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POULTRY FEEDS AND FEEDING

H. S. Gutteridge and M. Novikoff

« Close clipped alfalfa range saves feed and produces strong healthy birds »

Poultry Division
EXPERIMENTAL FARMS SERVICE
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BY

H. S. Gutteridge and M. Novikoff

INTRODUCTION

It has been the aim in this bulletin to make the subject of feeds and feeding of poultry as simple as possible. While it has seemed advisable to try to familiarize the uninformed reader with the more common scientific terms, this has been done only to such an extent as will permit the reader to study and mix feeds intelligently. Whenever terms that might be unusual to ordinary poultry keepers are used, care has been taken to explain them as simply as possible, so that any person reading the bulletin through should have no trouble in following it.

While sample rations are given for each kind of poultry, it must not be supposed that these are given as the only rations or even as the best rations. Each one is typical of rations which are generally used for the purpose under consideration and have proved satisfactory in experimental trials and in actual practice. The make-up of a ration should depend to a great extent upon what feeds are available, bearing in mind, however, that certain essential requirements must be fulfilled.

The Nutrients

The feeding of poultry is more or less like feeding of any other livestock, and the ration used must be varied according to the purpose for which it is intended. Normally a poultry ration will be composed of grain feeds (either whole or ground grain and their by-products), feeds of animal origin, mineral feeds, vitamins and water.

These feeds must not only be supplied, but they must be supplied in such quantities and proportions that they will form a ration suited to the purpose for which it is intended.

More specifically, a good ration will contain proteins, carbohydrates, fats, minerals, fibre and the necessary vitamins in the proportions required for the maintenance, activity and production of the animal to which it is fed. In addition it is essential that all of the above nutrients be supplied in such form and variety that proteins of the right type, minerals in proper balance and in readily available form and the vitamins necessary to bring about proper assimilation of these elements are provided. Each of the above mentioned elements of the ration will be considered separately in detail.

Protein.—Protein is the nitrogenous part of the food, and is largely used for growth, the repairing of waste tissue and production. Proteins are constituents of bones, ligaments, soft tissues, muscles, feathers, nails, beaks and skin. They are also components of the protoplasm of the living cell. Proteins on digestion

are broken down to amino acids of which they are basically made up. In addition to the elements carbon, hydrogen, oxygen, nitrogen, they usually contain sulphur and frequently phosphorus and iron. There are twenty-two or more known amino acids certain of which are essential to support life and others of which are not indispensable. The chicken is more sensitive than some animals to the absence of these acids in its feed and eleven of the twenty-two are absolutely essential, or indispensable, that is, they cannot be synthesized by the bird and so must be supplied in the feed. Most of the essential amino acids are found in animal tissues and at a sufficiently high level to supplement the vegetable protein, hence the importance of feeds of animal origin. Even this source is not always complete however and supplementation from other feeds is therefore necessary. Even the proteins of eggs and milk are not complete for the chick. However, our knowledge of the nature of the amino acids in many feed products enables us to combine different types of protein intelligently so that deficiencies in amino acids will not exist. It will be appreciated from the above that variety in sources of protein is very important.

Carbohydrates.—Carbohydrates are formed from combinations of carbon, hydrogen and oxygen and may be divided into two distinct classes, the sugars and the more complex forms which include starches, glycogen, dextrins, pentosans and cellulose (fibre). Carbohydrates minus fibre are designated as "nitrogen free extract". All carbohydrates may be converted into fat and stored in various parts of the body or into glycogen and stored in the liver to be used when needed by being changed in the body into glucose. For these reasons they play an important part in maintenance of body weight in fowl under heavy egg production. They are composed mostly of sugars and starches.

Fats.—Fats are very similar to carbohydrates particularly in the respect that they are used mainly for production of heat and body energy. They are stored in large quantities both in the tissues and surrounding the internal organs. Fats are a more highly concentrated source of energy than carbohydrates. Under a condition of insufficiency of both carbohydrates and fats, proteins may be converted for energy production. Carbohydrates and fats cannot be converted to proteins, however, so that a ration deficient in protein no matter how rich in carbohydrates and fats cannot give good results.

Minerals.—Besides the three fore-mentioned nutrients, minerals are also of importance, as they enter into practically all functions of the body and particularly into the formation of bones and egg shells. Certain minerals also, notably iron and copper, enter into the normal composition of the blood and are essential in the prevention of anaemia. The role of two minerals, calcium and phosphorus, particularly in the nourishment of the living cell and in bone formation, makes them of real importance in nutrition.

Still other minerals are essential but a deficiency is rarely encountered because they are plentiful in many feed ingredients. An exception to this statement is manganese which is required by chickens and often is not present in adequate quantities in many rations. Under certain conditions iodine also may be too low and as a precautionary measure these two minerals are usually added to rations. Still other unknown trace elements are not always found in adequate quantities since deficiencies are sometimes found when birds range on certain soils and are not found where they are raised on other areas.

It should be mentioned that with most classes of stock certain minerals when found in forages in excess are definitely toxic and therefore harmful. As an example, molybdenum in pastures is definitely toxic to cattle and selenium to many animals including poultry.

In the feeding of poultry, optimum quantities of minerals have not yet been determined. It is definitely known, however, that cereal grains which make up by far the greatest portion of the poultry ration are deficient in minerals for both growth and egg production. Thus the necessity of making provision for mineral feeds in addition to the regular cereal ration becomes obvious. Since, as mentioned above, requirements for optimum condition are not known it is necessary to supply minerals in excess, the proper balance then being maintained through elimination of surplus by the kidneys and digestive tract. It has also been shown that a proper balance between minerals is necessary particularly in the ratio of calcium to prosphorus for bone formation.

Fig. 1.—Laboratory of Nutrition, Poultry Division, Central Experimental Farm, Ottawa, Ontario.

Fibre.—Fibre is made up chiefly of the woody parts of plants. Unlike ruminants and most larger animals, poultry are unable to digest fibre in any quantities. The absence of cellulose-splitting enzymes together with the rapidity of digestion by poultry make it unlikely that much fibre digestion can be carried on. The value of fibre as a nutrient in poultry rations may therefore, for all practical purposes, be ignored. It does exert, however, a decided influence upon the bulk of the ration and thus on the amount of other nutrients consumed. Perhaps its most important function is that of separating the more finely divided

ingredients of the feed mixture and thus preventing it from becoming pasty and permitting greater penetration of the digestive juices throughout the feed. In addition it has been found in some instances that a ration extremely low in fibre caused the picking up of straw, dried grass or similar substances, in order to increase the intake of fibre with resultant wholesale crop impaction.

Vitamins.—Vitamins are substances largely of vegetable origin which are essential to life and specifically to certain functions of the animal body depending upon the particular vitamin under consideration. Those vitamins so far recognized have been classified and given definite names. While they are not all of importance in poultry nutrition they will be considered briefly.

Vitamin A.—This vitamin is fat soluble and therefore is found only in the fatty portions of feeds. It plays a part in normal growth and when absent from the ration causes several disorders, xerophthalmia, an eye condition, visceral gout, evidenced by an excessive deposition of urates throughout the internal organs and a collection of typical pustules in the mouth and throat. One of the most important roles of this vitamin is seen in its ability to increase resistance of the body to infections. If removed entirely from the diet of young chicks, cessation of growth, lack of control and death, result. The requirements of poultry for vitamin A are higher than those of most other animals.

Vitamin A is not found in plant materials as such but the carotene of green feeds and vegetable products is changed in the liver of the bird into vitamin A and for this reason carotene is often called "pro-vitamin A". During the season of plant growth greenfeeds are the most usual source of vitamin A while under conditions of confinement fish oils or dried greenfeeds are the principal sources.

Vitamin D.—This vitamin is also fat soluble. Its presence is essential to proper bone formation and the most important symptom of its absence is a severe condition of rickets. As with vitamin A, poultry have a very high requirement for the vitamin, and its absence has been shown to produce rickets, diminution of growth, production of soft egg shells and low hatchability. Vitamin D occurs in very few substances in sufficient concentration to be useful as a food supplementary to poultry rations. In the presence of direct sunlight, however, growth may be normal and bone formation perfect even though substances containing this vitamin are lacking in the ration. It is considered that the ultra violet rays of the sun activate a substance found in the skin with the resultant production of vitamin D. This source of vitamin D (sunlight) is of great importance in poultry nutrition. Many different forms of vitamin D have so far been definitely identified. The only forms which are of much concern under the heading of poultry nutrition are the fractions D_2 and D_3, the former called calciferol and the latter irradiated 7-dehydrocholesterol. Of these the last mentioned is the most important naturally occurring form and is the one which occurs in the skin, feathers and hair and is activated by the ultra violet rays of the sun. The former is less active for chickens than the latter and as a result substances which are to be fed to chickens as a source of vitamin D must be assayed on chickens before their effectiveness for poultry feeding can be guaranteed.

Vitamin B.—This vitamin is usually known as the "B complex" since it has now been ascertained that there are many different B vitamins. All the vitamins of this complex are water soluble. Many of the B vitamins will not even be named herein but those of most importance in poultry nutrition thiamine,

riboflavin, choline, pantothenic acid, pyridoxine, inositol and folic acid will be mentioned briefly. These may again be reduced to those which, being required by poultry, are often not sufficiently plentifully distributed in feeds and consequently must be given special attention. These are riboflavin, choline and pantothenic acid.

Thiamin.—Some of the contributions which this vitamin makes to the well being of the animal organism are promotion of appetite, digestion and growth, aid in resistance to parasites and maintenance of normal elimination. This vitamin is present in so many ingredients of ordinary rations such as grains and their by-products and fresh and dried greenfeeds that a deficiency of the vitamin is very unlikely to occur under normal feeding conditions.

Riboflavin.—This vitamin, of much more recent discovery than thiamin, is of very great importance in poultry feeding. In actual fact a deficiency of riboflavin in poultry rations is still quite common in spite of our knowledge that the vitamin is so essential. It is necessary for normal growth, to prevent a condition in chicks known by the descriptive term of "curled toe paralysis" and to sustain good hatchability in eggs from breeding stock. It should be emphasized that a ration which contains sufficient riboflavin to maintain high egg production may still be much too low in the vitamin to produce eggs which will hatch well. In view of the importance of this vitamin the level of riboflavin in many of the common feed ingredients is shown in Table 1.

Choline.—This vitamin is without doubt very important in the nutrition of fowl and particularly of the young chick or turkey poult. Growth is stimulated and a condition known as perosis can largely be prevented if choline is present at adequate levels. Perosis is quite often seen in chicks or poults raised on wire or in confinement. The hock joint becomes enlarged and degenerate permitting the tendon over the joint to slip to one side and the lower leg is thus pulled out of position and carried at right angles to the body. Choline is not the only contributing factor to this condition but is a very important one. Feeds high in choline are indicated in Table 1.

Pantothenic Acid.—This was formerly known as the filtrate factor and is essential for good growth, feathering, and prevention of dermatitis. Chicks with dermatitis have scabbing on the corner of the mouth, eye lids become thickened and often stick together (no discharge or cheesy matter from eye) and finally cracks appear on the feet and the scales on the shanks become thickened. In many instances, pantothenic acid may be the limiting factor in obtaining good growth in chicks. Breeding stock should be well supplied with this vitamin so that the chickens when hatched will have a reserve supply for normal development. Table 1 shows the pantothenic acid content of some common feed ingredients.

Pyridoxin (Vitamin B_6).—Chicks on diets deficient in pyridoxin lose appetite, grow slowly, and develop spasmodic convulsions and other nervous manifestations. The vitamin is also essential for normal reproduction. Pyridoxin is found in cereal grains, milk, meat, liver, yeast and in green feeds. Because of its widespread distribution in practical feedstuffs, pyridoxin requirements are easily satisfied.

Inositol.—Although essential for normal metabolism has been shown to be satisfied by practical rations and therefore like nicotine acid is not in a sense a poultry problem.

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Folic Acid.—One of the most recent of the B complex members and often designated as the "L casei factor" or the "eluate factor" has been shown to be essential for normal growth, blood building and feathering. Latest information on the sources of this vitamin indicate that leafy parts of plants, liver meal and yeast are good sources while cereal grains and by-products (wheat, oats, corn, polished rice, rice bran), linseed meal, soybean meal, fish meal, meat scraps, skim-milk and whey also contain the vitamin in appreciable amounts.

Vitamin C. (Ascorbic Acid).—Since chickens are apparently able to produce this vitamin within themselves from food eaten and are not subject to scurvey, which is caused by a deficiency of this vitamin, it is at the moment considered to be of no importance in poultry feeding. As a matter of fact, in experimental tests fowl have been raised normally upon a scorbutic diet, that is, one free from vitamin C, and have been found to have the vitamin in the body glands thus demonstrating synthesis of the vitamin in the body.

Vitamin E. (alpha tocopherol).—This vitamin influences fertility, and when absent may remove the possibility of reproduction. It also is known to prevent a condition frequently called "crazy chick disease" now termed nutritional encephalomalacia. Vitamin E is fat soluble and is destroyed by oxidation in the presence of fats that have become rancid. Its destruction in natural feeds is somewhat prevented by the presence of anti-oxidants (prevents oxidation of the vitamin). Vitamin E, itself aids in preventing the destruction of carotene, the provitamin A. It has been shown to exist, however, in large quantities in cereal grains, particularly in germ oil, in greenfeed and flesh, consequently it is probably of no particular significance in poultry feeding.

Vitamin K. (anti-hemorrhagic vitamin).—This vitamin is a member of a large group of fat soluble compounds whose primary function is to promote the formation of prothrombin essential to normal clotting of blood. Vitamin K is found in numerous greenfeeds, but particularly alfalfa products.

Other vitamins worthy of mention on which recent research has been carried out are factors R, S and M, vitamin B_c and vitamin B_c conjugate. It is believed that these vitamins may be one entity, namely folic acid which functions in the prevention of anaemia.

Biotin was found to be essential in the prevention of perosis along with manganese, choline and an unidentified factor present in the water soluble fraction of beef liver. Another factor, if lacking in the diet, causes erosion of the lining of the gizzard.

Too much emphasis cannot be placed on the fact that yeast is an excellent source of the above mentioned vitamins except for the gizzard erosion factor. This latter factor is present in soybean oil, wheat and rice brans, hempseed meal and alfalfa leaf meal.

In considering the role of vitamins in poultry feeding it is significant to know that the vitamins A, B_1 (thiamin), B_2 (riboflavin), pantothenic acid, nicotinic acid (pellagra preventing factor), inositol, choline, C, D, E and K, so important in human nutrition, are found in greater or lesser concentrations in poultry products, namely eggs and poultry meats. If these factors are present in the feeds it seems obvious that besides supplying poultry with the essential vitamins the resulting product will also be of greater nutritive value.

In recent years the actual chemical formulae for many of the vitamins have been determined and in some cases they can now be synthesized in pure or almost pure form.

Nutrients in Feeds

The principal nutrients, proteins, carbohydrates, fats, minerals, fibre, and vitamins have been discussed separately in preceding paragraphs. In order that a knowledge of these nutritients and of their respective functions in the animal body may be put to practical use it is necessary to know their relative occurrence in the feeding stuffs which are commonly given to poultry. Table 1 shows nutrient values covering a great many of the feeds commonly used at the present time. In many instances these figures represent more than one thousand individual analyses, consequently they may be taken as a fair average for the feeds considered. It should be noted, however, that variation from sample to sample of the same feed covers a wide range, consequently the only really accurate way of knowing the nutrient content of any sample is by a chemical analysis of that sample. For example, it was found that in three hundred cars of wheat middlings analysed by a large commercial firm the range of protein was from 13·02 per cent to 19·06 per cent and of one hundred consecutive cars in each of the months of February, July, and November, only four, eleven, and forty-seven cars respectively equalled or exceeded the Henry and Morrison average (17·4 per cent). Under such conditions average analyses as shown in the following table give only an approximation and are most useful to show the comparative merits of the different feeds.

It should be noted, however, that whole grains, fresh greenfeeds and vegetables will vary only within moderate limits, the milled feeds (by-products of grains), dried greenfeeds and feeds of animal origin being the most variable in analysis.

Every feed is used for a definite purpose and the choice between two feeds will largely depend upon the extent to which one or the other of the feeds contains the nutrient required. It will be seen that the grains are largely a source of carbohydrates rather than protein and minerals although they have a definite value as a source of vitamin B_1. The by-products of the grains are in most cases higher in protein and vitamins and serve a very useful purpose in adjusting the level of protein and fibre particularly, in the ration. The greenfeeds will be seen to be quite low in nutrients owing to their high water content but they are excellent sources of vitamins particularly of vitamins A and riboflavin. Greenfeeds also serve the purpose of adding bulk to the ration. Roots such as mangels and turnips have little to commend them as poultry feeds either in respect to nutrient or vitamin content and must not be considered as anything but a poor substitute for greenfeeds. Since for rapid growth and high egg production large quantities of protein and minerals are required, the feeds of animal origin are very important sources of nutrients being high in protein, particularly, and usually in minerals as well. In some instances they are also good sources of vitamin A and riboflavin.

Certain vitamins are present in reasonable quantities in so many of the ingredients commonly used in poultry rations that to supply them in sufficient amounts supplementary feeds are not necessary. Of the vitamins listed above only vitamins A, D, riboflavin, pantothenic acid and choline, are likely to be lacking in ordinary feeds and under ordinary conditions. Vitamin B_1 for

example, is present in reasonable quantities in the cereal grains and since these make up by far the greatest part of poultry rations (85-90 per cent) a deficiency is unlikely to occur. The one vitamin which occurs rarely in natural feeds and has therefore to be supplied by supplements to the ration is vitamin D. From April to October the sunlight provides sufficient ultra violet rays to make a deficiency of this factor unlikely, but during the remainder of the year it must be added to the ration. Vitamin D carrying fish oils are the only naturally occurring source, while certain irradiated products such as activated cholesterol are also efficient and one or other of these products must be a part of all winter rations if satisfactory results are expected. The other vitamins for which special provision must be made, namely, A, riboflavin, pantothenic acid and choline, can be made available in sufficient quantities through proper choice of ingredients using the vitamin potency shown in table 1. The average values for potency of these vitamins for the most commonly used feeds are indicated in these tables. Under the heading "Rations for Fowl" the application of the information on vitamins in this table to the compounding of adequate rations is given in detail. It should be pointed out that when birds are out in direct sunlight all day and have a large range with plenty of fresh succulent greenfeed such as grass, alfalfa or clover, no special supplements of vitamins A and D are required. It should also be noted that rapid curing of greenfeeds greatly enhances their vitamin value, a fact borne out by the high vitamin content of artificially dehydrated alfalfa leaf meals and grasses.

