the proteins is still in the experimental stage but we do know that they are very complex and many consist of a large number of different combinations. Recent feeding experiments with rats, guinea pigs and rabbits tend to show very great differences in the feeding value of the different proteins while some of the proteins have been found far more essential to life than others. The proteins and amids may be changed one to the other, the same as starches and sugars are changed, according to the needs of the plants.

Crude protein is found mostly in the leaves, seeds and

reproductive parts of the plants and very little of this material is contained in the plant fiber. All changes in the plant depend primarily upon their nitrogenous or protein compounds. Mineral matter or ash is also necessary in this changing of food materials and in the growth of young plants. It is found especially in the leaves and fibrous parts of the plants. Thus plants which furnish the feed for animals, form these compounds from the earth and air through the energy of the sun, and supply animals with the sun's heat and energy through plant life.

FACTORS INFLUENCING THE NUTRITIVE VALUE OF FEEDS

The value of feeds is somewhat affected by the climatic and soil conditions and also by the preparation of the feed. Feeds produced in different sections of this country show somewhat different analyses while the value of roughages and green crops are especially influenced by their stage of maturity. The crude protein content of cereals is quite variable in different sections as is also the fat and fiber content while the nitrogen free extract is less variable than these other constituents. Because of this variation it is advisable whenever possible to know the analysis of grains and feeds as it effects their feeding and purchase value.

In general, grinding, cracking and rolling of grains does not increase their digestibility except in the case of very hard feeds which would otherwise pass through the body in a whole form. Fowls are provided with a very

powerful grinding organism (the gizzard) and can utilize most hard grains very efficiently. Their digestive organs need some hard grains to keep them in the best of condition. Roughage and fiber are not utilized nearly as efficiently by poultry as by most livestock for which reason sprouting, soaking and steaming of grains and roughages may be especially advantageous for poultry. Fermenting is not considered advantageous in poultry feeding as it shows no marked advantage over soaking or sprouting and may furnish ideal conditions for the growth of undesirable and harmful organisms in the feed. The sprouting of grains, especially of oats, and to a less extent of barley, is carried on extensively to supply palatable green matter for fowls. Some poultrymen soak all oats and barley before feeding but the usual method is to feed all of these grains without soaking or sprouting. Exceptionally hard grains, such as the ordinary field or pea bean used for human consumption, should be soaked before feeding.

The steaming of clover and alfalfa hay renders these substances much more palatable for fowls but if these feeds are used in a finely ground form it does not pay to steam them. In general it probably pays to steam, sprout or soak grains or feeds of which the palatability for fowls is materially improved. Chickens to be fattened for a brief period can be fed to advantage entirely on very finely ground grains on which they will make greater gains than from feed which is more coarsely ground or that is in a whole or cracked condition. Cooking usually

lowers the digestibility of feeds except of potatoes and other starchy tubers, but may improve their palatability. These are the only feeds used by poultry which it pays to cook. The use of salt and the addition of lactic acid (the chief acid of milk) does not directly improve digestibility but has a beneficial effect on the fowls' appetite and may stimulate greater consumption of feed.

CHAPTER II

COMPOSITION AND STRUCTURE OF THE FOWL AND OF EGGS

Composition of a Fowl and of Eggs. Animals and poultry are composed of water, protein, fat and mineral matter which elements also make up plants, but protein and fat make up most of the animal body. The amount of carbohydrates present in animals is very small, while they make up most of the dry matter in plant life as plants contain only a small amount of protein. The average analysis of fowl and eggs is as follows according to analyses made at the New York Experiment Station and by the U. S. Department of Agriculture:

TABLE I

Composition of Poultry and Eggs

	Water	Protein	Fat	Ash	Shell
Leghorn Hen	55.8	21.6	17.0	3.8	...
Leghorn Pullet	55.4	21.2	18.0	3.4	...
Mature Capon	41.6	19.4	37.9	3.7	...
Total Egg (with shell)	65.7	11.4	8.9	0.8	11.4
Eggs (dry matter aside from shell.....	...	49.8	38.6	3.5	...
Egg Yolk	49.5	15.7	33.3	1.1	...
Egg Albumen	86.2	12.3	0.2	0.6	...
Dry Matter of Fowls' Body	...	48.9	38.5	8.9	...
Dry Matter of Entire Egg with Shell.....	...	33.3	29.5	35.6	...

The ash of the egg aside from the shell, contains 53.7 per cent of phosphoric acid. The analysis of the dry matter of the egg, aside from the shell, is very similar to the dry matter of the fowl. The difference in analysis between the capon and the hen is largely due to the larger per cent of fat in the capon. The high per cent of protein in both poultry and in eggs shows the necessity for supplying protein in a considerably greater quantity than is furnished by plants. Protein is found throughout the body in the blood, muscles, connective tissues, etc. Fats are found in fowls as body fat, in the bones and in eggs. The same ash materials found in animals are also present in plants.

PARTS TAKEN BY MINERAL SALTS

The mineral salts in addition to building up bone structure, play an important part in connection with the digestive acids and changes in the nutrients. Sodium and chlorine are absolutely essential to animal life as the gastric juice in the body contains free hydrochloric acid. Common salt (chemically one part sodium to two parts chlorine) supplies this sodium and chlorine and its use improves the appetite and increases the flow of digestive juices. Lime and phosphoric acid are the two minerals present in the greatest amount in the body as they make up the skeleton and constitute about 80 per cent of the mineral matter. Over 35 per cent of the dry matter in eggs (shells included) is ash or mineral matter while 10 per cent of the body of the fowl is mineral matter con-

sisting largely of phosphate of lime. Potassium and iron are two other essential mineral elements, the former being found especially in the cell walls, muscles, and blood, and the latter in the red coloring matter of the blood.

The feeding tests which have been tried with animals usually show sufficient minerals in their normal feed, but animals are fed largely on forage crops and all such plants containing a considerable amount of minerals. Many poultry, especially those kept confined, are fed more largely on grain with a very limited amount of green or forage crops, and therefore the relative importance of supplying mineral matter is much greater with poultry than with animals. Common salt (sodium chloride), ground bone (phosphate of lime), oyster shell (carbonate of lime), are the mineral matters commonly supplied directly to the fowls. Milk, meat scrap containing bone, and green feeds all contain considerable mineral matter and are excellent constituents of a poultry ration.

ANATOMY OF THE FOWL

The digestive process of poultry is rather similar to that of animals with some minor exceptions. Fowls have a beak but no teeth, so have to swallow grains whole, but can tear some kinds of feeds into fragments. The esophagus or gullet is large and can be greatly expanded. Fowls have a distinct reservoir or crop attached to and acting as a part of the esophagus while ducks and geese have no distinct crop but are provided with a dilated section of the esophagus. The food passes directly into the

crop in fowls where it is temporarily retained and softened with water and a very small amount of saliva. The salivary glands of poultry are very small and are thought not

1. Skull.
2. Eye cavity.
3. Nasal cavity.
4. Upper mandible.
5. Lower mandible.
6. Vertebræ of the neck.
7. Digit.
8. Bones of hand.
9. Digit.
10. Ulna.
11. Radius.
12. Humerus.
13. Backbone.
14. Ribs.
15. Scapula.
16. Clavicles (merrythought).
17. Acetabulum.
18. Ischium.
19. Pygostyle.
20. Femur bone.
21. Sternum or breastbone.
22. Tibia.
23. Tarso-metatsus.
24. Spur.
25. Back toe.
26. Toes.

FIG. 1. ANATOMY OF THE FOWL

to have any very important influence in the digestion of food. The crop in pigeons of both sexes is divided into two parts and secretes a milky fluid for a few days after their young are hatched which is used to feed their squabs.

DIGESTION AND ASSIMILATION OF FOOD

The food passes from the crop into the preventriculus or true stomach where it is acted upon by a gastric or stomach juice. Gastric juice is an acid fluid which contains enzymes and acids. The chief ferment of gastric juice is pepsin which in the presence of acids changes the protein into soluble nutrients. Thence the food goes into the gizzard which is a powerful grinding organ. This has a strong, rough lining in which the food is finely ground by the action of small pieces of sharp sand or gravel called grit.

The small intestines continue the digestive system from the gizzard and are looped around an elongated gland called the pancreas. Next comes the liver and the bile, the former being quite a large organ. The pancreas secretes juices which are essential digestive fluids and these act upon the protein, fats and carbohydrates, reducing them to simpler food forms. The liver has very important functions in regulating and assisting the digestive processes by acting as a regulator on the carbohydrates. The carbohydrates are stored up temporarily in the form of glycogen through the action of the liver and supplied to the system when needed for nourishment. The food

after being digested, changed and regulated by these various organs, passes into the blood directly from the intestines and is circulated and used to repair waste and rebuild tissue throughout the body. These blood veins cover the intestines and thus draw their nourishment directly from the intestines. The nitrogen is probably excreted almost entirely through the kidneys as urine. Water is given off both through the urine and through the lungs. Carbon is eliminated largely by oxidation in the lungs as carbon dioxide. The droppings consist of indigestible food nutrients which pass out through the body. The bile is a secretion of the liver which does not contain any ferments or have any direct digestive action, but cooperates with the pancreatic juices in the digestion of food by providing the proper medium and necessary conditions.

STRUCTURE OF THE EGG

An egg consists of about 57 per cent albumen, 33 per cent yolk, and 10 per cent shell. The yolk is supported near the center of the egg in dense albumen which is surrounded by a layer of finer or more liquid albumen. All of this is enclosed in two thin membranes commonly referred to as the skin of the egg which lie directly under the egg shell. These membranes separate at the large end of the egg and form a small air cell, which increases in size with the age of the egg. The egg shell is a hard substance consisting largely of lime. The size of the eggs from different breeds and from different strains of the same breed varies considerably. It is not influenced by

the feed unless an abnormal ration is used, but is dependent entirely on the individual and its breeding.

The average hen's egg weighs 2 ounces, making a dozen eggs weigh 1½ pounds. In size the egg is about 2.27 inches long and 1.72 inches in diameter at the widest point. The first eggs laid by pullets are under the normal size, but the size increases materially during the first few weeks of laying. Yearlings and older hens lay slightly larger eggs than do pullets. Eggs laid in the spring are slightly heavier than eggs produced at any other season of the year.

CHAPTER III

ECONOMICAL PRODUCTION OF EGGS AND OF POULTRY FLESH

Poultry ranks high as an economical producer of food for human consumption, both in the production of eggs and of poultry flesh, being next to hogs, far better than either sheep or beef cattle but not as good as dairy cows. Poultry produce flesh and edible solids much more economically than sheep or steers but not as economically as the pig, partly because of the lard produced by the pig. Eggs are produced as economically as cheese and considerably more so than butter. The following table gives the amount of animal food produced by farm animals and poultry from 100 lbs. of digestible matter consumed:

TABLE II

Relative Production of Animal Food by Animals and Fowls

Animal	*Marketable Product*	*Edible Solids*
Cow (milk)	139.0	18.0
Pig (dressed)	25.0	15.6
Poultry (eggs from Leghorn pullets)	41.2	9.6
Cow (cheese)	14.8	9.4
Poultry (dressed)	28.1	9.3
Poultry (eggs from general purpose pullets)	29.5	6.9
Cow (butter)	6.4	5.4
Steer (dressed)	8.3	2.8
Sheep (dressed)	7.0	2.6

The figures on eggs used in this table are based on the results secured by the U. S. Department of Agriculture on their experimental poultry farm. The figures on dressed poultry are based on experiments reported by the U. S. Department of Agriculture in their bulletins on fattening poultry. The rest of the table is from the book entitled, "Feeds and Feeding" by Henry and Morrison. Eggs rank quite high in marketable products but not so high based on their edible solids, which relative condition is also true of poultry but to a less degree. Considering that the bulk of the poultry in the country is raised on the general farm where they are able to secure a considerable part of their living from waste products and also that poultry like live-stock, restore fertility to the soil, the economical production of poultry products in this country is readily apparent.

Poultry easily holds first place in the production of animals products for home conditions, being adapted to a great variety of conditions where live-stock cannot be kept economically. These products are raised as a side issue in villages and cities where considerable waste feed is utilized and where the labor item is negligible. They are not only most easily kept but their products are also best adapted for use in the home in a fresh condition. Eggs are also high in the soluble fat product now recognized as being essential to life and growth, and which is only found commonly in eggs, milk and certain glandular organs of animals.

Figures kept at the Government poultry farm by the

U. S. Department of Agriculture at Washington show that Leghorn pullets consumed 4.8 pounds of feed in producing a dozen eggs, and general purpose pullets ate 6.7 pounds. The feed consumed by older hens was much greater, being 5.5 pounds for the Leghorn yearling hens and 9.6 for the yearling hens of the general purpose breeds. Tests by the same Department on fattening chicks or producing flesh in the Central West show that it took 3.26 pounds of grain to make a pound of gain in weight. Buttermilk was used with this grain at the rate of one and a half pounds of buttermilk to one pound of grain. In arriving at the figures used in the table on poultry and eggs, the grains were considered 76 per cent digestible and the milk 82 per cent digestible. Of edible solids 23.3 per cent were secured out of eggs while poultry gave 33 per cent of edible solids.

PLACE AND IMPORTANCE OF POULTRY FARMS

Poultry farms for the production of market poultry products are gradually taking a more important place in this country, and are a factor of considerable importance. It is conservatively estimated that 90 per cent of the poultry and eggs are produced on the general farms and from small flocks kept in the villages and cities in this country, leaving only 10 per cent produced on poultry farms. Both poultry and eggs can be produced more cheaply under general farm conditions than is possible on poultry farms. The general farm poultry products, however, rarely reach the consumer while they are in a

strictly fresh condition, especially where they are shipped to the more thickly settled parts of this country. For this reason commercial poultry farms devoted to the production of high class eggs are able to operate profitably.

While strictly fresh eggs have a value and quality considerably exceeding eggs which are not fresh, poultry produced on the farms can be marketed through the ordinary channels, put into storage and sold in any section of the country and at any season in direct competition with fresh goods. Many chickens and hens are shipped alive from the farming sections to the larger eastern cities. Therefore the production of poultry flesh as a specialty on poultry farms only offers in a few local sections the opportunities that exist in the production of market eggs. The market poultry farms producing eggs have been developed largely in the northeastern section of this country within easy shipping distance of New York, Boston and Philadelphia and to a less extent near some of the larger cities of the eastern part of the Central West and and northern part of the Southeast.

Another section in which egg farming is a big industry is on the Pacific coast, especially in central and southern California. Climatic conditions appear to be especially favorable for egg farming there and the industry has been developed to the point where hundreds of thousands of dozens of eggs are shipped annually to New York, while a few go to other eastern cities. The constant growth of the larger cities in this country gives the egg farmer assurance of a constant demand for eggs at profitable prices.

MEAT VERSUS EGG PRODUCTION ON POULTRY FARMS

A large amount of broilers and of roasters are produced as a side issue on poultry farms in the rearing of pullets for egg production and these sell at a fair price, especially those produced early in the season. Many people have been attracted by the high prices paid for broilers in the winter months and have tried to make the rearing of chickens, at other than the natural breeding season a success, but without permanent results. Undoubtedly the reason for this is the high cost and difficulty of rearing chicks during the winter months, the competition with the broilers produced as a side issue on egg farms and especially the competition with cold storage broilers and roasters.

Chickens are produced on general farms during the spring months at low costs, are fattened and dressed in an attractive manner and kept in cold storage until needed for consumption, and when sold are in first class condition and compete directly with freshly killed stock. Chickens can be kept in cold storage at very low temperatures so that the depreciation in their quality is very slight while eggs cannot be kept in the shell at any such low temperatures and do not compete to anywhere near the same extent with the strictly fresh product.

THE SOFT ROASTER INDUSTRY

The soft roaster industry as developed in the South Shore of Massachusetts, and in Pennsylvania and New

Jersey near Philadelphia, and the growing of green ducks are the two exceptions to the general lack of profit in producing poultry meat as a specialty. Both of these industries have proved very profitable in a limited way and have been more profitable than most other lines of poultry raising. The opportunities and markets for both of these industries are very limited. The soft roaster industry involved the rearing of chicks in the fall and winter, the caponizing of the males and the sale of both males and females in the late winter and spring months. The Boston market handled the bulk of this product at high prices. During the war period of 1917 to 1919 this business was practically discontinued and it has not been developed much since. A similar industry was conducted around Philadelphia but the rearing of the birds was on a smaller scale in that section.

DUCK FARMING

The production of "green ducks" on Long Island, N. Y., and somewhat in Massachusetts and Pennsylvania, involves the rearing of young ducks for the market during the late winter and spring months, these ducklings being forced for rapid growth and sold when they are 10 to 12 weeks old. At that age with these conditions, these ducklings will weigh nearly as much as an ordinary duck 6 or 7 months old. New York is the only big market for this product, although a considerable number of these ducks are sold in Boston and some other eastern cities.

COMMERCIAL POULTRY FATTENING

Commercial poultry fattening has been developed to a large extent in the poultry producing sections of this country where the chickens are raised largely on general farms and have to be shipped long distances to market. This work has been developed at a considerable profit in the Central West and somewhat but to a less extent in the northern section of the South. Many of the poultry fattening stations now have a feeding capacity of over 20,000 chickens at one time. The possibilities of profit depend on a great many conditions but the general farm chickens usually come to market in a thin and unfinished condition making a brief fattening period in a fattening station reasonably profitable. The fattening stations may be developed in connection with the purchase of eggs alone or small stations are often developed in connection with the purchase of eggs and of milk products.

The object of fattening chickens is to increase weight and improve quality. The fat in growing chickens is deposited as tissue between the muscular fibres making the meat tender and juicy as well as improving its flavor and digestibility. This fat on an especially highly fattened chicken will be deposited directly beneath the skin, especially on the back, while in mature fowls, more particularly hens, body fat is also freely stored about the internal organs. The percentage of gain in weight in fattening chickens is in inverse proportion to the weight of the chickens; the smaller chickens easily making the great est percentage gains. The most profitable gains and

those greatest in proportion to the size are made in the younger chickens weighing from 1½ to 2 pounds apiece. Hens which have been reasonably well fed are usually in good flesh and are therefore not especially fattened. The gains made by hens are much less than those made by growing chickens as the latter gain weight both by putting on fat and by the growth of the body structure.

Rations containing a greater percentage of carbohydrates and less protein are used in fattening the hens, the chicks requiring a larger per cent of protein because of the growth that occurs during the fattening period. Buttermilk or skim milk is used in mixing all fattening rations and is the one ingredient considered absolutely essential to commercial success. Milk makes up from 50 to 70 per cent of the fattening ration. It is easily digested and contains all of the elements essential to the maintenance of life and to growth. Its use stimulates the appetite, aids digestion and keeps the digestive organs of the chicken in good condition. The milk bleaches the flesh of the chickens, especially those on this feed for two weeks or longer, and the bleached appearance adds materially to the market value of the chicken. The rest of the ration consists of grains very finely ground to make them readily digestible. Usually the chickens are fed a very forcing ration for a couple of weeks to get them in a prime market condition.

The greatest gains are made in the early stages of fattening, the gains usually decreasing toward the end of the fattening period. Increase in weight is greatly influenced

by the size of the chickens and the weather conditions. Hot weather in the summer makes conditions in the fattening stations unfavorable, while wet, cold weather in the fall is also undesirable. The fattening season usually runs from August 1 to November 1, depending upon the size of the chickens and the market demand.

DRESSED WEIGHT OF POULTRY

The shrinkage after killing and picking without drawing (only blood and feathers removed) averages about 11.5 per cent in the fattening stations for the broilers, the shrinkage increasing gradually with the size of the chickens to 15 per cent for those averaging about 3½ pounds in weight. With hens the shrinkage is greater than on smaller chicks, averaging 13 per cent. Chickens which are especially fattened show a slightly lower shrinkage when killed and picked than do those not fattened. In experiments conducted at the Pennsylvania State College (Bulletin 87, Pennsylvania State College) White Wyandotte Cockerels gave 60.99 per cent of their live weight as flesh and 8.97 per cent as feathers, 7.78 as head and feet; 7.42 as bones of the body; 6.78 as intestines; 4.49 as giblets and 3.57 as blood. White Wyandotte Pullets gave 65.45 per cent of flesh, 6.07 as feathers, 7.75 as head and feet, 6.29 as bones of body, 6.62 as intestines, 4.64 as giblets and 3.20 as blood. White Leghorn Cockerels gave 56.75 per cent flesh, and White Leghorn pullets 58.67 per cent flesh.

Pullets have a larger per cent of edible flesh than cock-

erels of the general purpose or medium sized breeds. The per cent of flesh from poultry is lower than from hogs and beef cattle. Wyandottes dress out considerably better than do the light egg breeds (Leghorns).

CHAPTER IV

FEEDING STANDARDS AND THE EFFECT OF DIFFERENT NUTRIENTS

Measuring Feed Values for Animals. The usefulness of different feeds for animals is measured by determining the per cent of total crude protein, nitrogen free extract, fiber, and fat digested by the animals. Feeding tests have been made, and quite complete feeding standards have been prepared for animals to determine the amount of digestible nutrients required to maintain the life processes and in addition to provide for work, for the production of milk, for growth and for fattening. The first feeding standard was based on total rather than digestible nutrients and was proposed in 1859, and the first complete standard based on digestible nutrients was proposed by Dr. Wolff in 1864 which resulted later in the Wolff-Lehman feeding standards.

Numerous feeding experiments conducted since that time have led to the use of several other standards which are more accurate. Experiments with a respiration apparatus and calorimeter by Kellner and Zuntz and also by Armsby show that the energy required in eating and digesting feed must be subtracted from the total available digestible energy to secure the true net value of the feed. These tables show the amount of total dry matter, diges-

tible protein, and energy value in feeds; the amount required for different animals and are apparently more correct than the old standards. All these standards and the various multiplications while not absolutely accurate, have proven to be of great value in the feeding of animals.

HOW FEEDS ARE ANALYZED

The chemist finds how much water there is in a feed by using and drying out at a high temperature all the water from a finely divided sample of the product. This sample is then burned and only the ash or mineral matter remains. In determining the crude protein, the nitrogen content of the feed is found and the result multiplied by 6.25 since about 16 per cent of plant protein is nitrogen. The fiber is the product that remains after a sample of the feed has been boiled successively in a weak acid and in an alkali and the dissolved matter washed out. The part of the feed which will dissolve in ether is called the ether extract or fat. The carbohydrates are made up of the nitrogen free extracts and the fiber, the nitrogen free extract being determined by securing the difference between the total dry matter in the feed, and the combined amount of the ash, crude protein, fiber and fat.

DIFFERENCE IN VALUE AND IN THE USE OF FEED NUTRIENTS

While the nitrogen free extract and the fiber together make up the carbohydrates, the nitrogen free extract is more digestible and has a greater feeding value than the

fiber. Protein of animal origin has been found to have a greater feed value for poultry than vegetable proteins while in experiments with animals, proteins have been found to be very different in their feeding values. The flesh forming material in the feed is furnished by the protein which is essential in the production of lean meat, eggs, feathers, muscles, etc. It may also, if fed in excess, be used as fuel or energy but is much more expensive than carbohydrates as a source of energy. Carbohydrates supply fuel and energy and aid in forming fatty tissue after they are transformed into fats. Fats perform the same function as the carbohdrates and are 2.25 times as valuable as the latter as a source of heat and energy.

PRODUCTS ESSENTIAL TO LIFE AND GROWTH

Experiments conducted with pure chemicals to discover what elements are absolutely essential to life and growth show that the diet must contain protein, carbohydrates, fats, inorganic salts, namely calcium, sodium and chlorine, and two unidentified substances called for convenience by McCullom, "Fat soluble A" and "Water Soluble B." Fat Soluble (A) is associated with fats, especially with butter fat, egg yolk fats and fats of the glandular organs of animals, but not in fats or oils of vegetable origin. Water Soluble (B) is not associated with fats or oils but is widely distributed in various products from which it can be secured by extraction with water or alcohol. It is found especially in milk and leaves, fruit juices and in the liver and kidneys.

FIG. 2. FEEDS MAKING UP A BALANCED RATION: 1, CORN; 2, WHEAT; 3, OATS; 4, MEAT SRAP; 5, MUDDLINGS; 6, CORN MEAL; 7, BRAN; 8, OYSTER SHELL; 9, SPROUTED OATS; 10, GRIT.

FIG. 3. AVERAGE FEED CONSUMPTION AND EGG YIELD OF A PEN OF 30 RHODE ISLAND RED PULLETS.

SOURCES OF THESE ESSENTIAL PRODUCTS

All seeds resemble each other closely in properties and are largely deficient in the same substances. Leaves combined with seeds supplement all the nutritive deficiencies of the seeds but do not usually furnish the essential nutrients in suffiicent quantities. The dry leaf contains 3 to 5 times as much ash as the seed and is especially rich in calcium, sodium and chlorine. It is also richer in Fat Soluble A and contains a supply of protein. Milk is a complete food containing both Fat Soluble A and Water Soluble B. It is deficient in iron but most water contains sufficient iron to make up for this deficiency. Muscle tissue is lacking in minerals and is relatively poor in Fat Soluble A as compared with milk and leaves. The glandular organs, especially the liver and kidneys contain more of both (A) and (B) than the muscle tissues.

Eggs are a complete food but used alone do not produce the best results. The yolk is especially rich in these two desired factors. The effect of heating or drying on these products is not yet clearly established but Fat Soluble (A) in milk does not appear to be affected either by drying or canning, and both (A) and (B) in leaves are not affected either by drying. Feeds supplying Fat Soluble (A) require special selections but Water Soluble (B) is widely distributed in feeds and it is not nearly as likely to be deficient as (A). Milk, eggs and leafy vegetables should be regarded as protective feeds especially high in Fat Soluble (A) and in minerals. Fruits are high in salts and have a beneficial effect on the system. A bal-

anced ration requires supplementing seeds, tubers, roots and meat with milk and leafy vegetables.

FEEDING STANDARDS FOR FOWLS

Very little satisfactory work has been done in preparing feeding standards for fowls. Some digestive experiments have been conducted but the results have not been particularly satisfactory and the number of feeds included in this work is comparatively small. One reason why digestive tests with fowls is difficult is because the urine and dung is voided together and not separately as with animals, making it much more difficult to study the different elements digested in feeds. For these reasons the digestible nutrients of feeds which apply to animals are practically the only complete tables available for use with poultry, but the digestive experiments conducted with poultry so far, would indicate that the animal digestion tests do give somewhat similar results to tests with fowls. While the digestive tests which have been made with fowls are very limited in number and the use of nutritive values and ratios is of an indefinite nature, they still furnish our best available data and the nutritive ratios worked out in this book are based on digestible composition as worked out for animal feeding. Table (II) in the rear of this book gives the total composition of feeds and also the digestible composition of feeds for animals.

NUTRITIVE RATIOS

The proportion of the protein to the nitrogen free extract plus the fat reduced to terms of nitrogen free ex-

tract, is called the nutritive ratio. The fat has a feed value two and a fourth times as great as the nitrogen free extract so the fat is multiplied by 2¼ and added to the nitrogen free extract and the total of these two products, divided by the protein, gives the last figure of the nutritive ratio. The following example of a complete ration is given to show how this nutritive ratio is figured. In this example the scratch mixture and the mash have been combined on the basis that the same number of pounds (300) of scratch mixture are fed as of mash. The mash as given in this ration totals 300 pounds to equal the 300 pounds of scratch feed (corn, wheat and oats), making a complete balanced ration. Table (II) gives the number of pounds of digestible feed constituents (protein, nitrogen-free extract, and fat) in 100 pounds of each of the grains, so that in order to get the number of pounds of these

TABLE III

Example of Nutritive Ratio

Pounds of Feed	**Protein*	*Carbo-hydrates*	*Fat*
	%	%	%
100 corn	7.5	67.8	4.6
100 wheat	9.2	67.5	1.5
100 oats	9.7	52.1	3.8
196 cornmeal	13.5	135.1	6.9
80 meat scrap	39.8	....	14.8
12 bran	1.5	5.0	.4
12 middling	1.6	5.5	.5
Total.....	82.8	333.0	32.5

*Digestible nutrients

constituents in 196 pounds of corn meal the composition as given in the table is divided by 100 to get the amount in 1 pound of corn meal and this is then multiplied by 196. A similar process is gone through in the case of the meat scrap, bran, and middlings. The amount of constituents in the corn, wheat, and oats are the same as in Table II, since exactly 100 pounds of each of these feeds is used in this example.

The fat, 32.5, is multiplied by two and a fourth, giving 73.1, which is added to the carbohydrates, 333.0, making a total of 406.1. This, divided by the protein, 82.8 gives a nutritive ratio of 1 to 4.9 for this ration.

The value of a nutritive ratio in actual poultry practice is limited but it has some value where new feeds are being used to make a combination which approximates the mixtures ordinarily advised or which have been used successfully. It has never been determined just what nutritive ratio is best for egg laying, for fattening, or for growth and different rations having considerable variation in nutritive ratios have given good results in every line of feeding work. The nutritive ratio for laying rations should be about 1 to 4½ or 5, and a growing ration should have about this same proportion or it may be a slightly wider, that is, 1 to 4½ or 6. The fattening ration should be still wider, the ratio being about 1 to 7. In figuring nutritive ratio the proportion of scratch mixture and mash used for poultry is very important as ordinarily the mash has a low nutritive ratio and the scratch mixture a wide ratio. The nutritive ratios in this book are figured on the

basis of an equal consumption of mash and of scratch feed for the year which is the proportion advised for average conditions.

The composition of the feeds which directly affects the nutritive ratio of a mixture, is not in itself an absolute test of their feeding value for poultry. For instance, certain feeds are high in protein but if the protein is of vegetable origin it is not nearly as valuable for poultry as a feed in which the protein is of animal origin. Feeds high in crude fiber are undesirable in a poultry ration even though they contain considerable protein and other elements useful in poultry feeding. Therefore, it is impossible to work out satisfactory rations based on the analysis only, and the palatability and actual feeding practice of these feeds for poultry must be taken into consideration.

FEED REQUIREMENTS OF CHICKS AND MATURE FOWLS

A table showing the approximate feed requirements for chicks and fowls was worked out a number of years ago at the New York Experiment Station, Geneva, N. Y., by W. P. Wheeler. The actual working value of such a table is open to question but it does have a value in showing the approximate amount of feed required for chickens of different ages. Chickens cannot be fed by a table of any kind with success and the feeding practice must be successfully handled by the actual feeder who judges the amount to give by the appetites of the chickens. Some lots of chickens will consume considerably more feed than

another lot of the same breed and of the same age. The table as worked out by Mr. Wheeler is as follows: —

TABLE IV.

Feed Requirements of Chickens per Day for Each 100 *Pounds of Live Weight*

Birds	Digestible nutrients (pounds)					Fuel value (calories)	Nutritive Ratio
	Protein	Fat	Carbohydrates	Ash	Total dry matter		
Growing chicks:							
First two weeks...	2.00	0.40	7.20	0.50	10.1	18,800	1 to 4.1
Two to four weeks	2.20	.50	6.20	.70	9.6	17,830	1 to 3.4
Four to six weeks.	2.00	.40	5.60	.60	8.6	15,640	1 to 3.3
Six to eight weeks	1.60	.40	4.90	.50	7.4	13,780	1 to 3.7
Eight to ten weeks	1.20	.30	4.40	.50	6.4	11,680	1 to 4.3
Ten to twelve weeks	1.00	.30	3.70	.40	5.4	10,000	1 to 4.4
Adults (maintenance only)							
Capon, 9 to 12 pounds	.30	.20	1.74	.06	2.3	4,600	1 to 7.5
Hen { 5 to 7 pounds	.40	.20	2.00	.10	2.7	5,300	1 to 6.2
Hen { 3 to 5 pounds	.50	.30	2.95	.15	3.9	7,680	1 to 7.4
Egg production:							
Hen { 5 to 8 pounds	.65	.20	2.25	.20	3.3	6,240	1 to 4.2
Hen { 3 to 5 pounds	1.00	.35	3.75	.30	5.4	10,300	1 to 4.6

PART II

DESCRIPTION OF FEED STUFFS

CHAPTER V

CEREALS AND THEIR BY-PRODUCTS USED IN POULTRY FEEDING

Indian Corn and its By-Products. Corn is the leading cereal produced in this country and is the grain most extensively fed to poultry. According to the Yearbook of the U. S. Department of Agriculture 2,917,450,000 bushels of corn were produced in 1919, valued at $3,934,234,000 and 2,502,665,000 bushels in 1918 valued at $3,416,240,000. The average yield per acre (in the United States) was 28.6 bushels in 1919 and 24.0 in 1918. This crop equals in acreage and value all the combined principal grains together with several of the minor crops. The bulk of the crop is produced in the Central West where the land is wonderfully fertile and where the nights are warm during the growing season, but corn can be raised in nearly every State in the Union.

Corn is the great heat and energy producing grain, being composed largely of carbohydrates and oil, but being rather low in crude protein and especially deficient in mineral matter. The crude protein of this grain consists largely of a single protein called zein, which is thought to lack some of the amino-acids considered necessary for animal growth. This deficiency in mineral matter is made up by feeding the corn with bran, middlings,

meat scraps and green feed or grass secured on range. There are two kinds of corn used in feeding poultry, dent and flint. Flint corn is much harder than dent corn and the starch is more bonelike and flinty. This kind of corn is especially preferred for feeding pigeons, but both flint and dent corn are fed extensively to poultry. Corn on the cob is frequently fed to hens on general farms, but hens are not able to eat corn on the cob freely and it gives no opportunity to use the grain in the litter as a scratch feed. Feeding corn on the cob to fowls is not advised, as it undoubtedly pays to have the corn shelled.

It takes about 70 pounds of the average quality well dried dent corn on the cob to make a bushel (56 pounds of shelled corn). Flint corn has a larger proportion of cob to corn than has dent corn. Freshly husked corn contains a considerable per cent of water and in the early fall 75 to 80 pounds of dent corn on the cob are considered equal to a bushel of shelled corn. Shelled corn does not keep well in bulk, especially in the summer, and is usually kept as long as possible on the cob. Old shelled corn contains about 12 per cent water, and corn containing over 20 per cent water will not keep well in storage in large quantities. Soft corn is the result of corn being frosted before it is matured, and such corn will not keep well. If used for poultry it should be carefully watched to see that decomposition has not begun and that it is neither moldy nor musty.

Corn meal correctly refers to the ground whole corn grain, but this term is also often applied commercially to

finely ground siftings and waste from corn meal prepared for home consumption, as well as that secured in making cracked corn. This waste meal has a feed value about equal to ground whole corn. Corn chop usually refers to ground whole corn, although other ground corn by-products may be included in it. It is usually a much coarser product than corn meal. Ground grains have no more feed value than these same grains in their whole or cracked forms, but the best results in feeding poultry are secured where about one half of the feed is given in the whole or cracked form called scratch feed and the rest in the form of finely ground grains and meat feeds which make up what is called the mash.

Corn and cob meal, which is the corn and cob ground up together is not adapted to poultry feeding on account of its high fiber content and fowls are not able to digest or utilize crude fiber as well as live stock. Commercial starch and glucose are manufactured from corn by soaking the corn in water containing some acid and separating the desired constituents. Four products are secured in this process; the germ, used in making corn oil and germ oil meal or corn oil cake; the bran made up of the hulls; the gluten, and the starch. Corn gluten feed contains the gluten and the corn bran to which is added the residue from the water used in soaking the corn, making a rich concentrated food. It is rich in crude protein and fat and contains considerable carbohydrates. The composition of this feed is quite variable, depending on its manufacture, but the protein usually ranges from 18 to 29

per cent and the ash from 1 to 6 per cent. Both yellow and white corn are used which gives a corresponding color to the product. Artificial yellow coloring matter is sometimes added to the white product. The gluten meal is now practically all used up in making gluten feeds. Most of the oil is pressed out of the germ, leaving a cake that is called germ oil cake or corn oil cake. This is higher in fat than gluten, but lower in protein.