Digestible Nutrients

It is well known that feeds of almost identical nutrient composition are not necessarily of equal feeding quality. The animal body is able to make use of nearly all the nutrients of one feed and very little of another in spite of this similarity in chemical analysis. In other words, a large percentage of the nutrients of one food are digestible whereas much of those of the other are eliminated with the faeces. There is only one way to accurately determine the availability of nutrients in any food, namely, by a digestibility trial wherein the amounts and analyses of foods given are checked against the amounts and analyses of excrement voided, the difference, which has been assimilated into the body, being the amount digested for that particular food. These results are usually given as "Coefficients of digestibility" which represent the percentage of a food or nutrient which is digestible. Digestibility trials with poultry are complicated owing to the fact that the excrement of the kidneys and of the digestive tract are voided together and cannot be readily separated. Consequently very few digestability determinations with poultry feeds have been made. In table 1 the digestibility by poultry of a number of the most common feeds is shown not as coefficients of digestibility but as the actual amount of the nutrient which is digested. For example, barley contains 11·8 per cent of crude protein according to the table but only 8·5 per cent of protein will on the average actually be taken up from the intestinal tract and assimilated into the body. It should be stressed that figures for digestibility which have been obtained on other farm animals are not applicable to poultry. While it is not possible to go into the matter in a publication of this nature, the amount of a nutrient digested is not the ultimate value of that nutrient since, for example, proteins of the same digestibility may not be of similar use to the body each one having its own "biological value" as it is called.

TABLE 1.—AVERAGE NUTRIENT CONTENT OF FEEDS

Feeding Stuff	Dry Matter	Protien		Fat		N-Free Extract		Fibre	Mineral Matter	Calcium	Phosphorus	* Manganese	† Vitamin A	‡ Riboflavin	* Pantothenic Acid	* Choline
		Crude	Digestible	Crude	Digestible	Crude	Digestible									
	%	%	%	%	%	%	%	%	%	%	%					
Barley, common	90·4	11·8	8·5	2·0	1·2	68·0	55·8	5·7	2·9	·05	·36	6·3	400	450	3·6	630
Barley, hulless	90·2	11·6	.....	2·0	.....	72·1	.....	2·4	2·1	.....	.....	.....	.....	.....	.....	.....
Buckwheat	90·4	11·9	7·3	2·4	2·1	63·8	53·5	10·3	2·0	·06	·43	36·3	.....	300	.....	.....
Buckwheat, hulless	89·4	11·2	.....	2·4	.....	73·6	.....	0·7	1·5	.....	.....	.....	.....	.....	.....	.....
Buckwheat flour	87·5	8·6	.....	1·7	.....	75·3	.....	0·7	1·2	.....	.....	.....	.....	.....	.....	.....
Buckwheat middlings	88·7	29·7	.....	7·3	.....	39·4	.....	7·4	4·9	.....	.....	.....	.....	.....	.....	.....
Corn, dent	88·5	9·7	7·3	4·0	3·4	71·1	64·1	2·3	1·4	·01	·30	2·3	3,180	450	3·4	167
Corn, flint	88·5	9·8	.....	4·3	.....	71·0	.....	1·9	1·5	.....	.....	.....	.....	.....	.....	.....
Corn germ meal	93·0	19·8	.....	7·8	.....	53·2	.....	8·9	3·3	.....	.....	.....	.....	.....	.....	.....
Corn gluten feed	90·5	26·4	.....	2·5	.....	48·4	.....	7·1	6·1	·13	·64	10·9	.....	900	6·3	.....
Corn meal	88·8	8·8	6·3	2·5	2·3	75·5	69·4	1·1	0·9	·01	·30	1·8	.....	.....	.....	.....
Cottonseed meal	93·0	45·6	34·7	7·8	6·7	25·1	21·5	8·9	5·6	·23	1·18	8·2	600	450	6·4	.....
Flaxseed	93·6	23·5	.....	36·4	.....	24·2	.....	5·9	3·6	·25	·66	15·9	.....	.....	.....	.....
Hominy feed	90·9	11·0	.....	6·9	.....	65·5	.....	4·8	2·7	·03	·51	7·2	.....	.....	.....	.....
Linseed meal, old process	91·3	35·2	.....	6·3	.....	36·3	.....	8·0	5·5	·33	·74	18·1	200	900	1·3	.....
Millet seed (proso)	90·7	11·7	8·4	3·3	2·6	64·2	55·9	8·1	3·4	·01	·33	15·9	.....	.....	4·0	.....
Oats	91·1	12·0	8·9	4·7	.....	60·2	41·7	10·6	3·6	·10	·36	16·3	80	400	4·5	423
Oat hulls	93·5	3·8	.....	1·2	.....	51·2	.....	30·6	6·7	.....	.....	.....	.....	.....	.....	.....
Oats, light weight	91·3	12·3	.....	4·7	.....	54·4	.....	15·4	4·5	.....	.....	.....	.....	.....	.....	.....
Oats, hulless	91·7	16·2	12·4	6·4	5·7	65·3	59·1	1·9	1·9	.....	.....	9·5	.....	.....	.....	.....
Oatmeal, (rolled oats)	91·5	16·3	12·9	5·9	5·4	64·1	58·3	2·8	2·4	·08	·44	11·8	.....	500	.....	.....
Oat middlings	92·1	15·3	.....	5·5	.....	57·3	.....	9·9	4·1	.....	.....	.....	.....	.....	.....	.....
Pea, field	90·5	23·8	21·0	1·2	1·0	56·2	49·0	6·2	3·1	·08	·40	13·6	2,720	.....	5·0	294
Rice, with hull	89·7	7·9	5·9	2·0	1·4	66·3	55·6	8·8	4·7	.....	.....	9·1	.....	90	.....	.....
Rice, polished	87·8	7·4	.....	0·4	.....	79·1	.....	0·4	0·5	·01	·09	5·4	.....	355	5·0	399
Rice, polishings	90·5	12·7	10·3	11·5	10·9	57·2	51·1	3·0	6·1	·04	1·10	.....	.....	.....	.....	571
Rye	90·0	12·3	8·0	1·7	0·5	71·7	61·7	2·3	2·0	·05	·36	18·1	.....	.....	.....	1,544
Soybeans	90·2	36·9	25·8	17·2	16·0	26·3	20·1	4·5	5·3	·20	·53	14·1	.....	.....	.....	1,566
Soybean oil cake meal	91·7	44·3	36·9	5·7	4·6	30·3	25·2	5·6	5·7	·28	·66	13·1	170	1,800	6·3	.....
Sunflower seed (with hull)	93·1	16·1	.....	24·7	.....	21·3	.....	27·9	3·1	·41	·99	.....	.....	.....	.....	.....
Sunflower kernel	95·5	27·7	.....	41·4	.....	16·3	.....	6·3	3·8	.....	.....	.....	.....	.....	.....	.....
Sunflower oil cake meal	88·7	56·8	.....	6·5	.....	14·4	.....	4·1	6·9	.....	.....	.....	.....	.....	.....	.....
Wheat	89·8	13·1	9·7	1·7	0·8	70·0	62·2	3·0	2·0	·04	·38	14·1	750	450	5·6	417
Wheat, durum	89·6	14·1	.....	2·5	.....	68·6	.....	2·6	1·8	.....	.....	.....	.....	.....	.....	.....
Wheat, shrunken	91·4	11·9	.....	2·6	.....	70·2	.....	4·6	2·1	.....	.....	.....	.....	.....	.....	.....
Wheat bran	90·6	15·8	9·5	5·0	2·5	54·3	29·4	9·5	6·0	·11	1·21	49·0	150	900	11·3	648
Wheat bread (white)	66·2	7·9	.....	0·7	.....	55·4	.....	0·7	1·5	·03	·10	1·8	50	.....	.....	.....

TABLE 1.—AVERAGE NUTRIENT CONTENT OF FEEDS—*Continued*

Feeding Stuff	Dry Matter	Protien		Fat		N-Free Extract		Fibre	Mineral Matter	Calcium	Phosphorus	* Manganese	† Vitamin A	‡ Riboflavin	* Pantothenic Acid	* Choline
		Crude	Digestible	Crude	Digestible	Crude	Digestible									
	%	%	%	%	%	%	%	%	%	%	%					
Wheat flour (red dog)	89·2	16·9	.....	4·0	.....	63·3	.....	2·4	2·6	·07	·59	15·9	60	450	6·3	.....
Wheat flour (white)	87·5	11·5	.....	1·6	.....	73·4	.....	0·4	0·6	.....	.....	.....	.....	.....	.....	225
Wheat germ meal	91·1	28·5	.....	10·7	.....	44·9	.....	2·5	4·5	·07	1·01	72·6	1,900	1,800	3·2	.....
Wheat middlings (standard)	90·0	17·4	13·2	5·5	2·9	56·1	33·4	6·8	4·2	·08	·93	45·4	120	900	7·1	500
Wheat screenings	90·4	13·9	.....	4·7	.....	58·2	.....	9·0	4·6	.....	.....	.....	.....	.....	.....	.....
Wheat shorts (brown)	90·1	17·8	12·3	4·7	4·0	57·0	40·5	6·2	4·4	·08	·93	31·7	180	900	.....	671
Greenfeeds, Vegetables, etc																
Alfalfa (fresh green)	25·4	4·6	.....	1·0	.....	10·4	.....	7·0	2·4	·42	·07	3·2	63,560	2,000	114·4	.....
Alfalfa (fresh, before bloom)	19·9	4·3	.....	0·7	.....	8·2	.....	4·4	2·3	·78	·20	.....	.....	.....	.....	.....
Alfalfa (fresh, after bloom)	29·8	2·9	.....	0·6	.....	11·3	.....	12·8	2·2	.....	.....	.....	.....	.....	.....	.....
Alfalfa hay	90·4	14·7	.....	2·0	.....	36·4	.....	29·0	8·3	.....	.....	11·8	.....	.....	.....	.....
Alfalfa hay, (very leafy)	90·0	16·5	.....	2·7	.....	39·5	.....	22·6	8·7	.....	.....	.....	.....	.....	.....	.....
Alfalfa hay (stemmy)	90·4	12·1	.....	1·4	.....	33·1	.....	36·0	7·8	.....	.....	.....	.....	.....	.....	.....
Alfalfa hay (before bloom)	90·4	19·0	.....	2·7	.....	36·6	.....	22·3	9·8	2·52	·65	16·8	.....	.....	.....	.....
Alfalfa hay, (past bloom)	90·4	12·8	.....	2·1	.....	36·1	.....	31·9	7·5	.....	.....	12·2	.....	.....	.....	.....
Alfalfa leaf meal (dehydrated)	91·9	21·1	21·0	2·8	.....	39·8	.....	16·1	12·2	1·90	·22	11·8	95,000	8,000	18·0	554
Alfalfa leaves (dried)	89·0	21·9	.....	3·0	.....	39·8	.....	14·1	10·2	.....	.....	32·6	32,000	7,000	.....	.....
Alfalfa meal	91·9	15·2	9·6	1·9	0·4	37·9	13·0	28·4	8·5	1·44	·21	11·8	13,000	5,000	17·4	.....
Apples	17·9	0·5	.....	0·4	.....	15·3	.....	1·3	0·4	.....	.....	.....	1,800	22	.....	.....
Beet leaves (sugar)	11·6	1·9	.....	0·3	.....	6·5	.....	1·1	1·8	·15	·08	.....	.....	.....	·6	.....
Beet pulp (dried)	92·0	9·0	.....	0·8	.....	59·9	.....	18·8	3·5	·68	·07	9·5	.....	130	.....	.....
Beet, roots	13·0	1·6	.....	0·1	.....	8·9	.....	0·9	1·5	·03	·06	.....	.....	380	.....	.....
Cabbage, entire	9·4	2·2	.....	0·3	.....	5·0	.....	1·0	0·9	·06	·03	9·5	450	100	.....	.....
Cabbage, outer leaves	15·8	2·6	.....	0·4	.....	7·1	.....	2·7	3·0	.....	.....	.....	.....	.....	·8	.....
Carrots, roots	11·9	1·2	.....	0·2	.....	8·2	.....	1·1	1·2	·06	·07	.....	18,200	120	.....	430
Clover, alsike (fresh)	22·2	3·8	.....	0·6	.....	9·7	.....	5·8	2·3	·35	·18	.....	.....	.....	.....	.....
Clover, red (fresh)	25·0	4·0	.....	0·9	.....	11·2	.....	6·8	2·1	·39	·16	.....	.....	.....	.....	.....
Clover, hay alsike	89·0	12·0	.....	2·2	.....	39·8	.....	27·1	7·9	1·84	·78	.....	.....	.....	.....	.....
Clover hay, red	83·2	11·8	.....	2·6	.....	40·1	.....	27·3	6·4	2·07	·69	19·5	9,000	.....	.....	.....

Clover hay, red (before bloom)	89·6	18·7	.....	3·6	.....	41·8	.....	18·3	7·2	2·35	1·00	.....	.....	.....	.....	.....
Clover hay, red (past bloom)	88·2	12·3	.....	3·6	.....	36·8	.....	28·1	7·4	.....	.....	.....	.....	.....	.....	.....
Clover leaves, sweet (dried)	92·2	26·6	.....	3·2	.....	41·9	.....	9·5	11·0	.....	.....	.....	.....	.....	.....	.....
Clover meal	91·5	13·7	.....	2·3	.....	42·4	.....	25·9	7·2	.....	.....	.....	.....	.....	.....	.....
Grasses, mixed (immature)	29·7	5·1	.....	1·5	.....	13·8	.....	6·3	3·0	·10	·14	.....	.....	.....	.....	.....
Grasses, pasture (mixed)	28·7	5·7	.....	1·1	.....	12·8	.....	6·4	2·7	·25	·19	.....	.....	.....	.....	.....
Grasses, pasture (dried)	90·0	18·0	.....	3·5	.....	40·1	.....	20·1	8·3	.....	.....	.....	.....	.....	.....	.....
Grass, pasture, clipped frequently (dried)	90·0	25·3	.....	3·3	.....	30·2	.....	19·9	11·3	.....	.....	.....	.....	.....	.....	.....
Grass, cereal, before jointing (dehydrated)	.....	20·0	.....	3·0	.....	.....	.....	19·0	.....	·50	·50	.....	140,000	9,500	.....	.....
Kale	11·8	2·4	.....	0·5	.....	5·5	.....	1·6	1·8	·18	·07	.....	45,000	2,240	1·3	.....
Ladino hay	88·1	17·4	.....	2·6	.....	43·1	.....	17·6	7·3	.....	.....	.....	.....	.....	.....	.....
Mangels (roots)	9·4	1·4	.....	0·1	.....	6·1	.....	0·8	1·0	.....	.....	.....	.....	.....	.....	.....
Potatoes	21·2	2·2	1·0	0·1	.....	17·4	14·7	0·4	1·1	·02	·06	1·4	220	55	2·9	481
Potato flakes (dried)	87·9	7·1	.....	0·3	.....	73·6	.....	2·9	4·0	.....	.....	.....	.....	.....	.....	.....
Rape	16·4	2·9	.....	0·6	.....	8·1	.....	2·6	2·2	·34	·07	22·7	.....	.....	.....	1,044
Silage, alfalfa	54·0	10·0	.....	2·5	.....	22·0	.....	14·2	5·3	.....	.....	.....	.....	.....	.....	.....
Silage, corn	20·4	1·8	.....	0·6	.....	10·9	.....	5·8	1·3	.....	.....	.....	.....	.....	.....	.....
Silage, clover	24·4	3·9	.....	1·3	.....	10·4	.....	6·7	2·1	.....	.....	.....	.....	.....	.....	.....
Tomatoes	5·7	0·9	.....	0·4	.....	3·3	.....	0·6	0·5	.....	.....	.....	14,000	900	.....	.....
Turnip	9·5	1·4	.....	0·2	.....	5·9	.....	1·1	0·9	·07	·08	.....	.....	45	.....	426
Wheat fodder, fresh (five inches high)	24·2	6·5	.....	0·7	.....	10·1	.....	3·9	3·0	.....	.....	.....	.....	.....	.....	.....
Feeds of Animal Origin																
Blood meal	91·2	82·2	75·1	1·2	0·6	2·7	1·3	1·3	3·8	.....	.....	.....	.....	.....	.....	.....
Bone meal	94·0	25·8	21·5	2·9	2·8	2·9	2·3	0·8	61·6	27·0	13·0	5·9	.....	.....	.....	136
Bone, green cut	69·6	19·7	.....	25·0	.....	3·8	.....	.....	21·1	22·9	10·4	5·4	.....	.....	.....	.....
Bone meal, steamed	96·4	7·1	.....	3·3	.....	3·9	.....	0·8	81·3	28·8	13·3	2·3	.....	.....	.....	.....
Buttermilk	9·4	3·5	2·9	0·6	0·5	4·5	3·6	.....	0·8	·18	·10	.....	35	1,000	.....	.....
Buttermilk, dried	92·2	33·8	27·7	5·6	4·4	41·9	33·9	0·4	10·5	1·56	1·05	.....	200	11,500	19·8	.....
Buttermilk, semi-solid	35·0	13·4	.....	3·0	.....	15·9	.....	.....	2·7	.....	.....	.....	.....	.....	.....	.....
Cod liver oil meal	94·4	52·5	.....	29·4	.....	8·4	.....	1·0	3·1	.....	.....	.....	.....	.....	.....	.....
Crab meal	92·0	36·5	.....	2·9	.....	7·4	.....	5·7	39·5	13·2	·50	.....	.....	.....	.....	.....
Eggs	34·1	12·8	.....	10·6	.....	.....	.....	.....	10·7	4·0	·22	.....	3,150	2,250	12·2	.....
Fish meal	92·3	58·7	53·2	7·9	7·6	4·1	0·6	0·9	20·7	6·5	3·6	18·1	.....	3,200	3·5	1,498
Fish meal, white (high protein)	93·3	74·0	.....	1·9	.....	.....	.....	.....	17·4	5·8	3·0	.....	.....	4,200	.....	.....
Liver meal (animal)	95·0	65·4	.....	14·0	.....	9·8	.....	0·8	5·0	·11	·90	1·8	.....	18,500	47·6	.....
Meat meal, digester	92·2	61·3	52·3	8·8	8·4	1·5	0·6	1·4	19·2	7·16	3·53	6·8	.....	800	.....	636
Meat scraps, dry rendered	93·7	55·0	49·5	10·7	10·0	1·2	.....	2·2	24·6	8·2	4·0	8·2	.....	3,000	3·5	.....

TABLE 1.—AVERAGE NUTRIENT CONTENT OF FEEDS—*Concluded.*

Feeding Stuff	Dry Matter	Protein		Fat		N-Free Extract		Fibre	Mineral Matter	Calcium	Phosphorus	* Manganese	† Vitamin A	‡ Riboflavin	* Pantothenic Acid	* Choline
		Crude	Digestible	Crude	Digestible	Crude	Digestible									
	%	%	%	%	%	%	%	%	%	%	%	%				
Meat and bone scraps (dry rendered)	93·6	45·9	41·3	11·7	10·9	2·7	.....	2·2	31·1	10·2	4·9	4·5	.....	.....	.....	.....
Milk albumen (dried)	93·7	45·5	.....	11·0	.....	19·5	.....	.....	17·7	.....	.....	.....	.....	.....	.....	.....
Poultry meat (edible portion)	34·7	19·8	.....	14·0	.....	.....	.....	.....	0·9	.....	.....	.....	.....	225	.....	.....
Skim-milk	9·6	3·7	3·0	0·1	.....	5·1	4·1	.....	0·8	·13	·11	.....	15	1,000	.....	.....
Skim-milk, dried	93·8	34·8	31·3	0·9	0·8	50·1	42·6	.....	8·0	1·3	·96	2·3	130	9,000	15·2	726
Whey	6·6	0·9	.....	0·3	.....	5·0	.....	.....	0·4	·05	·04	0·4	.....	.....	.....	.....
Whey, dried	95·0	12·5	.....	0·7	.....	72·1	.....	.....	9·7	·83	·70	6·3	.....	10,000	24·0	317
Miscellaneous Feeds																
Beechnuts	91·4	15·0	.....	30·6	.....	27·5	.....	15·0	3·3	.....	.....	.....	.....	.....	.....	.....
Brewers grains (dried)	92·8	25·6	.....	6·7	.....	42·0	.....	14·8	3·7	·20	·46	9·1	.....	.....	.....	.....
Brewers grains (wet)	23·9	5·7	.....	1·7	.....	11·9	.....	3·6	1·0	.....	.....	.....	.....	.....	.....	.....
Wheat distillers grains (dried)	97·0	27·6	.....	7·1	.....	43·2	.....	15·7	3·2	·12	·49	.....	.....	1,000	.....	.....
Kelp (dried)	90·7	5·6	.....	0·7	.....	43·7	.....	7·5	33·2	.....	.....	.....	.....	.....	.....	.....
Malt sprouts	92·2	26·4	.....	1·5	.....	45·5	.....	12·7	6·1	·19	·70	15·9	.....	.....	.....	.....
Molasses (beet)	80·6	7·7	.....	.....	.....	62·6	.....	.....	10·3	·56	·06	.....	.....	2,000	2·7	390
Peanut oil cake meal	93·4	42·7	.....	8·5	.....	27·0	.....	8·9	6·3	·18	·56	8·2	250	1,350	24·1	1,025
Yeast (dried)	92·0	45·0	.....	3·0	.....	36·0	.....	1·0	7·0	1·26	1·21	·9	.....	17,000	90·7	1,996
Oyster shell	4·0	.....	.....	.....	.....	.....	.....	.....	.....	38·0	.....	45·4	.....	.....	.....	.....
Ground limestone	.....	.....	.....	.....	.....	.....	.....	.....	.....	39·2	.....	90·7	.....	.....	.....	.....

* Milligrams per pound.
† International units per pound.
‡ Micrograms (gamma) per pound.

Analyses in the above table are from—Digestibility and Production Cœfficients of Poultry Feeds, Fraps, G. S., Texas Agric. Exp. Station Bul. 372; Scientific Feeding of Domestic Animals, Klimmer; Technical Bulletin No. 159 Michigan State College; Cornell Bul. No. 660; U.S. Dept. of Agric. Year Book, 1939; Analytical files of the Poultry Division, Central Experimental Farm and by special permission of the Morrison Publishing Co., Ithaca, New York from Feeds and Feeding 20th Edition by F. B. Morrison.

Synthetic Vitamin carriers
Riboflavin.....453,600,000 mcgms./lb.
Calcium pantothenate (d).....416,435,191 mcgms./lb. (Pantothenic Acid)
Choline chloride.....393,634,000 mdgms./lb. (Choline)

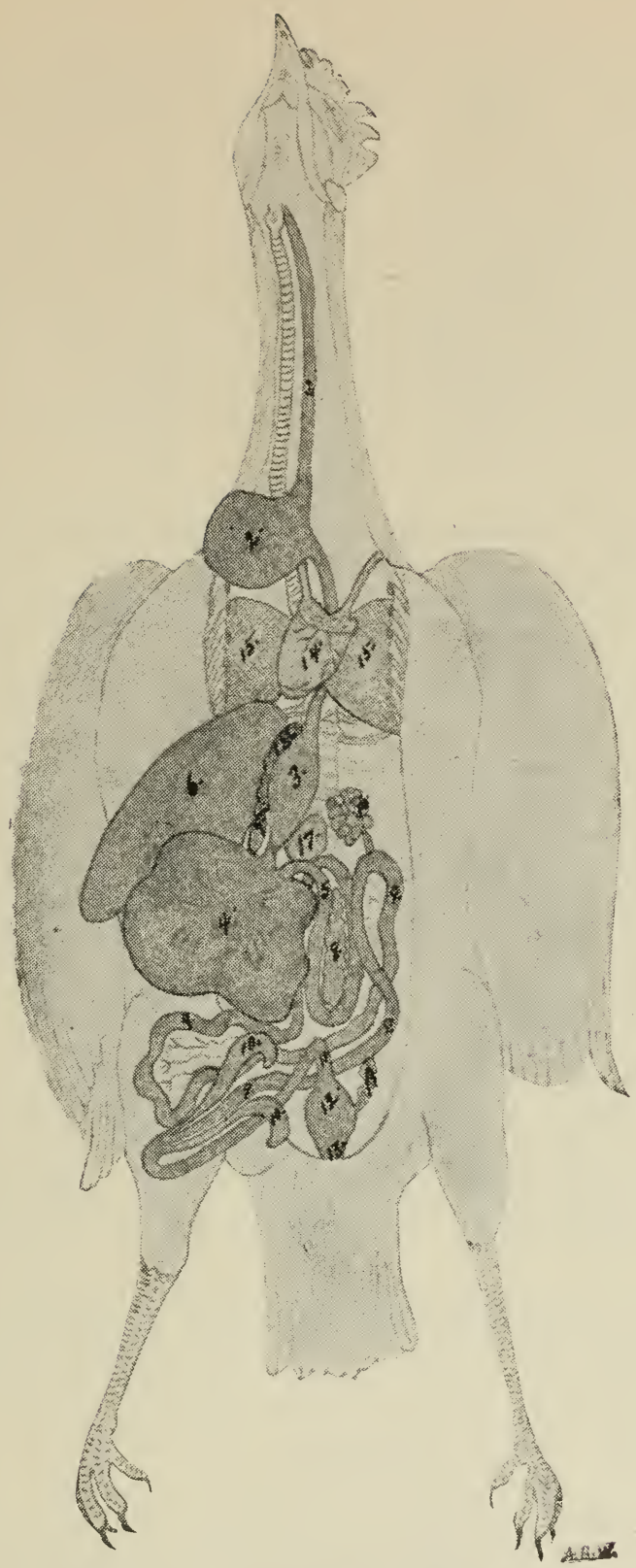


FIG. 2.—Description of plate showing digestive organs of fowl.

The food after entering the mouth passes into the gullet (No. 1), thence into the sack-like enlargement of the former, called the crop (No. 2), from where it passes into the true stomach (No. 3), where it is mixed with the digestive juices, after which it passes into the gizzard (No. 4), where it is ground fine; then into the duodenum (No. 5) (first portion of the small bowel), where a secretion from the liver (No. 6) called bile which is stored in the gall bladder (No. 7) and also the juices from the pancreas (No. 8) are mixed into it; then passes through the long intestine (No. 9) where absorption takes place and into the caeca (No. 10), after which the residue is passed on into the rectum (No. 11) and through a continuation of the rectum called the cloaca (No. 12) (junction of the intestine and the oviduct) to be voided at the vent (No. 13).

Other organs shown are: (No. 14) heart, (No. 15) lungs, (No. 16) ovary, (No. 17) spleen, (No. 18) margin where left lobe of liver has been removed, (No. 19) oviduct.

Original drawing by Dr. A. B. Wickware.

27838—3½

GRAIN FEEDS AND THEIR BY-PRODUCTS

The most commonly used grain feeds for poultry feeding are wheat, corn, oats and barley and their by-products. Other grains such as buckwheat, rye, rice, millet, peas, sunflower seeds and some others are used to a lesser extent for special purposes or in areas in which they are grown extensively. The more important grains will be considered individually as to their relative merits with particular reference to their suitability for poultry rations. The by-products of grains are subject to the regulations of the Feeding Stuffs Act (1937) of the Dominion Department of Agriculture and defined therein.

Wheat

Wheat is the most widely used grain in poultry feeding in Canada, due partly to its extensive production in this country and also to its very desirable nutrient characteristics. Containing 13·1 per cent of protein on the average it is superior in this very important respect to oats at 12·0 per cent, barley at 11·8 per cent and corn at 9·8 per cent. Actually the protein content of wheat varies greatly according to place of origin, precipitation, etc. and from some areas analyses 18 per cent protein. In contrast with oats and barley, wheat is low in fibre. Wheat is high in nitrogen free extract (mostly starch), is highly digestible and has a slightly greater total digestibility of nutrients than the other grains mentioned. Wheat, in common with the other cereals under discussion, while containing a large variety of minerals, does not contain them in sufficient concentration to support normal nutrition in most animals. Having no hull, it is extremely palatable to poultry and will be taken in preference to most other grains. It is exceeded only by yellow corn in its supply of vitamins. Frozen or shrunken wheat is quite palatable to poultry and is often higher in protein than sound wheat.

Actual feeding tests with poultry have shown low grade wheat to be the equal of high grade milling wheat for purposes of egg production.

By-Products of Wheat.—The by-products of wheat are extremely useful particularly those from the outer layers and from the germ because they contain proteins of better quality and a greater concentration of vitamins than the whole grain.

Wheat Bran.—This product consists largely of the outer lavers of the grain and is high in protein of good quality and moderately high in fibre. It is very useful in poultry mashes, not only because of its nutritive qualities but because of its bulky nature which gives a looser texture to ground cereals otherwise inclined to be pasty. Aso, the addition of bulk of this nature creates a more desirable condition in the digestive tract.

Wheat Shorts.—This product "consists of fine particles of bran, germ and a small proportion of low-grade or fibrous flour as separated in the usual processes of flour milling" (Feeding Stuffs Act 1937). Shorts are richer than bran in protein, somewhat higher in fat and less fibrous. Because of the lower fibre content shorts are commonly used to replace bran in mixed feeds for small chicks. An important consideration in evaluating this by-product is its relatively high content of vitamins of the B-complex.

Wheat Germ.—This "is the embryo with not over 25 per cent of other parts of wheat kernel." Wheat germ meal is particularly high in vitamins. For this reason it is used to a large extent in special vitamin feeds for human consumption, a fact which makes it difficult to obtain for feed purposes and somewhat

high priced. When available it has excellent nutrient properties being high in protein and low in fibre and can be used to good advantage in chick feed mixtures.

Bread.—Stale bread is a useful feed, when available, particularly for young chicks.

Wheat Distillers Grains.—This product is becoming available in increasingly greater quantities as wheat is used to a greater extent in the brewing industry. It it high-protein grain feed at 27 per cent and is also a fair source of riboflavin. It is fairly high in fibre but makes a satisfactory ingredient of mashes when used as a substitute for or supplementary to by-products such as bran and shorts. Its relatively high riboflavin content is important particularly where milk products are difficult to obtain or too high in price.

Wheat Screenings.—When wheat comes from the thresher it contains small, broken and shrunken wheat grains, wild oats, wild buckwheat, mustard seeds, chaff, etc., which are separated from the good grain before milling and are called screenings. Naturally these screenings vary widely in composition, those containing a large proportion of wheat, oats and buckwheat being much superior to those high in weed seeds, chaff, etc. The Feeding Stuffs Act (1937) sets forth standards for recleaned screenings under the headings. "No. 1 feed screenings," "No. 2 feed screenings," as follows:—

No. 1 Feed Screenings shall consist of wild buckwheat and broken and shrunken grain and may contain small proportions of other seeds of feeding value and wheat scourings. It shall contain not more than 7 per cent crude fibre, not more than 3 per cent small weed seeds, chaff and dust combined, not more than 5 per cent ball mustard, nor more than 6 per cent small weed seeds, chaff, dust and ball mustard combined, not more than 8 per cent wild oats, and shall be cool and sweet.

No. 2 Feed Screenings shall be grain screenings with or without wheat scourings and containing not more than 11 per cent crude fibre, not more than 3 per cent small weed seeds, chaff and dust combined, not more than 10 per cent ball mustard, not more than 10 per cent small weed seeds, chaff, dust and ball mustard combined, not more than 49 per cent wild oats, and shall be cool and sweet.

Uncleaned Screenings shall be grain screenings excluded from the preceding grades or classes because of the content of weed seeds, chaff or dust, but containing at least 35 per cent of material which, if separated, would classify as No. 1 Feed Screenings.

All but the uncleaned screenings are useful feed and have given satisfactory results in fattening particularly. They should be finely ground because of the hazard of spreading weed seeds.

Barley

Since barley is grown to a greater or lesser extent in all parts of Canada it is an important grain in poultry feeding. It is lower in protein than wheat and considerably higher in fibre. Owing to the coarse nature of its hull, which makes up 15 per cent of the grain, it is not very palatable to poultry except when hulless or when the hull has been mechanically removed. Birds become accustomed to it, however, and will then take it readily. This is particularly true if it has been fed from chick to maturity. The grain supplies slightly more digestible nutrients than oats. Ground and incorporated in the mash mixture it makes a satisfactory feed. It has been commonly used to substitute for corn, being satisfactory provided the ration is otherwise well supplied with vitamin A.

Brewers Grains.—Brewers grains may be fed wet, that is fresh from the brewery, or dried which is the most common form of feeding. They are high in protein and fat but also somewhat high in fibre

Malt Sprouts.—In the course of brewing the grain is sprouted and these sprouts are a by-product of this process and are sometimes used in poultry feeds. They are about the same as brewers grains in protein but lower in fat. As is the case with brewers grains they are only moderately palatable and are therefore better fed as a part of other mixtures.

Oats

Oats are very widely used in poultry feeding and are a home grown feed in all parts of Canada. They are not as palatable as wheat or corn due largely to their very hard, coarse hull. Heavy oats only should be used for poultry feeding as light weight oats may be largely hull and are poor feed at any price. The grain is almost as high as wheat in protein and is higher even than corn in fat. In total digestible nutrients it is considerably lower than either of these grains. In actual feeding practice the oat is very often crimped or lightly rolled so that the kernal is exposed and in this condition is quite palatable to the birds.

During recent years machine hulled oats, known as oat groats, have been obtainable at reasonable prices and have taken the place of whole oats to some extent in poultry feeding. Lacking the hull they are lower in fibre and more palatable. Hulled wild oats are also available and appear to be as acceptable as the domestic groat.

Recent work in which different cereal grains were contrasted as to ability to support growth, egg production and livability tends to indicate that oats when used as the sole source of cereal grain in the ration are more efficient for most of these purposes than corn or wheat.

Oatmeal.—This product, if available at a reasonable price, makes an excellent feed for chicks. It has the disadvantage however that it can be picked out of a mixture by the birds which has a tendency to upset the balance of the ration.

Corn

Corn and its by-products have been used to an increasingly greater extent during the past few years. Although it is largely an imported grain its feeding qualities are such that it is extremely useful for feeding both in grain and mash mixtures. Unlike the other common grains yellow corn is a good source of vitamin A, while white corn is devoid thereof. While lower in protein than the other common cereals, it is higher in fat, with the exception only of oats, higher in carbohydrates (mostly starch) and lower in fibre. Corn is highly digestible and is equalled only by wheat amongst the cereals in this respect and in available energy. It is also very palatable and because of its high fat content, is an excellent winter feed. It is lower in minerals than most grains. For fattening poultry it is superior in gain, in ability to increase fat and in efficiency of production of both gain and fat to all of the other common grains. If white fat is required the white rather than yellow corn should be used.

Corn has a tendency to heat very readily, particularly if high in moisture and must be carefully kiln dried for this reason. Domestic Canadian corn, because of relatively high moisture content, comes in this category.

Cornmeal.—This by-product is largely the whole grain in ground form and is an excellent and much used product. Unless from properly dried grains there is a tendency to heating which should be watched carefully.

Corn Gluten Feed.—Is that part of the grain remaining after the removal of most of the starch and germ in the making of starch or syrup. It is high in protein and mineral but low in starch. It is used more for larger animals than for poultry.

Corn Gluten Meal.—This product is similar to the gluten feed except that the bran has been removed as well as the starch and germ. It is very high in protein and makes an excellent feed when available.

Corn Bran, Middlings and Hominy Meal.—Of these products the bran and hominy meal are usually available. Corn bran is not comparable with wheat bran, being much poorer in nutrients. Hominy feed resembles ground corn but is higher in protein and fibre. It is also higher in fat and digestible nutrients. Hominy meal is usually kiln dried and therefore keeps better in storage than ground corn.

Fig. 3.—Save waste by proper storage of bagged feed. Note raised frames and space between piles permitting better control of rats and mice by cats.

Buckwheat

This grain is characterized by a hard hull and hence high fibre but is relatively high in protein at 11·9 per cent. It forms a small part of most scratch grain mixtures and is very useful in fattening, giving good gains and having a tendency to produce white fat.

By-products of Buckwheat.—As a rule the by-products of this grain are difficult to obtain. When available, however, both buckwheat flour and middlings are highly desirable feeds.

Millet

Owing to the fact that this grain has been greatly improved in recent years through the breeding of very high yielding varieties it is becoming more commonly available for feeding purposes. It is similar to barley and oats in protein and about midway between them in fibre. It is usually found in chick scratch mixtures and has been shown to be at least the equal of barley for egg production when used as 50 per cent of both scratch and mash mixtures.

Soybean Meal

Soybean meal is an oilcake meal of excellent quality running usually 45 per cent in protein and 6 per cent in fat. It may be considered as the outstanding high protein vegetable product for poultry feeding. In order to be most efficient for poultry feeding this meal has to be fairly well cooked in processing, hence a high temperature meal is more valuable for feeding purposes. It has been found that this high protein meal can be substituted almost entirely for the more expensive animal feeds. The oil of this meal has also been found to contain an unknown factor which prevents a brain condition in chicks which has been found in some areas.

Linseed Meal

Linseed meal is the ground cake residue left after the flaxseed has been heated and the oil removed from it. It is very high in protein usually 35 per cent and 6 per cent fat. It is not a desirable feed for poultry and cannot be satisfactorily substituted for animal protein feeds such as meat and fish meal. It apparently contains some unknown factor toxic to poultry.

Peas

Peas are not used to any great extent probably because they are not readily procurable at prices that would make them profitable to feed. They are a valuable and excellent feed and used in combination with other grains, are readily eaten and give very good results. Most chicks and pigeon feeds contain broken peas.

Rice

Rice, largely because it is not generally available at reasonable prices, is rarely used except in the feeding of young chicks. There is often broken rice in all chick grain mixtures, and in special instances it is sometimes boiled and fed like a mash, in which condition it is eaten with relish. Boiled rice is of special value as a regulator in case of bowel trouble.

Rice polishings, which are the polishings from brown rice in the process of refining to white rice for human consumption, are an excellent source of vitamins and when available make a satisfactory supplement to the ration.

Sunflower Seed

Sunflower seeds are used in many scratch grain mixtures and because of their high fat content they are considered to be excellent for fitting birds for show, giving a coveted gloss to the plumage. Even with the hull they are higher in protein at 16 per cent than the common cereal grains and the kernel alone runs as high as 28 per cent protein. The growing of sunflowers for their valuable oil has been greatly increased in Canada and the by-product of this oil production, sunflower oilcake meal gives promise of being even superior to soybean oilcake meal as a vegetable protein feed, running 12-14 per cent higher in protein than

the soybean product. Since tests have shown sunflower oilcake meal to be a satisfactory substitute for the latter its use in poultry feeding should greatly increase.