Hominy feed, also called hominy meal or chop, contains the bran coating, the germ and some of the starchy parts of the grain obtained in manufacturing hominy grits for human consumption. It is similar to corn in composition, but is slightly lower in nitrogen free extract and higher in fiber and in fat. It is sweet and clean and usually keeps better than corn meal. Corn bran contains slightly more nitrogen free extract and fat than wheat bran, but only about three-fifths as much protein, while it is higher than wheat bran in fiber. It is rarely sold as a separate feed and is not nearly as good a poultry feed as wheat bran.

Corn and corn meal are the grains most palatable and best liked by poultry. In the experiments conducted by the U. S. Department of Agriculture, Washington, D. C., where bran, middlings, meat scrap and corn meal were kept in separate hoppers before the fowls they consumed much larger quantities of corn meal than any other product throughout the year. The average consumption of these products for a year, for White Leghorns, was 66 per cent corn meal, 26 per cent meat scrap and 4 per cent

each of bran and middlings. A mash containing a considerable percentage of corn meal is very palatable to fowls and if properly balanced with meat scrap is not too fattening. Corn or corn meal alone are too fattening unless balanced with a high protein feed.

WHEAT AND ITS BY-PRODUCTS

Wheat is ranked next in importance to corn as a poultry feed and is especially well liked by most poultrymen, but on account of its extensive use for human consumption and its present relatively high price it is not being used so much as a poultry feed as it has been in the past. From 10 to over 40 per cent of the wheat crop is usually exported from this country while only 1 to 2 per cent of the corn crop is exported. Considerable of the wheat produced, especially that handled under unfavorable weather conditions, is of a low grade and not well adapted for making flour, which wheat is available and largely used in feeding poultry. A total of 940,987,000 bushels of wheat were produced in the United States in 1919 which were valued at $2,024,008,000. The average yield per acre for the United States was 12.8 bushels in 1919 and 15.6 bushels in 1918. Wheat is raised in nearly every State in the Union, being largely produced in the northern section of the Central West. It is also raised on a large scale in the Pacific Coast States where very little corn is produced.

Wheat contains more crude protein, less fat, and slightly more carbohydrates than corn. It is low in min-

eral matter and needs to be supplemented with feeds rich in lime and protein. It is an unbalanced feed the same as is corn and should be used with other feeds and not fed as an exclusive grain diet. The protein content of wheat varies considerably in different sections of the country. Durhum or macaroni wheat is grown extensively in the Plains States and has about the same composition as ordinary wheat grown in the same section.

In producing flour, wheat is milled through rollers, the object being to secure all of the starch and gluten possible, avoiding the germ and the bran. The by-products secured in the manufacture of flour are wheat bran, standard middlings or shorts, white or flour middlings, red dog flour, and mixed wheat feed, all of which together make up from 25 to 35 per cent of the wheat kernel. Thus a large amount of wheat by-products are available for feeding live stock and poultry on account of the large amount of flour produced in this country for human consumption.

Bran consists of the outer coating of the wheat and is quite rich in digestible crude protein and mineral matter and also contains considerable carbohydrates. This feed contains considerable fiber and is deficient in mineral lime. Wheat bran contains from 6 to 7 per cent of phosphorus, magnesia, and potash combined together. The laxative effect of bran noted in its use as a feed has been found to be due to its phosphorus content. Lime in some form should be supplied with bran and is generally given to poultry in the form of oyster or clam

shells and also through green feeds, especially the legumes. Bran gives bulk to the ration, adds considerable food value, and is especially desirable for breeding fowls and for growing chickens.

Red dog flour, also called red dog middlings, contains the germs of wheat and is a dark colored feeding flour with about the some composition and value as the best flour middlings. Wheat middlings vary greatly in quality from the red dog flour which contains considerable fine flour, to shorts which contain very little flour. Standard or brown middlings are made up of fine particles of bran to which considerable flour is attached. White or flour middlings are a better grade of middlings containing more low grade flour and being of somewhat higher food value than the standard or brown middlings. Shorts often consist of a poorer middlings than the grade referred to as standard middlings, being made of reground bran and sweepings. This term is also sometimes used interchangeably with standard or bran middlings. Wheat mixed feed or ship-stuff refers strictly to the entire run of the mill from wheat flour, but is often used to refer to mixtures of bran and middlings in various proportions. Its comparative value depends largely on the amount of flour which it contains.

A large amount of wheat screenings are produced at the mills, consisting of broken and shrunken wheat mixed with weed seeds. This wheat has good food value and some of the weed seeds are also of value, while other seeds have little value. All very hard small weed seeds are ob-

jectionable as possible sources of weed infection through the manure. Finely ground wheat screenings are in a form which prevents their serving as a source of weed infection and this product is used largely in the manufacture of proprietary feed stuffs and not sold much for poultry and live stock as a separate feed.

Bread is a splendid poultry feed and is used to quite an extent, especially in feeding small and growing chickens. Stale bread from bakeries can sometimes be secured at a price which makes it an economical feed for mature stock, but it is not considered to be of as great value in their ration as it is in the feed for young chickens.

OATS AND THEIR BY-PRODUCTS

Oats are grown all over the United States and are used extensively as a poultry feed. A total of 1,248,310,000 bushels of oats were produced in the United States in 1919, valued at $1,248,310,000 and 1,538,124,000 bushels in 1918. The production in number of bushels of oats is far greater than of bushels of wheat, although the value is less. The average yield per acre in the United States in 1919 was 29.4 bushels, and in 1918, 34.6 bushels. The weight and quality of oats is materially affected by the soil and climate. Those grown in the South sometimes weigh as low as 20 pounds to the bushel, while in the Northwest, oats weighing 50 pounds to the bushel are produced. The hull of oats makes up from 20 to 45 per cent of their weight and averages about 30 per cent. Oats which have the hulls clipped at the

pointed end are called clipped oats and contain a smaller per cent of hull than unclipped oats, provided that the oats are of good quality. The large per cent of hull in oats is somewhat objectionable for feeding poultry and a hull-less oats has been produced which is a better poultry feed but which is only raised on a small scale in this country. Oats are higher in crude protein than corn, and contain more fat than wheat, having about the same fat content as corn.

A large amount of oat by-products is made in the manufacture of oat-meal and other breakfast foods. Only the heavier grades of oats are used for these, and the hulls are removed, leaving a large quantity of oats hulls and considerable light weight oats available for feeding poultry and livestock. These oats hulls contain about 30 per cent fiber and have very little nutritive value but may have some value in furnishing bulk to a ration for livestock. They would be detrimental, rather than of value, in a poultry ration. These bulky products are sold in mixtures of other feeds as well as in ground or crushed oats so that the value of all oats product should be carefully considered on the basis of their composition, especially in regard to their fiber content.

Rolled oats and oat-meal prepared similarly to that used for breakfast food and human consumption are fed quite extensively to small chickens and to some extent to hens. Rolled oats which are not throughly cleaned or are not of the best grades for human consumption are those usually fed to poultry. Ground oats and oats feeds

consist of oats and its by-products ground up, and should always be bought on the basis of their guaranteed composition. It is very easy to include a large proportion of oats hulls or other feeds of very low value which are difficult to detect in a superficial mechanical examination of oats feeds. The fiber content will show approximately the relative amount of oats hulls in the feed.

Various by-products of oats are made but they are not much used in feeding poultry except as they are included in the commercial mixed feeds. Oat dust consists of the small hairs which adhere to the outer end of the kernel and contain considerable protein and fat and about 18 per cent fiber. Its feeding value lies between that of oats hulls and oats middlings. Oats middlings and oats shorts are made of the outside skins of this grain, occupying a position in the oats seed similar to the bran of wheat. Oats middlings contain more fat than wheat bran. Pinhead oatmeal or hulled oats are used extensively in feeding small chickens.

The berry of the oats with the hulls removed is called "oats groats" and is used extensively in a finely ground form in the commercial fattening of poultry in which a very finely ground product is desired with only a small amount of fiber. Ground oats, which have been reground, are also sometimes used, especially in fattening hens, but do not give as good results as do ground oats groats. Clipped oats by-products are made of clippings from the ends of oats and consists largely of fiber. This product is used mostly in preparing proprietary feeds. The feed

called ground corn and oats is very variable in quality, depending on the grade of oats, corn, and other products used in its manufacture. A good grade of ground corn and oats should not contain over about 7 per cent fiber, which would be about half each of corn and of oats.

Oats are an excellent feed for poultry and make sturdy growth, especially in young chicks. They are used extensively both for feeding chicks and for feeding mature fowls. The principal objection to oats is their fiber which is especially high and undesirable in light weight oats. Oats from which the hull has been removed, such as rolled oats and hulled oats are especially desirable for chick feed. Rolled oats are also used somewhat in feeding mature fowls and are greatly relished by them. Rolled oats are usually considered too high in price to be used for mature stock, although if one desires a nourishing feed which is especially palatable to the fowls they are worth considering as an addition to the mash. Ground oats, in which the hulls are included, are more commonly used for feeding laying hens. Ground oats which are specially prepared and of which an especially fine product is made, have been used extensively for fattening, in Sussex, England, in which section the oats are commonly spoken of as Sussex oats. Clipped oats are sometimes used for laying hens but if a fairly heavy oats is available they can be used without clipping. If the oats are very light it will pay to use clipped oats for mature fowls rather than the light weight oats.

BARLEY AND BREWERS' GRAINS

Barley is not fed nearly as extensively to poultry as are corn, wheat and oats, but is used considerably on the Pacific Coast where very little corn is produced. This grain is grown extensively in this country and has been used largely for brewing and stock feeding. Bald or hull-less barley is grown in the Western States and is a better feed for poultry than the ordinary barley because it has no hulls and does not contain so much fibre. Barley contains more digestible protein than corn but less than oats. It ranks between oats and corn in its carbohydrate content and is lower in fat than either of these grains. In 1918, 256,225,000 bushels of barley were produced in the United States, the average production per acre being 26.3 bushels. Its value was estimated at $234,942,000. In 1919 only 165,719,000 bushels were produced.

Malt used in making beer is produced from barley by steeping the grains in warm water and allowing small sprouts to form. In this process the diastase, which is the enzyme that converts starch into malted sugar, is greatly increased. After the sprouts are started the sprouting grain is quickly dried and the dried sprouts separated from the grains and sold as malt sprouts. The dried grains form malt, which is mixed with cracked corn to make beer by mechanical treatment and fermentation. The residue makes up wet brewers' grains which are dried in a vacuum to make dried brewers' grains. Experiments with live-stock show that there is more actual food value in the original barley than in the malt and malt sprouts com-

bined, but these later products are very palatable to stock and may have a value for specific feeding or conditioning purposes greater than their actual food content.

Dried brewers' grains keep as well as bran and contain over 70 per cent more digestible crude protein and twice as much fat, but less carbohydrates. The fibre content is higher than bran, making them a bulky feed, not especially adapted for poultry feeding, but used more for livestock, especially for dairy cows. Wet brewers' grains contain about 75 per cent water and can only be fed profitably where they are produced. They are not used in feeding poultry and considerable care must be exercised in their use for cows to keep the quarters sanitary and the stock in good condition. Malt sprouts make a bulky feed, rather low in carbohydrates and fat, but with about 20 per cent of digestible crude protein in a readily assimilable form. They swell greatly and are usually thoroughly soaked in water before being fed to cattle. Malt sprouts are used only for feeding cattle.

Barley feed is rarely found on the market and has about the same feeding value as wheat bran. It is a by-product from the manufacture of pearl barley and barley flour. Barley meal or ground barley is used extensively in poultry feeding on the Pacific Coast.

RYE

Rye is not produced extensively in this country and is rarely fed to poultry as they do not relish this grain. It is raised extensively in Europe and used there in making

bread for human consumption. When fed alone it is more apt to cause digestive troubles than the cereals commonly used for poultry in this country. A limited amount of rye may be fed to poultry in connection with other cereals, but it is not usually bought as a poultry scratch feed. Rye bran and rye middlings are usually mixed together and sold as rye feed. They have about the same feeding value as the corresponding wheat feeds as far as their analysis and actual food content are concerned but are not so well liked for poultry as the wheat products.

EMMER

Emmer is a member of the wheat family which is drouth resisting and of particular value in semi-arid sections. It is a comparatively new grain and is raised only to a limited extent in this country, being produced mostly in the northern plain States. It will give an average yield of about 22 bushels to the acre and resembles barley in appearance more than it does rye. It is a bulky feed with a composition similar to oats and like oats can be fed to fair advantage with the other cereals. A bushel of emmer weighs 40 pounds.

SORGHUMS AND MILLETS

Sorghums and millets are raised very extensively in India, China and Africa, where they serve as one of the main sources of bread for the people of those countries. Grain sorghums will grow and do well under semi-arid conditions and will recover from drouths which entirely check the plant's growth, when moisture is again avail-

able. The raising of sorghum is increasing rapidly in the southern part of the semi-arid plains section. The number of bushels of these grains produced in the United States in 1919 was 126,058,000.

The sorghums are divided into two classes: the non-saccharine or grain sorghums which include all those of interest to the poultryman, and the saccharine sorghums the stems of which are filled with sweet juices and are used as fodder for livestock. The grain sorghums include kafir, milo, durra, feterita, kaoliang and shallu, of which only the first four are of importance as poultry feeds. The standard weight by which sorghums are sold is 56 pounds to the bushel and it takes about 73 pounds of head kafir or 66 pounds of head milo to make a bushel of these grains. Kafir is the leading poultry grain of the sorghums and is the one most extensively grown in this country. It will give a yield of 50 to 75 bushels of grain to the acre on good soil with good climatic conditions, but the average yield is usually quite low, depending greatly on the amount of rain-fall. Milo is the next most important grain of this class and is grown in the drier part of the territory adapted for sorghums. Feterita is another promising grain sorghum and will mature in a somewhat shorter growing season than the other grain sorghums. It does well in the eastern section of the grain sorghum belt but is more difficult to grow and handle than the others.

The Durras which include both white and brown Durra, commonly called Egyptian or Jerusalem corn, have a thick head which is compact and egg-shaped. The

seeds of this grain are flat and not round as is Kafir corn. Kafir has a smaller seed than the Durra and is almost round. The white variety of Kafir is the one that is commonly raised. Feterita is a plump bluish white seed which is rather a recent importation and is only being used to a small extent. It has some use as a poultry feed and may be more popular for that purpose as time goes on. Both feterita and milo belong to the Durras. The Kaolings are not raised much in California but are a common Chinese sorghum which is brought in to a small extent from that country. Shallu, commonly known as Egyptian wheat is used slightly for a poultry feed and is not raised much in this country. It has a small hard grain.

The different sorghums are somewhat similar in composition and from their analysis would have a feeding value for poultry about equal to corn. They are not as palatable or so well liked by fowls as corn but are especially adapted for feeding pigeons on account of being a very hard sound grain. The sorghums are considered about 90 per cent as valuable a feed as corn for livestock. They are also used extensively in commercial scratch and chick feeds, because they are small in size, will keep well, and add variety to the mixtures. Very few feeding tests and little experimental work of any kind have been carried on with these grain sorghums to determine their relative value as poultry feeds. Kafir corn and milo maize are the only sorghum grains which are used much for poultry feeding outside of sections where they are grown extensively. Milo maize is just as good a feed as Kafir and has a

slightly beneficial laxative effect not secured from Kafir corn. Brown Durra (brown Egyptian corn) and Kafir seem to have a slightly constipating effect making it desirable to feed these with oil meal or green feed for livestock. White Durra (white Egyptian corn) and the milos do not have this constipating effect, making them slightly more desirable as a poultry feed. White Egyptian corn has been raised quite extensively in California in recent years and is used extensively as a poultry feed. It is commonly referred to locally as "gyp" corn. This grain and barley are the two common poultry grains in California and are used much more extensively than wheat, oats or common corn (maize). Egyptian corn sells about 1/3 higher than eastern corn and somewhat higher than Kafir corn, which is due apparently to its demand as a poultry feed since the analysis of Egyptian corn would not indicate that it had a feeding value materially greater than ordinary corn or Kafir corn.

Broom corn resembles wheat in its feeding analysis and appears to have a feeding value about equal to the grain sorghums. It is very little used as a poultry feed and some difficulty is experienced in getting the fowls to eat this feed unless the hull is removed.

The millets are grown largely as catch crops in good grain sections but are raised more extensively in the northern part of the semi-arid country where the season is too short for the grain sorghums. Ground millet seed has been found useful in hog feeding, for which purpose it has a feeding value about one-fifth less than wheat. A

small amount of millet seed on account of its small size is used extensively in combination with other grains in mixtures for small chickens and for pigeons, and to a less extent in commercial scratch mixtures for laying hens to add variety to these feeds. It is usually too high priced to be used to make up any considerable part of a poultry feed. Pigeons do not like millet seed and will only eat it when all the other grains are gone.

BUCKWHEAT

Buckwheat is fed to poultry in a small way to add variety to the scratch feed. It compares with wheat in analysis but has a much higher per cent of fibre and is not as palatable, thus making it less desirable feed. Buckwheat middlings contain a high per cent of crude protein and fat with only a very little fibre and are a desirable feed. Ordinarily a considerable per cent of hulls are added to the middlings to make up buckwheat bran or buckwheat feed, usually making a much less desirable feed than wheat bran, depending on the amount of fibre which it contains.

Buckwheat tends to produce a white fat and flesh, on which account it is used more extensively abroad than in this country as white fat is preferred in many of the foreign countries, while yellow fat and flesh have the preference in the United States. Buckwheat by-products do not keep as well as wheat by-products and should be mixed with some light feed such as wheat bran, if they are to be stored in bulk.

CHAPTER VI

SEEDS AND VEGETABLE PROTEIN FEEDS

SUNFLOWER SEED

Sunflower seed is high in fat and contains a fairly large per cent of protein, but it does not compare favorably with wheat and corn in the total food nutrients which can be secured from an acre of land and is, therefore, usually too high priced a feed to be used very much for poultry. It is fed more or less to poultry, especially during the molting period and is said to assist in molting, to add luster to the plumage, and to be somewhat of a conditioner. Linseed meal can be fed during the molting period for these same effects as it has a higher oil fat content than sunflower seed. A small per cent of sunflower seed is found in a great many of the commercial scratch mixtures as it adds variety to these feeds. It is doubtful if this seed is of sufficient value to be an economical feed to purchase at usual prices where the fowls are getting a well balanced ration.

Poultrymen can often plant sunflowers for shade to advantage outside of the poultry fences and incidentally secure a crop of considerable value to feed to the fowls. Sunflower oil cake is produced in Europe from sunflower seed and used considerably there as a feed for stock. Its crude protein content is equal to that of linseed meal but

it is higher in fiber. No reports of this cake having been used for poultry feeding are recorded.

CANADA FIELD PEA

The Canada field pea is not fed much to fowls as a seed but is used extensively in feeding pigeons. It contains about twice as much crude protein as corn, wheat, or oats, and is quite high in phosphorus and potash. This seed is preferred above all other feeds for pigeons and is one of the very best feeds to use in producing big squabs. Canada peas are a very hard grain which makes them especially desirable for pigeons, but hard grains are not so well liked by poultry. Peas are raised extensively in the Northwest, and waste peas, including those not available for seeds or which have been cracked or otherwise mutilated in handling, are fed somewhat to poultry in that section. The ordinary peas fit for seed or human consumption are too high in price to be economical as a poultry feed.

A very small percentage of Canada or other peas are found included in commercial scratch mixtures to add variety to the feed. Peas are used to some extent to sow with oats as a forage crop in the early spring and make a very desirable early green crop for poultry, either where the poultry are allowed to range on the field or where the crop is cut and fed to the poultry as fodder. This seed does best where the climate is moderately cool and is only raised to any great extent in the extreme northern part

of this country, especially in the States of Washington and Oregon. Peas, including the Canada field pea, are all legumes and tend to enrich the soil by taking nitrogen from the air and adding it to the soil.

USE OF PEAS IN PIGEON FEEDS

Pigeons kept confined for squab production are fed entirely on seeds; and no ground grains, meat or animal feeds, or green feeds are fed. Pigeons apparently find, in a ration of peas combined with a few of the more common grains, all of the necessary elements for a well-balanced feed. As all of the other grains used for pigeons are also commonly fed to poultry it appears that the peas in the pigeon ration furnish the essential ingredients supplied to the fowls from meat scrap and green feed, as fowls fed without these two products or substitutes do not give satisfactory results. The price of Canada peas or field peas is very much higher than that of the cereals used for feeding fowls and the same food value, especially the large amount of protein, can be secured in the fowls' ration in cheaper forms from other sources than from Canada peas. The several kinds of ordinary garden peas are similar in analysis to the Canada pea but are not usually available at sufficiently low prices to be used either for feeding pigeons or fowls. Occasionally poorer grades of such feeds are available at reasonable prices for such feeding. Garden peas will successfully replace Canada peas for feeding pigeons although they are not so well liked by the

pigeons add not in special favor with those who keep pigeons.

SOY BEANS AND SOY BEAN MEAL

Soy beans are raised very extensively in Japan and China and used both for human food and feed for animals in those countries. The bean contains from 16 to 21 per cent of oil and more crude protein than any other seed or grain used as a feed. Soy beans have not been raised much in this country except as a forage crop for stock but are being raised more extensively throughout the southern part of the United States where mills have been erected for handling this seed. They are a leguminous crop which is being used very extensively in the South as a green crop to improve and enrich the soil. Poultry do not relish soy beans either raw or in the cracked form but will eat soy bean meal fairly freely where it is mixed with other ground feeds. Oil is extracted in the process of manufacture and the soy bean meal produced in this process becomes available as a feed for stock and poultry and is also used as a fertilizer. The oil is used for human food and commercial purposes.

Soy bean meal contains the same amount of digestible protein as cottonseed meal and is considerably higher in carbohydrates. Some soy been meal is being used in the South and to a less extent in the North as a poultry feed, both in commercial mash feeds and in rations mixed at home. A large amount of this feed is imported on the Pacific Coast from Japan and China and is being ex-

tensively used in that section of the country as a feed for poultry and dairy cattle. It is valuable for growing chickens as well as for egg production on account of its high protein and mineral content.

In experiments conducted by the U. S. Department of Agriculture, it was found that soy bean meal was a good feed for laying hens but not nearly equal to the animal protein feeds, such as meat scrap or fish scrap. A mash for laying hens in which the high protein feed was made up of 10 per cent of soy bean meal and 15 per cent of meat scrap gave fairly satisfactory results but not as good results as a mash containing 25 per cent of meat scrap.

COWPEAS AND BEANS

Cowpeas are another leguminous crop which is grown considerably in the South and turned under as a soil improver. The cowpea is beanlike in shape, the seed is not palatable or much relished by poultry, but in some sections of the South these seeds are fed on the vines when a considerable amount of them is eaten. The cowpea is also used as a substitute for Canada peas in the rations for pigeons but is not so well liked for that purpose as the Canada peas. The cowpea is quite similar to the field pea in composition and contains considerably less fibre than that seed.

The common field bean is used extensively as a human food in this country and poor grades or damaged lots are sometimes available for feeding poultry. This seed is too hard to be adapted as a poultry feed in its raw state and

should always be cooked or soaked for poultry. When cooked it is very palatable and much relished by fowls. It is quite high in protein as are all the other legumes and should be fed with carbonaceous feeds such as corn.

PEANUTS AND PEANUT MEAL

The peanut is gradually becoming a crop of considerable importance in the southeastern part of the United States where it is used largely in the manufacture of oil and of peanut meal or peanut cake. The plant is often used as a hog feed by allowing the hogs to harvest both the peanuts and the plants in the field. If fed to hogs in too large quantities it will produce soft pork. While this is a comparatively new industry a considerable amount of peanut meal is now being produced, of which some is used for stock and poultry feeding. This meal is also being used with considerable success in the commercial fattening of poultry, for which purpose it has been only recently tried.

Peanut meal from hulled peanuts contains over 47 per cent crude protein which is higher in crude protein than cottonseed meal. Peanut meal made from unhulled nuts, or meal which has been adulterated by the addition of peanut hulls, is lower in crude protein and much higher in fiber than peanut meal without hulls, the analysis depending on the amount of hulls included. The addition of hulls greatly decreases the feeding value of the meal so that some grades of peanut meal contain as low as 28 per cent crude protein and as much as 23 per cent fibre. A small per cent of peanut meal is used quite extensively in

the commercial mash feeds for poultry. In experiments conducted by the U. S. Department of Agriculture, peanut meal was used successfully to replace part of the meat scrap the same as soy bean meal and cottonseed meal and proved as efficient a food for poultry as soy bean meal but not as good as cottonseed meal. Peanut meal is an especially valuable ingredient in fattening mashes.

COCOANUT MEAL

Cocoanut meal is the residue produced in manufacturing oil from the cocoanut and is considerably lower in crude protein than linseed or cottonseed meal but contains more crude protein and fat than bran and has a much higher value as a stock feed than that product. No experiments have been conducted with cocoanut meal for poultry but a small per cent is sometimes used in commercial mashes. Cocoanut meal by itself will turn rancid if kept longer than a few weeks in warm weather but a small amount in a commercial mash does not appear to depreciate materially.

COTTONSEED MEAL

Cotton is one of the largest and most valuable crops produced in this country and in 1918, 11,700,000 bales of 500 pounds each were raised in the southern part of this country. This crop gave about 6,000,000 tons of cottonseed as a by-product, and since a ton of cottonseed produces about 732 pounds of cake and meal, 841 pounds of hulls, 280 pounds of crude oil and 27 pounds of linters

or short fiber, a very large amount of cake or meal was produced for feed or to be used as a fertilizer. Cottonseed itself used to be fed to stock but very little is fed now because of the high value of cottonseed oil and cottonseed meal. The oil is pressed out of the cottonseed kernels by heating and crushing, leaving as a residue the cottonseed cake. This cake is finely ground, making cottonseed meal, and sold largely in that form in Eastern and Central States. Cottonseed cake is also broken into small pieces for cattle and sheep feeding instead of being ground. About one-fourth of the crop of this country is exported, usually in the form of whole cake. Cottonseed meal is the only form in which cottonseed products are fed to poultry.

Cottonseed meal varies greatly in quality, depending on its protein quality and its freshness, and should be bought on a guaranteed analysis. Standards for different grades have been fixed as follows:

Choice cottonseed meal must be perfectly sound and sweet in odor, yellow, not brown or reddish, free from excess of lint, and must contain at least 41 per cent of crude protein.

Prime cottonseed meal must be of sweet odor, reasonably bright in color, and must contain at least 38.6 per cent of crude protein.

Good cottonseed meal must be of sweet odor, reasonably bright in color, and must contain at least 36 per cent of crude protein.

Cottonseed feed is a mixture of cotton seed meal and cottonseed hulls, containing less than 36 per cent crude protein.

Dark or dull color may be due to age, to adulteration with hulls, to fermentation, or to over-heating during the process of cooking. All of these changes reduce the feeding value of the meal. The crude protein content of cot-

tonseed feed is very variable, depending on the per cent of hulls used in making this feed, thus making it very essential that cottonseed feed be bought only on a guaranteed analysis. A high fiber content makes cottonseed feed a much less desirable poultry feed than cottonseed meal, as fowls do not utilize fiber to as good advantage as do livestock.

Cold compress cottonseed cake is produced without heating or crushing the seed and usually contains a larger per cent of hulls than the cake produced by heating, so that its value depends entirely on its crude protein content. This product is sometimes called "caddo cake." Cottonseed hulls are used somewhat in the South as roughage for feeding cattle but contain very little food value. They have no place in feeding poultry but have been used some in the South as a litter for poultry houses for which purpose they are quite satisfactory. The use and value of cottonseed meal is discussed more in detail on page 148 under the "Value of Animal Protein Feeds."

FLAX SEED AND LINSEED MEAL

Flax seed is raised principally in the Dakotas, Montana, and Minnesota. In 1919, 8,919,000 bushels were produced which is only about half of the average production of the five preceding years. The yearly production during the period 1900 to 1905 was three times as great as in 1918 so that much less of the flax seed by-products is now available for feeding stock and poultry than was pro-

duced some years ago. The oil of flax seed may be removed either by crushing and pressure, which method is called the old process, or by dissolving the oil from the crushed seed by the use of naphtha, giving as a residue new process oil meal. The term linseed meal, oil meal, and linseed oil meal are all used interchangeably. Nearly all the linseed meal produced in the United States is produced by the old process and called old process linseed meal.

A test to determine whether the oil meal is made by the old or new process may be easily made by putting a level teaspoonful of puverized meal into a glass, adding 10 teaspoonfuls of boiling hot water and stirring the mixture thoroughly. If it is the new process product the meal will settle in one hour, leaving clear water on top, while if it is old process meal the solution will remain jelly-like. New process meal contains about 3 per cent more crude protein but only slightly more digestible protein than old process meal, while the old process meal contains more oil or fat than meal made by the new process.

Another flax seed by-product is flax feed, which consists of flax screenings including weed seeds and other waste products. This product is ordinarily used in mixed feeds and its value depends entirely upon its composition, but it is likely to be very much lower in food value than linseed meal. Flax plant by-products consist of flax pods, broken flax seeds, and pieces of stems and are usually of low food values. Unscreened flax oil feed is of less value than linseed meal as it contains screenings.

Linseed meal is the only one of these flax seed products used to any material extent in feeding poultry. Where used in limited quantities it is a good feed as it is rich in protein and has a slightly laxative effect. It is of especial value as a tonic for fowls or stock in poor condition and its use will give a glossy appearance to the feathers of poultry. It is rich in protein and mineral elements, making it an especially good feed to use while fowls are molting. The use of about 5 per cent in the mash mixture is beneficial just previous to and during the molting period, that is, from June 15 to December 15. Linseed meal is also of value for growing chickens as they are continually renewing their feathers. About five per cent may be used in the mash for growing chickens to good advantage. This feed is more expensive as a source of protein than some of the other high protein feeds but a small per cent in the ration is worth while as a tonic and regulator. Most of the commercial mixed poultry mashes contain some linseed meal.

HEMP SEED

Hemp seed is rarely fed to fowls and is usually too high in price for such stock but it is used somewhat in the feeding of pigeons, especially during the molting period. Its use for pigeons corresponds to the use of linseed meal during the molting period for fowls, the hemp seed being used for pigeons as they are usually only fed whole or cracked grains and no ground feeds. Only about 5 per cent of hemp seed is used in a pigeon feed.

RICE

The raising of rice in this country is rapidly increasing, the bulk of the crop being produced in Louisiana, Texas, Arkansas, and California. In 1919, 41,059,000 bushels of rice were produced in the United States, nearly all of which was used for human consumption in the form of polished rice. Polished rice is produced by removing the rice hull and the outer skin of the rice kernel called the rice bran. The kernel is then polished, producing another by-product called rice polish, and leaving the finished polished rice for human use. A sack of rough rice containing 162 pounds will give about 100 pounds of polished rice, 20 pounds of rice bran, 6 pounds of rice polish and 32 pounds of hulls.

Rice hulls are worthless as a feed and are apt to prove dangerous and irritating to the walls of the intestines. Rice bran where not adulterated with hulls, and which does not contain over 12 per cent fiber is a nutritious feed when used in limited quantities with other feeds. The rice oil or fat in rice bran will become rancid if this feed is stored for any considerable time, making it unpalatable for stock or poultry. Rice polish has a feeding value for stock about equal to corn but this product is used up almost entirely in the various mechanical arts. Poor grades of rice and broken rice are used more or less for feeding poultry and pigeons and a small per cent is often fed in commercial scratch feeds, especially in commercial chick feeds.

Rice is of especial value in adding variety to chick

feeds on account of its small size and the fact that it will keep well if kept dry, without danger of heating. Some of the grains used in chick feeds such as cracked corn are apt to heat during the spring months unless thoroughly kiln dried. Even these lower grades of rice are usually too high priced on account of their value as a human food to be used much for poultry. Rice is the highest in carbohydrates of all the cereals but is rather low in crude protein and fat. This grain appears to have a feeding value about equal to corn for live stock and probably not quite so much as this for poultry as it is not relished or liked by poultry nearly so well as corn or wheat.

Polished rice is very deficient in some of the products essential to the maintenance of life. If it is given to poultry as the only source of feed it will quickly produce the results caused by a feed deficient in certain essential elements. Birds fed on polished rice alone become affected with a condition called polyneuritis, the symptoms of which are decreased weight and the drawing up of the muscles and nerves, indicated by the drawing back or to one side of the head and also of other muscles and nerves on other parts of the body. If rice bran and rice polish are fed with the polished rice this injurious effect on the muscular and nervous systems is not apparent.

CHAPTER VII

ANIMAL PROTEIN, MILK AND MISCELLANEOUS FEEDS

Packing House By-Products. Large quantities of by-products are produced at the packing houses which are used in stock and poultry feeds. These products include meat scrap, meat meal, tankage, and dried blood or blood meal. All of these feeds are very rich in highly digestible protein and with the exception of blood contain considerable mineral matter in the form of lime and phosphoric acid. Meat scrap and tankage are made from fresh meat scraps and fat trimmings, from which the fat is rendered by being drawn off in a liquid form after the scraps have been cooked by steam under a high pressure. The scraps are then dried and ground into a meal, giving a product which contains from 40 to 50 per cent of crude protein, and from 1 to 10 per cent of fat. The composition of this product varies greatly and it should always be bought on a guaranteed analysis.

Blood meal usually contains a much higher per cent of crude protein than meat scraps but much less of mineral matter, since it does not contain any bone. Blood meal is used up largely in commercial calf meal and mixed mashes while meat scraps have a very extensive sale as a poultry feed. Blood meal is sometimes added to the meat scrap to increase the protein content. The average home made

mash for poultry contains from 5 to 30 per cent of meat scrap, making 2½ to 15 per cent of the total ration of meat scrap. These meat scraps, however, are also used extensively in commercial mixed mashes. Commercial dried meat scrap prepared in this form will keep in good condition for many months if kept in a moderately cool and dry place. Meat scrap or some product of this nature which furnishes protein of animal origin has been found to be essential in securing the best results both in growing poultry and in the production of eggs.

Feeding tests with laying hens indicate that a mash containing from 18 to 20 per cent of a good grade of meat scrap is most economical. Slightly better production may perhaps be secured by a higher per cent of meat scrap but the extra meat scrap does not produce the efficiency that is secured by smaller percentages. Some of the heavier breeds of fowls, especially Brahmas or Plymouth Rocks, which tend to become too fat, may be kept in good condition by feeding a mash containing a lower percentage of meat scrap, about 15 to 18 per cent.

The quality of meat scrap should be carefully determined by its appearance and odor and a more careful test can be made by pouring boiling water on a small amount of meat scrap and noticing the odor of the steaming product which should be like fresh scorched meat. Meat scrap and all of the animal protein feeds should be bought strictly on their protein analysis, the protein content indicating the value of the product. Oftentimes the high protein meat feeds are cheaper considering their protein

content than are the products containing less protein. Good grades of meat scrap usually range from 50 to 70 per cent of protein.

Tankage of good grades gives good results in feeding laying hens in place of meat scrap and is used considerably in the Central West for poultry feeding. It appears to be about equal to meat scrap in feeding value for poultry and often can be purchased at a considerably lower cost considering its protein content. Pork cracklings may be used in place of meat scrap but does not give as good results.