Rye

Although in analysis rye shows very little below wheat in feeding value, it is in very little favour as a poultry feed. Fowl do not like it and, unless they are forced to eat it by having other grains curtailed, they will consume it in only very limited quantities. It is definitely not a satisfactory feed for chicks. Its by-products are practically not available in this country.

Emmer and Spelt

Common emmer, often incorrectly referred to as "spelts" or "spelt" is grown to some extent in Canada and is used for poultry and the feeding of livestock. Although a member of the wheat family this grain closely resembles barley. Being drought and rust resisting emmer is grown chiefly on the prairies.

Since emmer has approximately the same composition as barley it may replace it pound for pound in the poultry feed. Owing to its hull coat it is much higher in fibre than wheat and hence should not replace more than one quarter of the wheat fed.

True spelt, another relative of wheat, and resembling emmer in composition and feeding value is seldom used in this country except for experimental purposes.

GREENFEEDS

It has been pointed out that grains alone are unable for various reasons to support normal growth, and this applies regardless of the variety and combination of seeds used. This has been shown to be due mainly to the fact, that cereals are relatively deficient in minerals and vitamins. Green feeds, by which is meant chiefly the green leafy part of plants, supplement the deficiencies of cereals in that they are high in vitamins and moderately so in minerals. Hence, growth, which is not supported on cereals alone can be greatly increased by the addition of greenfeeds to the ration. Thin-leaved plants are relatively greater in food value than thick-leaved ones, particularly in so far as their ability to supplement grains is concerned.

Thus it will be seen that greenfeeds in some form are a very valuable addition to the ration and particularly so in the case of poultry where grains and their by-products ordinarly make up from 80 to 90 per cent of the ration.

Form of Greenfeed Supplements

Greenfeeds are available as fresh greens or as a dried product such as in hays and leaf meals or as silage. Both young and mature birds will pick their own greenfeed when out on good range. Confined birds are usually fed fresh cut greens such as grass or alfalfa when in season. During the winter period, however, dried greenfeeds must be relied upon to fill this need. Since they are usually fed as a source of vitamins the manner of drying is important because there is a large loss of vitamins in field curing of hays and in subsequent storage of the dried product unless kept at a low temperature. Vitamin A, which is relatively unstable is the chief loss in curing of hays. Hay which has been rained upon or bleached in curing may be relatively worthless from the vitamin standpoint. For this reason both alfalfa and grasses are now dehydrated artifically with a minimum loss of vitamins and are stored at low temperatures to make excellent poultry feeds. Dehydrated alfalfa leaf meals and dehydrated

grasses are now the most satisfactory known sources of greenfeed and should be used whenever fresh greenfeeds are not available. If these products are not available the leaves of well cured clover or alfalfa which settle out from the mow are the next best substitute, the stems being discarded or fed to cattle or hogs as being too fibrous for poultry. At the Experimental Station at Harrow, Ontario, the steeping of good alfalfa hay for 12 hours before feeding has been found to be excellent practice in that consumption of alfalfa is increased greatly resulting in excellent egg production, health and feather condition.

Alfalfa, clover, and grasses can be preserved for winter feeding of poultry in the form of silage. If well prepared and ensiled it is very palatable to poultry. In some instances, with heavy feeding of silage, yolk colour is adversely affected. Whether this is due to the presence of certain weeds or to green silages in general is not certain.

Garden truck, such as lettuce, the outer leaves of cabbage, rape, kale and similar succulent plants also make satisfactory summer greenfeed. Green crops such as oats, wheat and barley make excellent forage while still short in growth and lawn clippings fresh or carefully dried can be used to good advantage. A bulletin (Publ. 771) covering green feeds and pasture for poultry, in detail, is published by this Division and is available from Publicity and Extension Division of the Department of Agriculture.

Succulent Feeds

Succulent feeds should not be classed with greenfeeds as they are much lower in feeding value. They are usually about 90 per cent water and lower in ash, protein and vitamins. Their chief function is of a regulatory nature and they tend to keep the digestive tract in healthy condition. They should not be considered as substitutes for greenfeed, however, but can be used if green feeds are not available.

Mangels, beets, turnips, carrots, etc., are the principal succulent feeds although raw potatoes may also be similarly classed. Cull apples or windfalls are also sometimes used although they are very low in nutrients. Yellow carrots are perhaps the most satisfactory succulent feed because of their high content of vitamin A.

Sprouted Grains

The use of sprouted grains, especially oats, is common, particularly among breeders. The process of sprouting is fairly simple, but necessitates additional equipment and a great deal of work. Whether the time and labour involved are justified is questionable, particularly if alfalfa or clover leaves, fresh or dry, or good quality alfalfa leaf meal are available. Certainly the practice of sprouting for greenfeed, that is, to two or three inches in length is of doubtful value under these conditions.

In the case of sprouting for green feed the object is to provide a direct supply of green feed during the season when it is not naturally available. If the production of germinated grain is under consideration, that is, sprouts about ½ inch in length a different object is in view, namely, the enhancing of the nutrient value of the grain through the sprouting process. It has been shown for example that the "B complex" value of the grain is greatly increased in the sprouting process.

Methods of producing sprouted oats for green feed and also germinated oats are given below.

Sprouting for Greenfeed.—Soak the oats for 12 hours in warm water, then drain and allow them to stand for another 12 hours, after which they should be spread out about an inch deep where the drainage will be good. Water freely

twice a day until ready for use, which in a suitable place will be in about six or seven days. It may be grown on the floor or in racks. When the grain is ready to feed it is taken out of the trays in a solid mat and torn or cut into pieces to suit the size of the flock. The chicks will tear at this just as they would at a clover sod, eating the roots as eagerly as the tops.

Germinating Oats.—The method where the grain is simply germinated is followed where large quantities are required for the feeding of mature stock. The operation is simple and large quantities may be sprouted with comparatively little labour and in a building too cool to successfully grow the long-sprouted grain.

In this method the grain may be sprouted either in boxes or similar vessels, or on benches, but in either case good drainage must be supplied. Take the grain that it is desired to sprout; put it into a bag; put sufficient water into a barrel so that the bag of grain may be immersed; allow the grain to soak for 24 hours; then hang up the bag for 24 hours to drain and heat, empty the grain into a pile and water; if the room is very cold the grain may be covered loosely with a bag to allow it to heat. The grain should be turned, loosened up, and thoroughly washed at least once a day.

When a sloping bench is used, the grain is started at one end and the sprouted grain removed from the other. Each day as the grain is turned and shaken up it is moved along the bench. A movable board is used to separate the different lots, and as the grain becomes more bulky, more space is allowed. In this may a continuous supply is being worked over the bench. The method is simple, requires no expensive installation, and the minimum amount of labour.

ANIMAL FEEDS

Under the heading of greenfeeds it was stated that leafy materials supplement the deficiencies of grains, particularly in vitamins and minerals. A combination of grains and leafy materials, while supporting growth does not supply sufficient nutrients to bring about normal or optimum growth. It is necessary to supply a greater concentration of protein as well as additional minerals particularly during the early stages of growth. Products of animal origin, mostly in the nature of slaughter-house or fish-plant by-products are usually considered as being the most concentrated sources of protein available. The amino acids of proteins of most meats are complete and satisfactory for growth, thus supplementing the proteins of grains and greenfeeds efficiently in this respect. Meat products are an excellent source of minerals. They also contain some vitamins, particularly in the liver and some other internal organs, but they are not considered to be as efficient and reliable a source of these vitamins as some others, and consequently are not commonly fed for that purpose.

Fresh Meats.—Fresh meat is perhaps the most relished form of animal feed, but there is often difficulty in securing it at a sufficiently low price to warrant its use. Horse flesh is available in some sections and makes excellent feed. Packing-house products, such as livers (see table 1) make the finest of feed and are available not only for feeding for heavy egg production but for the breeding stock as well.

Green Cut Bone.—This is usually prepared by cutting up fresh bones from the butcher shop or slaughter house. Poultry eat it ravenously but should not be given too large quantities. It is only moderately high in protein but is high in minerals, consequently it may be considered chiefly as a mineral addition to the ration, and as such should be given sparingly. As cut bone heats very rapidly, it is impossible to use it except in cold weather, or where a fresh supply for each feed is obtainable.

Slaughter House By-Products.—Under this heading come tankage, meat meal, meat scrap, meat and bone meal, meat and bone scrap, blood meal and bone meal. The feeding tankages may be produced by a wet rendering or a dry rendering process and if the former, are usually called digester tankage because of the process of tanking under live steam. They consist of such residues of animal tissues as are suitable for animal feeding and must contain not less than 50 per cent of crude protein and not more than 35 per cent of blood. If the protein content is less than 50 per cent it must be known as meat and bone tankage and under this classification must not go below 45 per cent of crude protein. Meat scrap or meat meal are either dry or open-kettle rendered residues of not less than 50 per cent crude protein. They must be free from blood except for such traces as may unavoidably occur in good factory practice. If below 50 per cent protein they must be designated as meat and bone scrap or meat and bone meal, but must not contain less than 45 per cent crude protein. This is evidence of the fact that the products lower in protein are usually so because of the high proportion of bone which they contain. Meat and bone meals and scrap are not used in poultry feeding if the meat meal or scrap can be obtained as the proportion of bone is too high. If required, bone can be added to the ration by using bone meal thus obviating the necessity of paying high meat-scrap prices for bone, a much cheaper product.

Blood Meal.—This is very high in protein but an unsatisfactory feed for poultry. The quality of the protein is low principally because the red cell fraction which constitutes approximately 70 per cent of the total protein is of very poor quality. If blood meal is used it must be remembered that its vitamin and mineral content is low in comparison with other products of animal origin such as meat meal and fish meal.

Fish Meal.—In recent years, fish meals have become of increasingly greater importance in poultry feeding. Two reasons for this might be mentioned namely, the fact that up-to-date methods of processing such as vacuum drying have greatly improved the product and a realization, as a result of scientific research, of the real nutritive value of this product. The best quality fish meals contain as high as 75 per cent of protein whose digestibility and biological value is generally considered to exceed that of the meat products. In addition fish meals are higher in all vitamins than meat products (exclusive of liver) and are usually good sources of vitamins. All things considered, fish meals, on the basis of their nutritive value, will undoubtedly become one of the most important sources of animal protein for feeding purposes. Fish meals having a fat content above 6 to 8 per cent, are undesirable, not so much for their fat, which is highly digestible to poultry, but because of the tendency for this fat to become rancid if improperly stored causing, among other things, destruction of vitamins. It may safely be stated that vacuum dried, high protein white fish meal leaves little to be desired as an animal protein feed.

Milk and Milk Products.—Milk has always been considered to be a perfect feed, particularly for young animals. It contains protein of excellent quality, which efficiently supplements the proteins of grains; is high in the important mineral elements calcium and phosphorus; supplies an abundance of energy in its milk sugar and fat and is a good source of vitamin A, and particularly riboflavin. Since skimmed milk only is used the vitamin A and fat removed in skimming are of no importance in animal feeding. As will be understood from the above facts skim-milk is an excellent feed for poultry of all ages. Its chief drawback is its very high water content of 90·4 per cent which makes it unsatisfactory as the sole source of animal protein since poultry cannot consume large enough quantities to obtain sufficient dry matter (9·6 per cent) for their purpose. For this reason skim-milk or buttermilk are usually used to supplement a ration

which already contains animal feeds and high protein vegetable feeds in reduced amount. If this principle is borne in mind skim-milk and buttermilk become very useful feeds for poultry.

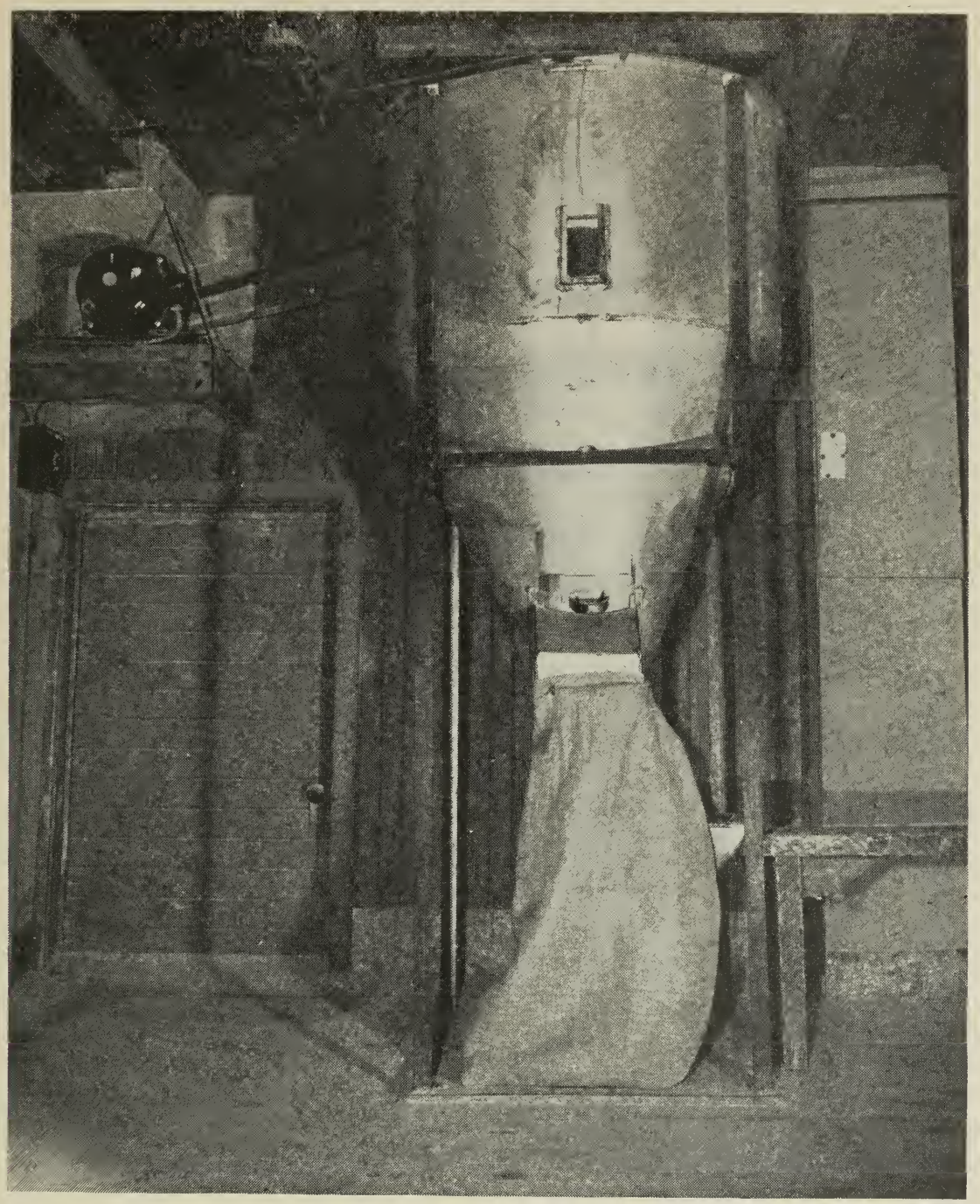


Fig. 4.—A feed mixer saves labour and ensures thorough mixing.

Dried skim-milk or dried buttermilk are excellent poultry feeds and containing only about 6 per cent of water are in concentrated form. They are very high in vitamin B complex some of which is important in hatchability hence these products are useful particularly in breeding rations.

Semi-solid buttermilk, when available, is also a useful product, and to some extent overcomes the matter of high water content.

Whey is used to some extent in poultry feeding but only contains about one-third the protein of skim-milk. The dried product is very useful if purchased at a reasonable price since it is an excellent source of the vitamin B complex.

Eggs.—Eggs are often fed boiled hard to small chicks and even to older stock when available in quantity. Perhaps the only justification for this procedure is the using up of infertile eggs from the incubator. When such eggs are used they must be kept as cool as possible to prevent further deterioration before feeding. They make an excellent feed since they are high in protein, fats and minerals. Egg yolk is, with the exception of fish oils, the most potent source of vitamin D, the vitamin least widely distributed in natural foods. Eggs from stock which is not pullorum free should not be fed because of the danger of spreading the disease to chickens through the egg. In view of existing evidence it is also possible that the disease leucosis might also be spread in this manner.

MINERAL FEEDS

As a considerable percentage of the dry matter in both egg and fowl is composed of mineral elements, it is evident that with a rapidly growing bird or with a fowl that is producing a large number of eggs the demand for food containing these elements will be urgent. Under free range conditions these mineral elements will be largely obtained through the ordinary feeds, and the green food, grubs, and grit that are picked up on the range. When fowls are more or less closely confined, it becomes necessary to supply the mineral foods, and the question of the most suitable form in which they can be obtained becomes important. Besides what is supplied through the feeding of alfalfa, meat meal, bran and other ordinary feeds, it is necessary to feed something that contains these elements in such quantities and in such form that they can be assimilated more freely. Bones, shells, and grit are the feeds that are generally used to supply these requirements.

Of recent years it has been demonstrated that the proper formation of bone requires suitable levels of both calcium and phosphorus. Just what the optimum ratios may be is not yet definitely known. It appears, however, that if the exact adjustment of these minerals could be arrived at, it might be possible to raise chicks without the presence of vitamin D or direct sunlight with normal bone and with complete absence of rachitic symptoms. It has also recently been found that one form of phosphorus, namely phytin phosphorus, can only be used with approximately 50 per cent efficiency. Rations which are apparently adequate in phosphorus may therefore be actually too low if a large part of the phosphorus is phytin phosphorus and not all digestible by the birds. Since the phosphorus of most grains and by-products is high in phytin phosphorus (wheat 46 per cent, oats 52 per cent, barley 63 per cent, corn 58 per cent, bran 85 per cent) most rations are much lower in phosphorus than their analysis would indicate. If a large proportion of the phosphorus in a ration is in the phytin form much larger quantities of vitamins and particularly witamin D are required. In view of these facts allowance should be made for additional phosphorus from an animal source when compounding rations. In table 1 will be found the calcium and phosphorus content of the most commonly used poultry feeds to serve as a guide in the compounding of rations.

Mineral Mixtures.—It has been the practice in some quarters to recommend the use of mineral mixtures supplementary to the poultry ration. As a general rule such mixtures are of an empirical formula and based on judgment rather than actual ascertained fact. The feeds for poultry which have been considered in this bulletin under the various headings when intelligently used with sufficient variety can be counted on to supply sufficient of all minerals which are at present known to be required with the possible exception of calcium. phosphorus, manganese and common salt, special provision for the feeding of which has been made in these paragraphs.

Bone Meal.—As previously pointed out, bones contain calcium and phosphorus in approximately the proper proportions for utilization in the animal body. Bone meals are also a fair source of protein and are often considered as a protein feed but are actually fed as a mineral addition to the ration and therefore in small quantities.

Shells and Limestone Grits.—These are usually given as free choice but are also sometimes included in the mash. It has been shown experimentally that very often laying birds will actually produce a greater weight of calcium in the shells of the eggs which they lay than they have absorbed into the body from their feed even when they have oyster shell free choice before them. Under conditions of high egg production therefore it is advisable to include a small percentage of calcium such as ground oyster shell or limestone in their mixed feed as well as leaving oyster shell or limestone grit before them at all times.

Since the feeds commonly given to poultry are relatively deficient in calcium attention to the matter of supplying this mineral in some supplemental form is important particularly during egg production. Limestone grits should contain 96 per cent or more of calcium carbonate if for no other reason than the probability that low-calcium grits may be high in magnesium which if in sufficient quantity is definitely toxic.

Hard Grit.—It has been common practice in the past to feed hard insoluble grit to poultry for grinding purposes. Experimental evidence to date hardly seems to justify the assumption that such grit is necessary if oyster shell or limestone grit are part of the ration since they apparently supply adequate grinding facilities before going into solution. Whether insoluble grit is essential under any conditions is not definitely proved and in any case hard grit once taken into the gizzard will remain there almost indefinitely if no more is supplied.

Salt.—Common salt is necessary both to ensure palatability and to supply definite requirements for stock of all ages. It usually comprises not more than one per cent of the mash mixtures and usually only one-half per cent in chick feeds.

Manganese.—This mineral has recently been shown to be necessary to vital processes in poultry and has an effect on growth, bone development, egg production and hatchability. Further it is not present in sufficient amounts in common feeds to suffice for all purposes. Since 15-25 milligrams of manganese per pound of the total ration are required, deficient rations should be augmented by the use of substances such as the chemical manganese sulphate or some high manganese feed substance such as rice bran, wheat germ meal, wheat bran or wheat middlings. It is possible by using the information in Table 1 to determine the approximate manganese content of any ration and to know whether and how much supplementation is required. If powdered manganese sulphate is used $\frac{1}{4}$ pound per ton of mash will supply 20 milligrams of manganese per pound of mash or approximately 10 milligrams per pound of ration if equal parts of grain and mash are fed. As the ingredients of the grain and mash will contain from 10-15 milligrams per pound, this addition to the mash is adequate. Since this is a very small quantity it must first be mixed with a small amount of mash then with a larger quantity and so on until good mixing through the whole lot is achieved.

Magnesium.—The mineral magnesium often found at high levels in limestone grits if required by poultry need be present in only very small quantities. Actually if the level of the magnesium exceeds approximately 1 per cent of the ration it is toxic to young chicks. Under practical conditions a sufficiently high

level of magnesium in the ration to be toxic is very unlikely to arise. Limestone containing a high proportion of magnesium is unsuitable however because the calcium content is lowered directly in proportion to the amount of magnesium present and the consumption of limestone is unnecessarily high. In addition high magnesium limestones cause a laxative condition in poultry.

Other Minerals.—While other minerals such as iron and iodine are definitely essential to nutrition in poultry they normally occur in sufficient quantities in commonly fed feeding stuffs that they do not have to be specially added to the ration. In the case of iodine available evidence suggests that it need not be added under most conditions. Some improvement in production of yearling birds and egg shell quality in pullets has been noted when iodinated protein has been fed. Until more evidence is available perhaps the use of iodized salt in poultry mashes will take care of any abnormal situations with regard to this mineral. Whether other less known minerals are necessary is yet to be determined.

MISCELLANEOUS FEEDS

Vitamin Supplements.—As pointed out in a previous section, supplementary substances containing vitamins A and D are essential excepting when birds are out in direct summer sunlight and upon good green range. Since the ultra violet rays which are essential as a substitute for vitamin D do not reach the earth in sufficient quantities during the winter months some source of vitamin D must be fed during this period (October to April inclusive). At the present time fish oils such as cod liver oil and pilchard oil, or blends of oils from various fish are the chief sources of these vitamins.

The majority of these oils are now sold on a biologically tested basis. This means that they are guaranteed to contain a definite number of units of the vitamins A and D. The biological method provides a direct measure of the actual utilizable vitamin potency of an oil. Such biologically tested oils are usually low in free fatty acids (1 to 3 per cent) and are manufactured by careful methods. They are superior to untested oils in every respect and actually cheaper since by purchasing biologically tested oils it is possible to measure exactly the quantity necessary. Vitamin D is considered to be the more important of the two vitamins from the fish oils. For this reason when buying an oil be sure to ascertain the guaranteed vitamin D potency.

Certain other types of vitamin supplements are available for example irradiated 7-dehydrocholesterol which is available as a commercial product and supplies vitamin D. It must be remembered when using this product that no vitamin A is contained therein and special provision must be made to be sure vitamin A is adequate. Several other vitamins are available in pure form as in the case of synthetic riboflavin. Such infinitesimal quantities of these pure vitamins are required that they must be mixed with the greatest care as has been suggested above for manganese. It must also be kept in the dark and under refrigeration when not in use.

Charcoal.—Recent research with charcoal as a supplement to poultry rations seems to indicate very definitely that this product has no beneficial effect for chicks or adult stock. Birds deprived of charcoal did equally as well as those to which charcoal was fed at different levels and were entirely normal in all respects. Under conditions where digestion is abnormal, such as is the case with acid or sour crop, it is possible that charcoal, because of its adsorptive capacity, may have a corrective effect but evidence on this point is somewhat indefinite. The results of some experiments suggest that where a ration has a tendency to be low in vitamin A charcoal may actually be deleterious in that it absorbs some vitamin A from the ration.

Epsom Salts.—Epsom salts are useful as a laxative or purgative depending upon the amount given. They should be given only when needed as evidenced by unthriftness and impaired digestion and in medium doses only. For mature stock not more than 12 ounces per one hundred birds in a wet mash should be given and for growing stock from 3 ounces to 8 ounces per 100 chicks from three to eighteen weeks of age, proportionate increase in amounts.

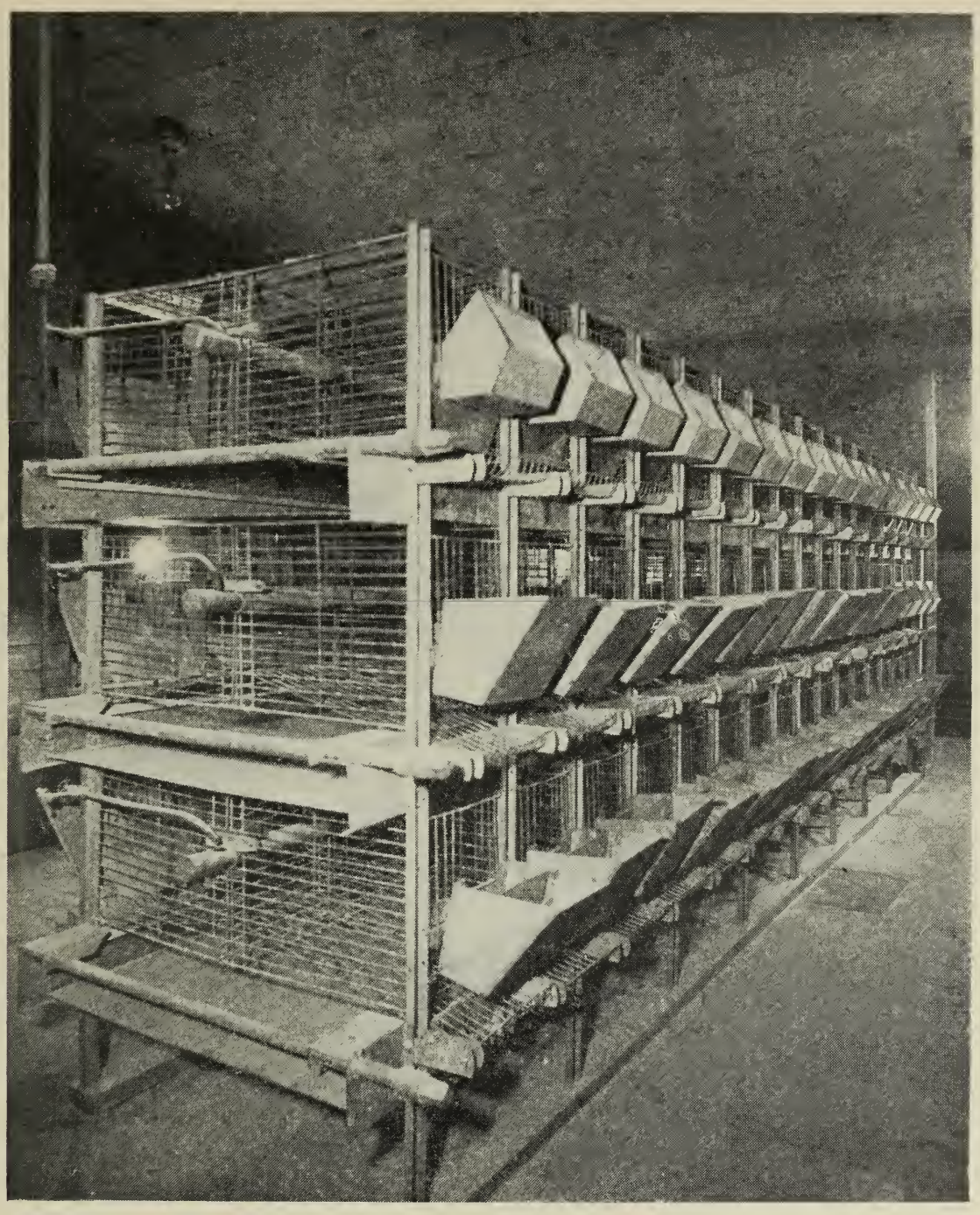


Fig. 5.—A laying battery of 96 bird capacity.

Condiments or Poultry Tonics.—Condimental foods are widely used for egg production. Under conditions of low vitality, usually brought about by some disease condition, a well made-up tonic is probably of some use as a temporary stimulant over a bad period. It has been shown that some of the best condiments are of no value fed over a period to increase egg production and constitute a type of product not to be recommended for poultry feeding.

FEEDING METHODS

For some years past there has been a definite tendency towards simplification of feeding methods. Steadily increasing knowledge as to the nutritional requirements of poultry and better housing and management have improved the condition of stock to such an extent that the great attention to detail in feeding methods once thought necessary is no longer required. For example, it has been found to be unnecessary to feed young chicks sparingly for the first few weeks and to keep feed away from them until the yolk has been absorbed and feed is now given immediately after hatching in unlimited quantities with superior results.

Hopper Feeding

At the present time practically all feeding is on a hopper basis. From the time the chick is hatched through its entire life feed is usually available constantly in hoppers. As a rule a mash mixture is kept before the birds at all times while a scratch grain mixture, if fed, is scattered in the litter on the floor. The practice of feeding the scratch grain also in the hopper is becoming increasingly prevalent and the grain is spread over the mash in the late afternoon. In order to be sure that all birds get a share of the grain a fairly large hopper space is necessary. For chicks not less than eight feet of eating space for 100 chicks is necessary with twice as much required at eight weeks and three times as much at three months. In the case of laying hens not less than 25 feet of eating space per hundred hens is required. The advantage of feeding with grain hoppers is that the grain is kept clean and not contaminated with the droppings and filthy litter of the floor, thus decreasing the possibility of spreading diseases such as worms and coccidia which are spread through the droppings. Its most serious disadvantage exists in the fact that the birds do not scratch in the litter which packs down and becomes covered with droppings thus decreasing its useful life. It has been contended that the exercise of scratching is beneficial to the birds but since equally good condition and production are obtainable when grain is fed in hoppers the justification for such a contention is not clear.

An alternative feeding method consists in leaving both grain and mash available in hoppers at all times for even in some instances keeping individual ingredients of the mash available each in separate hoppers so that the birds have free choice as in a cafeteria plan. Just what the merits of these systems are cannot be safely judged from the information available as they have not been subject to exacting critical test as yet.

Perhaps the most outstanding alternative to the feeding of mash and grain is the all-mash ration. The all-mash system of feeding birds has many advocates, and it seems apparent from research work to date that both young and mature stock will remain normal in every way under conditions where they receive no scratch grain but have a suitable mash mixture always before them in hoppers. This represents the most simple method of feeding yet introduced. Its chief disadvantages would be that it would not be possible to increase the proportion of carbohydrates to protein, when the condition of the birds warranted it, without mixing a new mash to a different formula, whereas with scratch grain the ration may be adjusted at will very simply by increasing or decreasing the amount of scratch grain fed. In addition, a feed of scratch grain just before going to roost probably supplies nourishment for a longer period during the night owing to the less rapid digestion of hard grains. Under northern conditions of cold winter nights this factor may be of importance. A definite advantage of the all-mash ration exists in the fact that the feeder knows the actual level of the various nutrients which his birds are consuming which is not the case with scratch grain feeding unless the grain is weighed out so as to maintain a

reasonably constant ratio of grain to mash consumption by increasing or decreasing the amount of grain in proportion to the amount of mash which the birds eat.

Moist Mash Feeding

The feeding of a daily moist mash was formerly the favourite method among poultry keepers, and even yet many follow this method in preference to the hopper system.

Some prefer feeding it in the morning, some at noon, and some at night. The time is really immaterial, and should depend on the conveniences of the feeder. When moist mashes are fed they should be given only in such quantity as will be clained up in one-half hour or less to avoid fermentation and digestive troubles.

A combination of moist and dry mash feeding is often used, hoppers of dry mash being before the birds at all times and a moist mash being given once a day, usually at noon. Extensive tests upon the Experimental Farms over a period of years indicated that nothing was gained by feeding moist mashes and the time and labour involved are considerable.

The chief advantage of feeding a moist mash is that table scraps and kitchen waste may be fed in this manner, and it is usually a small flock proposition. Moist mash is more palatable to the birds but total consumption of feed is not thereby increased.

RATIONS FOR CHICKENS

Compounding of suitable rations for the different purposes is a matter requiring an intimate knowledge of the feeding values of different feeds, the main features of which have been set forth in this bulletin. Rations giving fair satisfaction are easily made up with the feeds on hand and paying attention only to the most important principles of feeding. However, in order to get optimum growth or egg production the proper balance between various ingredients must be maintained and some judgment exercised in adjusting the ration to suit the environment.

* TABLE 2.—ALLOWANCES FOR DIFFERENT CLASSES OF CHICKENS FOR PROTEIN PHOSPHORUS, CALCIUM AND VITAMINS

Type	Protein required in total feed	Phosphorus required in total feed	Calcium required in total feed	Vitamin A per lb. of total feed	Vitamin D per lb. of total feed	Riboflavin per lb. of total feed	Pantothenic acid per lb. of total feed	Choline per lb. of total feed
	%	%	%	International units	A.O.A.C. chick units	Micrograms	Milligrams	Milligrams
Growing chicks (to 6-8 weeks)...	20	0·6	1·0	2,000	180	1,600	5·0	700
Laying stock.....	15	0·75	2·25	3,300	450	900	2·5	-
Breeding stock....	15	0·75	2·25	3,300	450	1,300	5·0	-

* Taken from U.S.D.A. year book of agriculture 1939 and Report No. 1 of committee on animal nutrition, National Research Council (U.S.).—Revised Nov. 1, 1946.

Availability of the various ingredients will be one of the first considerations and where a limited number of ingredients only are obtainable it will be necessary to choose them so that no essential nutrient is lacking for growth or production

as the case may be. Cost will also always be an important feature and where economies can be made without unduly sacrificing efficiency in the ration, this should, of course, be done.

Before being able to compound rations successfully it is essential that the poultryman know the requirements of different classes of stock for the different nutrients. The table following shows these as closely as can be approximated with present knowledge.

In explanation of the above table it should be stated that the requirements listed can be only an approximation since the need for protein, minerals and vitamins is related to rate of growth, production, etc. As a consequence, requirements diminish steadily during the growth period. For example in protein, after about six weeks the requirement drops from the 20 per cent of the chick starter period to probably 14 per cent just before the birds begin to redden up for egg production. The requirements for laying and breeding stock, on the other hand, are fairly constant so long as production is maintained or hatchable eggs are being produced.

The Brooding Period

As previously mentioned chicks should be fed immediately upon entering the brooder house from the incubator, which is usually at about twenty-four hours of age. From this time on dry mash may be set before them. It is advisable to put down some chick size grit just before feeding and they should have access to fine oyster shell as well.

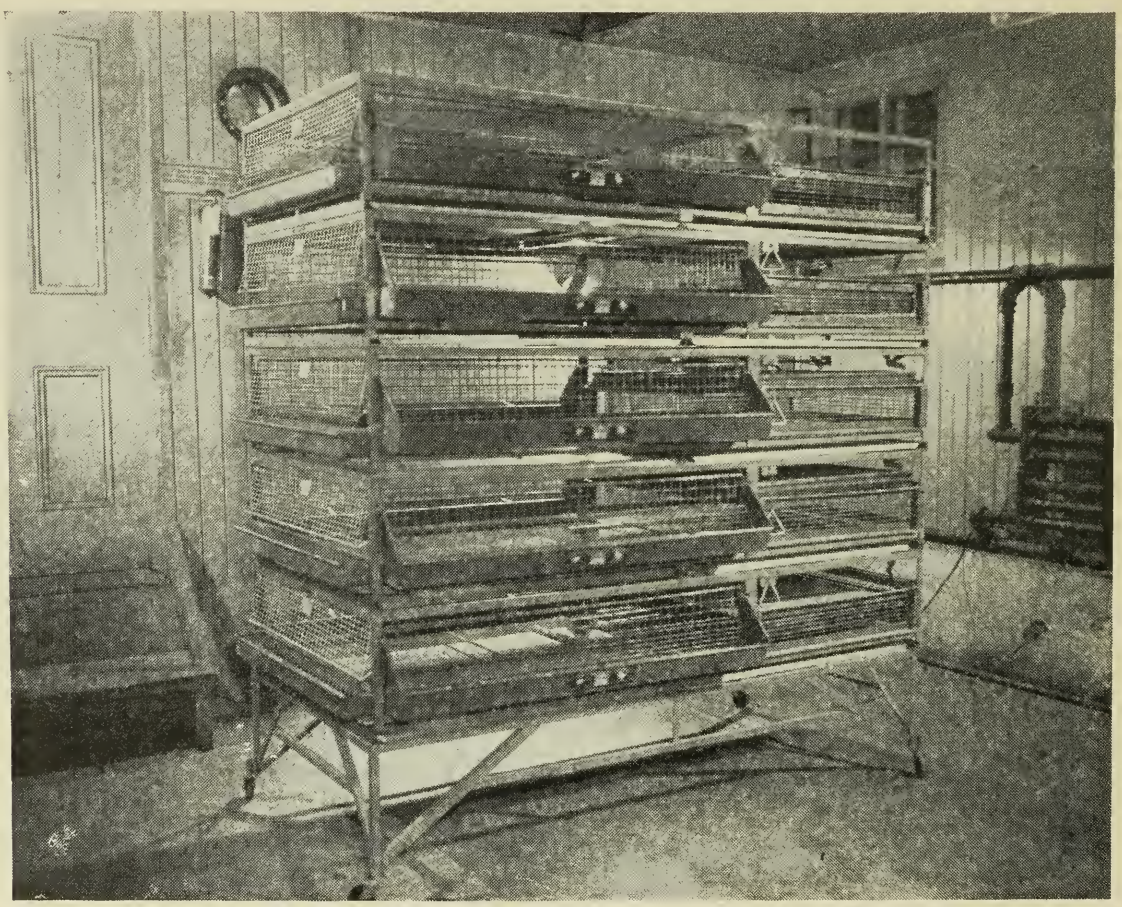


Fig. 6.—A typical five-deck battery brooder.