All experiments with chickens, fowls, and ducks have indicated the need of an animal protein feed in the ration and the much greater value of the animal proteins over the vegetable proteins for feed purposes. The finer or sifted forms of meat scrap are used for small chick feeding and the coarser sizes for large chicks and mature fowls.

FRESH MEAT AND BONE

Fresh meat is fed to poultry to a limited extent, especially horse flesh, and is greatly relished by fowls. In sections where there are a large number of poultry farms, like parts of California, an extensive business is carried on in furnishing fresh horse meat for poultry feeding. Care must be used to see that no diseased or decayed flesh is used when fresh meat scraps are fed, as such products will decompose very rapidly, especially in warm weather. It is easiest to feed fresh meats in cold weather when the

normal temperature is low enough to keep the flesh in good condition. The sterilization used in making dried meat scraps kills all the disease germs which may be in the fresh flesh. During cool and cold weather, fresh meat products, such as injured horses and other animals not commonly used for human food, are fed to poultry either ground up or in whole chunks.

Fresh green bone and some scraps are secured from various markets and local butchers, and fed to poultry after being run through a bone grinder. Small bone grinders operated by hand power are used where only a few hens are to be fed, but a power grinder is essential where this product is to be ground up for any considerable number of fowls. No satisfactory method has been found to preserve fresh meat to feed to poultry, other than the commercial process of making meat scrap which involves extensive and expensive machinery, making it impractical to preserve any quantity of meat in a small way for this purpose.

Bone meal and ground or crushed bone are fed to a small extent to poultry either by adding from 2 to 5 per cent of these products to the mash or by keeping one of them before the growing chickens. These mineral products are sometimes fed to laying hens, but their use is not general. Where the rations are deficient in lime (calcium) and phosphorus the necessary mineral matter can be most easily and cheaply supplied by these bone feeds. The meat scraps used in feeding poultry usually contain considerable bone, thus furnishing a sufficient amount of

mineral matter without the addition of any extra bone meal. Ground rock phosphate is usually a cheap source of mineral matter and may be used in place of ground bone. Freshly ground bone, fed at the rate of from one-half to three-fourths of an ounce per hen daily will take the place of meat scrap in the mash for laying hens and is greatly relished by them. Too much of this fresh bone will cause diarrhoea and looseness of the bowels. As a rule the use of this green-cut bone involves too much labor, time and expense to make its use advisable where any considerable number of fowls are kept.

FISH MEAL

Fish meal is made from the waste parts of fish products as a by-product from fish canneries and from the manufacture of glue and similar products. In some cases fresh fish not suitable or adapted for use as a human food is also made into fish scrap. Fish meal and scrap give good results as a poultry feed and may be used to replace all or part of the meat scrap to advantage. From experiments reported by the U. S. Department of Agriculture, fish meal appears to be equal to meat scrap of the same protein content. It is considerably higher in mineral matter than most meat scrap, a fact which helps to make it a good poultry feed and also of special value in the mash for baby and growing chickens.

Along the seashore, especially in sections where ducks are produced extensively as on Long Island, fish are caught, boiled up, and used extensively in feeding ducks

and to some extent to poultry. Fresh fish cooked in this manner are greatly relished by all kinds of poultry and make a splendid feed. Ducks grown as green ducks and marketed when from 8 to 12 weeks of age require a considerable amount of animal protein such as is furnished by fish products or meat products, but in feeding fresh fish it is advisable to eliminate the fish from the ration two weeks before the birds are to be marketed to avoid any possible taste in the flesh due to the use of this fresh fish.

A considerable number of the dried fish products are now on the market for poultry feeding and come from many sources. The fish scrap made from whole fish is usually a much better feed than the fish meals which are residue products. The high prices of meat scrap during the war period greatly stimulated the trade in fish meal and fish scrap. These products, like meat scrap and other high animal protein products, should be bought on their protein analysis and their value based on the analysis as compared to similar grades of meat scrap. Some grades of fish scrap cost just as much as the same grades of meat scrap, in which case the meat scrap is usually selected. In some sections and under certain conditions a good quality of fish scrap can be purchased much cheaper than meat scrap, making it a very good feed.

The oil content of the fish meals varies greatly but a moderate variation in the oil content does not appear to be in any way injurious to the fowls, although fish meal containing a high fat content is apt to spoil more quickly. Fish meal with a quite high oil content has been fed in

a small way to poultry without any effect on the taste of the eggs or the poultry flesh. Similar experiments with hogs by the U. S. Department of Agriculture on a more extensive scale have shown that the high oil content was not detrimental and even added some value to the feed.

MILK

Milk is one of the most complete and easily digested foods, containing all the nutrients necessary to sustain life and is of especial value for young and growing poultry and growing animals. The protein of both milk and of meat products has a much greater efficiency for growth of poultry, and for the production of flesh and of eggs, than do any of the grain proteins. The proteins of milk are more easily digested and consequently more efficient than the proteins of meat and fish.

Whole milk is not ordinarily used for poultry except in a few cases as for instance the first feed for young chickens, on account of the high cost of the milk. Skim milk is rich in protein and ash or mineral matter and is of especial value in building up the muscles and bones. Skim milk from separators contains about 3.8 per cent crude protein, 5.2 per cent nitrogen free extract, and from 0.1 to 0.2 per cent fat. The nitrogen free extract in sweet skim milk is practically all milk sugar, but when the milk sours, fermentation occurs until about 0.8 of one per cent of this sugar is changed to lactic acid.

Five to six pounds of skim milk is equal to about one pound of meat scrap for feeding both young and laying

stock, but its great value is to use it as a supplement with other feeds. Milk is a great appetizer and its use will increase the amount of feed consumed materially. It also serves as a regulator of the chickens' digestive system, and keeps them in the best of condition. Milk will entirely take the place of green feed in a ration both for chickens being fattened under confined conditions, and for laying hens. Growing chicks to do well need a good grass range for green feed and exercise even when milk is fed. Buttermilk is sometimes diluted with water at the creameries and in some cases is kept in dirty containers making it necessary to watch the quality of the product in buying this material. Whey is produced in making cheese and contains the milk sugar, the albumin and most of the ash contained in whole milk. It is high in water and contains only about 6.5 per cent of dry matter compared with about 9 per cent of dry matter in buttermilk. Whey contains 4.8 per cent milk sugar, 0.3 per cent fat and only 0.8 of one per cent protein. Hence is not nearly so good a food as skim or buttermilk, furnishing far less protein than those products. It has about half the value of skim milk as a feed for hogs and probably a similar relative value for poultry, although no experiments have ever been carried on with poultry to determine the actual food value of whey. As skim milk and buttermilk secured from creameries are subject to infection with the germs of bovine tuberculosis it is advisable, wherever possible, to get this product from creameries where the milk has been pasteurized.

DRIED MILK

Dried milk products are fed to growing chickens and to laying hens but have not been used as extensively as the liquid milk products and the relative value is not yet determined. It is quite often included in small quantities in commercial mash mixtures and especially in commercial ground mashes for chickens and appears to be an excellent feed. Its use is advised for small chicks when liquid milk products are not available. It is not advisable to feed over 15 per cent of dried milk in the mash so that less animal protein is fed in a laying mash using dried milk alone. It is better to feed this dried milk with meat scrap for laying hens but sufficient protein can be secured in the mash for chicks from the dried milk product alone without using meat scrap.

SEMI-SOLID AND CONDENSED BUTTERMILK

Condensed and semi-solid buttermilk are used extensively in the commercial fattening of poultry with excellent results; especially is this true of semi-solid buttermilk, the use of which has increased very greatly in the past few years. This semi-solid buttermilk is produced quite extensively all over this country as a by-product from creameries and when put up in barrels or kegs will keep in good condition for a very considerable period of time. After opening this milk, keep the surface covered with water to prevent decomposition.

From 2 to 7 parts of water are added to the semi-solid buttermilk to make it of the proper feeding consistency;

some poultrymen feed this semi-solid buttermilk without any dilution. Only from 2 to 3 parts of water are usually added to the semi-solid buttermilk where it is used in milk fattening as the bleach desired is obtained by the amount of milk consumed by the chickens. As high as 7 parts of water may be added where the semi-solid buttermilk is to be used as a stimulant for laying hens which materially reduce the cost of the milk in the production of eggs. Semi-solid buttermilk contains from 12 to 16 per cent protein, and dried buttermilk usually contains from 30 to 35 per cent protein, so that the cost of the protein in milk feeds is much higher than in meat scrap or other high protein feeds. The digestibility of milk is higher than from these other feeds and the milk has decided tonic values in addition to its protein content. It appears most economical to use sufficient milk for its tonic and laxative effects and to depend upon other feeds largely as a source of protein.

The buttermilk is fed either mixed with the mash or kept before the fowls as a drink. Thirty hens will consume about one-half pound of this milk daily as a drink, if it is diluted with 2 parts of water and kept before them practically all of the time. Semi-solid buttermilk rapidly dissolves in the water and the diluted product has a good consistency, if not too much water is added. All kinds of buttermilk are in great favor for feeding young chickens. In many places where ordinary buttermilk or skim milk is not available the semi-solid product is being used quite extensively in the feeding of small chickens.

BEET PULP

Beet pulp is a by-product of the manufacture of beet sugar, the juices of the beets having been extracted by soaking them in warm water. The dry matter in wet beet pulp, although the latter contains only one to two per cent of sugar, has sufficient other carbohydrates to make it equal to a similar weight of dry matter in root crops. This pulp is very low in mineral matter and contains only a small amount of crude protein. Much of this product is fed locally in a wet form to stock but a considerable amount is shipped away for feeding. As it will absorb considerable water it should be soaked in two or three times its weight of water before it is fed. Beet pulp is used somewhat for feeding poultry, as a feed by itself and also mixed in the mash. Poultry do not especially care for soaked beet pulp and it is usually fed to better advantage mixed in the mash than as a separate feed.

MOLASSES

The beet molasses produced from the beet sugar refineries contains about 66 per cent of nitrogen free extract, nearly all of which is sugar. The crude proteins of molasses have very little feeding value. Molasses is of a laxative nature on account of its high content of alkaline salts as well as other purgatives. It is considered worth about three-fourths of the value of corn as a stock feed. Cane molasses, called "black strap" is produced in the manufacture of cane sugar but is costive in its action if fed in large quantities. It has a feeding value similar to

beet molasses but is too high priced in most sections for use in feeding except as a conditioner. Most of the molasses available for feeding is used up in commercial molasses feeds in which the molasses is usually combined with a wide variety of feed products. Molasses combined with good by-products makes a very good and highly palatable feed. It is easy to use molasses to cover up feeds either very high in fibre or of poor quality and low food value so that it is very necessary that such mixed feeds be secured only from reliable dealers and on the basis of a definite guaranteed composition. Molasses absorbed by sphagnum moss or peat is called molassine meal and is of value as a feed. It is usually too high in price, considering its molasses content to be an economical feed. Molasses and molasses feeds are not so well adapted for poultry feeding as for feeding livestock, because with animals, feeds high in fiber can be made more palatable by the addition of molasses. Feeds high in fiber, however, are not adapted for poultry even though they are made palatable by such substances as molasses, since poultry are unable to utilize fiber efficiently. It would appear that any molasses feeds which are very low in fiber content would be of considerable value and highly palatable to poultry.

DRIED DISTILLERS' GRAINS

These are the by-products secured in the manufacture of alcohol and other liquors, where corn, rye, and other cereals are ground and treated with a solution of malt to

convert the starch into sugar. Distillers' grains are a bulky product containing considerable crude protein, fiber, fat and the more insoluble parts of the nitrogen free extract. It is a very good product when made from corn and is about equal to gluten feed. If produced from rye instead of corn, both the protein content and feeding value are much lower and not so well adapted for feeding poultry. Distillers' grains may be used to make up a small part of the poultry mash.

ACORNS

Acorns are often used as a hog feed where the hogs pick up the acorns off the ground. Turkeys on range will pick up a limited number of acorns and appear to thrive on them. Cases of stock poisoning have been reported from the use of damaged acorns or where they have been fed in too large amounts. Coarsely ground acorns were reported fed to laying hens in England without affecting egg yield.

CONDIMENTAL OR STOCK FEEDS

Condimental or stock feeds are extensively advertised both for stock and for poultry. They are usually made up of linseed meal, corn meal or wheat middlings, mixed with meat scrap, dried buttermilk, common salt, charcoal, anise, fenugreek, pepper, epsom salts, copperas, gentian, ginger and allspice. Follow the directions given on the boxes of these feeds furnished by the manufacturer. It is sometimes more desirable to buy the condiments and

mix such a feed at home than to purchase the commercial stock feeds. Such a mixture for poultry can be made of equal parts of red pepper or ground capsicum, ground allspice, ground ginger, ground cloves and one-half part of ground fenugreek seed, feeding about a tablespoonful to two quarts of mash two or three times weekly.

MINERAL FEEDS

Mineral matter is very essential in the feeding of poultry but is usually sufficiently supplied under normal feeding practices. Mineral substances in the fowl's body make up the ash, while the shell of the egg is mineral as well as part of the egg contents. Oyster and clam shells are fed to fowls to provide the lime used in the formation of the egg shell. Oyster shells contain about 97 per cent of carbonate of lime and clam shells have about the same composition. Experiments with calcium feeding to laying hens conducted at the Wisconsin Experiment Station appears to indicate that lack of calcium in the ration would materially reduce the number of eggs laid and similar results were secured at the New York Station at Geneva. The iodin combined with the mineral seems to be of considerable importance. Limestone grits to take the place both of oyster shell and of grit are being used in an experimental way somewhat. It is doubtful if the calcium is as readily available in the form of grit as it is in oyster shell. Oyster shell contains about 38 per cent calcium, 0.5 per cent magnesium and 0.5 per cent iron with a small amount of sulphur and a little chlorin but no phosphorus. Lime-

stone grit contains about 30 per cent calcium, 6.5 per cent magnesium and 3.3 per cent iron.

Bone meal and ground rock phosphate which are on the market in very fine and also in coarser forms are used in the poultry mash to furnish mineral matter and afford the cheapest and best sources for material of this kind. Bone meal contains about 21 per cent of calcium, 10 per cent of phosphorus, 0.5 per cent of sodium, 0.5 per cent of magnesium and a little potassium, sulphur and iron. Most of the meat scraps contain a considerable amount of bone which is indicated in their analyses by the mineral or ash content. Wheat middlings, bran, milk and green feeds all supply considerable mineral matter to fowls.

CHAPTER VIII

GREEN FEEDS

Various green feeds are fed to poultry, the best one to use depending upon the availability and cheapness of the feed. The green feeds most commonly used are common grass, mangel beets, cabbages, kale, alfalfa, sprouted oats, rape and any quick growing grain which may be fed as a forage crop. The importance of the use of green feeds for poultry is not well appreciated and far better results would be secured from fowls if more attention was paid to this part of their ration. When fowls are fed heavily, forced for egg production, and kept under more or less intensive conditions, the value of green feed can hardly be overestimated. Green feed supplies considerable mineral matter which contains certain elements that we know are essential to life and reproduction but the nature of which is little understood as is discussed more in detail on page 43. These greens supply actual food which will replace a considerable amount of grains, making the digestion of these other grains far more complete and at the same time keeping the fowls in the best of health. Fowls fed plenty of green stuff do not show high mortality or especially detrimental results from forced feeding or from being kept under intensive conditions. These green feeds also add bulk to the ration, which is of con-

siderable value where so much highly concentrated feed is used. Where no green feed is used epsom salts will assist in keeping the fowl's digestive system is fair condition, but far better results are secured by natural methods, using green feed. Epsom salts used for this purpose are fed at the rate of one pound dissolved in drinking water for 100 hens, used once every week or ten days. The ordinary growing grasses furnish the bulk of the green feed eaten by poultry and green growing grass secured by the fowls on range is the best possible source of green feed.

GRASSES

Immature grass contains a much larger proportion of crude protein than does hay and other grasses cut at maturity when the carbohydrates have been formed, but the total food content both of crude protein and of carbohydrates is much greater if the hay is grown to maturity. Kentucky blue grass or June grass is one of the best grasses for pasture and it is also one of the richest in crude protein and fat content. This grass should be gazed lightly in the spring and early summer so that it can withstand the hot, dry weather of mid-summer and freshen up and make splendid grazing in the fall and winter. It is one of thet best grasses for poultry ranges or yards in the northeastern part of the United States. Timothy is one of the best hay crops in the northeastern states but not so good a pasture grass for poultry as blue grass or red top. Red top is adapted to a wide range of climatic conditions, being especially useful in the north

and northeastern part of the United States and makes a good turf but is not so good for pasture as blue grass. It takes a couple of years to make a good sod and will grow on land too acid for other kinds of grasses. Orchard grass will grow well in the shade but grows largely in tufts and is only a fair pasture grass.

The small grains make excellent pasture. Fall sown rye and wheat make splendid late fall and early spring pasture in the North, and oats and barley are good forage crops to plant in the spring.

Meadow fescue does well in the same territory as timothy and is a very good long season pasture grass. The seed is usually high in price so that it is commonly used in mixtures rather than as a grass seed by itself. If a permanent meadow is desired a combination of grasses should usually be sown and clover should be mixed with the other grasses. The range should be kept in good condition and if the grass tends to get ahead of the fowls, pasture it with some kind of livestock, such as cows or sheep, to keep the grass short and tender for the poultry. The stock can be kept away from the watering and feeding places used for the poultry but putting up small fence enclosures, in which the fowls are fed and watered. If preferred the grass may be cut with a mowing machine with the mover set high. It is especially desirable on a chick range to keep the grass short as tall grass takes too long to dry out in the morning while the young chickens will be materially harmed by wandering through high, wet grass.

Colony houses on grass range should be moved at least once a year to prevent the grass becoming entirely killed in any one spot and if any spots do become bare, grass and clover seed should be scratched into the soil early in the spring to get a new stand where the ground is bare. In the southern part of this country the grass dries up in the summer and gets too tough and dry to be eaten by the fowls or chickens, making it necessary to grow forage crops to supply green feed during the summer and early fall. Farther north fowls on a good grass range will get a fair amount of green feed during the summer but should be supplied with additional green feed during the winter months when there is no green grass in the yards. Ordinarily sufficient manure will be dropped by the fowls in the yards and on the range to keep the grass range and soil well fertilized.

Bermuda grass is the best pasture grass for the far South and makes a heavy, permanent sod which furnishes a splendid feed from spring until into the fall. It needs to be kept closely cropped as otherwise it will become hard and wiry.

Johnson grass, which is a relative of the sorghums, is a good meadow grass for the South but has a spreading root stalk which makes it difficult to eradicate. It is advisable to plow it every two or three years on account of this creeping root stalk system. This grass makes a coarse feed and will give a large amount of green feed by cutting it at least once a month, chopping it up finely and mixing it in with a poultry mash.

Sudan grass is another close relative of the sorghums which will produce a very large amount of desirable green feed to be cut up for poultry and which is used extensively for that purpose in California. It is more desirable than Johnson grass as it has a more leafy stem and does not tend to become a weed pest, being easier to eradicate if desired. Although it makes a very rank growth the stems are thin and tender. Very large yields per acre of this grass can be secured in the South, especially in sections where it is grown under irrigation. It does not flourish in high altitudes or in the extreme northern States, but being fairly drouth resistant, it is adapted for the southwestern section of the U. S.

LEGUMES FOR FORAGE AND FOR HAY

Leguminous plants have a very high protein content and also contain a large amount of mineral matter, being especially rich in lime. These are especially desirable crops to grow in sections where they will make a good growth, because they not only furnish a large amount of food material per acre but enrich the land by adding nitrogen to the soil as well as furnishing a large amount of important vegetable matter or humus. Alfalfa is the best legume to grow for poultry wherever it will produce a good crop. It is one of the best crops to grow whether it is to be cut and fed as green forage, to be made into hay and later fed to the poultry, or to be used as pasture. In sections where alfalfa does not do well the various clovers are desirable crops to grow and will serve the same

purposes as the alfalfa but are not as desirable a crop. Consult with your State experiment station to see if alfalfa will do well in your section and secure directions for growing alfalfa and other forage crops.

Alfalfa thrives best in the semi-arid plans region and very large yields are secured from an acre of land, especially heavy crops being obtained where irrigation is available in sections having a mild climate. As many as 9 to 12 cuttings are secured in a season under the best conditions in such sections. Alfalfa requires a well-drained soil, rich in lime, and a specially well prepared sod bed. It is being grown more and more all over this country. In places where conditions are favorable it will hold a sod for many years, if the weather is not too extreme, and makes an ideal poultry range or pasture. Alfalfa should be cut for hay as soon as the new shoots are well started at the crown of the plants and before the stalks get woody. As large a proportion of leaf as possible is desired for poultry and great care should be used in harvesting alfalfa so as not to lose the leaves.

Ground alfalfa or alfalfa meal is not as valuable as bran as a feed as it contains somewhat less crude protein and three times as much fiber, but is useful in the ration to partially replace green feed. Alfalfa is not well adapted for silage but is occasionally used for that purpose. Alfalfa meal is produced extensively in this country, the product varying in fineness from a fine meal to a coarse product containing pieces of hay one-fourth to one-half inch long. There is considerable possibility

of adulteration or securing poor quality products in alfalfa meal as coarse, woody alfalfa stems and stalks may be ground up to appear like good alfalfa. Buy on a guaranteed composition and notice especially the fiber content which in the best grades should not exceed 30 per cent. As very little fiber is utilized by poultry it is especially advisable to consider carefully the fiber content of all feeds. Alfalfa meal is used quite extensively in mixed commercial poultry mashes, which feeds sometimes contain from 5 to 10 per cent of this meal. It is also used in home mixed-mashes when no other green feed is available, using 7 per cent in the mash; that is 7 pounds in 100 pounds of feed.

RED CLOVER

Red clover is another legume which is very valuable for feeding poultry and is raised extensively in the northern humid section of this country. It will not usually live well over two seasons and does best on well-drained soils rich in lime. Although only one or two cuttings are usually secured the yield per acre is quite heavy. Where alfalfa cannot be grown to advantage this clover is one of the best crops to grow for poultry in the North and Northeast States, either in the pasture mixed with other grasses or as a hay or forage crop. In sections where the season is too short for red clover to mature a second crop, the cutting secured is usually called rowen and makes an especially desirable feed for poultry as it contains less of the coarse, woody fiber than the first crop. Red clover

has about the same feeding value as alfalfa hay, being rich in protein and lime, but slightly lower in digestible crude protein. It should be cut for hay when about one-third of the heads have turned brown as it can be cured to better advantage at that time than when in full bloom.

OTHER CLOVERS

Mammoth clover makes a very coarse, rangy growth and the plant is usually longer lived than red clover but it yields only one crop annually. It will do well on poorer and lighter land than red clover and may be mixed to advantage with red clover seed.

Alsike clover does not stand up as well as the other clovers but is adapted for use on acid or wet soil. White clover is a lower creeping perennial which has a wide range of growth but is adapted only for pasturage for which purpose it is quite desirable in the North. It is also grown in the South but nearly disappears in the summer, freshening up again in the fall.

Sweet clover grows widely along roadsides and railroad tracks and will do well on many soils where the other clovers will not grow. Animals have to become accustomed to using sweet clover as it contains a bitter compound which they do not like when first eaten. Sweet clover should be sown thickly and should be cut when about 6 inches high. It will give from two to three crops in a season.

Crimson clover is an annual, grown principally from New Jersey to South Carolina, in which sections it is

usually sown in the late summer or early fall and plowed under as a green crop early in the following summer, as it will not live through this summer. If grown for hay, for which purpose it is not as well adapted as are the other clovers, it should be cut when the flowers at the base of the heads begin to fade. Crimson clover is not as desirable a feed as the other clovers.

A combination of oats with the field or Canada pea makes a good soiling crop if cut early or if allowed to mature makes a very nutritious hay, both of which feeds are especially well liked by poultry. This crop is adapted either for the field or yard in which the hens are allowed to range, or it makes an excellent feed to cut up while fresh and be used in the poultry mash. Cow peas and soy beans are grown extensively as a forage crop in the South to enrich the soil but are not well adapted for poultry, although poultry will eat some of the seeds of the matured crop.

ROOTS AND TUBERS

Roots are a highly desirable feed for poultry and are used considerably for that purpose in the northern part of this country. Root crops are grown and fed extensively to stock in Canada and in northern Europe as these crops are especially well adapted for climates where the summers are cool. Although roots are very high in water content and correspondingly low in dry matter, they contain dry matter which is highly digestible. Experiments in feeding cows show that a pound of the dry mat-

ter in roots has about the same value as a pound of dry matter in grains. The value of roots for poultry is not so much for their food content as for the succulence, bulk and beneficial effect which they have on the fowls. A ration for poultry composed of whole and ground grains is highly concentrated and needs some bulky product to make it less forcing to the fowls. Root crops are greatly relished by poultry of all ages and are usually fed by cutting them in half and sticking them on a nail where the poultry can eat them freely at will.

The mangel or mangel wurzel is one of the best root crops to grow for poultry as it is greatly relished, produces a very large yield per acre, is an easy crop to harvest and keeps well. Forty tons of mangels may be grown to the acre, furnishing 8500 pounds of dry matter. It is better not to feed roots until after the crop has been harvested and stored for a few weeks as freshly harvested roots may cause diarrhea. Sugar beets are also very desirable as a feed but are more difficult and more expensive to raise than mangels and do not produce a large amount of dry matter per acre. Culled beets or by-products from sugar factories are often available at profitable feeding prices.

The rutabaga or Swede will produce about 5,000 pounds of dry matter to the acre, is an easy crop to produce and keeps well. This root is not quite as well liked by fowls as mangels but is used considerably and with good success in feeding poultry. It is the most economical root crop next to the mangels to produce for poultry. Turnips

Fig. 4. Mangel Beets Prepared for Feeding

FIG. 5. GROWING GREEN FEED IN THE POULTRY YARD. THIS ALSO FRESHENS THE LAND.

do not keep as well as rutabagas and will only produce about 3,500 pounds of dry matter to the acre. They mature quickly and are of value to sow late in the season as a catch crop.

Stock carrots will produce about 5,000 pounds of dry matter to the acre and are well liked by poultry. They are not as easy or as economical a crop to produce and harvest as mangels or rutabagas and are not fed extensively to poultry.

Potatoes will not produce dry matter nearly as economically as these root crops because of their extensive use as a human food, and only small unmarketable potatoes are used for feeding poultry. A yield of 200 bushels of potatoes to the acre will give 2,500 pounds of dry matter. Potatoes should be boiled or steamed before being fed to poultry and may be used to advantage by mixing them in with the mash. Potato sprouts and unripe potatoes contain a poisonous compound called solanam and they should not be fed to fowls. The water in which potatoes are cooked is usually bitter and it is better not to use this liquor in mixing the poultry mash. Sweet potatoes are grown extensively in the South and when cooked are greatly relished by poultry. They are not usually fed much for this purpose because of their high value as a human food. One hundred hens will eat about 12 pounds of potatoes daily. Dried potato flakes are used somewhat in feeding stock, especially in Germany and probably could be used for poultry in this country if available at an economical price.

MISCELLANEOUS GREEN AND SUCCULENT FEEDS

Cabbages are greatly liked by poultry and are fed extensively as a succulent feed, ranking next to mangels in popularity as a food for this purpose. Cabbages are not as economical a feed to produce as mangels or rutabagas, as they produce only from 4,000 to 4,500 pounds of dry matter to the acre, require much more labor in their production, and are more difficult to store than mangels. They are usually fed whole and are hung up in the poultry houses where the fowls or chickens can eat them at will. Where both cabbages and mangels are produced the cabbages are used first in the fall and winter as the mangels will keep better and longer than cabbages. Mangels are better for small chickens to pick at than cabbages as they are only able to secure very small bits of this feed. Where cabbages are fed to very small chickens it is advisable to chop the cabbages up finely before feeding.

RAPE

Rape is one of the best forage crops, producing a large amount of succulent feed, which is well liked by poultry. From 5,000 to 6,000 pounds of dry matter may be secured from an acre of land where the rape is cut and fed as forage. Rape furnishes excellent grazing for poultry within 5 to 8 weeks after it is sown, under good weather conditions, and will continue to throw out new shoots if not grazed too closely. The dwarf Essex variety is the only one well adapted to raise for this purpose. It may be sown continuously from early spring until late summer either

broadcast or in drills. A small amount of rape seed may be sown to advantage, with oats and other growing grain crops, during the late spring and early summer where the yard is to be pastured with poultry. The feeding of salt is beneficial where poultry is run on forage pasture to prevent too laxative results from the green crops.

Rape has an advantage over root crops and cabbages in that poultry will harvest this crop themselves and it can be grown in the poultry yard where its cultivation will freshen and renew the land and at the same time furnish good succulent green feed. It is only adapted for use during the growing season. Rape may also be grown advantageously as a forage crop, cutting a small amount of this feed daily, chopping it into short lengths and mixing it in the poultry mash. Where sown in poultry yards for grazing it should be sown broadcast and where it is to be cut and fed as forage it may be sown either in drills or broadcast. Rape is one of the very best green crops to raise for poultry in the eastern section of this country.

KALE

Thousand headed kale, a cabbage-like plant which does not form a head, is grown extensively in Oregon, Washnington, and California and used there for feeding poultry. Very heavy yields can be secured on rich soil where plenty of moisture is available, and in the southern part of this section the feed can be grown throughout the year. Kale is grown as a soiling crop, a small amount

being cut daily, chopped into small pieces and mixed in with the poultry mash.

Pumpkins, squashes, and melons are not usually available for poultry feeding but are occasionally used. They are generally fed raw and neither pumpkins nor squashes are especially relished by fowls. Surplus or cull fruit of any kind is a great relish for poultry but is rarely available for that purpose. Such fruit contains slightly more dry matter than roots, the sugar being their chief food supply. In experiments with hogs conducted at Utah 100 pounds of apples were equal to from 9 to 15 pounds of grains.

Fowls will pick over and eat a little corn silage but do not eat enough of it to make this feed of any great importance for poultry. Corn silage contains too much coarse hard fiber to make it well adapted for a poultry feed. Immature corn stalks are chopped up and fed extensively to ducks and geese and corn silage is also used a little for these two kinds of waterfowl, especially for the geese. Ducks and geese are considered to be better able to utilize coarse fiber of this nature than are fowls.

SOILAGE OF CROPS

Soilage or furnishing freshly cut green crops to stock in confinement is a method used extensively in feeding dairy cows and other kinds of livestock as well as for poultry. The advantages of the soiling method are: 1. Larger crops may be secured by allowing the crops to nearly mature before harvesting than are secured by

pasturing; 2. The waste which occurs when poultry trample on the crops is avoided; 3. Less fencing is required, which is a big item of expense on poultry farms; 4. A constant even supply of green feed can be secured which it is very difficult to obtain by the pasture soiling system.

On the other hand the soilage system involves greater labor in handling the crop and more expenditure of time or money in providing fertilizer. The additional exercise secured by the fowls on fresh land which contains more or less insects and worms is also advantageous, and serves to keep the yards fresh and the soil sweet and clean. The poultry droppings or manure will usually supply sufficient fertilizer to grow plenty of green feed on a poultry farm. Soiling crops in their early stages are mostly water and do not contain much nourishment, but furnish the desired succulence and bulk. Many poultrymen desire some bulky green feed to mix in with the mash, which makes the mash more palatable, whereby the fowls will consume greater quantities of feed while this green feed removes any danger of ill effects from overfeeding or forcing the hens.

A combination of the two systems will usually give the best results, growing sufficient green crops on the yards attached to the poultry house to keep the land fresh, but having, at least during part of the year, generally during the hot summer months, a soilage crop to supplement the yard pastures, and also providing some succulent feed for use in the winter. The soiling system is used exten-

sively in California in the highly specialized poultry sections.

SPROUTED GRAINS

Sprouted grains, especially sprouted oats, are used extensively as a green feed for poultry on poultry farms and also by the suburban poultry keepers. Oats are the best grain to use for sprouting. They are greatly relished by fowls, and are quite beneficial to the fowls' digestive system. The disadvantage of sprouting oats is the considerable amount of labor attached to this work. Green feed can usually be supplied in a cheaper form by the use of mangel wurzel beets, cabbages, alfalfa, etc.

Where possibilities for raising other forms of green feed are poor, sprouted oats offer one of the best sources of succulent or green feed. Sprouting the oats does not increase their food content any, but makes them more palatable for poultry. Experiments conducted with animals show that a given weight of barley is of greater food value than the malt and malt sprouts produced from a similar amount of barley used in the manufacture of malt. The amount of diastase which converts the starches of grains into sugar is increased greatly in the sprouting of grains. The value of sprouted grains lies in their palatability and their beneficial effect on the digestive system of the fowls.

YEAST

Yeast has been used somewhat for poultry but not sufficiently to determine accurately its value. The object

of the yeast is to either change the feed by fermentation or to add valuable food constitutents, especially vitamines, of which yeast has a high content. In some work conducted with yeast no beneficial effects were noticed from the use of 3 per cent of dry yeast in the dry mash nor where a similar amount of yeast was used in fermenting poultry mash before it was fed. Bacteria and harmful organisms are apt to get into the fermenting mash during the time it is being held for fermentation which may do more harm to the fowls than the good that might be done by the yeast. Similar results in the use of yeast have been secured in hog feeding, showing that it was not an economical feed for that purpose, under present conditions.

POISONOUS PLANTS

Poisonous plants are not of a great deal of importance in the feeding of poultry as fowls will rarely eat plants which are poisonous unless they are forced to by extreme hunger. Diseased feed, or grain diseases, are much more dangerous as there are several fungi which attack grains that may injure poultry if much of the fungus is consumed. Ergot, a fungus which attacks rye, is especially injurious. The condition of the feed is also important in this connection as spoiled feed will produce very serious results. Damp grain which becomes sour and moldy is the cause of a great deal of damage, especially in corn and corn meal. In the early spring and summer it is very necessary to watch the cracked corn very carefully to prevent heating of the mass and spoiling.

PREPARATION OF FEEDS

The object of preparing feeds is to make them more digestible, to improve the palatability, or to permit the mixing of well-liked feeds with others not so well relished. It undoubtedly pays to cut up forage crops as the poultry will then eat them much more quickly and with very little waste. Cooking feed, instead of improving it, lowers its digestibility. It has been found that it does not pay to steam roughage for stock or to cook feed for hogs, although the latter has been done very extensively in the past. The only feeds for poultry which it pays to cook are garbage, potatoes, field beans and soy beans. Where the garbage is perfectly fresh and there is no question concerning its condition it does not pay to boil or cook this feed in any way, the object of cooking being to kill any disease germs and all bacteria which cause decomposition.

Potatoes need cooking to soften them and make them suitable for the fowls to eat. Field beans should be cooked to make them soft, as fowls will not eat uncooked beans freely. Warming or steaming the mash may be advantageous in winter as it tends to make it more palatable and better relished. It is especially necessary that feed for animals which are being fattened or are only to be kept a few weeks before being marketed, should be highly palatable and in some cases it may pay to cook such feed in order to make the chickens consume more of the ration. The poultry packing companies who fatten chickens commercially do not cook the feed at all.

PART III
PRACTICAL FEEDING OF POULTRY

CHAPTER IX

METHODS OF FEEDING LAYING HENS

Feeding is one of the most important factors in profitable egg production. On poor rations hens will live and even keep in fair health and condition, but well-balanced, palatable feeds are essential to get good egg production and produce profitable results. The additional cost of a good ration compared with a poor ration is repaid many times by the extra eggs obtained. The ration does not have to be complex or contain all kinds of feeds to produce good results, and as a rule the simplest feed mixtures composed of home-grown grains or those readily available, supplemented by meat scrap, sweet or sour milk, will give the best results and will produce eggs at the lowest cost. In addition to selecting the proper kinds of feed, good methods used in feeding and proper management of the fowls are very essential factors for success.

The ration should consist of a scratch mixture made up of the cheapest available grains which are well liked by poultry. In addition, a mash should be fed which is composed of ground grains, mill products and meat scraps. The scratch mixture should usually consist of two grains, and may contain more, as variety is beneficial, but not essential if the additional variety is made up of grains which are relatively high in price. A balanced ra-

tion is a combination of feeds which will furnish just the necessary amount of nutrients to produce the highest and most economical egg yields. The proportion of scratch grains to mash used, materially effects the balancing of the ration. The mash feeds are relatively high in protein, while the scratch mixture is high in starches and sugars. The best results are secured where about equal parts of mash and of scratch grains are fed daily. This mash may be fed either as a dry or wet mash. If fed as a dry mash, it is usually kept before the fowls all the time in a hopper. A wet mash is fed in a trough usually once a day. The moist mash may be fed either in the morning or at noon, the more common practice being to feed the mash in the morning. In mixing the moist mash it is very essential that only sufficient water be added to make the mash crumbly and not wet and sticky. A handful of the mash after it is mixed with the water should make a crumbly mass when pressed together, and should not be wet enough to be sticky or pasty.

RELATIVE VALUE OF MOIST AND DRY MASHES

The dry mash system is better adapted for the average poultry keeper, and especially for the novice in poultry work, as there is less danger of improper feeding by this method. The dry mash system is also adapted to poultry farms where much of the work is done by unskilled labor. The moist mash will give as good, if not better, egg production in the hands of a skilful feeder than can be secured by the dry mash. It requires considerably more

judgment and care in its use, and also involves more labor than the dry mash system. It is particularly advantageous where one desires to use the mash with other materials, such as green feed or garbage, as they can be easily mixed in a moist mash and a palatable well-relished product secured.

With all the dry mash kept in an open hopper all of the time the fowls can eat a little feed at frequent intervals and are always sure to have enough feed without stuffing or gorging themselves at any one time. On the other hand where a moist mash is fed just the right amount of mash must be given or poor results will follow. If too little moist mash is fed some of the hens will eat more than their share of the feed, while the others which are not so well able to take care of themselves as the stronger fowls, will get hardly any feed. If more moist mash is fed than the hens will consume within an hour or so the surplus will become stale and is likely to ferment. If the fowls eat this spoiled feed digestive troubles are likely to follow.

A wet mash must be mixed and fed each day, while a sufficient quantity of dry mash can be mixed at one time to last from 1 to 4 weeks, if large hoppers are used. A combination of these systems is sometimes found useful, especially in the fall to get pullets to commence to lay, and also for hens during the molting period as the hens are inclined not to eat mash freely during that period. In this combination a dry mash is fed in the usual manner with a light feed of moist mash given once daily, to get

the hens to consume more mash feed. A moist mash is much more relished by fowls than is a dry mash.

With a system of feeding whereby the fowls are handled so as to eat half mash and half scratch feed, there is a tendency to underfeed the fowls in the fall and early winter, before the hens get to eating the dry mash freely. By feeding this additional moist mash and proportionately more scratch feed the fowls will consume a greater amount of feed and produce more eggs during that season of the year. During the latter part of the winter and in the spring the fowls eat dry mash much more freely, thereby eliminating the necessity for the extra moist mash. This may also be handled by adding ten per cent of cracked corn to the dry mash if the fowls do not eat the mash freely in the fall and early winter.

SCRATCH FEEDS

Corn, wheat, oats, and barley are the principal grains fed to poultry. In making up the scratch feed or what is commonly called the "scratch mixture" Kaffir corn and buckwheat are also used but are not so generally available as the other grains and are usually much more expensive considering their relative food content. One grain alone does not usually give the best results but two or three well-liked grains will give about as high egg yields as will a much greater variety of grains, while a simple mixture is much less expensive than a mixture containing 6 or 8 different grains.

Use those grains most readily available or which are

produced in your section, provided they are grains which poultry relish. Corn and wheat are the two best grains and are about equal in value as poultry feeds, although wheat can be fed alone better than corn as the latter grain is inclined to be fattening. Wheat is not being fed as extensively as corn on account of its relatively high price, but most poultrymen like some of it in their ration, especially for the chick feeds.

Only the poorer grades of wheat, not fit for making flour, are usually available for feeding poultry. Wheat is generally available and is used in all sections of the United States. Oats and barley on account of their hulls and higher fiber content are not as good as corn and wheat and are not nearly as well relished by poultry. Many oats are very light in weight and the heavier grades make by far the best poultry feeds. It pays to use clipped oats for fowls if only light-weight oats are available. Oats are raised and are available all over the country. Whole oats are not adapted to feed young chickens but make excellent feed when prepared as rolled oats, pinhead oat meal, or hulled oats.

COMMERCIAL MIXED FEEDS

A large number of commercial mixtures, both of scratch grains and of ground grains or mashes are prepared for poultry feeds and sold extensively all over the United States. The large feed companies by handling an enormous amount of grains and by using machinery to save labor in mixing and handling are able to prepare

these mixed feeds very economically and are usually able to sell them at a price which is economical if the labor of home mixing is taken into consideration. By buying these prepared mixed feeds the poultryman is always able to get a variety of grains which are in good mechanical condition.

Where the individual feeds are bought in small quantities from small local markets the poultry keeper may have trouble in getting the grains desired which forces him to keep changing his ration. Some of the companies which produce breakfast foods also make poultry feeds on a large scale, using by-products from the manufacture of these breakfast cereals for their poultry feeds. A very high grade poultry feed is often produced as a by-product by this process as such feed is usually of the very best quality, although not of the right condition or size for human food.

The poultry keeper who has only a few fowls is not usually in position to buy in lots of 100 pounds the separate feeds necessary to make a varied and well-balanced ration, while if such feeds are bought in smaller quantities than this the rate per pound is usually much higher than for the larger quantities. If he buys only one scratch grain and one ground grain the results secured are not satisfactory, as a palatable and well-balanced ration cannot be made from such a combination. Consequently this class of poultry-keepers can usually purchase commercial mixed feeds to better advantage than they can buy the separate grains and mix their own rations. The price of

a mixture of this kind should be compared with the price of the individual grains to see which is the best product to purchase. One should note especially the protein and the fiber content of the prepared feed.

A system of preparing feeds which is being used in some sections, especially in the State of California, with excellent results is to have the mills mix a feed according to the formula furnished by individual poultrymen or by a poultry association. By this method the poultryman gets just the feed he desires and is pretty apt to get good quality grains at a price which compares fairly favorably with what he would have to pay for the individual grains and in addition he would save the labor of mixing the feeds at home. Some of the big feed dealers in California prepare a very large number of rations by this method. Where the grains are mixed at home, convenient working facilities should be made to mix these feeds to the best advantage. One easy way to prepare the scratch grains and also the dry mash is to work them over with a large scoop shovel on a smooth floor of the feed room. A mixing machine similar to those used in mixing bakers' dough is a good investment on all large duck and poultry farms where a moist mash is fed and can also be used in mixing large quantities of dry mash, although it is not essential for dry mash.

GREEN FEEDS

Forage Crops. In addition to the scratch feed and the mash, green feed, oyster shell and grit should be supplied.

Bone in some form is also of value where the birds are closely confined. The importance of green feed both as a source of bulky feed and a conditioner for poultry cannot be overemphasized. Green feed contains a considerable amount of the substances now recognized as absolutely essential to growth and health. The larger and greater the variety of green feed that can be produced and fed at a reasonable cost the greater will be the returns from the fowls in addition to the beneficial effect on their health.

Good kinds of green feeds are green grass, kale, rape, growing grains, sprouted oats, mangel beets, cabbages, chopped alfalfa and clover hay, and alfalfa meal. Kale, rape and all green crops should be put through a feed cutter and chopped into pieces one-half to three-fourths of an inch long. The fowls will eat a much greater amount of green feed where it is prepared in this manner and either mixed with a moist mash or fed as a separate feed daily by itself in troughs than if hens are allowed to range in a field where these crops are growing. However, the soil should be kept fresh and sweet by ploughing and seeding the yards with a quick growing green crop and the fowls allowed to range on these growing crops in the yards when the grain is 2 to 3 inches high. This method of handling the yards keeps the soil fresh and sweet and in addition provides considerable green feed.

Where extra green feed is grown it can be fed to the fowls while fresh to better advantage than to allow the hens to harvest the crops themselves as by the latter

method a considerable part of the green feed is wasted. Free range or large yards kept in grass furnishes ideal green feed and should be handled so that the grass is not killed out but is kept short, making the blades tender and palatable. Alfalfa and clover are especially desirable for such yards, as the fowls will consume large quantities of these grasses. Such grass ranges or yards furnish sufficient green feed as long as the grass is green and tender but should be supplemented with other green feeds during the winter months and also during the summer months in sections in the South where the grass dies out or becomes tough and wiry.

The crops to grow in the poultry yard or to be used as soiling crops for fowls are oats, wheat, kale, rape, peas, rye, buckwheat, and vetch. Oats are the staple crop adapted to most all conditions and which can be grown any time during the normal growing season. This is the grain most commonly used and generally a small amount, about 4 pounds to the acre, of rape seed is added to 4 bushels of oats or wheat. Dwarf Essex Rape is the best variety to use, and if sown alone use 15 pounds of seed to the acre. Several sowings of oats can be made in a poultry yard during the season, and the hens turned into the yards when the oats are 3 to 4 inches high. Wheat may be used in place of oats, or a mixture of oats and wheat makes a good combination with the rape seed. Canada peas and oats are a good mixture to grow early in the season. Buckwheat and cow peas are good mid-summer grains to use for this purpose, while rye, vetch and winter

wheat are good crops to sow in the fall as they will live through winter in many sections. Kale is the crop used most extensively on the Pacific Coast. All of these feeds may be utilized either by turning the hens into the growing grain or by cutting the grains as soiling crops and chopping them up for the fowls.

Sprouted Oats. Sprouted oats make a good green feed where other kinds of green feed are not readily secured as oats can be obtained and sprouted at any season of the year. Fowls greatly relish oats so treated and will readily eat about one square inch of sprouted oats' surface daily. Such oats may be fed at any time after the sprouts are well started, the usual practice being to feed them when the sprouts are from ½ to 1½ inches long. It takes 5 to 7 days to sprout oats to this length, the number of days depending largely on the temperature of the place where the oats are sprouted. Oats for sprouting should be soaked over night in water, and then spread out from one to two inches thick on trays having perforated or wire bottoms and put into the oat sprouter. Water the oats thoroughly and turn the trays around once daily to promote even sprouting. The oats should be stirred daily until well sprouted to keep the oats from molding and to help make more even sprouts.

Artificial heat should be supplied in cool weather either by the use of the kersosene lamp furnishing heat direct to the sprouter or by keeping an open sprouter in a room where the temperature ranges from 50 to 70 degrees. In an incubator cellar or brooder house where the room

temperature is moderate, oats are often sprouted by spreading them in a layer two inches thick directly on the cement floors, where very satisfactory results are secured. Oats so arranged can be watered and stirred very economically. It is very important to select a good grade of heavy oats for sprouting and it may be advisable to get seed oats for this purpose if the ordinary feed oats are of poor quality. The oats sprouter must be well-ventilated or the oats will be inclined to mould. Keep the sprouter clean and spray it occasionally with a disinfectant to prevent the growth of mould spores.

It is sometimes necessary, especially where one is forced to use a poor quality of oats, to treat the oats with formalin before they are sprouted, using one pint of formalin to 30 gallons of water which is sprinkled over and thoroughly mixed with 30 bushels of oats. The oats are covered with a blanket for 4 hours and then stirred and spread in the open until they are thoroughly dried, when the oats are sacked in a bag which has been previously soaked in formalin and then dried. Oats treated and dried in this way may be kept indefinitely to use for sprouting. While other grains may be used for sprouting, such as barley, rye and wheat, oats is the grain most commonly used and is the one which gives the best results.

Cabbage and Mangel Beets. Both cabbages and mangel beets are splendid green feeds for poultry and can be produced economically, as both supply a very large tonnage per acre in sections where the soil and climatic con-

ditions are well adapted for raising such crops. Root crops need a cool summer season to give the best results. These feeds are of equal value for poultry but mangels can usually be raised and handled more economically than cabbages. Information regarding the raising and storing of root crops and the comparative yield of these crops is discussed in chapter VIII.

Cabbages do not keep so well as mangel beets in ordinary cellars so that the former should be used up first and the beets kept for feeding later in the winter if both crops are raised. Beets and other crops of this nature are only raised extensively in the northern section of this country. Cabbages may be hung up on a wire or rope in the poultry house while beets are usually split and stuck on a nail on the side wall of the pen about a foot above the floor or they may be hung up as are cabbages. Vegetables which have been frozen can be thawed out and fed to fowls but will not keep long after they are thawed.

CLOVER AND ALFALFA

Freshly cut green clover and alfalfa are excellent green feeds and may be fed mixed in with the mash or fed separately in open hoppers. While the dried feeds such as alfalfa meal and clover or alfalfa hay are not nearly so well relished by fowls as are fresh green feeds the former offer a fair substitute using from 5 to 8 pounds in 100 pounds of the dry mash. Clover and alfalfa hay may be cut into one-fourth to one-half inch lengths and mixed

with the dry mash or they may be steamed and the liquid obtained by this steaming used in mixing the hay into the moist mash. Alfalfa ground into meal is sold extensively for feeding poultry and is usually mixed with either a dry or a moist mash without steaming or soaking the alfalfa. Many of the commercial mashes both for growing stock and for laying hens contain alfalfa meal. The best grades of alfalfa meal are made largely from the leaves and finer parts of the stems of alfalfa hay while the poorer grades contain an excessive proportion of hard woody stem which is ground up so finely that it is difficult to detect. Select such meals by their appearance and by their analysis, as the better grades have a larger proportion of fine meal without much coarse fiber and also have a low fiber content containing not more than 30 per cent fiber.

The second or last crop of clover hay sometimes called rowen is usually especially well adapted for feeding poultry as it contains a large per cent of leaves and fine stems and only a small amount of coarse woody fiber. Only good alfalfa or clover hay which has been properly cured and which is free from mould or must should be used for poultry.

OYSTER SHELLS

Oyster shells should be kept in an open hopper before both hens and growing stock all of the time. Use a large or coarse size of oyster shell for hens and the finer size of this product for young chicks and growing

stock. Oyster shells provide most of the lime used in making egg shells while growing chicks are also able to assimilate and use some of this lime during their growing period.

Lime can be supplied more readily by using oyster shells than by attempting to use a soft limestone to furnish both lime and to be used as a grinding surface. Clam and mussel shells have about the same analysis as oyster shells and serve the same purpose in feeding poultry. Select whichever of these two feeds are cheapest, the oyster shells usually being cheaper east of the Mississippi and the clam shells being cheaper west of that point.

Laying hens will eat from 2 to 3 pounds of oyster shells in a year which with the low price of the product makes this feed a small but very important item in the yearly feeding of the hens. The lack of oyster shells in a ration for laying hens will show up rapidly in the production of soft shelled eggs which can be changed quickly by supplying the necessary oyster shells or lime material. Where one desires to supply this material very rapidly the lime may be dissolved in water. Ordinary unslaked stone lime may be dissolved in water and the clear liquid skimmed off and supplied to the fowls. The amount of oyster shells needed and used depends also on the nature of the soil, less oyster shells being required in a limestone soil if the fowls have good range than is necessary in sections where there is no limestone in the soil.

GRIT

Grit should be kept before poultry all of the time and is usually one of the first feeds given to young chickens of all kinds. Chickens need a fine chick size grit while a coarser grit about the size of a large grain of corn is better adapted for fowls. The grit for hens should be very hard in texture as these hard stones assist in grinding the food in the fowl's gizzard.

One of the essentials of grit is hardness, and soft stones such as some of the softer limestones do not make good grit. Fine sharp clean sand mixed in with the feed is usually provided as grit for ducklings and goslings and may also be supplied to young chicks using about 3 per cent of this grit in the feed. Where hard grit is not available the temporary use of broken crockery will produce good results in sections where the ordinary stone is of a soft limestone nature. Reports from turkey sections in the South have indicated that supplying a hard grit to turkey poults resulted in much better results from the poults in sections where the natural stone was a soft limestone, even where the turkeys had excellent range.

Where chickens are fattened commercially grit is not usually supplied during the short fattening period although some feeders use a limited amount of grit. Chickens on free range on a gravelly soil containing large quantities of fine hard pebbles or grit do not need additional grit nearly so much as do chickens kept confined to small yards or where there are no small hard stones in the soil.

The amount of grit used is small and grit is usually low priced so that the cost is a factor of small importance. In experiments at the Government Poultry Farm laying hens consumed about 1.5 pounds of grit in a year. Grit is quite essential for pigeons and commercial products commonly called health mixtures are produced and sold extensively for that purpose. These products contain varying proportions of grit, charcoal, oyster shells, salt and some stimulating feeds.

A mixture of this kind may be made of 40 pounds of granite grit, 40 pounds of oyster shells, 10 pounds of charcoal, 5 pounds of fine salt and 3 pounds of Venetian Red. The salt is usually moistened with water and then mixed with the rest of the product so that it is thoroughly distributed throughout the mixture and much of the salt adheres to the grit and oyster shell and is not left in a loose dry form by itself. This prevents the pigeons from eating too much salt at one time, which they may do if they can get at a big supply of fine loose salt. Commercial chick feeds sometimes contain 5 to 10 per cent grit but under the present feed inspection laws the use of grit in such feeds is usually prohibited or if grit is used it must be plainly marked on the bag.

CHARCOAL

Charcoal is quite generally supplied to poultry of all ages and may be kept before them in hoppers or mixed in with the mash. Where it is mixed in with the mash from one-half to 1 per cent of charcoal is usually used.

Charcoal is also used by some poultry fatteners although others do not believe it is essential or worth while. It probably assists in correcting digestive troubles and keeping the birds in good condition by its ability to absorb gases. There is some difference of opinion as to its value for any kind of poultry and many poultrymen do not use it at all, but as the amount of charcoal consumed by fowls or chickens is very small it probably is at least worth the small cost involved. Some poultrymen make their own charcoal by occasionally burning a few sticks of hardwood for this purpose. Most commercial mash mixtures contain a small per cent of charcoal.

WATER

Fresh clean water should always be kept before poultry of all ages. An egg with the shell contains over 73 per cent water, making it very necessary that a large supply of water be furnished all kinds of poultry. The drinking vessels must be kept clean and should be thoroughly cleaned and washed at least once a week, and should be scalded once a month.

It is essential to supply fresh water 2 or 3 times daily in houses where the water freezes during the winter and this should also be done during hot summer weather when the water soon becomes very warm and stale and where the fowls are apt to drink all the water rather quickly. Fowls will drink considerably more water if the water is kept fresh than where it is only changed once a day and becomes warm and stale. Throughout the

year, except for conditions noted above, water should be supplied fresh once daily and receptacles large enough to hold a day's supply of water should be provided.

The drinking fountains or pans should be emptied at night during cold weather to prevent the water from freezing but it is very essential that water be supplied early in the morning just as soon as the fowls come off the roost if the best results are to be secured from poultry.

Automatic watering devices are used on many large poultry farms and keep a constant supply of fresh water before the fowls all of the time. Automatic devices for watering and arrangement of equipment of this kind is discussed more in detail in chapter XIV.

Such appliances are especially valuable in long houses in sections where the water does not freeze so that they can be used throughout the year, without making it necessary to provide against cold weather. All waterfowl require large amounts of drinking water, making some convenient watering system almost essential on duck farms.

Where electric lights are used in stimulating egg production during the winter months it is very essential that water be available to the fowls early in the morning as soon as the lights are turned on. In sections where the water freezes in the house some arrangement must be made whereby water can be kept from freezing under those conditions or else fresh water supplied in the morning when the lights are turned on. Where growing chickens are kept on a range which is often a considerable distance from the other buildings and where the birds

are fed entirely by the hopper method both for their grain and mash, barrels of drinking water may be used and fresh water supplied only once or twice a week. A faucet in the barrel may be regulated so that the water drops slowly into a pan, making the supply last for several days and keeping water before the chickens constantly. A small amount of disinfectant such as pottassium permanganate or iron sulphate should be put in the barrel of water to keep it sanitary and prevent the development of mosquitoes and other insects.

QUANTITY OF GRAIN TO FEED

Poultry keepers must use their own judgment in deciding how much grain to give hens as the amount of feed which they will eat varies with the condition and size of the fowls as well as with the seasons of the year and the method of feeding used. Hens will eat more grain when they are in good condition and laying heavily than during the periods of low egg production or when they are not in the best of physical condition. More feed will be consumed when the fowls are fed a small amount of grain 3 or 4 times daily than where they are fed only once or twice daily as is the more common practice.

While higher egg production will be secured by the more frequent feeding it is questionable whether such a method is more profitable under average conditions than the simpler method of feeding grain twice daily. The best general rule to follow is to give the fowls all of the grain that they will clean up within 10 or 15 minutes after

they are fed for all of the feeds except the last feed given in the evening. For the evening meal a full feed should always be supplied so that the fowls will go to the roosts with full crops and it is advisable to feed enough grain at night so that there will be a little grain left in the litter for the fowls to eat and scratch for when they get up in the morning. It is especially desirable and essential that fowls have a full crop when they go to roost in cold weather on account of the length of the winter nights.

A fair general estimate is to feed about one quart of scratch grains and an equal weight of mash, that is, about 1½ quarts of mash, daily to 13 hens of the general purpose breeds such as the Plymouth Rocks, Rhode Island Reds or Wyandottes and to 16 hens of the smaller or egg breeds. This would be about 7½ pounds each of scratch grains and of mash daily to 100 Leghorns and about 9½ pounds of each to 100 general purpose fowls. This is advised where a simple method of feeding is used and the birds are not forced highly for egg production. General purpose fowls fed in this manner and kept on a good range will eat about 75 pounds of feed in a year including both scratch grains and mash and Leghorns will eat about 55 pounds in addition to the green food consumed by both of these breeds. It is advisable to feed about half mash and half scratch grains during the year, the proportion of these varying somewhat at different seasons. In the egg laying competitions where the hens are forced more heavily for production and grain is fed more frequently, a larger amount of grain is consumed.

PROPORTION OF GRAIN AND MASH

The best results in feeding a dry mash are obtained where the hens are fed so that they consume about equal parts of mash and of scratch grains in the course of the year. The mash is usually kept in an open hopper before the fowls all of the time and the amount of scratch feed given is regulated roughly according to the amount of mash which the fowls are eating. Very radical changes should not be made in the feeding and all changes in the kinds of feed or the proportion of scratch grains to mash should be made gradually.

Pullets should be in good flesh when they go into laying quarters in the fall and it is usually best to feed these pullets rather freely on scratch grains at that time especially if there is any change in the ration from their growing feeds. If when the pullets are moved from the range and put in their winter quarters they do not eat the mash freely and the amount of scratch grains is kept rather limited, the birds are apt not to eat sufficient feed to start egg production freely; therefore usually making it advisable to feed two parts of scratch feed to one of mash at that time. Then as the pullets eat the mash more freely the proportion of mash consumed will gradually come up to the amount of scratch grains fed by January. About July 1 start reducing the scratch feeds until the fowls eat 1½ parts mash to one part scratch feed.

If the fowls do not start to eat the mash fairly well using this method and egg production starts very slowly,

it may be hastened by giving a light feed of moist mash daily in addition to the dry mash kept in the open hopper. Feeding freely of scratch grains to the pullets during the fall helps to bring egg production up gradually rather than securing a very rapid increase of egg production in the early fall when the pullets are not fully enough developed or in good enough flesh to keep up this production throughout the winter, thereby often resulting in a material slump in production in the middle of the winter. Always feed very lightly of scratch feeds in the morning.

During the spring months when egg production is highest the fowls will usually eat the dry mash very freely and at that time they should consume equal parts mash and scratch grains. About July or when the egg production begins to drop off and the moulting period approaches, the fowls are inclined to eat very much less mash and it is often very helpful at this season of the year to give a light feed of moist mash in addition to the dry mash. Hens which are inclined to get over-fat like the Brahmas, Orpingtons and large-framed Plymouth Rocks may be kept in good condition by feeding a dry mash containing 5 per cent less meat scrap than is recommended for general use and only feeding the same weight of scratch grains as they eat of the mash.

It is also advisable to feed the scratch grains for these fowls in a deep litter and to make the hens scratch for their feed. Some poultrymen who keep these heavier breeds shut up the dry mash hoppers during part of the

day to prevent the fowls from eating so much feed and becoming too fat to produce eggs profitably.

QUALITY OF FEED

Grains of good quality and in good condition should be used in feeding poultry. Fowls and chickens are very quickly affected by spoiled feeds and such feeds frequently cause diarrhea and stop the hens from laying for several weeks. Chicks fed such feeds are prevented from growing steadily. Any change or condition of feed which temporarily stops egg production or which stops the normal growth of chicks produces serious results as it takes considerable time to get hens back into good laying condition while chickens whose growth has been temporarily stopped will never make as good chickens as those which have grown steadily throughout the season.

Grains which are small or somewhat shriveled up, but which are not damaged enough to make them unfit for poultry feeds may often be used for poultry advantageously if they can be bought at a price considerably under the market price for good feeds. The slightly damaged and shrunken feeds are often sold at prices only a little under the price of good feeds thereby making them poor rather than good investments. Badly musty or mouldy feeds should not be fed to any kind of poultry as their use is apt to put the whole flock in bad condition and may result in considerable mortality in the fowls. Feeds which are only slightly musty may be fed if used with care but should be dried as thoroughly as possible by

spreading them out in the sunshine or in a thin layer on the feed room floor until the must is all dried up.

Corn and corn products are the poultry feeds which are most apt to become mouldy or musty especially during the spring and early summer. Cracked corn and corn meal should never be kept in large quantities during the spring and summer and should, if possible, be cracked or ground only a short time before they are used. Purchase small lots of these feeds at that season of the year and watch their condition carefully. If the grain starts to heat in the bins or sacks, work it over several times with a shovel on the floor of the feed room to prevent heating. Heated feeds or those which have been wet will quickly get musty or mouldy.

Meat scrap frequently gets wet and cakes up and becomes mouldy, making it very essential that this feed be kept in a dry cool place. Great care should be exercised in feeding garbage especially garbage containing waste meat products to avoid feeding any decayed meat feeds.

FEEDING THE GENERAL FARM FLOCK

The general farmer especially if he grows considerable grain is in the best position of any poultry keeper to make money from his fowls. Poultry having free range on the farm will pick up all their green feed and a very large amount of waste feed including grains, seeds and bugs. More or less waste products from the garden as well as skim or butter milk are also available for feeding poultry on many farms. The farmer should feed home

or locally grown grains if possible, feeding at least two grains, and in addition a mash of corn meal or corn chop and bran or middlings mixed with milk if available or if no milk is used, add 20 pounds of meat scrap or tankage to 100 pounds of the mash in winter and 10 pounds in summer.

Some kind of meat scrap or milk is very essential during the winter months and it pays to feed these products throughout the year although they are not so essential during the spring and summer if the fowls have a range where they can pick up a considerable number of insects and bugs. The use of a self-feeder for hogs has been a great aid to poultry on general farms as they are also able to get this hog feed thereby furnishing them sufficient grain and tankage to make up for the feed lacking on their range.

Fowls on the average farm should be allowed free range if possible as this range furnishes all the green feed needed as well as a large amount of other feed and at the same time keeps the poultry in the very best of physical condition. Fence the garden and let the chickens have free range. If possible keep the growing stock in a separate place or at a considerable distance away from the older hens so that the chickens will have a good chance to make good growth.

Place the poultry house where it will be as convenient as possible without having it so near the house that the fowls will become a nuisance around the home. Keep a dry mash before the hens all of the time or feed a moist

mash once daily if no dry mash is provided. Be sure that the fowls get some kind of meat feed or tankage especially during the winter. Always give the fowls a good feed of grain at night and they should have a light feed of grain in the morning. The amount of grain to feed in the morning depends upon the amount of feed available on the range. Feed more than one grain, always using two or three grains for variety.

FEEDING THE BACKYARD FLOCK

The small flock kept in the village or city backyard should be given a light feed of scratch grains in the litter early in the morning, kitchen garbage or table scraps at noon, and a good feed of scratch grains late in the afternoon. The table scraps may be fed in the morning with a very little feed of scratch grains and no feed be given to the hens at noon, if it is more convenient to feed the table scraps in the morning than later in the day. Feed 2 or 3 times as much grain in the afternoon as is fed in the morning and always be sure that the fowls go to roost with a full crop, especially in the winter when the nights are long and cold.

It is often advisable to mix a small amount of dry or moist mash with the table scraps unless one has a very abundant supply of waste products. Keep dry mash before the hens during the latter part of the day, opening the dry mash hopper when the hens are given their afternoon feed and leaving it open until they are fed the following morning or noon. This method of feeding pro-

FIG. 6. FEEDING GARBAGE ON A FEEDING BOARD TO PREVENT WASTE GARBAGE FROM SPOILING ON THE GROUND.

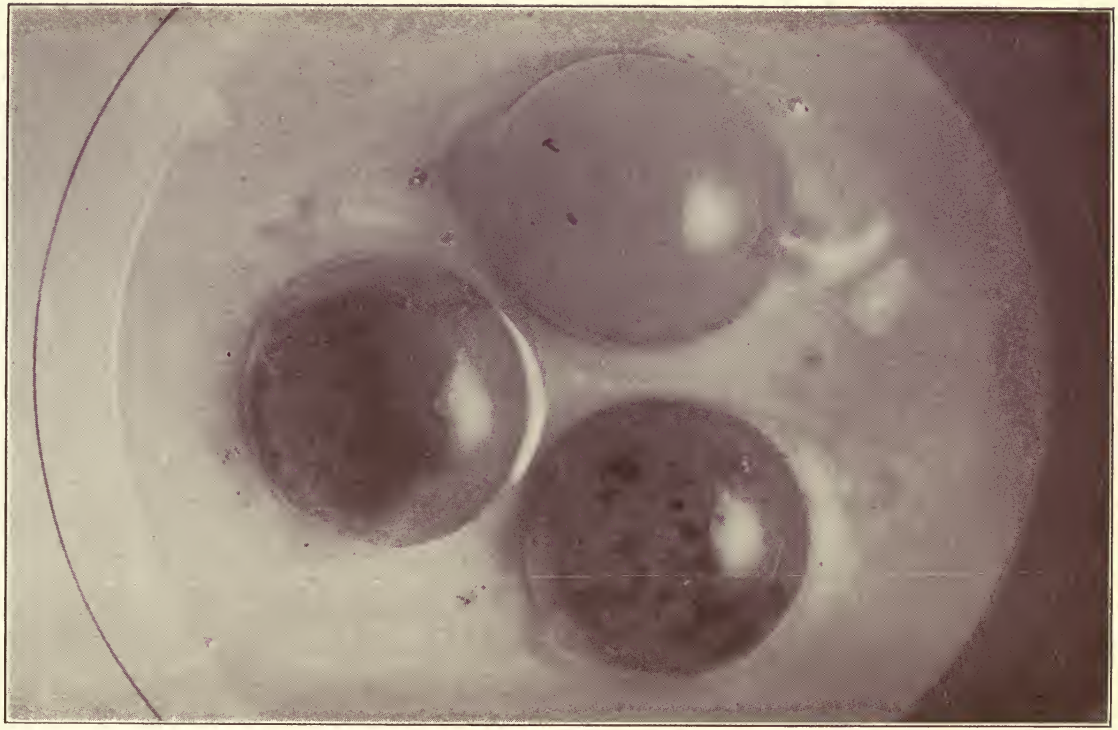


FIG. 7. SPOTTED EGG YOLKS SHOWING THE EFFECT OF FEEDING A LARGE PER CENT OF COTTONSEED MEAL. THE CLEAR YOLK WAS PRODUCED ON A RATION WHICH DID NOT CONTAIN COTTONSEED MEAL.

vides the hens always with sufficient feed but keeps them hungry during the early part of the day so that they will clean up all of the table scraps available. Feed the scraps in troughs preferably on a feeding board especially in the summer or at least use some method whereby the troughs in which the scraps are fed, and the place around them, may be kept absolutely clean. This is very essential because when the waste products which the fowls do not eat get mixed with the ground it makes a very unsanitary place which may result in decayed products and cause heavy mortality in the flock.

It is also very necessary to be sure that the table or kitchen scraps are in good condition and do not contain any decayed meat or a large amount of salt or salty meat as these products are especially injurious to fowls. If more waste products are available than are readily eaten by the fowls it may pay to put these products through a meat or feed chopper to get them into a more palatable form so that the fowls will consume a larger quantity. Vegetables and feeds do not need to be cooked for poultry except small potatoes, which should be boiled.

Green and succulent feed should be provided and a large supply is usually available to the backyard poultry keeper during the growing season, consisting of weeds and waste vegetables from the garden and fresh lawn clippings. During the summer and fall any part of the garden not used for vegetables may be sown to oats or rye and this growing green feed cut when it is three to six inches high and fed to the hens or to growing chickens.

Where double yards are used considerable green feed can be supplied to the fowls by sowing grain four times during the year in whichever yard is vacant, alternating these yards and allowing the fowls to range on this green feed when it is two to four inches high.

When only one yard is available part of it should be sown to a quick growing grain crop to freshen the land at least twice each year, confining the hens temporarily to a small part of the yard near the house. The hens may sometimes be allowed to range on the lawn during the latter part of the day and part or all of the vegetable garden may be used as a poultry range during certain periods of the year, by using a temporary fence around the garden, if conditions are such that the hens cannot be allowed to go free. Two permanent yards large enough so that they can be kept in green grass by alternating them every two or three weeks makes the ideal arrangements both for yards and green feed but requires more room than is usually available in backyard poultry raising. Cabbages and mangel beets may be raised for use during the winter or sprouted oats should be provided if no other green feed is available.

Two or more grains may be bought for the scratch feed or a commercial scratch feed may be used. Be sure that the grain is of good quality and in good condition. Commercial mash feeds may be purchased or the separate feeds may be bought and the mash mixed at home. Wherever sufficient feed is used to make it worth while to mix in half or ton lots and a good place is available

to hold the feed, it may be found cheaper to mix one's ration than it is to buy the commercial mixtures.

In addition to the analysis the quality of the feed must be carefully considered to see that it is in good condition and free from musty, mouldy, or shriveled feed. Oyster shell, grit, charcoal and fresh clean water should always be kept before the fowls.

CHAPTER X

EGG LAYING RATIONS

Selection of a Ration. Select a ration of palatable feeds made up of grains available in your section which are lowest in price and which will supply a balanced ration for the fowls. The same ration can be fed to advantage throughout the year without changing its composition. Adapt the method of feeding and the amount of feed to the time of the year and condition of the stock. A larger proportion of scratch feed than of mash should be fed in the fall and about equal parts of scratch feed and mash during the winter, while more mash than scratch feed is consumed in the spring and early summer. In selecting the best feeds, study the market and compare the grains according to their analysis, always considering whether or not these grains are well relished and are palatable to the fowl. An extensive list of good egg laying rations is given in Table I in the appendix of this book.

Corn, wheat, oats and barley are the principal grains fed to poultry, while Kaffir corn, buckwheat, feterita and Egyptian corn are good feeds to use in certain sections. Corn and wheat are the two best grains, being about equal in value as poultry feeds, although neither one gives good results if fed alone as corn is inclined to be too fattening and wheat does not contain all of the necessary characters to make a good feed by itself.