The brooding period is characterized by a high requirement for protein and minerals as would be expected since growth is extremely rapid at this time. For similar reasons, and also due to the fact that the chicks are of necessity

confined indoors for a large part of the brooding period, their vitamin requirements are also particularly exacting. It is essential therefore that the mash to be used should be considered with great care. Since the actual consumption of feed during this period is relatively low (Table 3) owing to the small size of the chicks, a complete and somewhat costly ration if fed at this time adds very little to the total cost of raising the stock. For this reason it is suggested that it is poor economy to feed inferior rations during this period.

As an indication of the type of mash used during the first 6 to 8 weeks of the chick's life and to show the method of balancing a ration for all the important nutrients according to the requirements of the birds the following starter is given. All data required for these calculations are taken from Table 1.

Ingredients	Protein	Fibre	Calcium	Phosphorus	Manganese	Vitamin A	Riboflavin
lb.	%	%	%	%	Milligrams	I.U.	Micrograms
Ground yellow corn.....25	2·42	0·57	·0025	·075	57·0	79,500	11,250
Ground heavy oats.....20	2·40	2·12	·0200	·072	326·0	1,600	8,000
Wheat shorts.....20	3·56	1·24	·0160	·186	634·0	3,600	18,000
Wheat middlings.....20	3·48	1·36	·0160	·186	908·0	2,400	18,000
Dehydrated alfalfa leaf meal..... 5	1·05	0·80	·0950	·011	59·0	475,000	40,000
Fish meal (high protein). 5	3·70	.....	·2900	·150	90·0	.....	21,000
Meat scrap (55% protein) 2	1·10	.....	·1640	·080	16·4	.....	6,000
Dried skim-milk or buttermilk..... 2	0·70	.....	·0260	·019	4·6	260	18,000
Bone meal..... 1	0·26	.....	·2700	·130	5·9	.....	.....
Total.....100	18·67	6·09	·8995	·909	2,100·9	562,360	140,250
Per pound of mash.....	.....	.....	.....	.....	21·0	5,623	1,402

To take care of vitamin D requirements $\frac{1}{8}$ per cent of a fish oil guaranteed to contain 400 A.O.A.C. units of vitamin D per gram would give 225 units per pound of mash which more than satisfies requirements for growth. Since the above ration has a very large surplus of vitamin A the additional A of the fish oil would not be required hence an oil moderately high in vitamin D and low in vitamin A would be satisfactory. An alternative course would be the use of a straight vitamin D source such as an irradiated cholesterol which does not contain vitamin A. It should be remembered that in this mash yellow corn and dehydrated alfalfa leaf meal are present in large amounts, hence the high vitamin A content, while in many rations the vitamin A of the fish oil would be necessary to meet requirements. When fish oil is added in such small quantities it must be mixed with a small quantity of mash, this in turn with a larger quantity and so on to assure complete mixing.

The above mash is completed by adding $\frac{1}{2}$ per cent of common salt and $\frac{1}{2}$ per cent of ground limestone (95 per cent calcium carbonate) or ground oyster shell to raise the calcium by 10 per cent giving a calcium level of 1·0 per cent which is adequate. The phosphorus and manganese are already sufficient. If, in making up a ration the manganese is found to be inadequate, powdered manganese sulphate at the rate of 4 ounces per ton of mash should be added. While the riboflavin in this ration is below the level given as required (Table 2) it is considerably above the average requirement for the first six weeks of life and is sufficient to assure good, although not maximum growth. Perhaps the most important point which should be brought out by the above analysis is that by suitable choice of ingredients on the basis of values indicated in table 1 adequate levels of all the necessary nutrients can be attained in the mash.

TABLE 3.—WEEKLY BODY WEIGHTS AND FEED CONSUMPTION FOR PULLETS, COCKERELS AND CAPONS OF BARRED ROCK AND LEGHORN BREED AND FOR BARRED ROCK X LEGHORN CAPONS

Age in Weeks	Leghorn Pullets		Leghorn Cockerels		Leghorn Capons		Barred Rock Pullets		Barred Rock Cockerels		Barred Rock Capons		Leghorn X Barred Rock Capons	
	Average Weight per Bird	Average Feed Consumed per Bird	Average Weight per Bird	Average Feed Consumed per Bird	Average Weight per Bird	Average Feed Consumed per Bird	Average Weight per Bird	Average Feed Consumed per Bird	Average Weight per Bird	Average Feed Consumed per Bird	Average Weight per Bird	Average Feed Consumed per Bird	Average Weight per Bird	Average Feed Consumed per Bird
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
0	0·08	.....	0·08	.....	0·08	.....	0·08	.....	0·08	.....	0·08	.....	0·08	.....
1	0·15	0·14	0·15	0·14	0·14	0·14	0·16	0·14	0·17	0·14	0·16	0·14	0·21	0·14
2	0·19	0·38	0·19	0·38	0·19	0·38	0·22	0·38	0·22	0·38	0·22	0·38	0·31	0·37
3	0·24	0·69	0·23	0·69	0·25	0·69	0·38	0·66	0·34	0·66	0·34	0·66	0·43	0·64
4	0·33	1·16	0·31	1·16	0·36	1·16	0·57	1·10	0·50	1·10	0·54	1·10	0·59	1·25
5	0·46	1·75	0·44	1·75	0·48	1·75	0·76	1·74	0·80	1·74	0·83	1·74	0·80	1·78
6	0·63	2·38	0·62	2·38	0·67	2·38	1·05	2·36	1·13	2·51	1·14	2·48	1·03	2·40
7	0·85	3·08	0·89	2·98	0·87	2·94	1·42	3·20	1·49	3·45	1·31	3·13	1·29	3·13
8	1·07	3·94	1·16	3·84	1·12	3·71	1·72	4·22	1·93	4·48	1·66	3·78	1·57	3·70
9	1·30	4·76	1·46	4·79	1·39	4·69	1·86	5·32	2·09	5·77	1·96	4·85	1·83	4·35
10	1·43	5·72	1·71	5·84	1·67	5·81	2·07	6·29	2·33	6·87	2·22	5·85	2·09	5·12
11	1·64	6·46	1·90	6·75	1·93	6·80	2·32	7·39	2·72	8·36	2·52	6·70	2·37	5·77
12	1·76	7·23	2·11	7·79	2·19	7·64	2·49	8·49	3·07	9·90	2·73	8·01	2·64	6·62
13	1·95	8·23	2·37	8·74	2·52	8·75	2·71	9·52	3·22	10·99	2·82	9·09	2·93	8·01
14	2·15	9·15	2·72	9·88	2·66	9·85	2·92	10·77	3·34	12·49	3·13	10·49	3·20	9·43
15	2·47	10·22	3·20	11·20	3·09	11·13	3·15	12·11	3·65	14·09	3·46	11·94	3·48	11·02
16	2·66	11·44	3·40	12·69	3·35	12·64	3·47	13·62	4·03	15·86	3·83	13·68	3·78	12·80
17	2·85	12·80	3·75	14·40	3·68	14·30	3·84	15·27	4·52	17·84	4·45	15·74	4·04	14·53
18	3·07	14·18	4·03	16·21	3·96	16·12	4·05	16·78	4·76	20·33	4·91	18·11	4·32	16·42
19	3·19	15·82	4·30	18·12	4·29	18·20	4·08	18·21	5·23	22·68	5·09	20·26	4·61	18·31
20	3·18	17·11	4·24	19·76	4·34	19·87	4·31	19·73	5·59	24·79	5·44	22·26	4·90	20·06
21	3·37	18·68	4·28	21·52	4·77	21·99	4·49	21·82	5·82	26·95	5·57	24·49	5·14	21·82
22	3·55	20·05	4·71	23·36	4·85	23·91	4·63	23·99	6·05	29·23	5·46	26·67	5·28	23·64
23	3·67	21·40	4·78	25·08	5·08	25·81	4·84	25·55	6·43	31·64	6·49	29·01	5·44	25·53
24	3·70	22·59	4·88	26·55	5·11	27·49	5·11	27·53	6·70	33·65	6·67	30·89	5·88	27·17
25	3·78	23·75	4·92	28·43	5·26	29·10	5·22	29·34	6·87	35·78	6·72	32·82	5·81	29·23
26	3·93	25·00	5·07	29·55	5·37	30·83	5·41	30·86	6·91	37·64	6·98	34·79	6·13	30·71

Special mention should be made of protein. The high protein feeds comprise the most expensive part of the ration. Any lowering of the level of protein which can be accomplished without too greatly reducing the efficiency of the ration is therefore economically worth while. Experimental evidence indicates that 20 per cent of protein gives maximum growth with the greatest efficiency of utilization of feed. This being the case, where maximum growth is required, as in the production of broilers a ration of approximately 20 per cent protein is indicated. For growing pullets, however, satisfactory growth with similar body weights, egg production and egg weight at maturity can be obtained on much lower levels. This is particularly true if adequate succulent pasture is available. For example, a ration containing a protein level of 16 per cent fed up to 7 weeks of age and which was gradually decreased to approximately 14 per cent at 24 weeks, has given satisfactory results when good pasture was available. All high-protein feeds used in poultry rations need not be from an animal source, however, since soybean meal may be substituted for an amount not exceeding 75 to 80 per cent of the amount of animal feeds used in the mash. When this substitution is made, however, adjustments should be made to maintain the other nutrients at the desired level.

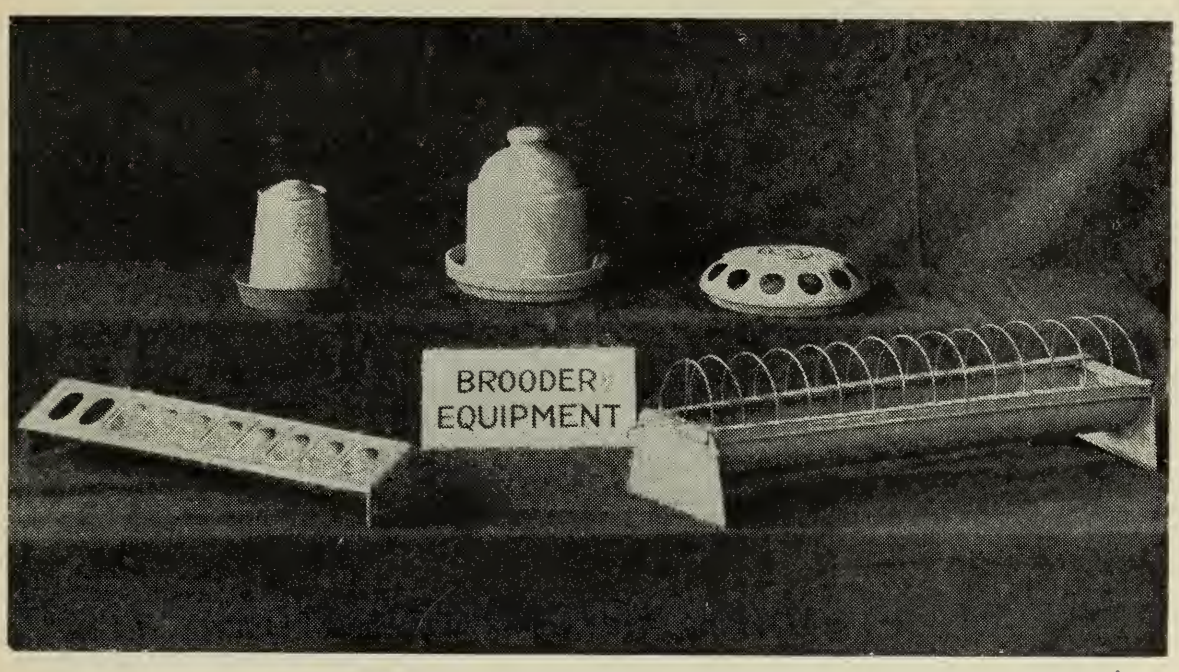


Fig. 7.—Water fountains and feeding hoppers for use with small chicks and during the early rearing stage.

Under some conditions it will be necessary to make certain substitutions for some ingredients of such a mash. While this should not be done unless absolutely necessary some guidance may be given as to what extent it may be done with the minimum of reduction of the efficiency of the mash. For example, if skim-milk or buttermilk is available in large quantities as a drink the buttermilk or skim-milk powder may be eliminated from the mash. If a constant supply is available so that no water is given to drink the fish meal and meat meal may also be reduced by one-half. If either fish meal or meat meal cannot be obtained one may be used in place of the other making due allowance for the higher protein content of the fish meal. If meat and bone meals (50 to 55 per cent protein) only are obtainable a slightly larger quantity must be used and the bone meal may be left out of the mash. The cereal ingredients of the mash should be available under most conditions but where substitution must be made it must be remembered that high fibre feeds such as ground oats and ground

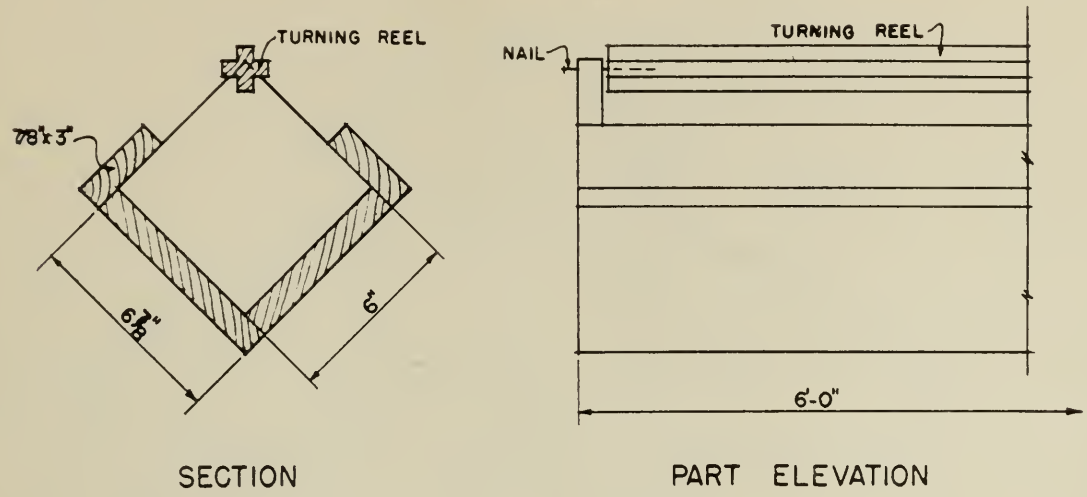
barley are not desirable in large quantities in a starter mash and when used should have the hulls largely sifted out. In making substitutions it should be borne in mind that the ration as above set forth has been calculated to be adequate in proteins, fats, minerals, fibre and vitamins and that any change which appreciably lowers or in the case of fibre, increases the level, of these substances in the ration, may interfere with its efficiency.

Fig. 8.—Simply constructed stand hopper.

The Rearing Period

The rearing period, from roughly eight weeks to maturity, differs from the brooding period in several respects, namely, the chicks are no longer confined and should have continuous access to sunshine and fresh green feeds and the rate of growth gradually diminishes as maturity approaches. For these reasons this period is the least exacting of the life cycle from the standpoint of nutrition. Because of the smaller growth rate the requirements for protein, minerals and vitamins particularly are lessened. The amount of feeds of animal origin such as meat meal, fish meal, milk powder, etc., is reduced in quantity, thus cutting

down the intake of protein and minerals. If any are on good green range so that they have all the greenfeed that they desire, their requirements for vitamin A will be thus met and if in direct sunshine little if any supplementary vitamin D is required thus practically removing the necessity for the vitamin containing fish oil of the starter ration. It should also be noted that with increasing size the chick is able to handle a coarser ration and the necessity for avoiding fibrous feeds is not so important.



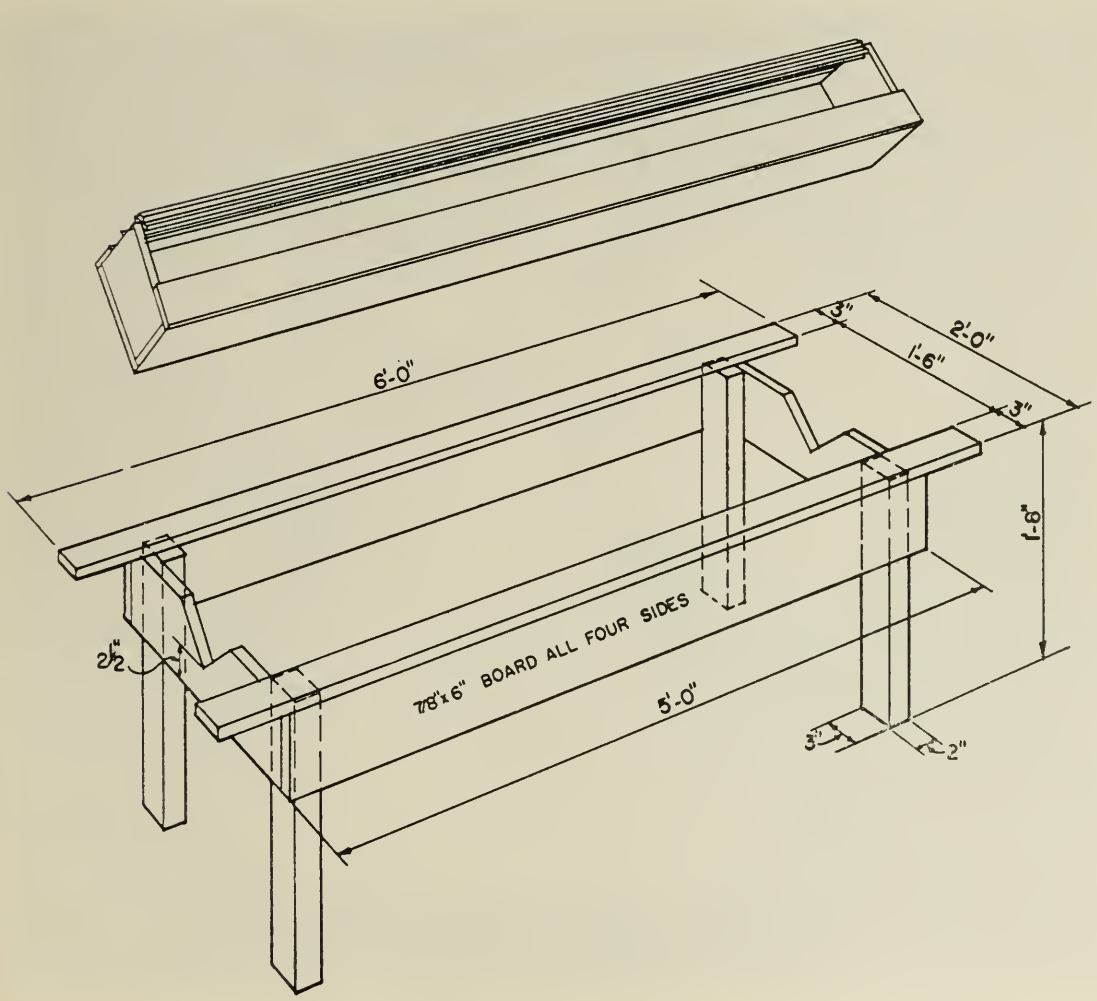


FIG. 9.—Plans for stand hopper.