Oats and barley on account of their hulls and higher fiber content are not as good as corn or wheat. Oats are usually better relished by fowls than is barley, especially if a good grade of heavy oats is available.

Rye is not well relished by fowls and its use is not advised except in limited quantities in sections where it is relatively low in price. Wheat screening or slightly damaged feeds sometimes may be bought to advantage, their value depending entirely upon their quality and condition, but as a rule only sound grain in good condition should be fed to poultry and mouldy grains should never be used.

BALANCED RATIONS

A properly balanced egg-laying ration is a combination of feeds which furnish just the necessary amount of nutrients (protein, nitrogen-free extract, and fat) to produce the highest egg yield which is economical. Protein is a nitrogenous nutrient which supplies material for body structure, while nitrogen-free extract consists of the starches and sugars, and supplies heat, energy, and fat. Feeds used primarily to supply protein are meat scraps, fish meal, milk products, and cottonseed meal. Feeds especially high in nitrogen-free extract are corn, wheat, oats, and their by-products.

THE NUTRITIVE RATIO

A good egg-laying ration should include (1) a scratch mixture and (2) a mash composed of palatable feeds

containing some animal protein feed, considerable bulk, and supplying roughly about 1 part of protein to 4½ or 5 parts of carbohydrates and fat, the fat being changed to terms of carbohydrates, which is done by multiplying the fat by 2¼. The proportion of digestible protein to the total digestible carbohydrates is called the nutritive ratio, as given in the Appendix.

Sufficient experiments have not been conducted in poultry feeding to determine the exact digestive value of the various grains for poultry, as has been done with cattle. Therefore either the total composition of the feedstuffs or the digestible composition may be used in figuring this nutritive ratio. In figuring the nutritive ratios in this book the fiber is included in the carbohydrates, but very little fiber is digested by poultry. The composition of the various poultry feeds is shown in Table (2) in the rear of this book. The digestible composition of these feeds as secured from experiments with animals is also given in that same table.

VALUE OF ANIMAL PROTEIN FEEDS

Meat scrap or some other animal feed high in protein is the one essential constituent of the mash which cannot well be omitted and is the part of the ration usually lacking, both on the farm and with the small poultry keeper. There is no other part of the ration which will give greater returns than the meat part of the feed and no other part which if omitted will reduce egg production more than the meat feed. In experiments conducted at

the government farm at Beltsville, Maryland, a pen of pullets on free range which did not get meat scrap or any other animal protein feed, laid an average of only 90 eggs each in a year compared with yields of from 125 to 150 eggs from similar pens of fowls which were fed rations containing meat scrap. The eggs from the pen where no meat scrap was fed cost several cents more a dozen for feed than from pens where the meat scrap was included in the ration.

Experiments conducted at Purdue University in Indiana showed an average production of only 59 eggs from hens without meat scrap or animal feed as compared with 179 eggs from those receiving meat scrap or milk. These hens were confined to yards where they did not get the opportunity to pick up any bugs or waste products which the fowls did in the experiments on the government farm showing that the importance of meat feed is even more essential where hens are confined than where they are allowed free range.

Even with free range conditions on the general farm, where fowls can pick up many bugs, insects, and waste products the value of meat scrap or milk is very great and is not sufficiently appreciated by the farmers. On such farms the amount of meat scrap can be reduced in the spring and summer months to about half of what is advised for winter use. Fish meal or fish scrap can be used to replace the meat scrap and compares favorably with a good grade of meat scrap containing the same per cent of protein. In considering the relative value of these two

feeds, base it entirely on their protein content. Skim milk or buttermilk, either sweet or sour, is excellent for replacing part or all of the meat scrap. The milk may be used in mixing the mash if a moist mash is fed, or can be kept before the fowls as a drink. Where it is provided constantly before the fowls they should also have some meat scrap.

A small amount of bone meal may be added to the mash, using two per cent which can be used to replace that amount of meat scrap. Green cut bone, if fresh and sweet, will take the place of meat scrap if fed at the rate of half an ounce per hen daily. If too much of this bone is fed it will give the fowls diarrhea or cause looseness of the bowels. The difficulty with green cut bone is to get this material while it is in a fresh sweet condition as well as the large amount of labor of grinding it up for the poultry, unless one has some convenient form of power. The use of table scraps and cooked vegetables will help to reduce the necessary meat feed from one-third to one-half, depending on the quantity of meat products in the scraps.

VEGETABLE PROTEIN FEEDS

High vegetable protein feeds will not entirely replace meat or animal protein feeds to advantage, but in sections where the former are produced they may be used to replace about half or slightly less of the meat scrap. In experiments conducted at the government poultry farm at Beltsville, Maryland, cotton seed meal gave the best re-

sults of any of the high vegetable protein feeds, using an equal amount of cotton seed meal and of meat scrap in the mash. The other high protein feeds which gave good results, named in their relative order of value were; peanut meal and soy bean meal, while velvet bean meal did not prove very satisfactory. Fairly good results were obtained in using these high vegetable protein feeds where mashes containing 10 per cent of the high vegetable protein feed and 15 per cent of meat scrap were fed. Another successful ration of several vegetable protein feeds mixed with a little dried buttermilk is also given in the Appendix.

Not more than one-tenth of the mash should be composed of cotton seed meal as the use of a larger proportion of cotton seed meal will cut down the egg yield materially and may affect the quality of the eggs, producing spots and blotches on the yolks which make them unattractive and unmarketable. Other of the vegetable protein feeds which can be used with success for poultry are gluten and linseed meal.

COMMERCIAL SCRATCH MIXTURES AND MASHES

Commercial scratch mixtures and mashes have their place in poultry feeding, especially for the person keeping only a small flock as discussed under the subject of feeding a backyard flock on page 142. Very good grades of commercial feeds are available but should be carefully selected from a study of their analysis, especially their

protein content, which should be comparatively high, and the fiber content which should be low.

Commercial poultry feeds are stamped on the bag with a general statement of contents which is supposed to tell what constituents are in the feeds but does not give the proportions of the various grains. The bag also has an analysis of the feed usually given in the terms of protein, fiber, carbohydrates and fat, the carbohydrates representing the sum of the nitrogen-free extract plus the fiber.

The protein in the mash should be largely of an animal source and not be derived in any great percentage from a vegetable source, other than that ordinarily furnished through the common grains such as corn, wheat and oats and their by-products.

The fiber content is also given and the amount of this is quite an important factor in poultry feeds as hens do not utilize fiber to advantage. While the analysis of commercial feeds varies considerably a protein content of 15 to 20 per cent, carbohydrates of 50 to 60 per cent, and fat of 4 to 6 per cent with crude fiber not exceeding 6 to 10 per cent indicates a good general mash. A good general scratch mixture should have the following analysis; protein 8 to 10 per cent, carbohydrates 60 to 70 per cent, fat 2 to 4 per cent, fiber not exceeding 5 per cent. It should always be remembered that the analysis is not the only consideration as the kind and quality of feed should also be carefully considered and unless feeds are used that are well relished and palatable to the fowls

and are also of good quality, they will not give good results regardless of their analysis.

Large feed companies are able to purchase, store and mix grains in very large quantities and thereby are able to handle feeds more economically than small feed dealers. During certain seasons, especially during spring, these large companies are able to supply a much better grade of cracked corn and some other feeds which are apt to spoil readily, than are smaller dealers. For these reasons commercial mixed feeds are often sold at prices which make them a good investment for the poultry keeper.

On the other hand there is more or less distributing and operating costs connected with the handling of these commercial feeds which must be added to their price. By buying the mixed feeds the poultryman or poultry keeper can get a variety of feeds without purchasing a large quantity of each feed which he may have to keep under conditions whereby they are subject to waste by rats, mice and other destructive forces. Most poultrymen agree that it pays to get mixed chick feeds on account of the danger of getting cracked corn in the spring which does not keep well or which will heat and become mouldy or musty.

The cracked corn and chick grain handled by the large feed companies usually contains a kiln-dried corn which has been held by them for some time, often for more than one year, to be sure that it is perfectly dry and the product is in good condition. Each poultryman or poultry keeper

must decide for himself as to whether his operations and conditions are such that it is more economical to purchase separate feeds or to mix his own rations.

There are various poultry feeds put on the market which in general come under the following heads: Chick feed and chick mash, which are fed to newly hatched chicks until they are 8 or 10 weeks old; growing scratch feeds and growing mashes, to be fed after the chick feeds are discontinued and until the cockerels are marketed and the pullets are put in their laying quarters; and laying mashes and scratch feeds, which are fed to both pullets and hens. Most of the states have quite strict feed laws now, whereby the state experiment station or some designated official has charge of the feed inspection for the state and information as to whether any brand or make of commercial feed corresponds to the analysis can be secured from the experiment station.

EFFECT OF FEED ON QUALITY OF EGGS

Feeding affects the quality of the eggs within rather broad limits but a considerable variation of ration can be used without a noticeable effect on quality, as long as the feeds are in good condition. Fowls fed a well-balanced ration are able to convert these feeds into high quality eggs and the variation within reasonable limits does not affect either the quality, composition or the size of the egg. If abnormal rations are fed they may and often do affect the eggs, producing either poorer quality eggs or affecting the size, making smaller eggs. Fowls

on farms which are fed only a very small amount of grain and left largely on grass feeds may produce eggs which are weak and watery and not of good quality.

In purchasing grains, corn and corn meal are the products especially subject to mould and must, and should be carefully examined in the spring and summer for spoiled feed. If these feeds have been wet they will spoil quickly during that time of the year. Corn which has not been properly cured will have a green heart, the inside of which is very harmful and poisonous to fowls, and especially so to young chickens.

Meat scrap and mixed mashes which have been sacked and held for some time will cake up and get mouldy if they have been wet, making them unfit for feeding. Be careful in feeding grains in the fall before they are thoroughly cured, especially corn. Soft wheat which is not thoroughly cured and dried is also dangerous. Rye is not used much in feeding poultry, but if used care should be taken to see that there is no ergot in it as this will have a very detrimental effect on the poultry flock.

Cottonseed meal as discussed on page 151 if fed in large quantities will affect the appearance of the yolks of the eggs. The feeding of onions and large quantities of rape to fowls which have not had rape previously may affect the flavor of the eggs. Feeding of large amounts of slop garbage will also affect the quality of the eggs, producing weak or watery eggs. Spoiled feeds or those not adapted for poultry usually stop production before they have had much opportunity to affect the quality of

the eggs. Musty and mouldy feeds will usually stop egg production.

The color of the yolk of eggs is readily affected by the feed. Green feed is the material which gives yellow coloring to the yolks, while yellow corn also gives the yellowish or golden color to the yolk. Oats, wheat, and white corn tend to give a light or pale color to the yolks and the yolks ordinarily are much yellower and deeper colored in the spring and summer when the birds have range on grass land, than they are in the winter months when the quantity of green feed is limited. The color of yolks of eggs can be readily changed by the feeding of aniline dyes showing how quickly and readily this color factor is affected.

CHAPTER XI

FEEDING AND FATTENING CHICKENS

Feeding Baby Chicks. Young chickens should be fed from 3 to 5 times daily depending upon one's experience in feeding. Undoubtedly chickens can be grown faster by feeding five times daily than by feeding three times daily, but it should be borne in mind that more harm can be done to the young chickens by overfeeding than by underfeeding, and at no time should they be fed more than barely to satisfy their appetites and to keep them exercising, except at the evening or last meal, when they should be given all they will eat. Greater care must be taken not to overfeed young chicks that are confined than those that have free range, as leg weakness is likely to result in those confined.

The young chicks should not be fed until they are about 48 hours old, whether they are with the hen or in a brooder. If home mixing of feed is to be followed the first feed should consist of baked johnnycake broken up into small pieces, or hard-boiled eggs mixed with stale bread crumbs or rolled oats, using a sufficient quantity of the latter to make a dry crumbly mixture, or a mash of 2 parts rolled oats, 1 part bran and 1 part middlings by weight, mixed with milk or with boiled eggs. These feeds or combinations of feeds may be used with good

results for the first three or four days. Then gradually substitute daily for two feeds a mixture of equal parts of finely cracked wheat, cracked corn, and pinhead oatmeal or hulled oats to which may be added a small quantity of broken rice, millet, or rapeseed, or all combined, and charcoal if obtainable. If corn cannot be had, cracked kafir, rolled or hulled barley may be substituted.

Commercial baby chick scratch and chick mash may be fed to good advantage in place of the home mixed feeds and can be bought from almost any feed dealer. Buying these ready mixed feeds for small chickens is much simpler than securing the separate grains and no more expensive unless good sized quantities of feed are to be bought, and even then better results are apt to be secured, for the variety of feeds is wider and the mixing and milling more uniform.

Milk in some form is very beneficial for small chickens and may be kept before them as a drink and also used in mixing this moist mash. Giving the chickens a drink of milk for the first feed is an excellent practice.

HOW TO MAKE JOHNNYCAKE

Corn meal, 5 pounds; infertile eggs (tested out from settings or from an incubator), 6 pounds, and baking soda, 1 tablespoonful. Mix with milk to make a stiff batter and bake thoroughly. When infertile eggs are not available use a double quantity of baking soda and add one-half pound of sifted meat scrap.

When the chicks are about 10 days or 2 weeks old, use a growing mash composed of the following to take the place of the johnnycake or bread:

MASH FOR LITTLE CHICKS

Rolled oats, 1 part by weight; bran, 2 parts; corn meal, 1 part; middlings, 1 part, and 10 per cent sifted meat scrap.

This mash may be placed in a hopper where it will not be wasted and left before the chicks at all times or it may be fed as a moist, crumbly mash once daily, feeding suitable chick grains three times a day. When the chickens are 8 or 10 weeks old add 1 part of ground oats and increase the meat scrap to 1 part, the corn meal to 2 parts, and decrease the bran to 1 part in the mash. As soon as the chickens will eat the whole wheat, cracked corn, and other grains, the small sized chick feed can be eliminated and the chicks are fed only 3 times a day. The chickens' growth can be hastened if they are given sour milk, skim milk or buttermilk to drink in addition to the feeds, and milk is splendid to mix with the mash.

FEED FOR GROWING CHICKENS

Growing chickens kept on a good range may be given all their feed in a hopper, mixing 2 parts by weight of cracked corn with 1 part of wheat, or equal parts of cracked corn, wheat, and oats in one hopper and the dry mash in another. The beef scrap may be left out of the

dry mash and fed in a separate hopper, so that the chickens can eat all of this they desire. If the beef scrap is to be fed separately it is advisable to wait until the chicks are 10 days old, although many poultrymen put the beef scrap before the young chickens from the first without bad results.

Chickens confined to small yards should always be supplied with green feed, such as lettuce, sprouted oats, alfalfa, or clover, but the best place to raise chickens successfully is on a good range where no extra green feed is required. Fine charcoal, grit and oyster shell should be kept before the chickens at all times, and cracked or ground bone may be fed where the chickens are kept in small bare yards, but the latter feed is not necessary for chickens that have a good range.

The amount of feed required to grow chickens depends very largely on what success one has in rearing the chicks as the amount of feed required per chicken is quite different if 5 per cent of the chickens die than if 25 per cent of them die before maturity. This makes it difficult to give accurate figures on this subject but records kept at the Connecticut Experiment Station show that it took 17 pounds of feed to grow Rhode Island Red chickens to 24 weeks, and 37 pounds to grow them up to 32 weeks. Leghorns at this same station took 20 pounds of feed to grow them to 24 weeks of age. Barred Plymouth Rocks at the Canadian Experiment Station at Ottawa ate 5 5/10 pounds of feed up to 10 weeks and 19.75 pounds up to 20 weeks of age.

FATTENING POULTRY FOR MARKET

It pays to have poultry in good flesh before it is marketed and all thin chickens should be fattened for one to three weeks before they are marketed. The cost of putting on this extra weight is usually considerably less than either the market price of chickens or the cost per pound of rearing chickens to market age. Growing chickens which are thin or in an unfinished condition can be fattened profitably while hens which have been properly fed are usually in good flesh and do not need any special fattening. It is much more profitable to fatten chickens than hens although hens which are thin may be fattened to advantage. In addition to increasing the quantity of flesh by fattening, the quality is also greatly improved which should make the well-fattened chicken command a higher price per pound than the ordinary chicken which is not specially fattened. Farmers and handlers of all kinds of livestock recognize the value of fattening hogs and cattle for market but often do not realize that the same opportunity for profit and improvement exists in the fattening of poultry.

BEST CHICKENS TO FATTEN

The greatest, cheapest and most profitable gains are made on early broilers because broilers will not only make far greater percentage gains than larger chickens but they also bring the highest market prices per pound, especially those sold early in the season. Broilers or any small-

sized chickens can be fattened at a profit for a longer period than can roasters or large chickens. Chickens weighing one to 1½ pounds are classed as squab broilers, those weighing 1½ to 2½ as broilers, while friers is the term applied to chickens weighing from 2½ to about 3½ pounds. Chickens weighing more than this are called roasters.

As large chickens tend to become hard in flesh which is indicated both by the hardening of the end of their keel bones and by the beginning of the growth of spurs which appear like small buttons on their legs, they are classified as stags and are sold at a much lower price than roasters. General purpose breeds such as Plymouth Rocks, Wyandottes, Orpingtons and Rhode Island Reds, produce the best chickens for fattening. Chickens of these breeds can be marketed to advantage at most any time during their growing period, producing good broilers, friers or roasters.

Leghorn chickens do not make good friers or roasters and should be marketed as broilers when they weigh from one to two pounds. Fowls of the heavier breeds usually sell at prices ranging from one to three cents a pound more than do light breeds of hens, such as Leghorns. Chickens with black legs or those with feathers on their legs are undesirable for fattening as they make an unattractive appearance when dressed for market. Rapid growth, a good meat type at any age and early maturity are important factors in the production of market poultry.

METHODS OF PEN FATTENING

The two methods of fattening chickens that are of importance in this country are pen fattening and crate fattening. Pen fattening takes less labor and equipment than is necessary in crate fattening and is a better method for most farm conditions. A better grade of poultry, however, is obtained in crate fattening as the chickens are confined to smaller quarters and their flesh is thereby made more tender. Crate fattening is used entirely in the commercial fattening stations. In pen fattening 20 to 50 chickens are usually confined in a pen with a small yard and are fed a fattening mash. This special fattening increases their weight materially while the confinement tends not only to soften their flesh but at the same time allows practically all their feed to be used in producing flesh and fat.

A good fattening mash for pen fattening is made of one part bran, one part middling, 3 parts corn meal and one-fourth part meat scrap by weight. Green feed should be provided if the chickens are kept confined and have no green feed in their yards. If buttermilk or skim milk is available it provides one of the very best fattening feeds and the same mash as previously mentioned, except that the meat scrap should be omitted, can be used mixed with milk instead of water. When milk is used no green feed need be fed. The best results in fattening are secured where milk is used. Other good fattening feeds are, rolled oats and low grade flour or red dog middlings, either of which may be used in place of the middlings in

this ration. The mash should be fed twice daily, giving it in the morning and afternoon, and in addition, a light feed of cracked corn should be given late in the afternoon. Mix the mash to a crumbly consistency and keep fresh water and grit before the chickens all of the time.

These rations are adapted for either small or large chickens, the length of the fattening period being adapted to the age and size of the birds. Broilers may be confined to a pen and fattened profitably for from 12 to 18 days but it rarely pays to fatten roasters longer than from 10 to 14 days. Hens should only be fattened for from 4 to 8 days. Whenever the birds show signs of going off their feed and do not gain in weight they should be marketed at once. A good mash for fattening hens is made of one part bran, 2 parts ground oats and 4 parts corn meal by weight. This should be fed either with milk or with green feed but it is not essential to use meat scrap for fattening hens if they are only fed for a few days.

Capons and roasters termed "soft" roasters are grown and fattened in colony houses on free range as they have a long growing period. "Soft" roasters are a distinct product for which a special market has been built up especially around Boston and Philadelphia. Chickens of the larger breeds are hatched for this purpose in the fall and winter. They are caponized and then grown and fattened to be sold late in the following winter or early in the spring when they will weigh from 5 to 9 pounds. Birds for "soft" roasters are given free access during

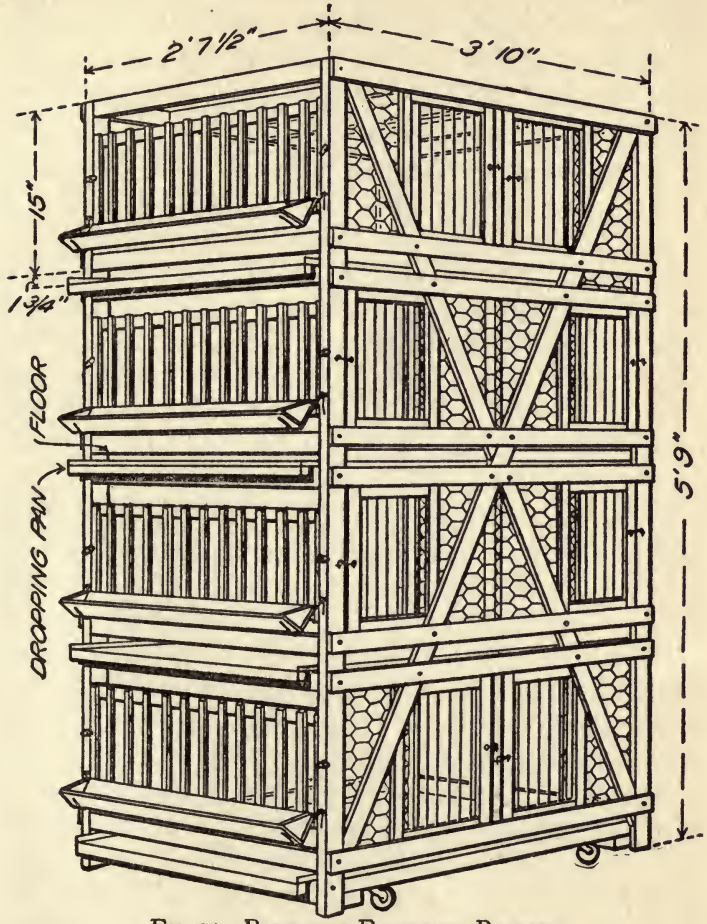


FIG. 14. PLAN OF A FATTENING BATTERY

their growing period to cracked corn and meat scrap which is kept in separate hoppers before them all of the time. It is very essential that a good grass range be provided for chickens so fed because of their long growing and fattening period. This business has not been profitable since 1913 when grain became so high-priced.

CRATE FATTENING

Crate fattening is a method of feeding used entirely in fattening stations in which from 6 to 10 chickens are confined together in each compartment of a crate. These crates are arranged in tiers for convenience in feeding and cleaning and by such an arrangement a large number of chickens can be fattened in one room or building. This industry has grown to large proportions in the Central West and is gradually spreading farther South in that territory as well as being carried on to some extent in the southeastern part of this country. The chickens produced on the general farms in these sections are usually underfed and when sold to the fattening stations are in a thin condition which makes it comparatively easy as well as quite profitable to increase their weight and to put them in better shape for market.

The object of confining the chickens to crates is not only to make their flesh soft and tender by keeping the birds from exercising but also to increase their weight materially. Birds so fed are called milk-fed chickens, as milk is the basis of all the rations used in this commercial crate fattening. The distinguishing character of such

Fig. 9. Milk Fattening of Chickens.

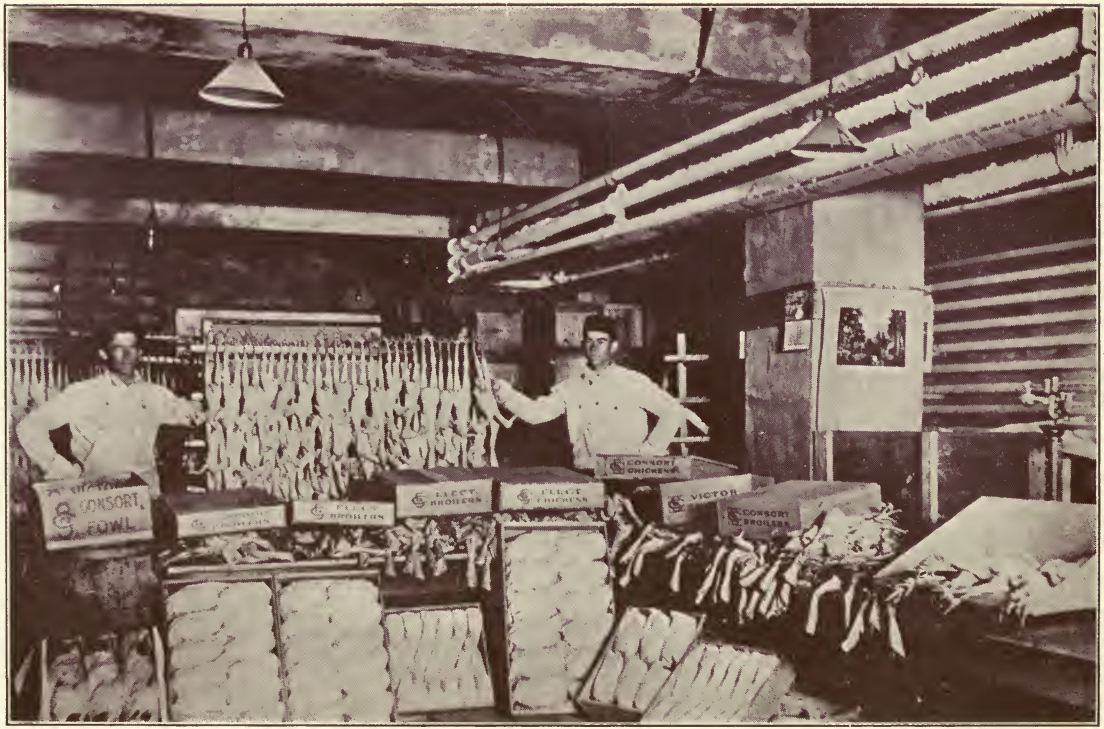


FIG. 10. INTERIOR OF A POULTRY GRADING ROOM SHOWING DRESSED POULTRY ATTRACTIVELY PACKED.

chickens in addition to being well fleshed, is a thorough bleaching of the skin caused by feeding milk.

Chickens are used for commercial fattening after they weigh from 1 to 1½ pounds and are then fed the fattening rations for from 6 to 17 days. The smaller sizes are fed for a longer time than the larger-sized chickens. Hens are only fed under those conditions for a short period, usually from 4 to 8 days while only a very small proportion of the hens marketed through the fattening stations are fattened at all. Chickens are usually fattened up to about Christmas time although the number fattened after November 1 is comparatively small. Chickens available for fattening after the first of the year are too large in size to make good gains while their flesh has already started to become hard. Some of the fattening stations have a feeding capacity of over 50,000 chickens at one time and will fatten 200,000 or more chickens during the season.

The average gain in weight in this feeding is directly in proportion to the size of the chickens. In experiments conducted at one of the large fattening stations in the state of Kansas by the U. S. Department of Agriculture, broilers weighing 1.60 pounds gained 34.9 per cent and consumed 3.69 pounds of grain in addition to milk in producing a pound of grain while larger chickens averaging 3.05 pounds in weight gained only 14 per cent and consumed 5.5 pounds of grain while making a pound of gain. As the broilers make the best gains they are fed longer than roasters which partly accounts for this great differ-

ence in percentage of gains, but even when broilers and roasters are fed for the same length of time the gains with the broilers are much greater than with the roasters.

FATTENING HENS

Thin hens or those which are covered with small pin feathers are sometimes fed at many fattening stations primarily to get them in better market condition rather than to make any great gains in their weight. Gains secured from hens are much smaller than from chickens so that it only pays to fatten hens for a few days. In commercial fattening stations the fattening period is usually from 3 to 8 days, but only a small per cent of the hens marketed through these stations are fattened at all.

FATTENING RATIONS

Buttermilk and skim milk form the basis of all commercial fattening rations and are usually fed in a sour condition although no special attention is paid to see whether the milk is sour or sweet. Semi-solid, condensed and dried buttermilk are also used quite extensively where the fresh buttermilk is not available and these products are giving very good satisfaction. In feeding both the dried and the semi-solid or condensed buttermilk it is possible to produce a better bleach on the chickens by feeding a larger percentage of milk in the ration, which is done by only partly diluting the semi-solid products back to their original consistency. Instead of adding 6 or 7 parts of water to the semi-solid

product only 3 or 4 parts are added in many instances which gives a much richer and thicker milk than ordinary buttermilk.

A good fattening ration may be made of 60 per cent white corn meal, 37 per cent low grade flour and 3 per cent bran. Another very good ration is made of 50 per cent rolled oats or oat groats, 42 per cent white corn meal, 5 per cent low grade flour and 3 per cent bran.

From 5 per cent to 6 per cent of beef tallow may be used in fattening and was used a number of years ago in many of the fattening stations, but the present opinion is that the addition of tallow is inadvisable as it is likely to produce a softer flesh which is not of the highest quality. Where beef tallow is fed it is only used in any considerable amount during the last few days of the fattening period as its use at that time does make the fat become more noticeable on the chicken. The buttermilk used in fattening hens which are held for only a few days results in a marked growth in their pin feathers and those which have short stubby pin feathers change so that the pin feathers may be readily pulled out when the fowl is dressed, giving it a much better market appearance.

FEATHER PICKING

One of the vices which is quite troublesome in fattening stations is feather picking. It is especially noticeable where the chickens are making big gains and are in particularly good flesh. It seems to be influenced by the heating effect of the forcing ration, by the confinement,

and by the lack of something to do. In some cases it is probably brought about by allowing the birds to become too hungry due to irregularity in the time of feeding. If this vice becomes widespread it is difficult to stop and may result in big losses in a fattening station. A chicken which is being picked, if not removed from the crate, will stand still and allow the other chickens to pick it to pieces. The chickens which are picked should be removed from the crates just as soon as noticed, and if only slightly picked may be dressed for market but make an undesirable grade of dressed poultry. No absolute remedy for this vice has been found but the use of rations containing a large proportion of milk and the use of care to see that the chickens always have plenty of feed have been found beneficial. The addition of about 4 pounds of salt to the feed or 10,000 chickens may be of some help in preventing feather and flesh picking.

Grit is not usually fed in fattening chickens commercially as sufficient grit is available to carry the chickens through the short fattening period. If the birds show any tendency to go off feed it is advisable to materially cut down their feed and to furnish them with some grit.

LENGTH OF FATTENING PERIOD

Chickens are usually fattened from 6 to 17 days under commercial conditions, the length of time depending on the size and price of the chickens and on the weather. Early in the season the small chickens are fattened for the longest periods, usually from 13 to 17 days, and they

make a material growth during these periods as well as put on flesh. The greatest percentage and the cheapest gains are made on the small chickens. It takes about 4 pounds of dry feed to produce a pound of gain on chickens weighing 1½ pounds to 2 pounds while 5 to 6 pounds of feed is required to produce a pound of gain on chickens weighing 3 pounds or more.

Slightly higher prices are paid for broilers than for larger chickens but when the former are fattened and dressed for market they bring a very much higher price than the larger chickens. The greatest gains are made in the early stages of fattening, the gains usually decreasing toward the end of the fattening period, depending on the size of the bird and on the weather. In experiments conducted in some of these fattening stations, broilers cost 17.6 cents per pound in July, 1911, while the gains, including labor, cost 7 cents per pound. In November of that year in the same stations the larger-sized chickens cost 9 cents per pound into the fattening station while the gains including labor cost 10.5 cents per pound. In other words, a pound of gain was put on the broilers at less than half the original purchase price while in the larger-sized chickens, the purchase price was about the same and in many cases less than the cost of gain in fattening. The dressed broilers also bring a much higher price per pound.

The common practice is to feed all the broilers and the small chickens secured early in the season for about 14 days. Around the latter part of August the period is

dropped to 11 to 14 days and by the middle of September the chickens are often divided into two lots, broilers and roasters, the former being fed 12 to 14 days and the latter 6 to 10 days. The question of length of time of fattening depends materially on help conditions especially in the dressing room, and also on the supply of chickens on hand. It is always necessary to adjust the length of period to these two factors in order to handle the fattening station successfully. The market for which the chickens are being produced also affects the best length of time to fatten the chickens.

The weather and environment materially affect fattening. During hot summer weather the chickens are sometimes very adversely affected by the extreme heat, making them lose their appetite and in some cases causing large mortality. Placing 20,000 chickens in one room produces a large amount of body heat making it difficult to keep the room comfortable in hot weather. The most successful fattening stations have their sides made up entirely or largely of glass or wooden shutters which can be opened to secure the best possible ventilation. In the early fall the broilers or small chickens consist largely of late hatched or poorly developed chickens and while the weather conditions are better for fattening, the gains secured are usually less than earlier in the fattening season, on account of the quality of the stock.

Late in the fall the chickens are more or less affected by cold and wet weather which is apt to develop colds and roup or sickness among all of the poultry. The

problem in the fattening stations in the fall and early winter is to keep the chickens comfortable and still supply plenty of fresh air and ventilation. The object in the management of the chickens is to keep them contented at all times.

In the early history of fattening stations in this country, the chickens were kept quiet by having them in a dark room but this lack of light and sunshine tended towards poor sanitary conditions and poor ventilation, and the best results are now being secured where an abundant supply of ventilation is provided which also necessarily produces a well-lighted room.

CRAMMING POULTRY

Fattening chickens on a cramming machine is a method of feeding used extensively in England but which has not generally given satisfactory results in this country, although it has been tried under many different conditions. It produces a better fattened chicken than any of the other methods but requires far more labor and greater skill in handling the chickens. It is difficult to secure labor which will use a cramming machine with success, while the public in the United States is not usually willing to pay the price which one must receive for poultry fed in this way, on account of the high labor cost.

Cramming machines are successfully used only by some small producers who sell extra quality well-fleshed poultry direct to the consumers. In cramming, the birds

are fed from 7 to 14 days from the troughs as in crate fattening, and are then crammed twice daily from 7 to 10 days until they begin to go off feed, when they are marketed. The operator gauges the proper amount of feed to force into the chicken by holding his hand on its crop. If the crop is not almost or entirely empty at the next feeding time the bird is not given any additional feed. The rations with milk advised for crate fattening can be used to good advantage in cramming, but the feed should be made thinner for the latter purpose, mixing it to the consistency of cream.

BEST TIME TO MARKET POULTRY

It usually pays the poultry keeper best to sell his poultry as soon as it is in shape for market. Leghorns are usually sold most profitably as small broilers weighing from one to two pounds. The early broilers from any of the breeds bring the highest prices while later in the season it may pay to keep the chickens for roasters if one has sufficient room and a good range. The production of broilers and roasters is as a rule a side issue to the raising of pullets; therefore the prime object should be to give the pullets the best possible growing conditions, which usually makes it necessary to sell the cockerels as broilers.

On general farms or poultry farms where a large amount of good range is available and where there is possibility of picking up a considerable amount of waste food, it may and often does pay to keep chickens up to

FIG. 11. FEEDING CHICKENS WITH A CRAMMING MACHINE.

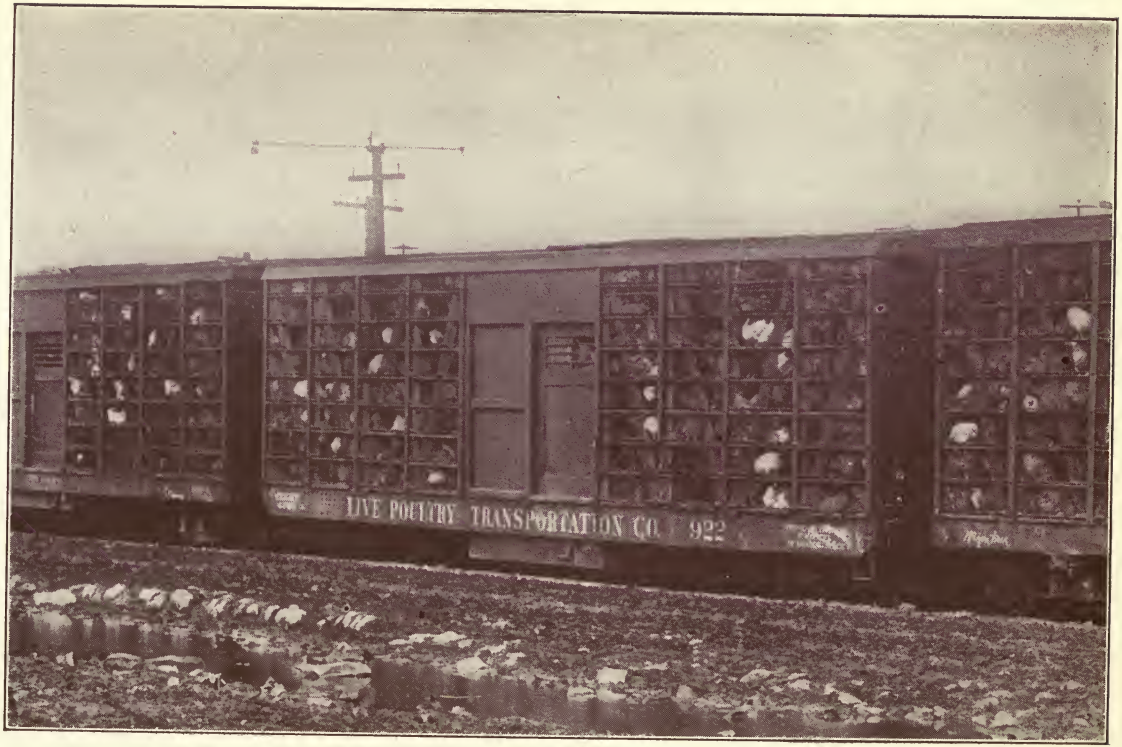


FIG. 12. LIVE POULTRY SHIPPING CARS.

the roasting stage. The later hatched chickens may often be kept and caponized where one has good range conditions for raising capons. The price paid for chickens is usually much higher in the early summer than in the fall, the lowest point usually coming about October or November. The following shows the average monthly price for chickens for one year in the New York market beginning with January, 1919: 27.5 cents per pound; 29.4; 29.5; 87.0; (broilers) 60.1; 50.3; 42.9; 36.4; 31.4; 26.1; 25.3; 27.7.

Hens are usually marketed to best advantage at the end of their second laying season although the best Leghorn hens in the flock may often be kept to advantage until the end of their third laying period. Many of the hens can be marketed to advantage at the end of their first laying season, the culls and poor producers being removed at that time. As a rule the hens which moult earliest in the summer are the poorest producers and a considerable percentage of them can be sold at the end of their first laying year.

The hens of the general purpose breeds rarely produce profitably after their second laying season and a larger proportion of them can be marketed to advantage at the end of their first laying season than with Leghorns. Some farmers sell their hens during the latter part of the winter or the very early part of spring when the prices for fowls are at the highest point but hens which have been kept until that time should be kept through their laying season as they will produce suffi-

cient eggs in the spring to make them very profitable at that time. The market price per pound received for hens in the early summer is only a few cents lower than that paid early in the spring, so that the hens will return a good profit by being kept until June, July or August, depending upon the condition of the stock and on the section of the country.

SELLING HENS ALIVE

The market for live hens in many large cities has been so good in recent years that it is often more profitable to sell hens alive than to dress them for market. The question of which is the more profitable method depends therefore upon market conditions and what facilities and labor are available for dressing the fowl. The best market periods for live poultry in New York City, which is one of the very best markets for this product, are during the Jewish holidays. The Jewish trade takes a large part of the live hens marketed and this demand is what makes the live poultry market of New York City so good. The dates of the Jewish holidays vary each year, being as follows from October, 1921, to June, 1922: October 3 to 4, October 12, October 17 to 18, October 24 to 25, March 4, April 13 to 14, April 19 to 20, and June 2 to 3.

In catering to a market of this kind for live poultry the produce must be shipped so that it will reach the market from 3 to 6 days previous to the holidays in

order to bring the highest prices. During the year 1920 the wholesale prices for live hens on the New York market had an average price in cents for each month as follows: January, 39.1; February, 41.4; March, 42.9; April, 46.6; May, 38.3; June, 36.4; July, 36.6; August, 36.4; September, 39.4; October, 31.2; November, 29.2; December, 29.7.

While these figures represent the averages for the months, showing the times of the year when live poultry brings the highest prices, there is considerable variation in prices throughout the month, especially during the period of Jewish holidays. For instance, on October 1, 1920, fowls were quoted at 40 to 44 cents which was during the Jewish holidays, but dropped to 32 and 35 cents for October 6 and to 21 and 29 cents on October 19. The prices gradually came up from that period to 35 and 37 cents on October 30, making the top quotations vary during the month from 29 to 44 cents.

The wholesale prices for dressed poultry on the New York market were about the same as for live poultry during the year 1920. The average prices for each month in cents beginning January, 1920, being as follows: January, 31.9; February, 35; March, 34.5; April, 37.2; May, 37.3; June, 36.2; July, 35.1; August, 34.5; September, 34.5; October, 33; November, 32.7, and December, 30.2. During that year the prices for live hens were several cents higher during certain seasons of the year than the prices of dressed hens.

SHRINKAGE IN DRESSING POULTRY

There is considerable shrinkage in dressing poultry which must be considered in comparing the profits of live and dressed fowls. The shrinkage in hens, where the birds are merely killed and picked is about 13 per cent and the same shrinkage is found in chickens; broilers averaging 14.3 per cent and roasters 14.7 per cent. If the hens or chickens are drawn as well as killed and picked, removing only the body contents the shrinkage will be about 21 per cent, increasing to 28 per cent if the head and feet are removed. Dressed poultry, except for home sale, is sold undrawn as it keeps better undrawn than after it has been drawn. Dressed poultry is always put into cold storage undrawn on account of its better keeping qualities in that condition. Experiments on the keeping qualities of dressed and undrawn poultry conducted by the U. S. Department of Agriculture gave results considerably in favor of the common practice of putting dressed poultry into storage without drawing it.

Many poultrymen are able to sell in the summer and early fall the best of their surplus yearling and two-year-old hens to other poultry keepers who desire these hens for breeding stock. Hens sold in this way bring a considerably higher price than they would be sold at as live or dressed fowls on the market. Pullets will give a greater return over feed cost than yearling or older hens, therefore the poultryman culls out the number of hens needed to make room for his pullets.

In experiments conducted by the U. S. Department of

Agriculture, Leghorn pullets gave an average return over feed costs of $2.72 for the first year; $2.18 for the second year; and $1.94 in their third year.

The value of eggs over feed costs in the general purpose breeds is much less in the older hens than for the Leghorns. The value of eggs over feed costs for the first year being $2.86; for the second year, $1.25; and for the third year, $0.39. The common practice on commercial Leghorn farms is to replace from one-third to one-half of the hens with pullets each year. The tendency in recent years is to have a larger per cent of pullets in the flock and some poultry farms only keep pullets for egg production.

Yearlings and older hens make better breeders than pullets and the best of the hens should always be saved for that purpose at least. The cost of raising the pullets and the price secured for the stock which is sold must also be considered. If sold for market, hens usually bring the same price per pound regardless of their age and will therefore bring just as much per pound when two or three years old as at the end of their pullet year. Yearling hens sold as breeders are in much better demand and will bring considerably more money, than older hens.

The best of the general purpose hens, while not nearly as profitable producers as Leghorns in their second and third years, should be kept for breeders and only a few of the older hens kept for market eggs. It would ordinarily be a better policy to keep a larger per cent of pullets in a flock of general purpose birds than in a flock

of Leghorns on account of the comparative production in these two types of fowls as they get older. The best proportion of pullets to keep is also influenced by the same factors which are discussed under the Leghorns.

FEEDING AND SHIPPING LIVE POULTRY

Poultry is shipped extensively in cars built expressly for this purpose and this trade has developed into a big business. These cars of live hens and chickens are collected in the great poultry producing states of the Central West and in the South and shipped to the large Eastern cities. A similar trade of the same kind is conducted between the Central West and the Pacific Coast. These cars of live poultry are from two to seven days en route and are accompanied by an attendant who travels with the car to see that the birds are given the best of care. The object is to get the birds to market with as little shrinkage as possible and in some instances slight gains are secured. Under good conditions, the shrinkage rarely exceeds 5 per cent, but this shrinkage is greatly affected by weather conditions in addition to the care given by the attendant.

These cars are usually divided into eight tiers, each tier divided into sixteen coops, allowing 36 fowls to each coop, a live poultry car will accommodate about forty-six hundred head, or about eighteen thousand pounds of poultry. With slight alterations, similar trains are used for geese and turkeys, holding from two thousand to

twenty-four hundred geese or from twelve to fifteen hundred turkeys.

The car is arranged to carry a supply of water and feed, all compartments having feed and water troughs accessible throughout the car. The feed may be mixed with water, but better results are secured if milk is used in mixing the feed, which can be done by using the semi-solid milk product and diluting it with water in the preparation of the feed. Dried buttermilk should be used in the mash if liquid buttermilk is not available. The same rations used in milk fattening for either hens or for chicks may be used with excellent results in feeding live poultry. Rations of some less expensive feeds may also be used, especially with hens, which can be fed on a mixture of corn meal or ground chop containing from 10 to 20 per cent of shorts, mixed with buttermilk.

CHAPTER XII

MANAGEMENT OF LAYING STOCK

Value of Early Hatching. The value of early hatching for producing good pullets and especially for gettings eggs in the fall and early winter cannot be overemphasized. Unless one gets pullets out in good season it is practically impossible to get fall eggs from the pullets regardless of how well they are fed and handled during the growing season. Chickens which have been hatched early will grow much more rapidly and do better than chickens hatched late in the spring.

Pullets which have been hatched early should be ready to put in their winter quarters in September or October and should be moved to their laying quarters, if these quarters are different from the place in which they are raised, at least 2 or 3 weeks before they are ready to lay. All of them should be settled and used to their winter quarters before the weather gets cold. Be sure that the pullets are marked in some way so that if they mix with the hens their age can be told whenever the pen is to be culled for market.

EXERCISE

Exercise is very essential especially for hens kept confined to the poultry house during the winter. This is

most readily secured by feeding the scratch mixture in a litter on the poultry house, having a litter of straw 2 to 4 inches deep. Straw makes the best litter but other material may be used if more available or cheaper. Sawdust makes a fairly good litter. Cotton hulls are used somewhat in the South for this purpose and fine white sand which is free from dust is used in some sections. Leaves make a good litter for a short time but break up very quickly and soon become very dusty. New litter should be added whenever necessary to keep up the required amount, and the litter should be changed whenever it becomes badly soiled and gets wet.

Poultry houses with dropping boards which are properly cared for, do not usually need to have the litter entirely changed more than 2 or 3 times a year. By feeding the scratch mixture in the litter the hens are always kept busy by scratching for their feed. Plenty of litter on the floor of the poultry house is very essential where the hens are confined to the house during the winter months. The need and value of litter on the floor of the poultry house is not so great where the hens have a good range or large yards in which they are allowed to exercise and work.

In addition to the feed it is very important that a constant supply of fresh cool water be supplied to the fowls. As an egg is about 65 per cent water the necessity for plenty of fresh water in the production of eggs is readily apparent. During the summer the water should be placed in the shade or at some point where it will keep

as cool as possible and should be changed at least twice a day. In the winter arrangements must be made to keep the water from freezing in cold climates or else to provide fresh water at least twice a day in case the water freezes in the houses. Where hens are confined in large poultry houses during the winter it is especially essential that all conditions in the house be made as near ideal as possible.

A considerable number of commercial poultry farmers keep their hens confined in the houses after they are put into these laying quarters in the fall and do not allow them to go outside until the weather becomes settled the following spring, the exact dates depending on the weather conditions and on the section of the country. It is thought that more eggs are secured by keeping the hens confined where they are less subject to the sudden changes in temperature and to adverse weather conditions than if the hens are allowed to go out of the house throughout the winter season. Many breeders who are especially desirous of getting fertile eggs, and especially breeders who keep other breeds of fowls than Leghorns, prefer to allow their hens to go out of the houses every day regardless of the weather as it tends to keep the hens in better breeding condition and to insure a larger percentage of fertile eggs in the spring.

USE OF ARTIFICIAL LIGHTS

During recent years artificial lighting systems for poultry houses have been used with considerable success

FIG. 13. USE OF ARTIFICIAL LIGHTS TO INCREASE FALL AND WINTER EGG PRODUCTION.

FIG. 14. FEEDING SCRATCH GRAINS IN THE FLOOR LITTER AND DRY MASH IN A WALL HOPPER.

so that the practice is now quite general in a few sections of this country, especially in New York, New Jersey, Oregon and California. The object is to provide a normal length of day throughout the winter season, usually about a fourteen-hour day, so that the fowls are able to eat and assimilate a much larger amount of feed than they can get in the average short winter day. It does not pay to use artificial lights unless fowls are properly housed and otherwise well cared for.

The method used apparently at the present time with most success is to provide lights early in the morning at such a time that it will give the hens 14 hours of daylight, which means putting the lights on about 4 a. m. and leaving them on until morning, using the lights from about November 1 to April 1, depending upon the section of the country. Lights may be used both in the morning and at night, still limiting the day to 14 hours. Where artificial lights are used the fowls will lay a much larger percentage of their eggs in the fall and winter but do not lay a much larger number of eggs for the entire year than where no lights are used, as their spring production is usually lower than that from hens kept under normal conditions. Fowls so handled must be given extra feed and are usually fed about four times a day, at 8 in the morning, at noon and just before dark, giving them plenty of feed at this last feeding time. Unless sufficient grain is left over for the early morning feed, additional grain is scattered in the litter after the hens go to roost. In addition to the extra feeding, water must be provided

so that the hens will have it as soon as they come off the roost which means that in the winter arrangements must be made to keep the water from freezing so that it can be left in the poultry house over night. Also provide plenty of green feed for fowls so handled.

KIND OF LIGHTS TO USE

The electric lights are the most practical source of artificial light for this purpose on account of their adaptability for use automatically as they can be set so that an ordinary alarm clock will throw the switch on for the lights at any time desired without the attention of an operator. In a pen 20 feet by 20 feet the use of two 40-watt lights will give the desired amount of light.

Another system tried in experimental work which seems to be worthy of trial is to give the fowls an extra feed from 8 to 9 o'clock in the evening, allowing them to go to roost at the normal time and using the lights for only one hour each evening. In the use of artificial lights it is very essential that the lights be discontinued gradually, reducing the time about ten minutes daily until normal daylight is reached, because if a sudden change is made it will almost invariably force the hens into an unnatural moult. Fowls on which the lights are used are usually kept confined in the house throughout the winter period. It only pays as a rule to use this system with pullets, and pullets or hens which are going to be used as breeders should not be forced for egg production for a long period previous to the hatching season.

Artificial lights are used with fairly good success on hens kept as breeders beginning to use the lights about January 1 or a few weeks before eggs are desired for hatching. The cost of this lighting under average conditions is quite small and the fowls have paid a very good profit on many different poultry farms where the operator has been reasonably successful in keeping the fowls in good condition. The greatest trouble has been caused by the fowls going into a partial moult which in most cases is due to the lack of experience on the part of the operator whereby he neglects his lighting system at some time or does not feed the fowls properly and makes too sudden changes in his system of management.

FORCING THE MOLT AND FEEDING DURING THE SUMMER

It is doubtful whether it is best to make the birds molt earlier than the normal time by changes in the feed and the best practice known at the present time is to give the birds normal rations during the summer months. The condition of the birds during the molting period can be materially improved and the length of the molting period shortened by giving the hens plenty of green feed and by feeding milk during the summer and early fall. The addition of 5 per cent of linseed meal to the mash is also very helpful.

Buttermilk or skim milk make excellent products for this purpose and semi-solid buttermilk is also very good if the fresh products cannot be secured at a reasonable feeding price. In addition to supplying the ground feed

and the milk, it is very essential to get the fowls to eat as much mash as possible during the molting period. This can be done where the dry mash system of feeding is carried on by reducing the scatch grains materially, making the fowls consume at least as much mash as scratch grains and preferably from one-fourth to one-half as much more mash than scratch grains. This extra consumption of mash during the summer not only helps to keep up the summer production previous to molting, but makes the hens lay later in the summer and fall and also shortens the molting period, when the hens are normally non-productive. If green feed can be secured in connection with a large or open range, it is also very desirable as it gives the fowls exercise in addition to supplying green feed.

The molt can be forced early in the season by giving the hens very light feeds or a semi-starvation ration. This will stop the hens laying in June and July if desired and throw them into a complete molt. As soon as the hens have started to molt freely they are given full feeds of a regular ration and the fowls made to consume as much mash as possible. This can usually best be done by feeding a moist mash in addition to the dry mash, if the dry mash system of feeding is in use.

CULLING AND SELECTION OF STOCK

In order to get the most profitable returns from the feed consumed and to make the feeding results worth while, it is necessary to cull out the poor producers. The

best time to cull the laying flock is in August, September, and October. In addition to culling the entire flock at that time, sick hens, or those in poor condition should be culled out whenever they are found in any season of the year. The characteristics to observe in culling are molting, color of the shank, the appearance of the comb, color of the beak, the condition and spread of the pelvic bones, and the size and flexibility of the abdomen. The good producers lay late into the summer and fall and do not molt until October and November. The poor producers molt earlier in the season—in July and August—and will have a complete new coat of feathers in August or September, while the plumage of the best producers will be ragged and rough in appearance at that time.

The shanks or legs of hens that are naturally yellow in color will be pale and faded in August and September if they have been good producers. The poor producers will have bright yellow legs at that time. These same color indications apply to the beak. The comb of a hen when she is laying is plump, and is bright red in color, while a non-laying hen has a shrunken comb which is pale or dull in color and is usually rather hard. The abdomen of a good producer is flexible and large, and hens of the smaller breeds such as Leghorns should have a distance of at least the width of four fingers between the keel and pelvic bones. The larger birds should have a spread of at least the width of a hand between these bones. The pelvic bones in a laying hen are thin, flexible, and spread wide apart. When she is not laying, they are

closer together, they feel thick, and are less flexible. When a hen is laying, the distance between the pelvic bones should usually be one and one-half inches or more, while if she is not laying it will be less than one and one-half inches.

METHODS OF FEEDING HENS AND PULLETS

The common practice with most poultrymen is to use the same methods of feeding for different breeds and birds of the same breed which are of different ages. It is more profitable, however, to give the pullets a more highly stimulating ration than the older birds and Leghorns can be fed a ration containing a larger per cent of meat scraps than can be used for the heavier birds.

A mash containing 25 per cent of meat scrap can be fed to advantage to Leghorn pullets while the meat scrap can be reduced to from 18 to 20 per cent during the second and third years. This is especially true of Plymouth Rocks and if they have a tendency to become overfat, it is advisable to feed not more than 20 per cent meat scrap to pullets, which can be reduced to 15 per cent in their second and third years. It is very essential to make the older hens work for their feed, especially hens of the larger breeds, in order to keep them from becoming too fat to lay well.

MANAGEMENT OF BREEDING STOCK AND MALE BIRDS

While hens for egg production are often kept confined throughout most of the year, breeding stock should be

given as much range and exercise as possible. The securing of eggs which are fertile and which will produce strong livable chicks is more essential in the handling of breeding stock than is the actual number of eggs received during the breeding season. Breeding stock to give the best results needs to be in good condition but not fat and preferably slightly thin rather than overfat. This condition is secured by feeding the birds moderately but not over-feeding; by making the birds eat plenty of mash, which is done by feeding only a very limited amount of scratch grains; by making the birds exercise and by furnishing plenty of green feed, preferably on a free or large range.

Stock for breeding should not be forced for egg production during the breeding season, but can be fed heavily without injurious results until about two months prior to the time that the eggs are to be saved for hatching. Forcing egg production by the use of stimulating drugs should never be done with breeding stock under any conditions and it is very doubtful if it pays to use such feeds for any kind of poultry. Any forcing method which tends to especially stimulate egg production, such as the use of electric lights, should be discontinued at least two months previous to the breeding season. If the stock is given good breeding conditions two months before eggs are to be saved for hatching, good results will be secured. The male birds should be well taken care of throughout the year and always given as much range as possible.

MANAGEMENT OF BROODY HENS

Broodiness in laying hens wastes a lot of valuable laying days throughout the year, especially in the spring and early summer. Hens which are not desired to use for hatching and rearing chicks should be removed from the laying nests just as soon as they start to become broody and their desire to sit broken up by confining them to a broody coop. Indications of broodiness in hens are: staying on the nests all day or for long periods, the ruffling up of the feathers and a screeching or clucking noise and an attempt by the hens to keep from being touched when they are approached.

The hens are broken of their desire to sit by being confined to well-ventilated coops which have slat bottoms or to small pens in which there is no place for the hens to make a nest. Placing a vigorous young male bird in the coop or pen and feeding the hens on mash without any scratch feed, aids materially in breaking up broodiness promptly. These hens should always have plenty of water. Starving the hens for several days, although it does to some extent help to break up broodiness more quickly, is not advisable because it puts the hens in poor condition to start in laying again, while the free use of mash gets the hens into laying condition quickly. Removing the hens from the nests just as soon as they start to go broody is the most effective way to shorten the broody period. Hens do not lay any eggs while broody.

The time required to break up broodiness varies with different hens and with the seasons of the year. It

usually can be done in from four to seven days if the hens are managed properly, although some hens will remain broody for a much longer period. The broody period is usually longer in the spring and early summer than either in the late winter or fall. Certain breeds, especially the Buff Cochins and the Buff Orpingtons are much more inclined to broodiness than most breeds, while the light-weight breeds like the Leghorns are practically non-broody. Some strains are more inclined to broodiness than others. As soon as the broody hens are through their broodiness, which is indicated by a lack of those signs indicating broodiness, they should be returned promptly to the laying pen.

CHAPTER XIII

FEEDING DUCKS, GEESE, TURKEYS, PIGEONS AND CAPONS

The Feeding of Ducks. The kind of ducks kept affects materially the feeding. Pekin ducks are kept primarily for the production of green ducklings and their eggs are used very largely for hatching on duck farms. They should therefore be fed egg-laying rations only during the breeding season or at the time that eggs are desired for hatching. The rest of the year they are carried on maintenance rations. Indian Runner ducks or ducks kept for commercial egg production are fed the egg-laying rations throughout the year.

Ducks need more green feed and vegetable feeds and are usually given a larger proportion of mash than is fed to hens. Pekin ducks are fed for egg production from about December 1 until June or early July. From July 1 to December 1 they are carried on a maintenance ration in which the amount of mash given to the ducks is materially reduced.

FEEDING DUCKLINGS

Ducklings do not need feed until they are from 24 to 36 hours old, after which they may be fed five times daily on a mixture of equal parts, by measure, of rolled oats and bread crumbs, with 3 per cent of sharp sand mixed in the feed. About the third day this feed is

changed to equal parts of bread, rolled oats, bran, and corn meal; then after the seventh day to three parts of bran, one part each of low-grade wheat flour and of corn meal, 10 per cent of green feed, and 5 per cent of meat scrap, with about 3 per cent of sand or grit in all of the rations.

Feed four times daily after the seventh day until the ducklings are 2 or 3 weeks old, when they need to be fed only three times daily. After the ducklings are a week old the grit or sand may be fed either in the mash or in a hopper, but the common practice is to feed grit in all duck rations. Meat scrap is not usually fed until the ducks are a week old, when about 5 per cent is added to the ration, which amount is gradually increased to 15 per cent by the end of the third week. Gradually increase the proportion of corn meal and decrease the bran for those ducklings which are to be marketed, until the ration becomes the fattening ration given below. Those to be saved for breeding should be given the duckling ration with the increased meat scrap (15 per cent), but not fed the fattening ration. The latter should also be given a good range where grass and running water are available; if confined to bare yards, considerable green feed and vegetables should be fed.

The ducklings to be marketed should be fattened for two weeks before killing on a ration made of three parts, by weight, of corn meal, two parts of low-grade flour or middlings, one part of bran, one-half part of meat scrap, with 3 per cent grit and 10 per cent green feed.

Feed this mash three times daily, or use a mash of three parts corn meal, one part low-grade wheat flour, one part bran, 5 per cent meat scrap, and 3 per cent oyster shell, with the green feed and grit added. The green feed is sometimes left out of the ration during the last seven days of fattening, but it is easier to keep the ducklings in good feeding condition on a mash containing green feed. Boiled fish may replace the meat scrap, but should only be fed up to within 2 weeks before they are killed, as it may give a fishy taste to their flesh. A considerable quantity of boiled fish is also fed in the mash to laying ducks in sections where the duck farms border on the water and where fish are available at a very small cost. This fish aids materially in reducing the cost of feeding.

Green ducks are marketed at from 8 to 12 weeks of age, according to their condition and weight. Two or 3 per cent of oyster shell is recommended in most fattening rations, but bone ash, ground or cracked bone, or bone meal would appear to be better mineral feeds to add to these mixtures. If milk is available at profitable feeding prices, the rations recommended for crate-fattened chickens would give good results in fattening ducklings, producing a well-bleached, milk-fed green duck. Celery seed may be used in fattening ducklings, as it is said to flavor the flesh, but its use is not general.

FEEDING BREEDING AND LAYING DUCKS

Breeding ducks, if not kept for the production of market eggs, should have a grass range if possible after the

hatching season is over and be fed sparingly on a mash of one part, by weight, corn meal, two parts bran, one part low-grade wheat flour, one part green feed, 8 per cent beef scrap, and 3 per cent grit, given once or twice daily, with one feed of mixed grains; or the mash may be made of three parts, by measure, corn meal, four parts bran, two parts low-grade wheat flour, three-fourths of a part of meat scrap, and two parts of green feed, with a small amount of grit and shell or mineral matter.

Feed Pekin ducks for eggs beginning about the first of December on a mash of 1 pound of corn meal, 1 pound of low-grade wheat flour or middlings, 1 pound of bran, 15 per cent of beef scrap, 15 per cent of vegetables or green feed, and some grit, feeding this mash twice daily, in the morning and at night, and also giving 1 quart of mixed corn and wheat to every 30 ducks at noon when they are laying heavily. This laying ration should be fed throughout the year to Indian Runners or to any breed of ducks kept principally for the production of market eggs. If the Indian Runner ducks are not laying they should be fed sparingly. All rations are by weight unless otherwise stated. Thirty laying ducks (Pekins) will eat about 10 quarts of moistened mash and green feed at each meal.

Green cut alfalfa, clover, rye, oats, and corn are used as soiling crops or green feed for ducks and ducklings, and are mixed in the mash. Ducklings and ducks are usually fed mash on flat feed boards rather than in troughs. The drinking water should be near the feed, so

that the ducks can eat and drink at about the same time. Water fountains for ducks should be deep enough to allow the latter to get their bills into the water to wash sand or grit out of their nostrils.

Wet or moist mashes are used almost exclusively, but as they are more forcing than whole grains it would be advisable, in case many of the eggs are infertile, to feed more whole or cracked grains and less mash to ducks during the breeding season.

FEEDING GEESE

Geese are raised generally where they have a good grass range or pasture, and, except during the winter months, usually pick up most of their living. The pasture may be supplemented with light feeds of home-grown grains or wet mash daily, the necessity and quantity of this feed depending on the condition of the pasture. During the winter, when pasture is no longer available, they should have both grain and roughage, but great care should be taken not to overfeed the breeders so that they will become too fat, with the consequent result of poor fertility and unsatisfactory hatches.

Oats make a desirable grain feed for breeding geese, but a limited proportion of corn, wheat, or barley may be added for variety. The greater part of the feed, however, should be made up of roughage, such as vegetables, clover, or alfalfa hay, chopped-corn stover, or silage. Silage is an ideal feed if it does not contain too much corn and is perfectly free from mold.

It is desired to have the geese lay early, so that the first goslings will hatch by the time there is green grass for pasture; and as the breeding season approaches it is necessary to increase the quantity of feed slightly and add to it a mash, which is usually given in the morning, and may be made of 3 parts bran or shorts, 1 part corn meal, and one-fourth part meat scrap; or buttermilk may be used in place of meat scrap. This mash should be fed with the vegetables or roughage.

Grit and oyster shell should be kept before the geese when they are laying and may be provided all the time to advantage. A constant supply of drinking water should be available at all times, and it is best supplied in drinking fountains or vessels so constructed that the stock can not get their feet into the water.

FEEDING OF GOSLINGS

Goslings do not need feed until they are 36 hours old or more, when they should be fed stale bread soaked in milk or water, to which finely chopped boiled eggs may be added. This should be fed three or four times daily for the first 2 or 3 weeks, with chopped grass or some other green feed added, this latter to be increased in quantity from the first. Plenty of fresh, clean water should be supplied, and 5 per cent of fine grit or sharp sand may be added to the feed or this grit kept in a hopper before the goslings.

After 2 or 3 weeks, if the goslings have a good grass range, they will need only one light feed daily of a mash

made up of 2 parts shorts and 1 part of corn meal or ground oats or ground barley. After they are 6 weeks old, if they still need extra feed, change the mash to equal parts shorts, corn meal, and ground oats, with 5 per cent meat scrap. Where the pasture is good, many goslings are raised from the time they are 2 or 3 weeks old to fattening time without any grain feed, but the addition of a small amount of the mash given above is an advantage at all times. Whole grains are not usually fed until the goslings are well feathered.

PREPARING FOR MARKET

In a few sections, young geese, when fully feathered or when the long flight wing feathers reach the tail, are fattened in large numbers by buyers who make a specialty of this business. Different methods are used successfully in the special fattening of geese on a large scale. A goose-fattening farm in Illinois buys large numbers of geese and fattens them for one month in an orchard or cornfield of flocks of 1,000 or more. No shelter is provided other than that of trees or standing cornstalks, except in unusually severe weather, when the geese are driven into sheds.

Corn on the cob and plenty of water are kept before the geese all the time and they eat the leaves off the cornstalks for roughage. These geese are then shipped alive in a poultry car to the New York market. Some farmers fatten their own geese. The geese may be "pen fattened" in flocks of from 20 to 25 and fed three times daily, giv-

Fig. 15. Large Flock of Geese on a Fattening Farm.

Fig. 16. Feeding Young Ducks Moist Mash.

ing one feed of a moist but not sloppy mash, made of one-third shorts and two-thirds corn meal and two feeds of corn with some oats or barley.

The pens should be kept partly darkened and the geese disturbed as little as possible. It is important to use plenty of bedding of oat straw, both to keep the pens clean and to provide roughage, as the geese will eat a considerable quantity of the straw. Some roughage or vegetables should be provided. An increase in weight of from 4 to 6 pounds can be obtained by this method of feeding.

NOODLING GEESE

Another method which produces a much better fattened goose but involves considerably more work is to stuff large geese with noodles for 3 or 4 weeks. From 8 to 10 geese are confined to a pen about 8 by 12 feet, which is kept heavily bedded with fresh oat straw. The feeder sits on a box in one corner of the pen, holds the goose between his legs and stuffs it with noodles, usually beginning by feeding from 3 to 5 noodles three times daily and gradually increasing to 6 or 7 noodles five times daily at 4-hour intervals.

The noodles are made of scalded corn meal, ground oats, ground barley, and ground wheat or wheat flour, using about equal parts of each. Add salt as for bread, thoroughly mix the feed, and put it through a sausage stuffer, cutting the product into pieces 2½ or 3 inches long. Boil them from 10 to 15 minutes, or until they float, in a wash boiler containing a wire rack which

stands 1½ inches above the bottom of the boiler. Dip the noodles in cold water and roll in flour to keep them from sticking together. Pour hot water over the noodles just before they are fed to make them slippery and keep them warm.

The number of noodles fed depends on the size and condition of the bird and the judgment of the feeder. The noodles are put into the mouth, one at a time, and worked down with the hand on the outside of the neck. If any feed can be felt, no noodles are given at the next feeding time; otherwise the bird will go off its feed. Keep plenty of drinking water before the geese. The young ganders are used for this special fattening, and any older ganders or geese to be disposed of. A partition extending half-way across the pen is used to keep the geese separate as they are fed. The pen is kept dark and the geese disturbed as little as possible.

One man can feed from 50 to 100 geese by this method, but it involves lots of work and long hours, the first feed being given at 5 in the morning and the last at about 11 in the evening. A high price must be obtained for geese thus fed to make this kind of fattening profitable. Noodlings will give a gain of from 6 to 10 pounds, while a price of from 10 to 15 cents a pound above that paid for geese not specially fattened is often received.

FEEDING TURKEYS

Turkeys for breeders should be fed sparingly and need to be kept on free range where they will pick up most

of their feed. If turkeys are fed freely and kept closely confined they do not as a rule make good breeders. Where free range is available on which there is considerable natural feed, one feed of grain daily, either oats or wheat, and only a little corn is all that the birds require. This feed should be given in the evening in order to bring the birds back around the farm house every night. If not fed any grain the turkeys are apt to wander a long ways away from the house and may wander off and not return at all. The turkeys will pick up grass, nuts, seeds and other things of this kind from the range during the spring and summer.

In the North the turkeys should be fed more feed during the winter months and are usually fed twice a day on grain using a mixture of oats, wheat and corn with not over one-third corn and in addition are given plenty of green feed or roughage such as sprouted oats, cabbages, mangel beets or some vegetables. A small amount of animal feed can be added to the turkey's ration in the winter months when they are not able to get any insects from the range. This may be added by feeding milk in some form or scraps of fresh meat if any are available. A limited amount of commercial meat scrap can be used if none of the other animal feeds are available. A constant supply of grit, oyster shells and charcoal should be kept where the turkeys can get at it all of the time. The essential thing is to keep the turkeys in good breeding condition but not to let them get fat.

FEEDING TURKEY POULTS

Feeding the poults properly is very important as turkey poults are more difficult to raise than chickens and there is no question but what the feeding of poults has much to do with their success. If poults are fed freely and especially where they are kept confined they will not do well. Over-feeding with lack of exercise will bring on digestive troubles and result in heavy mortality in the flock of poults. They should be fed lightly and made to range for a considerable part of their feed. Where a good range is available they can secure all of the feed necessary except for one good feed of grain at night. It is advisable to give one good feed every evening in order that the poults will come back to the house and learn to roost there at night.

Turkey poults do not need any feed until after 48 hours, the yolk of the egg being sufficient sustenance for them during that period. They should be given water and supplied with fine grit or coarse sand and green feed. After 48 hours they should be given feed, the amount depending on the quality of feed on the range. It is essential that they be kept hungry to make them exercise and range a considerable distance from their house. Turkey poults should not be fed over two or three times a day if they have a reasonable range but would need to be fed very lightly four or five times daily if they are kept confined to a small place.

Many different kinds of feeds are used for turkey poults with good results, the amount and kind of feeds

given having more influence than the actual feeds used. One of the most common methods is to use hard-boiled eggs chopped up fine, mixed with bread crumbs and rolled oats for the first week, after which wheat and hulled oats are fed. The turkey poults need some special feed for the first few days regardless of the range. Milk in some form is an excellent feed for turkeys and assists materially in keeping the turkey poults well. Stale bread soaked in milk and fed after the milk has been squeezed out makes a good feed for the first few days followed by the wheat and hulled oats or by chick feed. Skim milk or buttermilk kept before the turkey poults all of the time is an excellent feed. Some turkey breeders do not give any soft feed but start the poults right off on finely cracked grains allowing them to get all of the other feed from the range. Johnnycake or corn bread is also used with good results for the first few days. Green feed should ordinarily be secured from the range but if for any reason the poults are confined, green feed should be provided. Chopped onion tops, alfalfa, dandelion leaves and lettuce leaves make excellent green feed. They may be fed to advantage during the first 3 or 4 days of their lives to all of the turkey poults whether yarded or on range. Grit in the form of coarse sand or finely sifted grit should be provided and a little coarse sand can be sprinkled on the soft feeds which are fed to the baby poults.