It is common practice to mix up a ration for the rearing period reducing the amounts of animal feeds and vitamin feeds, using coarser ingredients such as bran in place of shorts and ground oats in place of ground oat groats and eliminating the fish oils. An alternative procedure, however, is to use the same starter ration right up to the time the pullets go into the laying house and relying on the feeding of grain to reduce the protein, minerals, etc., in the ration. For example, a starter ration such as the one above cited will contain approximately 19 per cent of protein whereas a mixture of common grains will contain approximately 11 per cent. If sufficient scratch grain is fed that equal parts of grain and mash are consumed the level of protein in the total ration will be 19+11÷2 or 15 per cent; if twice as much grain as mash is fed there will be 19+11+11÷3 or 13·7 per cent protein in the ration, which is approximately the correct level for birds close to maturity. Thus by starting to feed grain at six to eight weeks of age and increasing the amount fed gradually until two parts of grain are consumed to every one of the starter mash the protein and mineral level of the ration will be gradually decreased parallel with the decreased requirements of the birds. If grains with hulls such as oats and barley are used in the scratch grain mixture the coarseness of the ration is also automatically increased in keeping with the birds' requirements. The advantages of this system are several. In the first place it permits the ration to be changed very gradually and the gradually changing requirements for growth are thereby satisfied. In the second place the increasing proportion of scratch grain fed cheapens the rations sufficiently to make up for the slightly higher cost of starter mash as opposed to rearing mash; lastly starch grain being in many cases a home-grown feed

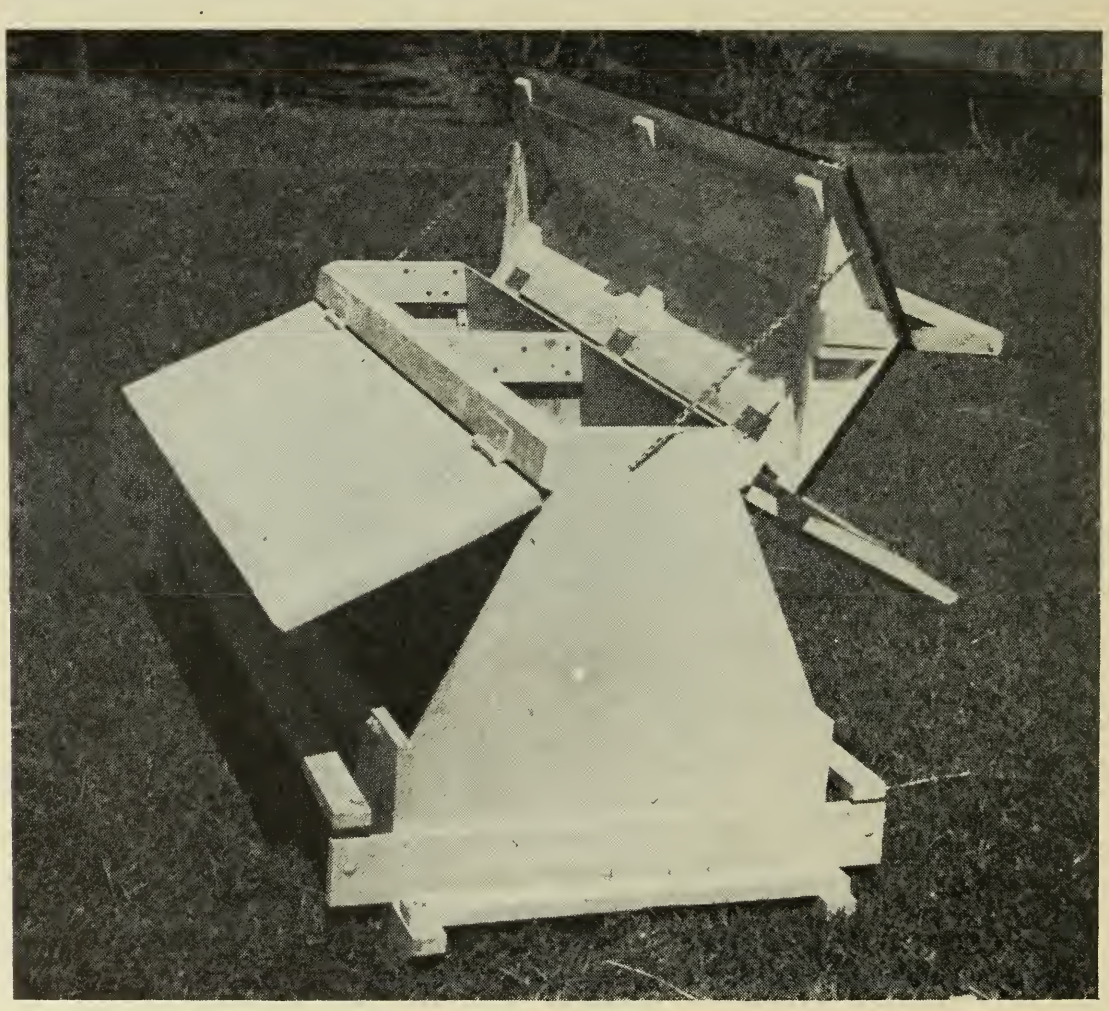


Fig. 10.—Range hopper. Note perches are adjustable for birds of different ages.

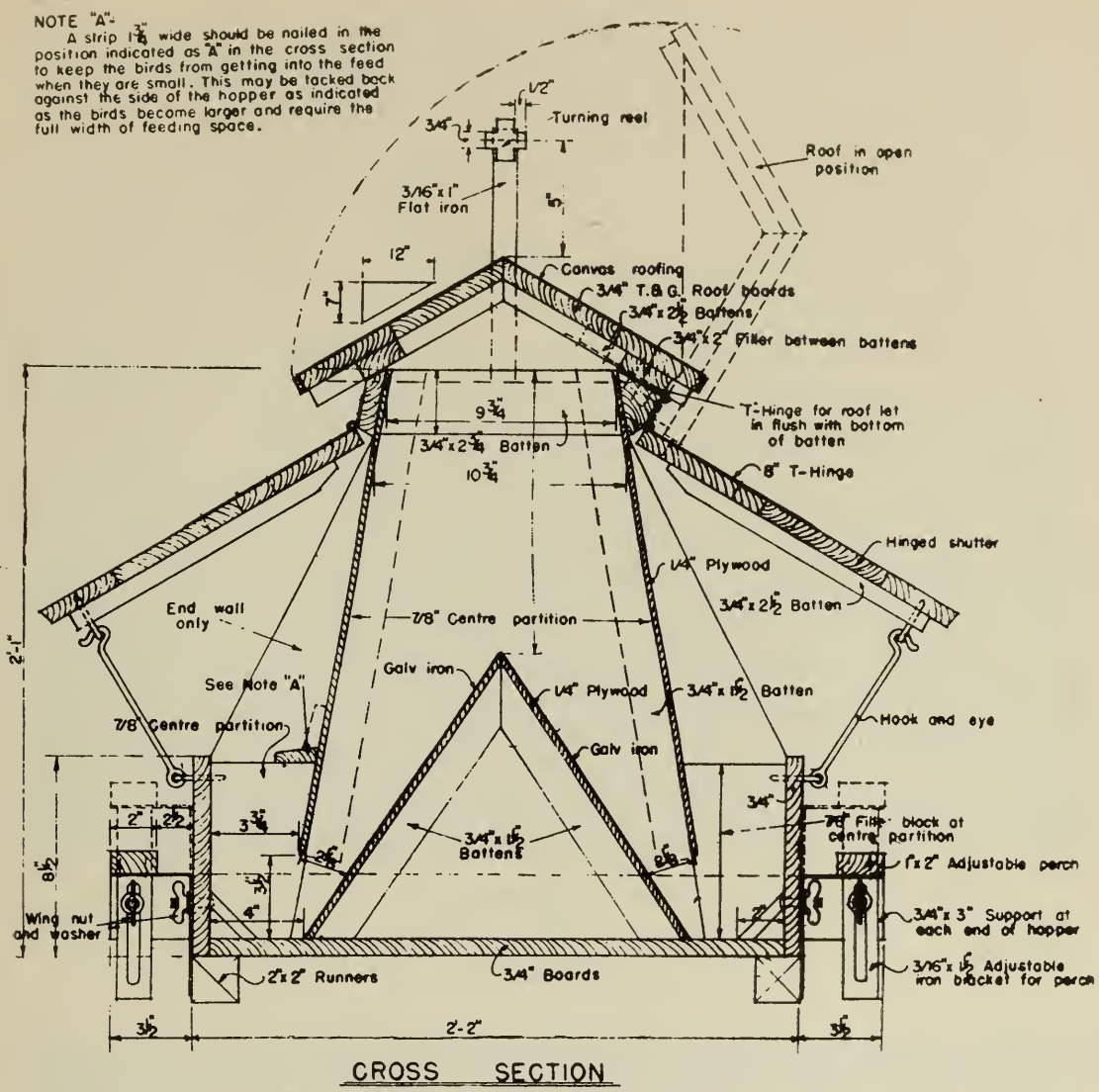


FIG. 11.—Range hopper (cross section).

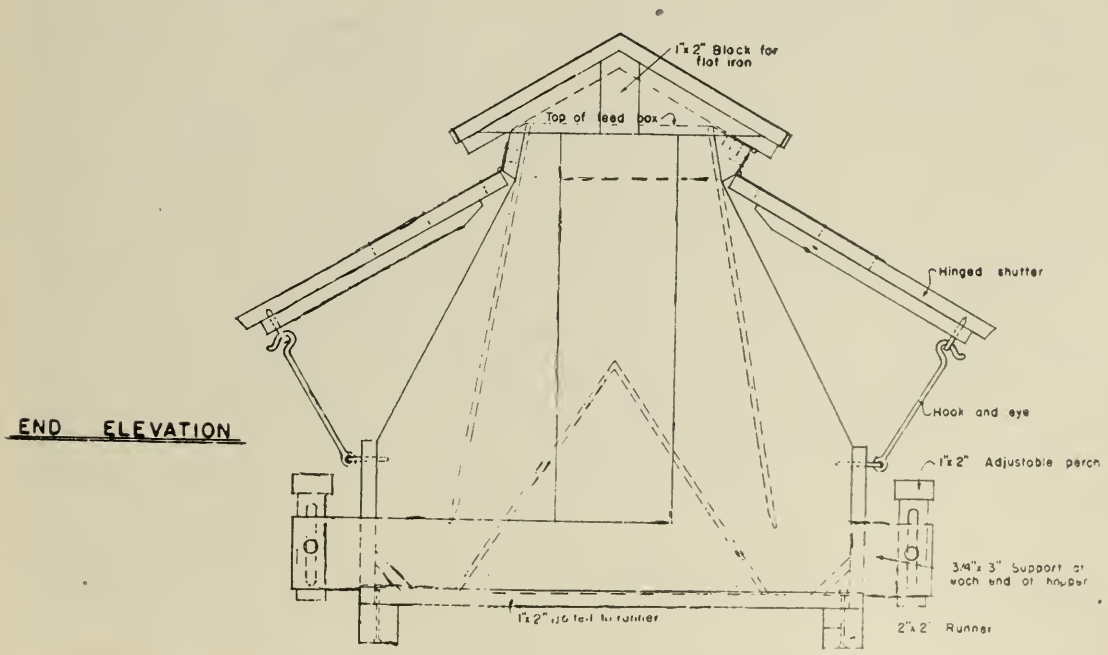


FIG. 12.—Range hopper (end elevation).

it permits the use of a larger proportion of home-grown feeds rather than mill feeds with a consequent saving. It is important to note that if the birds are not on good green range supplements such as fish oil, dehydrated greenfeed and dried milk are definitely needed in the growing ration.

A scratch grain mixture may be made up of almost any combination of grains. Wheat will normally make up a large proportion of the mixture since both oats and barley have the objection of being high in hull. Heavy oats only should be used. Cracked corn is an excellent grain for this purpose and when available should be used at a moderate level.

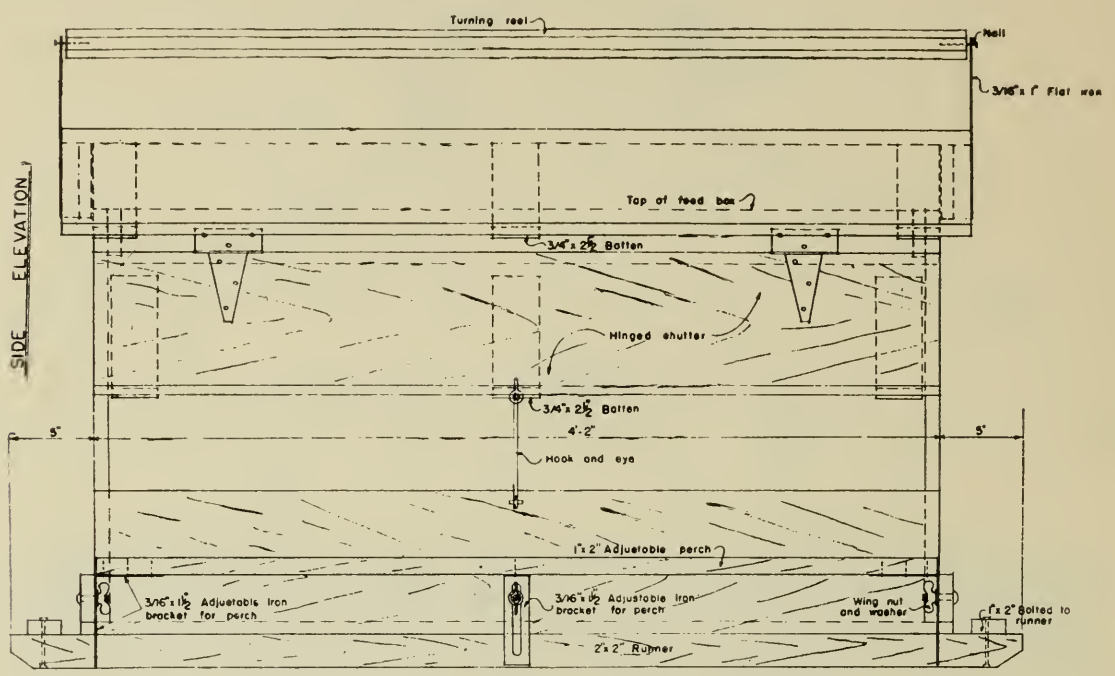


FIG. 13.—Range hopper (side elevation).

Period of Egg Production

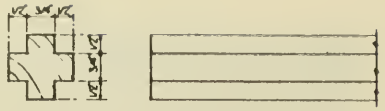
The requirements of laying pullets are more exacting than those during the rearing period and fairly closely approximate those of the brooding period. The requirements for the production of eggs are similar to those for early growth with an added mineral requirement largely because of the production of egg shell. During this period the starter ration outlined is entirely satisfactory with minor changes such as the substitution of wheat bran for the wheat shorts. In order to meet the requirements for egg shell formation 3 per cent of ground oyster shell or ground high calcium (95 per cent) limestone should be added to the mash. In addition oyster shell or limestone grit should always be available in hoppers. The reason for the addition of the ground product to the mash is that it has been found that when given oyster shell free choice in hoppers a large number of pullets do not eat calcium in the form of shell and in their ration to nearly equal the amount they lay out in egg shell and thus are forced to draw calcium from their bones. The fish oil should be increased to $\frac{1}{2}$ per cent of the mash depending on its potency.

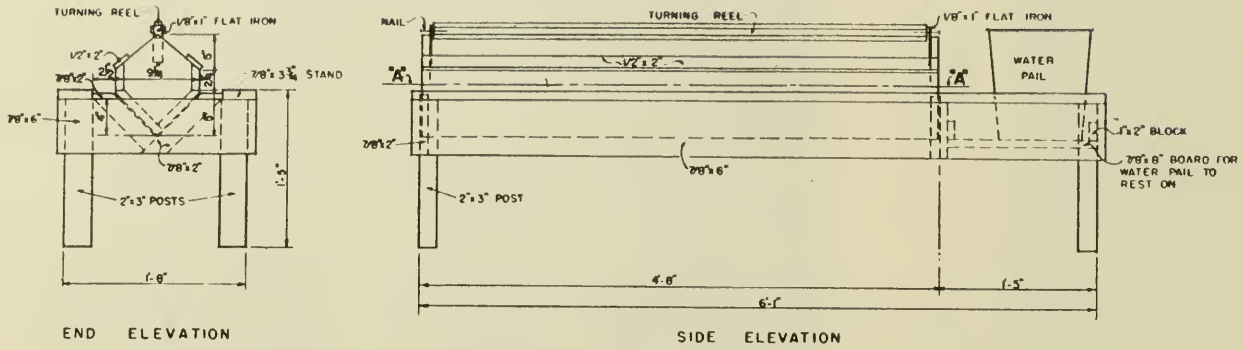
The ration above suggested is to be fed with scratch grain so that equal parts of grain and mash are consumed thus giving a protein level of 15 per cent which apparently is approximately correct for egg production.

Birds which are kept in laying batteries apparently will give satisfactory results with ordinary laying rations provided additional ground oyster shell or ground limestone (95 per cent calcium carbonate) is added to the mash. Approximately 2·5 per cent calcium (6 per cent calcium carbonate) in the total amount of food appears to give satisfactory results.

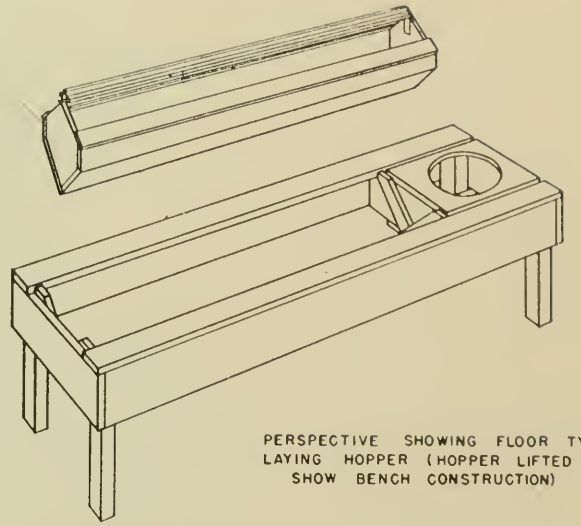
FIG. 14.—A satisfactory wall hopper and water stand.

FIG. 15.—Wall hopper adapted to floor stand.