The mother hen if brooding poults should be fed a mixture of grain such as equal parts of corn, wheat and oats

and should be provided with green feed, grit and plenty of fresh water. A small amount of meat scrap or fresh meat is greatly relished by hens which are raising a brood of poults. The feed for the poults is usually given outside of the coop so that the poults get it and it is not eaten by the hen. The hen and the poults should not be confined for more than 3 or 4 days unless the weather conditions are unfavorable. If the poults are kept confined in coops at night it may be worth while to confine small turkey poults for a short time in the morning until the grass gets dry.

FATTENING TURKEYS

Turkeys will not stand close confinement for fattening and usually lose rather than gain weight under such conditions. They may, however, be fed fattening feeds during the fall in order to get them in good market condition, still allowing them free range. About October 1, two moderate feeds a day may be given which can be increased three times daily during the week previous to marketing. They should only be given what feed they will clean up in a few minutes. Corn, wheat and oats are the feeds commonly used but corn alone should not be used as the turkeys are not apt to do well if only given corn. A mixture of equal parts corn, wheat and oats makes a good feed to begin the fattening about the first of October, gradually increasing the amount of corn so that the turkeys are getting from two-thirds to three-fourths corn at the time they are ready for market.

During the fall months and at the time when turkeys are getting in shape for market they will pick up many nuts and in some sections they pick up sufficient nuts such as beechnuts, chestnuts, acorns and pecans to get them in good market condition without additional feeding. As a rule, however, it pays to give additional feed previous to marketing.

FEEDING PIGEONS

The feeding of pigeons for squab raising is different from the feeding of pigeons for flying purposes as more expensive feeds are used for the flying birds. The pigeons feed their own young so that it is necessary to feed the breeding birds freely during the time that they have squabs. The squabs are reared and fed by both of the parent birds on a thick creamy mixture called pigeon milk which is produced in the crop of the pigeons. Care should be taken not to frighten or disturb the pigeons right after feeding as at that time they usually feed the squabs. If the parent birds die the squabs may be removed to another nest where there is only one squab or they may be fed artificially. The latter process, however, takes considerable time.

FEEDING SQUAB BREEDERS

Many varieties of grains are used in feeding pigeons. A good mixture of staple grains may be made of equal parts by weight of small whole corn, hard red wheat, Kaffir corn, and Canada peas, with a small quantity (about

5 per cent each) of hemp and millet seeds added during the molting period. Other grains which may be substituted for or added to these are peanuts, dried garden peas, cowpeas, oats or hulled oats, buckwheat, Egyptian corn, and milo maize, while a small quantity of stale bread, rice, rape, millet, canary, vetch or sunflower seed may be fed for variety. Canada peas are expensive, but seem to be essential to the best results, especially during the breeding season. They apparently take the place of green feed to some extent. Peanuts, cowpeas, and dried garden peas give quite good results and sometimes are used in place of Canada peas when the latter are high in price. Soy beans do not seem to be so well liked by pigeons. Tender green feed, such as freshly cut clover, alfalfa, and grass, lettuce, plantain leaves, and chickweed may be fed, but are not essential.

A variety of good, hard, thoroughly dried grains is essential to success. Grains which are in poor condition should not be fed. Old grains which are hard are much better than new soft grains, especially for pigeons with squabs. New soft grains, especially wheat and corn, should never be fed to pigeons, as they will cause bad results in the flock, particularly among the squabs. Feed whole corn and avoid cracked corn unless it is freshly cracked. Pigeon corn which is smaller and harder than common corn is used extensively for pigeons. Many pigeon breeders reduce the proportion of corn during the summer, feeding from one-half to three-fourths less of this grain than in the winter. Red wheat is considered

better than white wheat by many pigeon breeders. Good wheat screenings are often fed with success, as they usually contain a variety of seeds. Various stimulating seeds, such as lentils and vetch, are sometimes fed as a tonic to breeding birds during the molting period.

The following table gives an analysis of the grains most commonly used in feeding pigeons. The protein content is very high in the three kinds of peas and in peanuts. One feed very high in protein seems to be essential to get the best results. The ration of equal parts by weight of whole corn, red wheat, Kafir corn, and Canada peas contains 14.2 per cent protein, 65.6 per cent nitrogen-free extract, 69.2 per cent carbohydrates (total of nitrogen-free extract plus the fiber), and 2.8 per cent fat, is a good one.

TABLE V

Composition of Pigeon Feedstuffs

Feedstuffs	*Water*	*Ash*	*Protein*	*Carbohydrates*		*Fat*
				Fiber	*Nitrogen free Extract*	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Corn	10.9	1.5	10.5	2.1	69.6	5.4
Wheat	10.5	1.8	11.9	1.8	71.9	2.1
Kaffir corn	12.8	2.1	9.1	2.6	69.8	3.6
Oats	11.0	3.0	11.8	9.5	59.7	5.0
Canada peas	15.0	2.4	23.7	7.9	50.2	.8
Peas	13.4	2.4	22.4	6.4	52.6	3.0
Cowpeas	11.9	3.4	23.5	3.8	55.7	1.7
Peanuts	7.5	2.4	27.9	7.0	15.6	39.6
Buckwheat	12.6	2.0	10.0	8.7	64.5	2.2
Egyptian corn	12.6	1.9	9.9	1.9	69.7	3.9
Millet	12.1	2.8	10.9	8.1	62.6	3.5
Hempseed	8.0	2.0	10.0	14.0	45.0	21.0
Sunflower seed	8.6	2.6	15.3	29.9	21.4	21.2

Note: Also see Table II in Appendix for Composition.

The grain may be fed on the floor of the pen, in troughs, or kept before the birds in hoppers. It is not generally considered advisable to feed the grain on the ground, especially on heavy soil where it may get wet and moldy. Unless the floor is kept clean it is better to feed the grain in troughs than on the floor. The troughs should be made so that the pigeons will not roost on them and soil the feed with their droppings. Hoppers in which considerable feed is kept are sometimes used with success but may attract rats in some pigeon houses. Troughs and open hoppers should be fitted with wires or slats about two inches apart so that the pigeons cannot waste the feed by throwing it out on the floor. If the grain is not kept in hoppers the pigeons should be fed twice daily, in the morning and in the afternoon, at regular hours, giving about 1½ to 2 quarts of grain at each meal to 20 pairs of pigeons and adding an extra pint if the pigeons have many squabs. The feeder must regulate the quantity of grain according to the appetite of the birds, giving them all they will eat and keeping a little grain in the feeder.

Clear drinking water, grit, sifted oyster shell, and charcoal should be kept before the pigeons at all times. Salt is fed to pigeons in various forms, and a supply is generally considered essential. Pigeons not accustomed to eating fine salt may eat too much if given a large quantity at one time, although it is used with success by many careful feeders. Salt may be fed in lump form, such as rock salt or as fine salt moistened and baked into a hard lump, without danger of the pigeons' eating too much. Mix-

tures of commercial grits containing varying proportions of grit, charcoal, oyster shells, and salt are used by many pigeon raisers. A mixture of this kind may be made of 40 pounds of granite grit, 40 pounds of oyster shells, 10 pounds of charcoal, 5 pounds of salt, and 3 pounds of Venetian red. Such mixtures are relished by the pigeons and seem to have some value in keeping them in good breeding and feeding condition.

Pans of water for bathing should be provided daily except during the winter and placed in the yards or flyways. These bath pans are usually filled in the morning and emptied about noon. They should be used only about twice a week during the winter.

FEEDING FLYING PIGEONS

Pigeons for flying purposes, especially during the time when the birds are used in races or long flights, are fed largely on the hardest grains, principally Canada peas. It is not advisable to use much corn in their ration and only a small amount of wheat should be fed. Special attention must be paid to securing a good grade of hard red wheat as a soft wheat is not good for such pigeons.

A good mixture for flying pigeons can be made of two parts Canada peas, one part Kafir corn or milo and one part Argentine corn with 10 per cent of hemp seed and 5 per cent of vetch. During special races or when it is necessary to have the birds in the very pink of condition, the Argentine corn can be omitted and the pigeons fed entirely on Canada peas, Kafir corn, vetch and hemp seed.

Some pigeon keepers like a small amount of millet seed and many of the commercial pigeon feeds contain from 5 to 10 per cent of this seed. This seed, however, is not especially relished by pigeons and they will only eat the millet when they are quite hungry.

Pigeons for flying purposes are bred during the spring and early summer and the matings are usually broken up at the end of the spring. When the birds are not being used for flying or breeding, the amount of corn and wheat can be increased slightly in the ration and the amount of peas, hemp seed and vetch reduced in order to cheapen the cost. It is not advisable, however, to feed too large a proportion of corn during warm weather and not over 35 per cent should be fed during the summer months.

A very good mixture for flying birds to keep them in the pink of condition may be made of 3 parts of Argentine corn, 3 parts Canada peas, 1½ parts vetch seed, 1 part hemp seed, 1½ parts good rice and 1 part canary seed. This is a rather expensive mixture for constant use.

FEEDING CAPONS

As capons are usually kept until they are at least 9 or 10 months old, they need to be raised on a good grass range in order both to keep them in good condition and to cheapen the cost of feeding. A good growing ration should be used until about four weeks before they are to be marketed when the corn and corn meal in their feed can be gradually increased until the ration becomes a fat-

tening feed. For the growing mash use 1 part rolled oats, 1 part ground oats, 1 part meat scrap, 1 part bran, 1 part middlings and 2 parts corn meal.

A good scratch feed to use with this mash can be made of 2 parts cracked corn, 1 part wheat and 1 part oats. Gradually decrease the oats in the mash and increase the corn meal until the mash becomes a fattening mash of 1 part bran, 1 part middlings, ½ part meat scrap and 3 parts corn meal. Use with this fattening mash a scratch feed of 4 parts cracked corn, 1 part wheat and 1 part oats. The quality of capons can be materially improved by either pen or crate fattening them for the last two or three weeks, using the rations advised for fattening in chapter XI.

CHAPTER XIV.

PROFIT AND ECONOMY IN POULTRY FEEDING

The object in feeding laying hens is to produce eggs most economically and at the same time keep up the health and vitality of the fowls. This means the selection of the cheapest feeds which will give good egg production and does not necessarily mean the selection of the highest producing ration if it consists of too high-priced feeds. The method of feeding is also of material importance as affecting the economical cost of producing eggs and a method involving only moderate expenditure of labor may prove a more profitable way of handling laying hens than some other method which, although producing more eggs, produces the extra eggs at too great a cost.

Frequent feeding of poultry as is done at the egg-laying competitions does undoubtedly increase production but most poultrymen find that a simpler method of feeding, involving less labor and producing fewer eggs is more profitable for their conditions. Hens should be fed at least twice daily which system works fairly well where a dry mash is used. It may pay to feed hens three times a day giving the green feed at noon, where the dry mash system is followed.

If the moist mash system of feeding is used it may

also pay to feed three times, giving the moist mash at noon and grain in the morning and in the evening. Some poultrymen who use the moist mash give this in the morning and feed the scratch grains at night, which system works all right where the hens are on free range in colony houses but is not so well adapted to hens kept in long houses and confined to small or only fair-sized yards.

Eggs must be produced at all seasons of the year to make poultry farming most profitable but each poultryman must decide for himself whether or not it is most profitable for him to make special efforts to get fall and winter eggs by special methods, such as by the use of electric lights, or merely to rely on the more common practices of getting the chicks hatched early, using well-balanced rations and providing comfortable winter quarters. As far as the actual returns over immediate cost is concerned the poultryman usually makes a greater profit during the spring months when the hens are laying freely and when eggs are at their lowest price, than he secures in the fall and winter, when eggs are much higher in price.

FEED COST OF PRODUCING EGGS

The feed cost of producing eggs necessarily varies greatly according to the success used in the management of the fowls, the breed kept, and the price of the feeds used. Where high egg production is secured without using too expensive feeds or methods, the cost of egg

production is much lower than where only moderate production is secured. This is also materially affected by the breeding of the fowls.

The following table gives a fair estimate of the amount of feed required to produce a dozen eggs from both general-purpose fowls and from Leghorns. This table was worked out from tests made at the Government Poultry Farm, Beltsville, Md., and from reports of egg-laying contests in the states of Connecticut and New Jersey. It represents a large number of fowls so that it gives figures which are representative. The government tests cover pens during a period of seven years. The fowls at the government farm were fed by a simple method of feeding so that the egg production was only moderate and is no higher than any poultryman can get on a commercial plant which is well handled. Feed consumption from both pullets and yearlings are given. From the amounts of feed required to produce a dozen eggs it is easy to find the feed cost of producing eggs in any section, by getting the local price of feeds. The proportion of pullets to older hens must be considered in any estimate of this kind as the older fowls consume much more feed in producing a dozen eggs than pullets, especially in the heavier breeds. This is very apparent from this table while the difference is even more marked with hens in their third and fourth years. At the government farm the Leghorns ate 6 pounds of feed in producing a dozen eggs in their third year while the general-purpose breeds ate 13.4 pounds. The difference in feed per dozen eggs be-

tween the Leghorns and the general-purpose breeds gives one of the main reasons why the Leghorns are the breed kept exclusively on commercial egg farms in this country.

TABLE VI

Feed Consumed per Dozen Eggs at Government Poultry Farm and at Egg Laying Contests

Place	*Year*	*Fowls*	*Age*	*Average Number Eggs Produced*	*Pounds Feed per Dozen Eggs*
Storrs, Ct.....	1915	820	pullets	145	6.83
Storrs, Ct.....	1916	1,000	pullets	152	6.60
Storrs, Ct.....	1917	1,000	pullets	162	6.81
Vineland, N. J.	1916	1,000	pullets	162	5.89
Vineland, N. J.	1917	1,000	yearlings	129	7.55
Gov't Farm...	1913 to 1920	1,710	pullets	...	7.16

The results from these different sources are fairly consistent and the differences can largely be accounted for by the relative percentage of Leghorns and heavier breeds at the various places. The Leghorns eat less feed in producing a dozen eggs as well be seen in the following table. There were approximately 40 per cent Leghorns and 60 per cent general-purpose fowls at Connecticut while at New Jersey the figures were reversed with 60 per cent Leghorns and 40 per cent general-purpose fowls. On the government farm only 16 per cent were Leghorns. The results with the amount of feed used by different breeds was not consistent, varying greatly with the different tests. The difference between the light-weight

breeds (Leghorns) and the general-purpose breeds was quite consistent in all tests.

In the following table representative results of tests made at the government farm are given, the table being made up of pens fed on the best rations. The average egg production is given together with an average production for each month which can be obtained under ordinary conditions with simple methods of feeding. The Leghorn hens ate from 55 to 60 pounds of feed in a year in the government tests and the general-purpose breeds ate from 70 to 85 pounds. At the contests the feed consumption was considerably higher due largely to more frequent

TABLE VII

Monthly Record of Total Feed Consumed per Dozen Eggs and Egg Yield per Hen at the Government Farm

Month	General-purpose pullets		General-purpose yearlings		Leghorn pullets		Leghorn yearlings	
	Feed per dozen eggs	Eggs per hen	Feed per dozen eggs	Eggs per hen	Feed per dozen eggs	Eggs per hen	Feed per dozen eggs	Eggs per hen
	Lbs.	*No.*	*Lbs.*	*No.*	*Lbs.*	*No.*	*Lbs.*	*No.*
November ...	10.9	8.1	34.6	2.4	.....	.....	.....	.....
December ...	7.4	11.2	32.9	2.6	5.3	9.1	20.3	3.0
January	10.9	9.9	32.7	2.5	6.6	10.0	10.0	7.0
February	5.5	10.8	12.6	6.1	5.4	12.1	5.8	10.3
March	5.8	16.4	8.5	9.3	4.7	16.0	5.1	14.2
April	4.6	16.5	5.7	13.1	3.3	18.3	3.6	17.7
May	4.4	13.9	5.3	10.5	3.0	19.0	3.3	19.4
June	4.7	12.0	6.1	10.4	3.2	14.8	3.4	16.3
July	6.3	9.9	7.5	8.6	4.9	10.4	3.9	14.8
August	6.9	9.3	7.6	11.0	4.8	10.6	5.3	11.5
September ..	9.2	7.5	10.0	6.7	8.6	8.0	7.1	7.4
October	14.1	5.0	21.0	4.9	10.9	5.2	30.8	2.9
November ..	.....	.....	.....	.....	18.4	5.2	18.6	.4
Average or total...	6.7	130.5	9.6	88.1	4.8	138.7	5.5	124.9

feeding, and with the Leghorns also partly due to their being larger sized birds than on the government farm.

The general-purpose pullets ate in a year an average of 6.7 pounds of feed per 1 dozen eggs produced and the yearlings ate 9.6 pounds. The Leghorn pullets ate 4.8 pounds and the yearlings 5.5 pounds. The general-purpose pullets ate 1.9 pounds more feed in producing a dozen eggs than the Leghorn pullets, and the difference increases very rapidly with the age of the stock, the general-purpose yearlings consuming 4.1 pounds more feed per dozen eggs than the Leghorn yearlings; therefore the Leghorns produced eggs more cheaply than the general-purpose breeds.

The value of the general-purpose breeds for market or for hatching and breeding makes them usually the most desirable breeds for the general farmer and the backyard-poultry raiser, while the Leghorns are especially adapted for commercial egg farms.

FEED COST OF GROWING CHICKENS

The feed cost of growing chickens is a much more variable factor than the feed cost of producing eggs because growing chicks are more affected by various factors, especially by mortality and by weather conditions. The mortality in laying hens will average about 10 per cent in a year in pullets and yearlings of the general-purpose breeds and is usually from 2 to 5 per cent lower than this in the Leghorns. The mortality in growing chicks may

be as great as 50 per cent and will usually average from 10 to 25 per cent even under good conditions. This includes weak and unthrifty chicks culled and those which are lost or killed by rats, hawks and crows. These factors make it much more difficult to give reasonably accurate figures on the feed cost of growing chickens, especially figures which will be applicable to various conditions and to different people.

The amount of data available on chick feeding is also very much more limited than the data on feeding hens. The following table gives figures on the feed required to rear chickens as secured at the Indiana experiment station, at the Connecticut station and at the Canadian government farm, Ottawa, Canada;

TABLE VIII

Feed Required to Grow Chickens

Breed	Kind	Age weeks	Weight pounds	Feed pounds	Milk pounds	Place
White Plymouth Rocks	Broilers	9 to 10	2.0	4.8 to 5.6	6.5 to 8.5	Indiana
"	Roasters	24	6.5	24 to 27	22	"
"	Pullets	28	.....	27 to 30	22 to 37	"
"	Capons	41	9.5	64 to 67	62 to 79	"
White Leghorns	Broilers	8	1.0	3.5	.....	Conn.
"	"	14	2.0	9.8	.....	"
"	Pullets	17	2.5	13.6	.....	"
"	"	21	3.0	19.4	.....	"
Rhode Island Reds	Broilers	7	1.0	3.0	.....	"
"	"	11	2.0	7.2	.....	"
"	Pullets	16	3.0	13.6	.....	"
"	"	22	4.0	23.7	.....	"
Barred Plymouth Rocks	Broilers	10	.....	5.5	.....	Canada
"	Pullets	20	.....	19.7	.....	"

In Table VIII the Leghorn chickens at the Connecticut station were all pullets after the eighth week and the Reds were all pullets after the eleventh week. The White Plymouth Rock and the White Leghorn pullets would be practically mature at the age given but the Rhode Island Reds and the Barred Plymouth Rocks would not be mature at these ages unless there were a strain of birds which were small and which matured earlier than the average birds of these breeds. It takes Plymouth Rocks from 4 to 7 weeks longer to mature than Leghorns and Rhode Island Reds from 2 to 5 weeks longer than Leghorns.

Table IX gives detailed figures on the weights of growing chickens of several breeds secured on the government experiment farm, Beltsville, Maryland. These figures give average weights of these breeds where the growing chickens are kept under good conditions. Weights for both pullets and cockerels are given and these weights vary slightly from those given in the previous table. The cockerels in these tests weighed considerably more than the pullets after the first few weeks of age. Chickens which do not approximately come up to these weights are either being improperly managed or are from poor strains or of poor breeding.

LABOR COST OF PRODUCING EGGS

The cost of labor in producing eggs is a big item and one that has to be carefully considered in profitable poultry farming. In many cases it means the difference

TABLE IX

Normal Weights of Growing Chickens

	White Plymouth Rock		White Wyandotte		R. I. Red		Buff Orpington		White Leghorn	
Wgt.	cockerel	pullet	cockerel	pullet	cockerel	pullet	cockerel	pullet	cockerel	pullet
lbs.	age in	weeks	age in	weeks	age in	weeks	age in	weeks	age in	weeks
1	7	8	8	8	8	9	8	8	8	9
2	10	12	12	12	12	14	11	12	12	15
3	13	15	15	16	15	19	14	15	17	25
4	15	19	18	20	19	25	16	19	23	..
5	18	23	22	25	23	..	19	24	..	..
6	20	..	24	..	25	..	21	..	..	..
7	24	..	..	..	..	..	23	..	..	..

between profit and loss in the management of the farm. The poultry farmer must plan his farm to economize labor in every way that is not detrimental to the health and production of the fowls. The labor on general farms where poultry is a side issue is a factor of small importance but becomes a big factor on specialty poultry farms. Convenience in the arrangement of the poultry houses, the use of simple methods of feeding, and having labor saving devices and large feed hoppers assist greatly in keeping the labor charges to a low level. The poultry farm should be planned for future growth and development and the effect of arrangement on future labor costs should be carefully considered.

It is essential in the rearing of chickens and in the keeping of breeding stock that the fowls be given a reasonable amount of yard or range space as it is easily possible to congest the plant so that the vitality of the stock cannot be maintained. An arrangement which is too congested to keep up vigor and vitality is not practical, although it may involve the lowest expenditure of labor. Labor can be saved economically by the arrangement of the yards and buildings, by the placing of gates, by the use of large dry mash hoppers and in some cases by the use of feed and litter carriers. Litter and feed carriers are only practical where the houses are about 200 or more feet long. If there are several houses in one group, a central feed and shipping building may be maintained and the track arranged to use the trolley from the central house

to each poultry house. Be sure to select only simple equipment and devices which will wear well and which do not get out of order easily.

Reports of a survey made of Connecticut farms and published in 1917 showed that the poultry feed constituted 41 per cent of the operating cost of these farms. Some general farming was carried on, involving considerable labor and giving good returns. The report gave the average cost as follows: poultry feed, 41 per cent; interest on investment, 20 per cent; miscellaneous expenses, 12 per cent; miscellaneous labor, 9 per cent; miscellaneous feed, 7 per cent; poultry labor (hired), 5 per cent; rent, taxes, etc., 4 per cent, and 2 per cent for seed, spraying, and fertilizer. The owner's labor is not charged as the net returns make up his income. If his labor were included and charged at a fair price the labor item would represent an important item in the cost of the eggs. The receipts showed that 69 per cent came from poultry products and 31 per cent from other farm products.

In a survey of cost of operation of New Jersey farms reported in 1918 by the State College, the feed cost was 44 per cent of the total and the outside man labor was 19 per cent. These farms were almost entirely devoted to poultry and did not include nearly as much general farming as the Connecticut farms. The most successful poultry farms are those operated directly by the owner whose labor is the biggest labor charge but on which it is difficult to place any actual figures. Most large poultry

farms operated by salaried managers have not been successful as economical producers of market eggs.

GROWING CROPS ON POULTRY FARMS

The poultryman should at least raise crops enough to utilize his poultry manure to good advantage and he may find it advisable under some conditions to raise a considerable part of his feed. Raising crops gives an advantage in that it freshens the land and makes it much better for chickens to range upon. As a rule the bulk of the poultry feed can be raised more cheaply on grain farms than it can on poultry farms. The general farmer who keeps poultry should plan to raise a grain crop suitable for poultry and can in most cases raise to advantage all of the necessary feed except the bran, middlings and meat scraps.

Where the poultry farmer can raise only a limited amount of feed the green feed should usually be considered first and then the raising of one or two grain crops. For green feed, mangel beets are one of the best crops to raise, especially in the upper half of this country. Other good green feeds to consider are cabbages, alfalfa and clover. In sections where it does well, especially on the Pacific Coast, kale is one of the best green crops to produce and rape is raised somewhat for similar use. Alfalfa and clover are very excellent crops when produced easily and will furnish an abundance of succulent feed during the growing season. Alfalfa hay or meal is not so well liked by poultry as is the green succulent crop

but can be used if no other green crop can be raised to advantage. Corn is one of the best grains to raise but at least a small crop of grain which produces straw is well to consider producing in sections where oats or wheat can be raised. The furnishing of the straw is an item involving considerable expense on a poultry farm.

If sufficient land is available to raise all of the grain for the hens it will take about 26 acres planted to corn, wheat and oats to raise the amount of these kinds of feed consumed by a thousand Leghorn hens, and about 35 acres to raise these crops for 1,000 general purpose fowls. This does not allow for the feed used for growing chicks to replace these laying hens nor does it allow for all of the feed required to make up a hen's ration as the bran, middlings and meat scrap will have to be purchased. Where 25 to 35 acres of these grains are raised each year it would be necessary to have available land of at least twice this area to use in rotation of crops in the successful raising of these grains.

CARE OF THE YARDS AND RANGES

Where fowls are kept more or less intensively it is very essential to give careful attention to the yards in order to keep the land fresh and incidentally to furnish some growing green feed. The care of the yards will depend considerably on the plan and lay-out of the poultry farm, and if double yards are available for each flock, one yard can be kept in a growing crop while the other yard is be-

ing used for the fowls, alternating these yards several times during the growing season.

Where weather conditions are favorable it is possible to alternate the yards as often as every 4 to 6 weeks and to get a green crop of sufficient height in that time to allow the poultry range and green feed. Where only one yard is available it is advisable to sow this to grain at least twice during the growing season, confining the hens to a small part of the yard near the house for about 6 weeks until the grain is 2 or 3 inches high before the hens are allowed to range on it. If the yard is ploughed once each year it can be harrowed for the succeeding crops unless the land is very heavy. Quick growing grain crops are best to use for this purpose, oats being the most common crop in which about 5 per cent of rape seed can be added especially during the summer months.

Seed oats or other grains at the rate of 2 to 2½ bushels per acre and from 5 to 7 pounds of rape seed may be added to advantage in the summer. A mixture of oats and wheat makes a very good combination and in the fall rye should be sown either straight or mixed with oats as rye will stand freezing weather in many sections of this country and much of the grain will live throughout the winter if the fowls do not eat it too closely. Any quick-growing grain crop adapted to one's section should be the one to grow in the yards.

OAT SPROUTERS

Sprouted oats make an excellent feed where no other form of green feed is available for use or to supplement

other green feed. Oats can be easily sprouted in a home-made oat sprouter or commercial sprouters for this purpose may be bought. Where an oat sprouter is used only during mild weather a series of open trays will answer the purpose very satisfactorily.

Arrange a series of trays like the drawers in a cabinet, using seven trays which makes a convenient number, as it gives one tray of oats for each day of the week. This means filling one tray of oats to soak for sprouting each day. A convenient size for the trays is 18 inches square which would give enough sprouted oats daily if seven trays are used, for about 250 or 300 hens, feeding one square inch of sprouted oats' surface per hen daily. Use one-eighth inch mesh wire for the bottom of the trays if the sides of the trays are made of wood and make the sides two inches high.

A more substantial tray can be made of galvanized iron with holes one inch apart each way and one-eighth of an inch in diameter covering the entire bottom of the tray. A solid galvanized iron pan of this same size should be placed in the bottom of the sprouter to catch all the surplus water which drips through the trays of oats. Have the supports on which the tray slides 5 inches apart which will allow 3 inches of open space between each tray. In an open sprouter of this kind which does not have to be boxed in, all that is necessary is the seven trays and a skeleton cabinet made of strips 2 in. by 2 in. for the corners, and cleats on both sides about one-half inch thick and one and a half inch wide on which to slide the

FIG. 17. OPEN OATS SPROUTER WITH OATS AT DIFFERENT STAGES OF GROWTH.

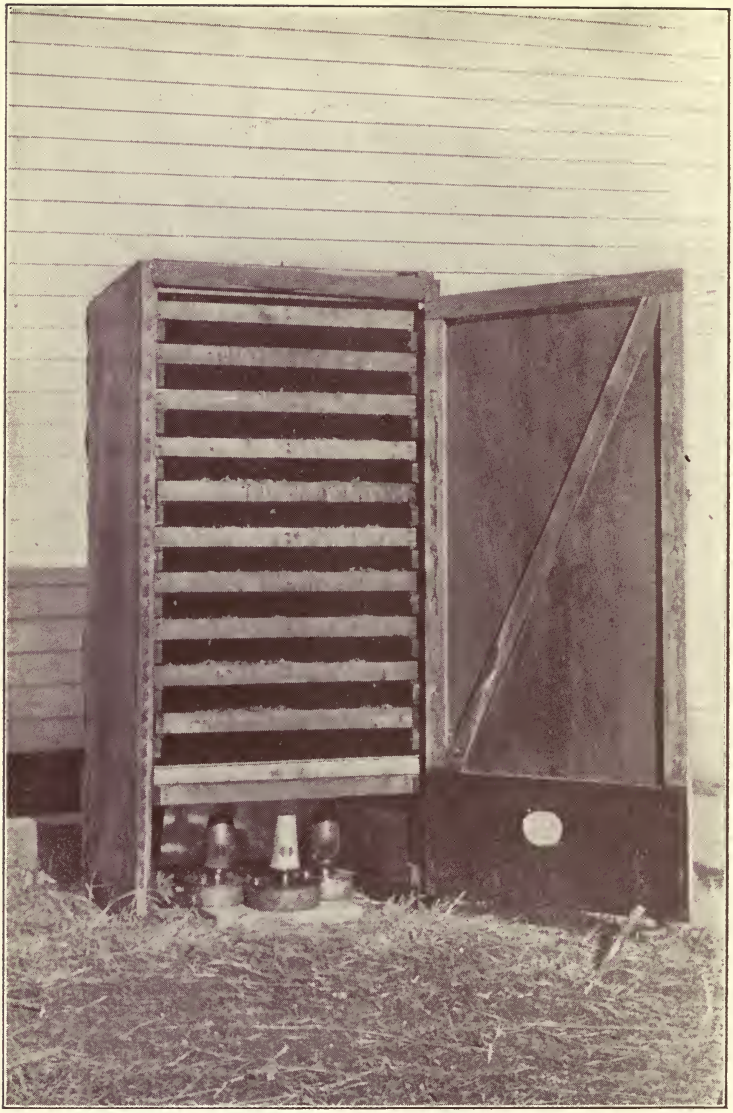


FIG. 18. ENCLOSED OATS SPROUTER WITH LAMPS USED FOR HEAT. SIMILAR TO SPROUTER IN FIGURE 6 BUT MORE TRAYS HAVE BEEN ADDED AND THE ENTIRE STRUCTURE ENCLOSED.

trays. These cleats would make two solid sides, and three pieces of 2 in. by 2 in. uprights on both the front and back would make the cabinet sufficiently strong.

If the open sprouter described above is used in a kitchen or a cellar near the heater, sufficient heat will be available to sprout oats even in the winter time. If it is desired to use this sprouter during cool weather in an unheated room or cellar it will be necessary to box in the entire frame work, preferably making a double wall and to furnish a kerosene lamp or some other source of heat. Heavy roofing paper makes an excellent covering and wall for a sprouter which has sufficient framing material to support the roofing paper. The lamp should go underneath the sprouter and it is advisable to make a tin compartment in which the lamp is placed to prevent any danger from fire. A heavy galvanized iron pan should be placed in the bottom over the lamp in which water should always be kept. The steam from the pan helps to supply moisture to the oats. The heat from the lamp thus would strike directly on this pan and go up through the open double wall which should be open at the bottom to receive the heat. This air space can be made from a half to an inch in thickness. Two holes about an inch and a half in diameter should be bored on the sides of the sprouter near the top to let out the surplus heat and allow ventilation. The top of the sprouter should be hinged so that it can be raised to let out extra heat or furnish additional ventilation in very warm, damp weather. A door hinged on the side covering the entire front of the sprouter

is necessary and if this can be made of glass it will assist one in seeing the condition of the oats without opening the door, although this is not essential. It also gives green color to the oat sprouts. The compartment underneath in which the lamp is inclosed should have a separate tin or galvanized iron door with an open space about an inch and a half high, below the door for air and also a hole about three inches in diameter opposite the flame of the lamp so that the light can be readily seen without opening the door. A large lamp with a wick of from one to one and a half inches in width is preferable for a fair sized sprouter in order to supply plenty of heat during the coldest weather. A tin chimney about five inches high with a small piece of isinglass opposite the flame should be used on the lamp, placed in a hinged screw burner which will hold this tin chimney tightly. Let the sprouter legs extend three or four inches below the lamp box so that the entire sprouter will stand well up off the floor and thereby keep dry. Place a one-half inch strip in the center of the inside of the back of the cabinet to prevent the trays from fitting tight against the back and thereby provide additional ventilation in the sprouter.

LABOR-SAVING DEVICES

Large feed hoppers will save considerable labor on a poultry farm if the dry mash system of feeding is used. An indoor hopper for the mash is commonly used and may be of several different styles. One of the simplest plans is an open box hopper such as is shown in Figure

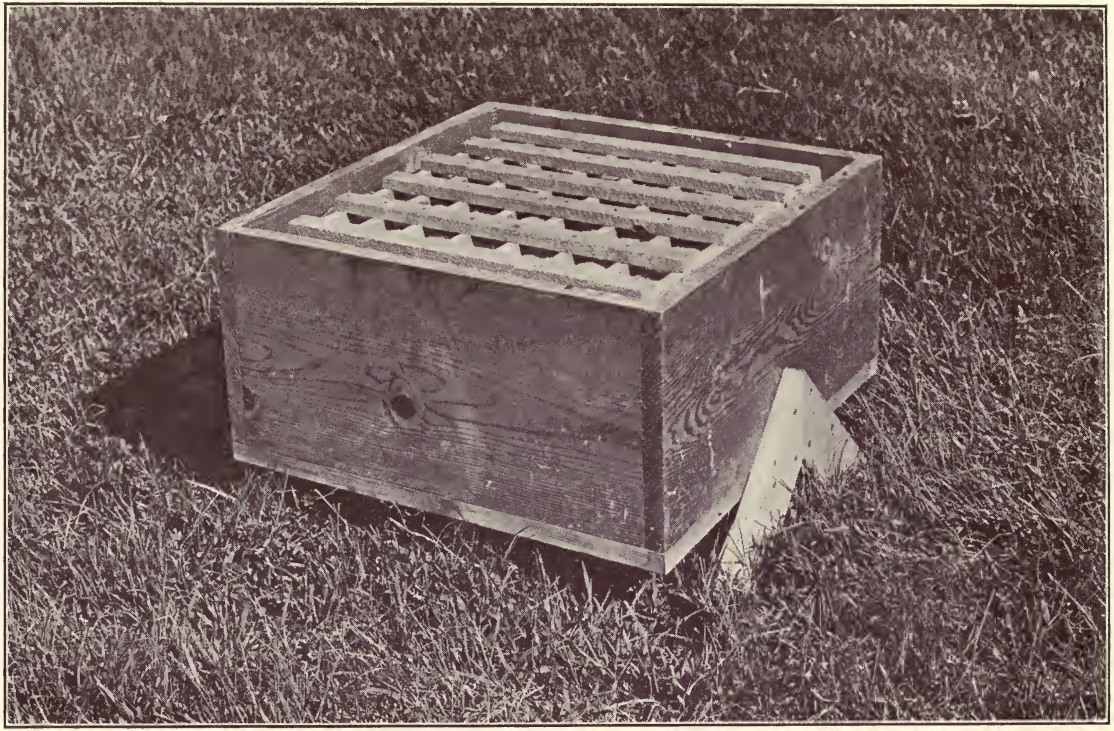


FIG. 19. SIMPLE BOX STYLE OF INDOOR MASH HOPPER.

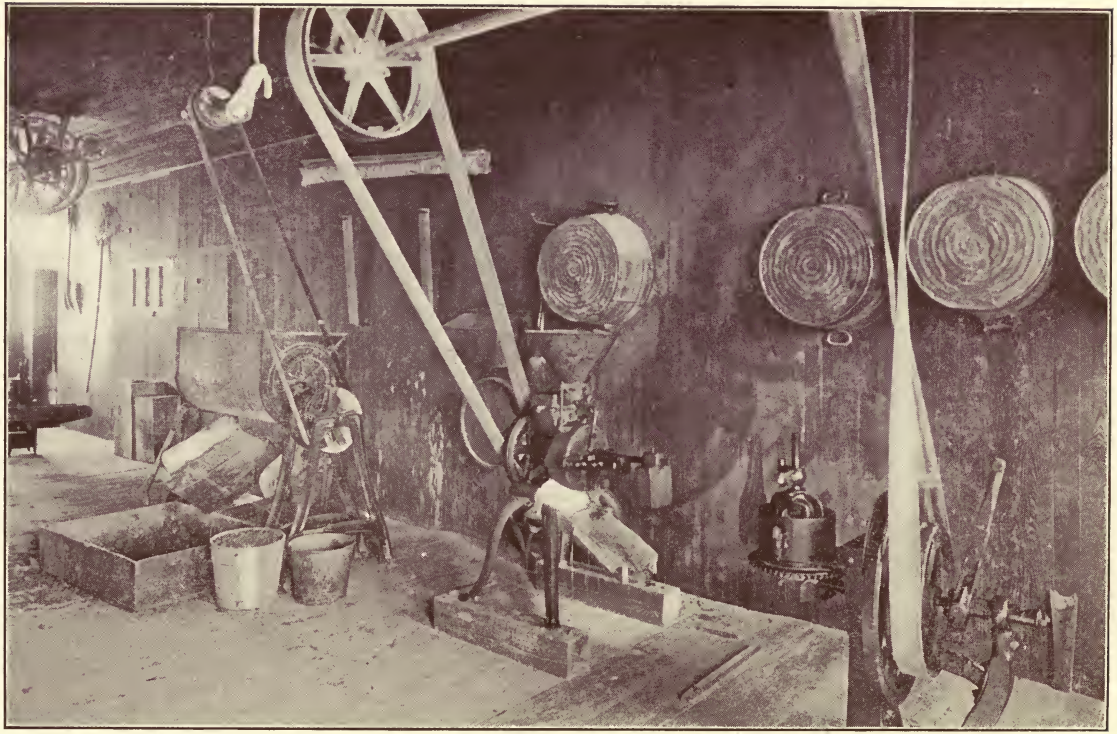


FIG. 20. LABOR SAVING DEVICES. FEED MIXER ON THE LEFT, GRAIN MILL AND BONE CUTTER.

13 which may be made of any size desired. This is merely an open box arrangement with a slat follower laid on top of the mash. The holes in the slat follower should be 2 inches square and the follower should be 2 inches narrower than the dimensions of the inside of the box. A convenient sized hopper for a small pen is a box 18 inches square and 10 inches deep while for a larger pen a long narrow box, one 3 or 4 feet long, 18 inches wide and 10 or 12 inches deep is very satisfactory. Such a hopper is absolutely wasteproof and the feed is always available to the hens. In wet weather where the yards are very muddy the hens may track some of the mud into this hopper, making this style of hopper slightly objectionable. On light soil or where the hens are kept confined in a house so that there is little or no opportunity for mud to get into the box, a hopper of this kind is very satisfactory.

Another style of indoor dry mash hopper which is shown on page 232 makes a good type of wall or room hopper which has a storage feeding arrangement whereby the mash comes down to the hens as it is eaten out of the hopper. The difficulty with this type of hopper is to have the mash flow freely and still not come down so fast that the hens can dig it out of the feeding part of the hopper and waste the mash. A curved metal bottom used on this hopper makes the grain flow freely and having an opening on either side of the hopper largely eliminates the possibility of the grain choking so that it stops flowing freely in the box. A hopper of this type can be made

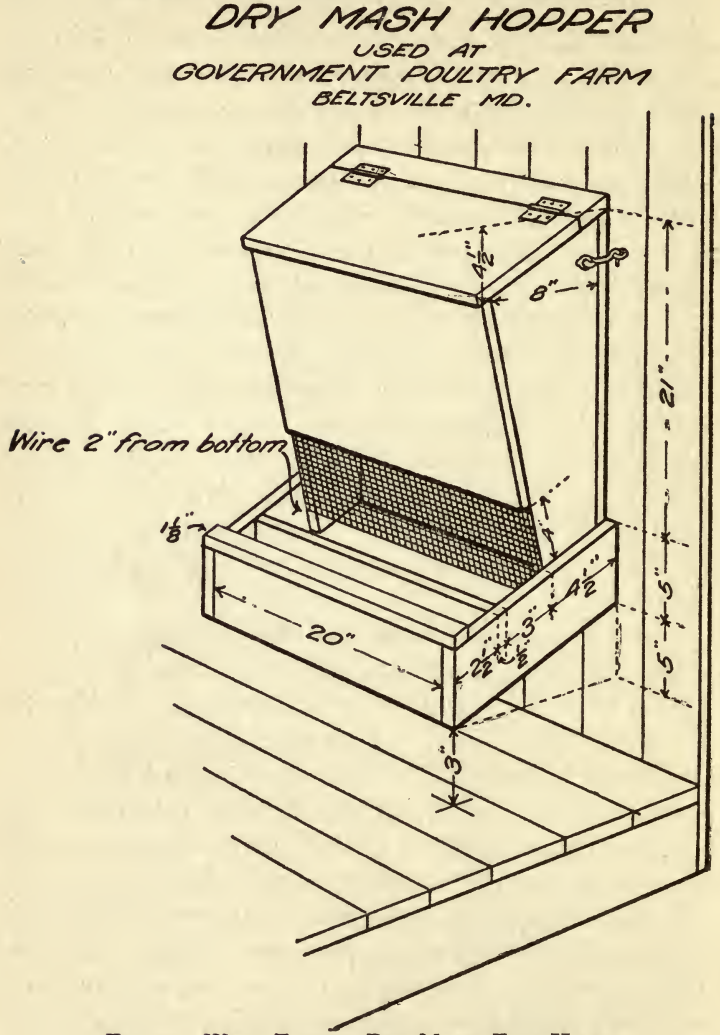


FIG. 21. WALL TYPE OF DRY MASH FEED HOPER

any size desired depending on the size of the flock. A hopper which will hold about 2 weeks' supply of mash is usually sufficiently large as it is not advisable to have too large a supply of mash in the hopper. Allow about 10 pounds of mash daily for 100 hens. Both types of dry mash hoppers should be raised 4 to 6 inches above the floor so that the straw will not be scratched into the hopper. The hopper may be placed on a platform a foot or 18 inches above the floor to prevent any chance of straw getting into the mash.

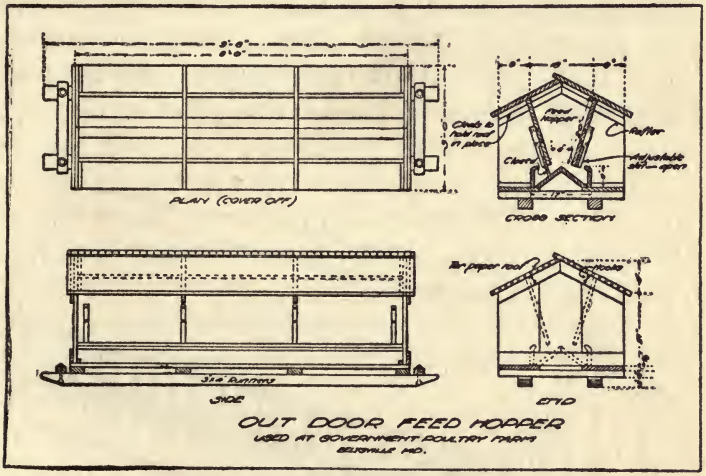


FIG. 22

A good type of self-feeder for the dry mash for growing chicks is shown above which is used on the poultry range out of doors and is covered with roofing paper to keep the feed dry in all kinds of weather. By

having a constant supply of mash on the range the chickens are always able to get plenty of feed and a hopper of this kind is a splendid investment. If a dry mash is used for the small chicks in the brooder house an open box hopper along the types shown in Figure 13 but much smaller in size is very satisfactory. Such a hopper should be about 12 inches wide, 18 inches long and 4 to 5 inches deep. It will be necessary to put this hopper right on the floor for the small chicks in order that they can get into the box but as the chicks grow larger it can be raised up off the floor to keep the litter from getting into the feed. Baby chicks just hatched should be fed by hand in open troughs until they are large enough to jump up into a box of this kind.

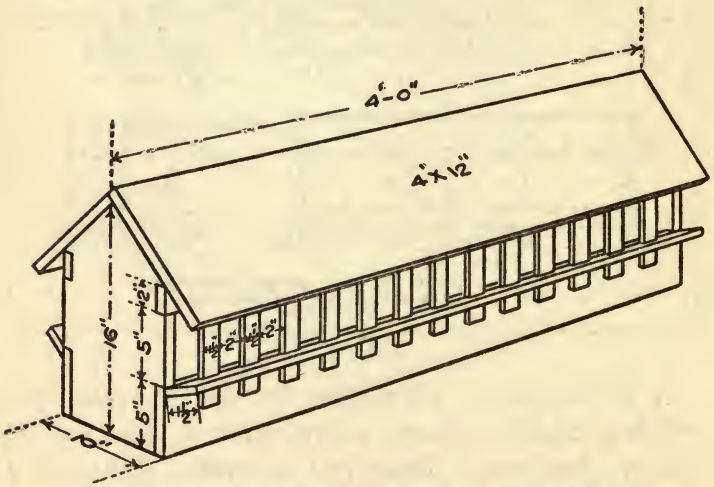


FIG. 23. ANOTHER STYLE OF OUTDOOR FEED HOPPER

Automatic watering devices are very helpful on a large poultry farm and are especially practical in sections where the water does not freeze during the winter. Various types of automatic devices such as are manufactured by dairy supply houses and other implement manufacturers are used in poultry houses. The simplest kind of devices should be secured for this purpose as complicated systems are expensive to keep in repair. Supplying water automatically saves a large amount of labor and also keeps a fresher supply of water before the fowls. It usually pays to have water piped to the different poultry houses and different parts of the range even though automatic devices for supplying water are not furnished in each pen in the poultry house or in each yard on the range. Litter and feed carriers may sometimes be used to advantage on a poultry farm but are only practical on poultry farms where the hens are kept in long poultry houses. Where the houses are 16 or more feet in depth and 200 or more feet in length, the use of a litter and feed carrier is worth considering but it is questionable whether they are a profitable investment in all cases even in houses of this size.

APPENDIX

This table gives a number of the best rations for egg production to supplement the material found in the text of this book. These rations include those recommended by the United States Department of Agriculture and also by experiment stations in each section of this country. The mash is the most important part of an egg laying ration. The scratch mixture can be changed freely, according to the prices of grains as each of the various constituents of the scratch mixtures have about the same nutritive ratio and much of the same value.

TABLE I—EGG LAYING RATIONS

Recommended by	Mash	Scratch Mixture
U. S. Department of Agriculture	16 lbs. corn meal 6½ lbs. meat scrap 1 lb. bran 1 lb. middlings	1 or 2 lbs. cracked corn 1 lb. wheat 1 lb. oats
	2 lbs. corn meal or barley meal 1 lb. bran 1 lb. middlings 1 lb. meat or fish scrap	2 lbs. cracked corn 1 lb. oats 1 lb. wheat or barley
	1 lb. bran 1 lb. middlings 3 lbs. corn meal 1½ lbs. meat scrap 2 lbs. ground oats 5% linseed meal	3 lbs. cracked corn 2 lbs. oats 1 lb. wheat

The last ration given is especially adapted for general purpose fowls or any fowls which have a tendency to become overfat on the other rations given above.

Mash	Mash or
9 lbs. corn meal	1½ lbs. cottonseed meal
5 lbs. middlings	1½ lbs. peanut meal
4 lbs. bran	2 lbs. gluten meal
2 lbs. cottonseed or gluten meal	9 lbs. corn meal
2 lbs. meat scrap	4 lbs. bran
2% bone meal	5 lbs. middlings
	2% dried milk

These mashes utilize cottonseed meal but do not give as high egg production as mashes with meat scrap.

Recommended by	Mash	Scratch Mixture
Vineland Egg Laying Contest (N. J.)	100 lbs. bran 100 lbs. middlings 100 lbs. ground oats 100 lbs. corn meal 100 lbs. meat scrap	100 lbs. cracked corn 100 lbs. wheat 100 lbs. clipped oats
Massachusetts Agricultural College	100 lbs. bran 100 lbs. middlings, Red Dog or low grade flour 100 lbs. corn meal or hominy 100 lbs. gluten 100 lbs. ground oats 100 lbs. meat scrap	300 lbs. cracked corn 200 lbs. wheat 100 lbs. oats or barley
New York State College of Agriculture	60 lbs. corn meal 60 lbs. middlings or shorts 50 lbs. meat scrap 30 lbs. bran 10 lbs. linseed 10 lbs. alfalfa meal 1 lb. salt	3 lbs. wheat 2 lbs. corn or kafir 1 lb. oats
Purdue University	5 lbs. bran 3 lbs. shorts 3½ lbs. meat scrap or tankage	10 lbs. corn 10 lbs. wheat 5 lbs. oats
Ontario Agricultural College	500 lbs. shorts 500 lbs. low grade flour 750 lbs. corn chop 300 lbs. bran 500 lbs. oats chop 150 lbs. high grade tankage	40 lbs. cracked corn 40 lbs. wheat 20 lbs. oats or buckwheat

This ration is fed with buttermilk as a drink before the fowls. If no buttermilk is available, increase the tankage to 600 lbs.

Owens Farm Breeding Mash	2 lbs. clover 2 lbs. alfalfa 3 lbs. bran 3 lbs. ground oats 4 lbs. corn meal 1 lb. oil meal 2 lbs. gluten meal 3 lbs. scrap

This is especially adapted for breeding fowls.

California Agricultural College

50 lbs. bran
50 lbs. middlings
50 lbs. ground barley or ground oats
10 lbs. soy bean meal or linseed, cottonseed or ground beans
30 lbs. meat or fish scrap
5 lbs. charcoal
1 lb. fine salt
2 lbs. rolled or whole barley or wheat
1 lb. Egyptian corn or Milo Maize
1 lb. cracked corn

TABLE II

*Composition and Digestible Nutrients of Poultry Feeds**

	Composition						"Digestible Nutrients"				
			Carbohydrates								
	Dry Matter	Crude Protein	Fiber	N-free Extract	Fat	Ash	Crude Protein	Carbo-hydrates	Fat	Total	Nutritive Ratio
Grains	%	%	%	%		%	%	%	%	%	
Corn	89.5	10.1	2.0	70.9	5.0	1.5	7.5	67.8	4.6	87.7	10.4
Wheat	89.8	12.4	2.2	71.2	2.1	1.9	9.2	07.5	1.5	80.1	7.7
Wheat Screenings	89.8	13.3	7.4	61.1	4.1	3.9	9.6	47.3	3.6	65.0	5.8
Oats	90.8	12.4	10.9	59.6	4.4	3.5	9.7	52.1	3.8	70.4	6.3
Barley	90.7	11.5	4.6	69.8	2.1	2.7	9.0	66.8	1.6	79.4	7.8
Rye	90.6	11.8	1.8	73.2	1.8	2.0	9.9	68.4	1.2	81.0	7.2
Emmer (spelt)	91.3	14.9	2.1	68.5	2.5	1.5	9.5	63.2	1.7	76.5	7.1
Kafir	88.2	11.1	2.3	70.1	3.0	1.7	9.0	65.8	2.3	80.0	7.9
Milo	89.3	10.7	2.4	70.5	2.9	2.8	8.7	66.2	2.2	79.9	8.2
Feterita	89.2	11.5	1.2	71.7	3.2	1.5	9.3	66.6	2.5	81.5	7.8
Durra	90.1	10.1	1.7	72.8	3.5	2.0	8.2	67.9	2.7	82.2	9.0
Shallu	90.3	12.5	1.7	71.1	3.4	1.6	10.1	66.3	2.6	82.2	7.1
Buckwheat	87.9	10.8	10.3	62.2	2.5	2.1	8.1	49.7	2.5	63.4	6.8
Seeds											
Cowpea	88.4	23.6	4.1	55.8	1.5	3.4	19.4	54.5	1.1	76.4	2.9
Field Pea	90.8	22.9	5.6	57.8	1.1	3.4	19.0	55.8	0.6	76.2	3.0
Peanuts (whole)	93.5	20.4	16.4	16.4	36.2	4.1	18.4	15.3	32.6	107.1	4.8
Peanut Kernel	94.0	26.8	2.6	17.5	44.9	2.2	24.1	14.9	40.4	129.9	4.4
Garden Pea	88.2	25.6	4.4	53.6	1.6	3.0	21.2	51.5	0.9	74.7	2.5
Soy Bean	90.1	36.5	4.3	26.5	17.5	5.3	30.7	22.8	14.4	85.9	1.8
Navy Bean	86.6	22.7	5.8	53.0	1.5	3.6	18.8	51.3	0.8	71.9	2.8
Velvet Bean	88.3	20.8	7.5	51.0	6.4	2.6	18.1	50.8	5.3	80.8	3.5
Rice (Polished)	87.7	7.4	0.4	79.0	0.4	0.5	4.6	72.8	0.4	78.3	16.0

*Largely from Henry and Morrison's Feeds and Feeding.

TABLE II—(Continued)

	Composition						Digestible "Nutrients"				
			Carbohydrates								
	Dry Matter	Crude Protein	Fiber	N-free Extract	Fat	Ash	Crude Protein	Carbohydrates	Fat	Total	Nutritive Ratio
	%	%	%	%	%	%	%	%	%	%	%
Sunflower Seed	93.1	16.1	27.9	21.3	24.7	3.1	13.5	38.1	20.3	97.3	6.2
Hemp Seed	92.0	10.0	14.0	45.0	21.0	2.0	....	....	....	.....	....
Flax Seed	90.8	22.6	7.1	23.2	33.7	4.3	20.6	17.0	29.0	102.8	4.0
Broom Corn	88.2	10.2	8.2	63.5	3.4	2.9	8.3	62.9	2.6	77.0	8.3
Millet Seed	89.2	12.1	8.4	61.0	4.1	3.6	8.6	60.6	3.0	76.0	7.8
Mill and Ground Feeds											
Wheat Bran	89.9	16.0	9.5	53.7	4.4	6.3	12.5	41.6	3.0	60.9	3.9
Wheat Middlings (shorts)	89.6	17.4	6.0	56.8	4.9	4.4	13.4	46.2	4.3	69.3	4.2
Flour Middlings	89.3	17.8	4.7	58.1	5.0	3.7	15.7	52.8	4.3	78.2	4.0
Red Dog Flour	88.9	16.8	2.2	63.3	4.1	2.5	14.8	56.5	3.5	79.2	4.4
Wheat Four	87.7	10.9	0.4	74.6	1.3	0.5	8.1	69.6	0.9	79.7	8.8
Bread	66.2	7.9	0.7	55.4	0.7	1.5	5.8	51.9	0.5	58.8	9.1
Corn Meal or Chop	88.7	9.3	2.3	72.0	3.8	1.3	6.9	69.0	3.5	83.8	11.1
Corn and Cob Meal	89.6	8.5	7.9	67.6	4.1	1.5	6.1	63.7	3.7	78.1	11.8
Hominy Feed	89.9	10.6	4.4	64.3	8.0	2.6	7.0	61.2	7.3	84.6	11.1
Corn Bran	90.0	9.7	9.8	62.4	5.7	2.4	5.8	56.9	4.6	73.1	11.6
Gluten Meal	90.9	35.5	2.1	47.5	4.7	1.1	30.2	42.9	4.4	84.0	1.8
Gluten Feed	91.3	25.4	7.1	52.9	3.8	2.1	21.6	51.9	3.2	80.7	2.7
Oatmeal or Rolled Oats	92.1	16.0	25.0	66.1	6.5	2.0	12.8	56.9	6.0	83.2	5.5
Ground Oats	89.2	12.1	9.9	59.2	4.7	3.3	9.4	51.4	4.1	70.0	6.4
Barley Meal	90.7	11.5	4.6	69.8	2.1	2.7	9.0	66.8	1.6	79.4	7.8
Brewers' Grains (dried)	92.5	26.5	14.6	41.0	6.9	3.5	21.5	30.5	6.1	65.7	2.1
Malt Sprouts	92.4	26.4	12.6	45.6	1.5	6.1	20.3	47.4	1.3	70.6	2.5
Rye Feed	88.5	15.3	4.7	61.5	3.2	3.8	12.2	55.8	2.9	74.5	5.1
Buckwheat Middlings	88.0	28.3	4.8	42.7	7.4	4.8	24.6	38.3	6.1	76.6	2.1
Cottonseed Meal (prime)	92.2	39.8	10.1	26.4	8.3	6.6	33.4	24.3	7.9	75.5	1.3
Linseed Meal (O. P.)	90.9	33.9	8.4	35.7	7.5	5.4	30.2	32.6	6.7	77.9	1.6

Peanut Meal (No Hulls)	89.3	47.6	5.1	23.7	8.0	4.9	24.1	14.9	40.4	129.9	4.4
Soy Bean Meal	88.2	41.4	5.3	28.7	7.4	5.4	38.1	33.9	5.0	83.2	1.2
Cocoanut Meal	90.4	20.9	11.7	45.3	8.1	4.9	18.8	42.0	81.0	79.0	3.2
Packing House Products, Milk, etc.											
Meat Scrap	92.9	53.9	2.2	5.0	10.7	21.1	....	....	....	....	....
Blood Meal	90.3	82.3	....	3.8	0.9	9.7	69.1	....	0.9	71.1	0.03
Fish Meal	92.9	60.9	0.5	2.6	14.1	14.8	....	....	....	....	....
Fresh Bone	69.6	19.7	....	3.8	25.0	21.1	18.3	....	24.5	73.4	3.0
Bone Meal	92.7	24.3	....	3.6	3.1	61.7	22.6	....	3.0	29.4	0.3
Pork Cracklings	95.0	56.4	....	4.1	32.2	2.3	52.4	....	32.6	125.8	1.4
Tankage	92.6	63.1	3.6	2.5	12.9	10.5	58.7	....	12.6	87.0	0.5
Buttermilk	9.4	3.6	....	5.0	0.1	0.7	3.4	4.9	0.1	8.4	1.5
Skim Milk	9.9	3.8	....	5.2	0.2	0.7	3.6	5.1	0.2	9.1	1.5
Semi-Solid Buttermilk	44.3	15.7	....	19.8	4.0	4.8	....	....	....	....	....
Dried Milk (Buttermilk)	90.4	29.7	0.3	43.8	5.5	11.1	....	....	....	....	....
Whey	6.6	0.8	....	4.8	0.3	0.7	0.8	4.7	0.3	6.2	6.8
Dried Skim Milk	91.7	36.6	....	25.8	4.2	25.1	34.4	25.3	4.1	68.9	1.0
Green, Succulent, Mineral and Miscellaneous Feeds											
Mangel Beet					0.1	1.0	0.8	6.4	0.1	7.4	8.2
Rutabaga	10.9	1.2	1.4	7.0	0.3	1.0	1.0	7.7	0.3	9.4	8.4
Turnip	9.5	1.4	1.1	5.9	0.2	0.9	1.0	6.0	0.2	7.4	6.4
Carrot	11.7	1.2	1.1	8.0	0.2	1.2	0.9	8.6	0.2	9.9	10.0
Potato	21.2	2.2	0.4	17.4	0.1	1.1	1.1	15.8	0.1	17.1	14.5
Cabbage	8.9	2.2	0.9	4.7	0.3	0.8	1.9	5.6	0.2	7.9	3.2
Beet Pulp (dried)	91.8	8.9	18.9	59.6	0.9	3.5	4.6	65.2	0.8	71.6	14.6
Alfalfa Hay (dried)	91.4	14.9	28.3	37.3	2.3	8.6	10.6	39.0	0.9	51.6	3.9
Alfalfa Meal	91.2	14.3	30.1	35.8	2.0	9.0	10.2	38.7	0.8	50.7	4.0
Clover Hay (dried)	87.1	12.8	25.5	38.7	3.1	7.1	7.6	39.3	9.8	50.9	5.7
Alfalfa (green)	25.3	4.5	7.0	10.4	1.0	2.4	3.3	10.4	0.4	14.6	3.4
Rape	16.7	2.9	2.6	8.4	0.6	2.2	2.6	10.0	0.3	13.3	4.1
Kale	11.3	2.4	1.5	5.0	0.5	1.9	1.9	4.7	0.3	7.3	2.8
Molasses	74.7	3.5	....	66.0	....	5.2	1.1	59.4	....	60.5	54.0

INDEX

The New Egg Farm

By H. H. STODDARD. A practical, reliable manual on producing eggs and poultry for market as a profitable business enterprise, either by itself or connected with other branches of agriculture. It tells all about how to feed and manage, how to breed and select, incubators and brooders, its labor-saving devices, etc., etc. Illustrated. 331 pages. 5 x 7 inches. Cloth. . . . . .

Poultry Feeding and Fattening

Compiled by G. B. FISKE. A handbook for poultry keepers on the standard and improved methods of feeding and marketing all kinds of poultry. The subject of feeding and fattening poultry is prepared largely from the side of the best practice and experience here and abroad, although the underlying science of feeding is explained as fully as needful The subject covers all branches, including chickens, broilers, capons, turkeys and waterfowl; how to feed under various conditions and for different purposes. The whole subject of capons and caponizing is treated in detail. A great mass of practical information and experience not readily obtainable elsewhere is given with full and explicit directions for fattening and preparing for market. This book will meet the needs of amateurs as well as commercial poultry raisers. Profusely illustrated. 160 pages. 5 x 7½ inches. Cloth. . . .

Poultry Architecture

Compiled by G. B. FISKE. A treatise on poultry buildings of all grades, styles and classes, and their proper location, coops, additions and special construction; all practical in design, and reasonable in cost. Over 100 illustrations. 125 pages. 5 x 7 inches. Cloth. . . . . .

Poultry Appliances and Handicraft

Compiled by G. B. FISKE. Illustrated description of a great variety and styles of the best homemade nests, roosts, windows, ventilators, incubators and brooders, feeding and watering appliances, etc., etc. Over 100 illustrations. Over 125 pages. 5 x 7 inches. Cloth. . . . . .

Turkeys and How to Grow Them

Edited by HERBERT MYRICK. A treatise on the natural history and origin of the name of turkeys; the various breeds, the best methods to insure success in the business of turkey growing. With essays from practical turkey growers in different parts of the United States and Canada. Copiously illustrated. 154 pages. 5 x 7 inches. Cloth. . . . .

Farm Grasses of the United States of America

By WILLIAM JASPER SPILLMAN. A practical treatise on the grass crop, seeding and management of meadows and pastures, description of the best varieties, the seed and its impurities, grasses for special conditions, lawns and lawn grasses, etc., etc. In preparing this volume the author's object has been to present, in connected form, the main facts concerning the grasses grown on American farms. Every phase of the subject is viewed from the farmer's standpoint. Illustrated. 248 pages. 5 x 7 inches. Cloth. . . . . .

The Book of Corn

By HERBERT MYRICK, assisted by A. D. SHAMBIA, E. A. BURNETT, ALBERT W. FULTON, B. W. SNOW, and other most capable specialists. A complete treatise on the culture, marketing and uses of maize in America and elsewhere for farmers, dealers and others. Illustrated. 372 pages. 5 x 7 inches. Cloth. . . . . .

The Hop—Its Culture and Care, Marketing and Manufacture

By HERBERT MYRICK. A practical handbook on the most approved methods in growing, harvesting, curing and selling hops, and on the use and manufacture of hops. The result of years of research and observation, it is a volume destined to be an authority on this crop for many years to come. It takes up every detail from preparing the soil and laying out the yard, to curing and selling the crop. Every line represents the ripest judgment and experience of experts. Size, 5 x 8; pages, 300; illustrations, nearly 150; bound in cloth and gold; price, postpaid. . . . . .

Tobacco Leaf

By J. B. KILLEBREW and HERBERT MYRICK. Its Culture and Cure, Marketing and Manufacture. A practical handbook on the most approved methods in growing, harvesting, curing, packing and selling tobacco, with an account of the operations in every department of tobacco manufacture. The contents of this book are based on actual experiments in field, curing barn, packing house, factory and laboratory. It is the only work of the kind in existence, and is destined to be the standard practical and scientific authority on the whole subject of tobacco for many years. 506 pages and 150 original engravings. 5 x 7 inches. Cloth. . . . . .

Feeding Farm Animals

By Professor THOMAS SHAW. This book is intended alike for the student and the farmer. The author has succeeded in giving in regular and orderly sequence, and in language so simple that a child can understand it, the principles that govern the science and practice of feeding farm animals. Professor Shaw is certainly to be congratulated on the successful manner in which he has accomplished a most difficult task. His book is unquestionably the most practical work which has appeared on the subject of feeding farm animals. Illustrated. 5½ x 8 inches. Upward of 500 pages. Cloth. . . .

Profitable Dairying

By C. L. PECK. A practical guide to successful dairy management. The treatment of the entire subject is thoroughly practical, being principally a description of the methods practiced by the author. A specially valuable part of this book consists of a minute description of the far-famed model dairy farm of Rev. J. D. Detrich, near Philadelphia, Pa. On the farm of fifteen acres, which twenty years ago could not maintain one horse and two cows, there are now kept twenty-seven dairy cattle, in addition to two horses. All the roughage, litter, bedding, etc., necessary for these animals are grown on these fifteen acres, more than most farmers could accomplish on one hundred acres. Illustrated. 5 x 7 inches. 200 pages. Cloth. . . . . .

Practical Dairy Bacteriology

By Dr. H. W. CONN, of Wesleyan University. A complete exposition of important facts concerning the relation of bacteria to various problems related to milk. A book for the classroom, laboratory, factory and farm. Equally useful to the teacher, student, factory man and practical dairyman. Fully illustrated with 83 original pictures. 340 pages. Cloth. 5½ x 8 inches. . . . . .

Modern Methods of Testing Milk and Milk Products

By L. L. VANSLYKE. This is a clear and concise discussion of the approved methods of testing milk and milk products. All the questions involved in the various methods of testing milk and cream are handled with rare skill and yet in so plain a manner that they can be fully understood by all. The book should be in the hands of every dairyman, teacher or student. Illustrated. 214 pages. 5 x 7 inches. . . . . .

Animal Breeding

By THOMAS SHAW. This book is the most complete and comprehensive work ever published on the subject of which it treats. It is the first book which has systematized the subject of animal breeding. The leading laws which govern this most intricate question the author has boldly defined and authoritatively arranged. The chapters which he has written on the more involved features of the subject, as sex and the relative influence of parents, should go far toward setting at rest the wildly speculative views cherished with reference to these questions. The striking originality in the treatment of the subject is no less conspicuous than the superb order and regular sequence of thought from the beginning to the end of the book. The book is intended to meet the needs of all persons interested in the breeding and rearing of live stock. Illustrated. 405 pages. 5 x 7 inches. Cloth. . . .

Forage Crops Other Than Grasses

By THOMAS SHAW. How to cultivate, harvest and use them. Indian corn, sorghum, clover, leguminous plants, crops of the brassica genus, the cereals, millet, field roots, etc. Intensely practical and reliable. Illustrated. 287 pages. 5 x 7 inches. Cloth. . . . . .

Soiling Crops and the Silo

By THOMAS SHAW. The growing and feeding of all kinds of soiling crops, conditions to which they are adapted, their plan in the rotation, etc. Not a line is repeated from the Forage Crops book. Best methods of building the silo, filling it and feeding ensilage. Illustrated. 364 pages. 5 x 7 inches. Cloth. . . . . .

The Study of Breeds

By THOMAS SHAW. Origin, history, distribution, characteristics, adaptability, uses, and standards of excellence of all pedigreed breeds of cattle, sheep and swine in America. The accepted text book in colleges, and the authority for farmers and breeders. Illustrated. 371 pages. 5 x 7 inches. Cloth. . . . . .

Clovers and How to Grow Them

By THOMAS SHAW. This is the first book published which treats on the growth, cultivation and treatment of clovers as applicable to all parts of the United States and Canada, and which takes up the entire subject in a systematic way and consecutive sequence. The importance of clover in the economy of the farm is so great that an exhaustive work on this subject will no doubt be welcomed by students in agriculture, as well as by all who are interested in the tilling of the soil. Illustrated. 5 x 7 inches. 337 pages. Cloth. Net . .

Land Draining

A handbook for farmers on the principles and practice of draining, by MANLY MILES, giving the results of his extended experience in laying tile drains. The directions for the laying out and the construction of tile drains will enable the farmer to avoid the errors of imperfect construction, and the disappointment that must necessarily follow. This manual for practical farmers will also be found convenient for reference in regard to many questions that may arise in crop growing, aside from the special subjects of drainage of which it treats. Illustrated. 200 pages. 5 x 7 inches. Cloth. . . . .

Barn Plans and Outbuildings

Two hundred and fifty-seven illustrations. A most valuable work, full of ideas, hints, suggestions, plans, etc., for the construction of barns and outbuildings, by practical writers. Chapters are devoted to the economic erection and use of barns, grain barns, horse barns, cattle barns, sheep barns, cornhouses, smokehouses, icehouses, pig pens, granaries, etc. There are likewise chapters on birdhouses, doghouses, tool sheds, ventilators, roofs and roofing, doors and fastenings, workshops, poultry houses, manure sheds, barnyards, root pits, etc. 235 pages. 5 x 7 inches. Cloth. . . . . .

Irrigation Farming

By LUTE WILCOX. A handbook for the practical application of water in the production of crops. A complete treatise on water supply, canal construction, reservoirs and ponds, pipes for irrigation purposes, flumes and their structure, methods of applying water, irrigation of field crops, the garden, the orchard and vineyard, windmills and pumps, appliances and contrivances. New edition, revised, enlarged and rewritten. Profusely illustrated. Over 500 pages. 5 x 7 inches. Cloth. . . . . .

Forest Planting

By H. NICHOLAS JARCHOW, LL. D. A treatise on the care of woodlands and the restoration of the denuded timberlands on plains and mountains. The author has fully described those European methods which have proved to be most useful in maintaining the superb forests of the old world. This experience has been adapted to the different climates and trees of America, full instructions being given for forest planting of our various kinds of soil and subsoil, whether on mountain or valley. Illustrated. 250 pages. 5 x 7 inches. Cloth.