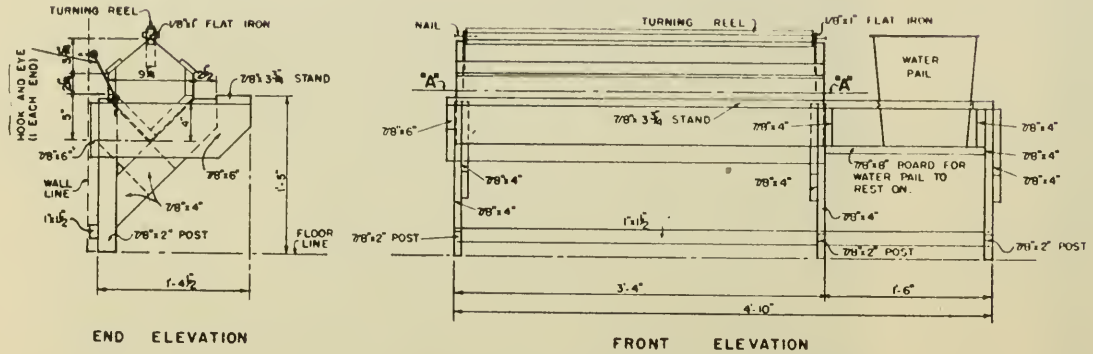




LAYING PEN FEED HOPPER
FLOOR TYPE



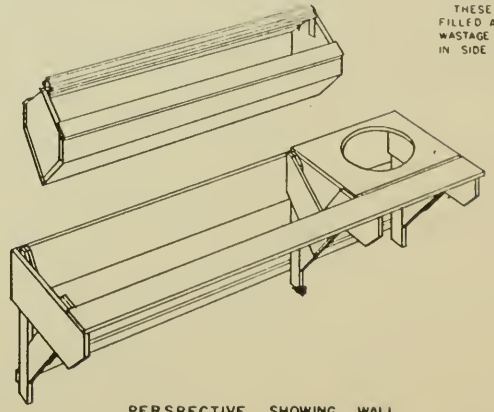
PERSPECTIVE SHOWING FLOOR TYPE LAYING HOPPER (HOPPER LIFTED TO SHOW BENCH CONSTRUCTION)



LAYING PEN FEED HOPPER
WALL TYPE

THESE HOPPERS MAY BE EXTENDED ON THE BASIS OF FIVE HENS PER RUNNING FOOT OF FEEDING SPACE

THESE HOPPERS SHOULD NOT BE FILLED ABOVE LINE "A-A" TO PREVENT WASTAGE. A "V" GROOVE SHOULD BE CUT IN SIDE OF HOPPER AS GUIDE



PERSPECTIVE SHOWING WALL TYPE LAYING HOPPER

Fig. 16.—Plans for wall hopper and adaptation to floor stand.

Breeding Period

This period is definitely the most exacting because to the demands made upon the nutrition of the bird for heavy egg production are now added those of the production of eggs which will hatch. Increasing the fish oil to ½ per cent depending on its potency as was recommended for the laying ration makes it adequate for hatchability in vitamins A and D as can be readily calculated on the basis of requirements shown in table 2. The riboflavin when equal parts of grain is fed however, is only at a level of approximately 900 micrograms per pound and must be increased to 1,300 by substitution or such changes as increasing the dehydrated alfalfa leaf meal or the dried skim-milk or the use of synthetic riboflavin. If skim-milk is available as the only beverage the riboflavin content may thus be sufficiently raised. It must be remembered that equal parts of grain and mash are being fed during the laying and breeding periods and this fact must be taken into consideration when calculating the adequacy of the total ration.

Concentrates

There are at present available on the market what are known as concentrates or supplements such as growing mash concentrate, laying mash concentrate and hatching concentrate. These feed mixtures contain the main essentials of the ration exclusive of the ground grains and their by-products. For example a laying concentrate may contain fish meal, meat meal, buttermilk powder, cod liver oil, salt, ground limestone, manganese sulphate, etc., and may analyse upwards of 30 per cent protein. The purpose of these feeds is to supply the more expensive ingredients which are difficult to obtain in the country and which are costly when bought in small quantities. In most cases the poultryman or farmer finds real difficulty in obtaining some of these ingredients and must necessarily pay the additional cost of small quantity purchasing. In addition broken bags of such products must be held over for later mixing and sometimes deteriorate with improper storage, particularly in summer. In such cases the concentrate serves a very useful purpose in that a farmer can use his own ground grains to mix with the concentrate. In the case of a 35 per cent protein concentrate for example, it is mixed with two parts of home-grown grains to one part of concentrate giving a protein level of 19 per cent in the mash, which mixture in turn is fed with equal parts of scratch grain making five parts of home-grown grains to one part of purchased concentrate. If an all-mash ration is desired five parts of ground home-grown grains may be mixed with one part of concentrate. The advantages of such feeds under some conditions should be obvious.

Deterioration in Feeds

The careful compounding of a ration so that it is adequately supplied with all the required nutrients is no guarantee that the feed will be adequate when fed. Both individual feed ingredients and mixtures are subject to deterioration during storage, vitamins being particularly sensitive to destruction. In so far as storage is concerned the length of storage period and storage temperature are the most important factors governing deterioration. Feeds should be used as soon as possible after mixing and if stored should be at as low temperature as possible. It is poor economy to purchase in quantity to attain a low price and have to store under high temperatures.

Important causes of deterioration are oxidation and incompatability of ingredients used in mixtures.

The destruction of vitamins is most marked when premixes are used. Because some ingredients are used in very small quantities and are therefore very

difficult to distribute evenly throughout a large quantity of feed these ingredients are often mixed together with a carrier of some kind such as middlings, ground oat groats, etc., so that they will have sufficient bulk for proper mixing. These premixes as they are called are sometimes held for long periods and are used as required. If storage conditions are unsatisfactory premixes deteriorate rapidly. The fact that certain ingredients often used in premixes are not compatible greatly increases deterioration particularly of vitamins.

The following cautions when premixes are used should reduce destruction of vitamins to a minimum:

1. Avoid using very finely ground ingredients.
2. Avoid feeds high in fat and store them properly.
3. Do not mix manganese sulphate or common salt in a premix containing vitamin bearing ingredients.
4. Do not use bone meal, calcium carbonate, dried milk products, ground limestone or oyster shell in premixes particularly if they must be stored for long periods.
5. Avoid using finely divided charcoal.
6. Common salt in the iodized form should be used when large proportions of soybean meal are present in mixtures.
7. Manganese sulphate if premixed with iodized salt destroys iodine.
8. Store ingredients and mixtures at low temperatures in dry air.

It should be understood that while the precautions above apply to premixes similar destruction but at a slower rate will also occur in mixed feeds.

Fattening and Finishing

Preparing poultry for market has taken on new interest in the past few years since grading of dressed poultry has made it possible to obtain a premium for high quality. The greatest contribution toward that end can be made through proper feeding during the fattening period. Whether crate fed or pen fed, a mash mixture moistened with skim-milk gives the most satisfactory results. In both crate and pen feeding the most satisfactory procedure is to give two soft feeds daily, morning and evening. Any feed which is not cleaned up in half an hour should be removed and fed elsewhere. In pen feeding at least three weeks and preferably four or more weeks are required to lay down sufficient fat to put the birds in the top grades. In crate feeding, on the other hand, periods of three weeks are rarely exceeded because the inactivity imposed by confinement in crates makes it difficult to maintain the appetite of the birds and they are apt to lose weight. It has been found that as a rule the economical period of feeding does not exceed two weeks in crates owing to the fact that gains are greatly diminished after the second week. Moreover, if proper rations and technique are used practically all birds should be sufficiently fat to enter the top grades after two weeks feeding. As a general rule the appetite and thriftiness of the birds is the best guide as to when the fattening treatment should be ended.

Rations for Fattening

Whole grains are not used for fattening poultry as a rule. Ground grains, however, make up the greater part of the fattening ration. Experiments have indicated that the common grains come in the following order of merit for efficiency in fattening: Corn, wheat and buckwheat (approximately equal), oats and barley. Corn is definitely superior, particularly in gain per unit of feed consumed and in actual increase in fat, regardless of whether white or yellow corn is used. Wheat and buckwheat are slightly less efficient than corn. Oats

and barley, however, are somewhat poorer than the other grain mentioned and are approximately equal in value. It has been shown, however, that the inferiority of these grains is largely due to their high percentage of course hull since ground oat groats were found to be superior to corn for gain, provided the groats were not too finely ground. Whether this would also hold for hulled barley is a matter of conjecture since hulled barley was not used in the experiments cited. It would seem therefore that a fattening mash made up largely of ground corn and ground oat groats, with ground wheat and ground buckwheat as possible alternatives would give the most satisfactory results in fattening. None of these grains should be ground too finely since their palatability is thereby reduced.

Since only relatively white fleshed birds are capable of making the top "milkfed" grades it is advisable to use white rather than yellow corn where white flesh is desirable.

Since fattening feeds are always soft the mixer is important. Experiments have shown that much greater gains can be expected if skim-milk or buttermilk are used for mixing rather than water. Whey has also proved to be the equal of skim-milk for this purpose. Whey which contains a large proportion of washings or which has had water added would be expected to be less efficient in proportion to the degree of dilution which it has undergone.

Numerous supplements to the fattening ration have been tested out such as mutton and beef fat, meat meal, molasses, bone meal and ground limestone. Of these the only ones which gave definitely superior results were mutton and beef fat and meat meal. Up to 7 per cent of the fats may be added to the mash without imparting their flavour to the chicken meat, but at higher levels this disadvantage is met. Fats must be rendered out and mixed quickly with the mash while hot to avoid lumping. Meat meal very definitely increased the gain produced. In the case of all these suplements, however, the cost of the mash is thereby increased and the additional gain must be balanced against this added cost.

From the above the relative usefulness of the different grains may be determined and they may be fed singly or in combination balancing their comparative efficiency against their cost or availability. In any event the feeds mentioned, properly used, are quite capable of not only making relatively cheap gains in weight but of increasing returns through the augmented quality of the product.

Publication No. 745—Fattening Poultry for Market, deals with this subject in detail and is available from the Department of Agriculture, Ottawa, Ontario.

TURKEYS

A. G. Taylor and H. I. MacGregor

Domestic turkeys largely follow the habits of their wild ancestors, and if they are given as much opportunity as possible to gratify their wild instincts, such as ranging over unlimited areas in search of food, and roosting in whatever sheltered tree or nook they may select, there will be a minimum mortality. Kept under such conditions it will be found that the poults will be very little more difficult to rear than chickens.

What has been said in the previous pages with reference to the principles of feeding applies equally as much to turkeys and other poultry as to chickens. The necessity for strict sanitation cannot be too greatly emphasized. The great advance that has been made in the successful rearing of turkeys during recent years is largely due to a realization by growers, of the necessity for feeding in such a way as to avoid contamination of the feed.

All feed given should be supplied in dishes or troughs which are kept scrupulously clean. No feed should ever be given on the ground. The feed containers should be placed on wire covered slats so that any feed spilled will fall through the wire mesh and so prevent the poults from picking it up once it may have become contaminated.

Poults.—The poults are started in the same manner as chicks, that is, they are allowed to rest in the incubator (or under the mother) for a day after hatching to gain strength, after which they are moved to the brooding quarters.

Turkey growers rearing poults in the natural way should start the poults on turkey starter mash in just the same way as the commercial turkey grower who rears them in brooders. It is a good plan to have a water fountain and feed trough available from the time the poults are moved from the nest to the brooding quarters. Take each poult and dip its beak in the water about twice and get it acquainted with the water supply then repeat the same performance at the feed container and this will help in getting the poults to start feeding without delay. If the brood is a large one practice on about 10 to 12 poults and these will soon teach the others to feed. A little time used in this way is time well employed. Skim-milk or buttermilk is an excellent feed if available, but fresh water should be supplied daily.

When turkey poults are being reared in large lots and brooded artificially the usual practice is to feed dry mash to the poults from the start. This mash is fed in small hoppers which are so constructed that the poults cannot tramp in the mash and probably carry infection, which, when taken into the digestive tract might cause disease, principally blackhead. Turkey poults require a starting mash which is much higher in protein than that required for chicks. Experiments conducted at Ottawa show that the starting mash for turkeys should be about 25 per cent protein and that it should be fed for at least six or seven weeks. The development of the poults is the deciding factor as to the length of time starter mash should be fed. A desirable turkey starter should contain a variety of feeds. All the information necessary to formulate adequate rations for turkeys has been given in Table 1 of this publication excepting the nutritive requirements of the different classes and ages of turkeys. These requirements in so far as they are known at present appear in Table 4 following.

TABLE 4.—DESIRABLE LEVELS OF NUTRIENTS IN TURKEY RATIONS

Nutrient	Starter Ration (6 to 8 wks)	Growing Ration (to maturity)	Breeding Stock Maintenance Ration	Hatching Rations
Crude protein, per cent	25·0	Gradual reduction in all nutrients from starting to maintenance levels	13·5	15·0
Fibre, per cent	6·0		6·0	6·0
Minerals—				
Calcium, per cent	2·0		1·0	2·4
Phosphorus, per cent	1·0		0·5	0·8
Salt (NaCl), per cent	1·0		1·0	1·0
Manganese, milligrams/lb	27·0		18·0	15·0
Vitamins—				
Vitamin A, Int. Units/lb	4,000		2,500	4,000
Vitamin D, A.O.A.C. units/lb	800		100	800
Riboflavin, micrograms/lb	2,000		1,000	1,800
Choline, milligrams/lb	900		–	–

The optimum levels of nutrients for different ages of turkeys have not been fully determined. Indeed, there may be several nutrients required by turkeys not yet isolated or identified. The practical method is to include feeds rich in known vitamins at levels that are adequate or slightly in excess. Dried brewers yeast and fresh and dehydrated greens are rich in most known vitamins. These feeds may also contain essential unidentified nutrients.

Table 5 shows feed ingredients of sample turkey mashes calculated to be adequate in known vitamins and other nutrients. These have been calculated for adequacy using table 1 and table 4 in a similar manner to that explained in the section of this publication dealing with rations for chickens (see page 31).

TABLE 5.—SAMPLE RATIONS FOR TURKEYS

*Ingredients	Starter Ration	Growing Mash	Maintenance Ration	Hatching Ration	Hatching Mash
	lb.	lb.	lb.	lb.	lb.
Grains	27·0 or more	39·0 or more	80·0	71·0	47·5
Wheat bran, shorts and middlings	30·0 or less	30·0 or less	5·0	10·0	20·0
Dried brewers yeast	2·0	.....	2·0	2·0	4·0
Alfalfa leaf meal	5·0	5·0	6·0	6·0	12·0
Fish meal	10·0	.....	1·0	3·0	5·0
Meat meal or meat scrap	.....	10·0	.....	.....	.....
Soybean oil meal	20·0	10·0	.....	.....	.....
Bone meal	2·0	1·5	1·5	4·0	7·0
Oyster shell or limestone (fine ground)	1·5	1·5	1·5	1·2	3·0
Granite grit	1·5	2·0	2·0	2·0	.....
Iodized salt	0·5	1·0	0·5	0·5	1·0
Fish oil 1850A/400D	0·5	.....	0·05	0·3	0·5
Manganese sulphate	·02	·02	·01	·02	·02
Total (lb.)	100	100	100	100	100

* For completion and substitution in these rations see the paragraphs following.

Riboflavin should be added at the rate of 1 gram per 2,000 lb. of mash in starter and hatching rations and in the hatching mash.

In addition to the amounts designated in the table, granite grit, oyster shell or limestone grit (95 per cent calcium carbonate) and bone meal should be hopper fed at the rate of 1·5-2·0 per cent of the whole grain consumption in the case of the growing ration, and similarly for granite grit only in the case of the hatching ration. Oyster shell or limestone grit (95 per cent calcium carbonate) should be hopper fed with the hatching mash and hatching ration.

If dried skim-milk or buttermilk is available at low cost it may substitute for part of the fish meal until a maximum of about 10 pounds of dried milk per 100 pounds of mash has been reached. Liquid skim-milk or buttermilk, if easily and cheaply available may be used as a complete or partial substitute for drinking water. In such case protein supplements in the mash could be reduced in proportion to the amount of dry matter in the milk fed (see table 1).

Instructions for Feeding Turkeys

Starter Ration.—Most starting rations are fed for the first six to eight weeks of the turkeys life and are "complete" in that they supply all known nutrients at optimum levels for birds reared in complete confinement. Fresh finely chopped greenfeed may be given daily at the rate of 25 per cent of dry feed consumption. This fresh green feed is greatly relished by the poults but is not a necessary supplement.

Growing Mash.—The poults are gradually changed over to growing mash at about eight weeks of age. Most growing mashes unless specially designed, are not completely adequate and must be supplemented by fresh greens, pasture, minerals and sunshine. The minerals such as bone meal, oyster shell or high calcium grit may well be hopper fed but the amount supplied week by week will depend on the whole grain consumption. Whole grains or whole and cracked grains are usually introduced at six to eight weeks of age so that the poults are able to choose mash or whole grains both of which are hopper fed at will. One acre should normally supply adequate green feed, as pasture, for fifty growing turkeys. This pasture should be clipped or mowed frequently to keep the herbage short and nutritious. Poults may be allowed the use of pasture as early as three weeks of age.

Maintenance Ration.—The maintenance ration is designed as a complete feed for overwintering breeding stock. A yard or pasture will promote exercise for the birds and will make available unfiltered sunshine on bright days.

Hatching Ration.—The hatching ration has been designed for those turkey raisers who do not wish to feed supplemental whole grains during the breeding season. This ration when kept before the birds need only be supplemented by oyster shell or limestone grit hopper fed and freely available. Fresh drinking water daily should of course supplement rations for all ages of turkeys. A yard or pasture should be available to enable the breeders to obtain exercise and greenfeed.

Hatching Mash.—This mash should be hopper fed to the breeders. Additional feeds required are: (*a*) whole grains hand fed daily so that breeders consume about equal parts of mash and grain. (*b*) Oyster shell hopper fed and freely available. (*c*) A weekly feed of granite grit at a rate of two per cent of the whole grain consumption. (*d*) Good quality pasture continuously available at a rate of one hundred to two hundred breeders per acre.

General Notes on Turkey Feeding

The composition of various turkey mashes may be altered to incorporate grains, milk feeds, protein supplements, or green feeds locally available at low cost. For example, fish meal may be expensive and scarce in one part of Canada where liquid skim-milk or buttermilk is abundant and cheap. In this instance liquid skim-milk or buttermilk may be used as a protein substitute for fish meal, being careful to see that the quantity consumed is sufficient to balance the loss in nutrients through the elimination of fish meal (see table 1). Grains carrying hulls such as barley and oats are not palatable to turkeys in the coarsely ground form so they should be finely ground when incorporated into mashes for young turkeys. Oats may be rolled or flattened when incorporated into mashes for older birds. Hulless grains such as corn, wheat and hulless oats may be cracked, coarsely ground or rolled when incorporated into mashes for all ages or sizes of turkeys. If mashes or rations are fed in amounts which will be consumed daily, then selection by the turkeys of individual ingredients because of their coarse size from a mash or ration will be of minor consequence.

Mashes or rations are sometimes commercially available in pellet form. The pellets are sized to suit the kind or age of bird. Pelleting completely prevents selection of ingredients from a mash mixture. Rations in pelleted form may cost five to ten cents per hundred pounds more than in the unpelleted form.

GUINEA AND PEA-FOWL

Guinea and pea-fowl, and birds of similar nature, are handled in the same manner as turkeys, and the ration suitable for the one is equally suitable for the others.

DUCKS

Ducks are voracious feeders, and it is necessary to supply roughage in the form of green feed, or roots, liberally. Otherwise, if they are fed generously, not only will the keeping cost be too high, but they will become too fat to reproduce properly.

If ducks are on grass range they will thrive on any ration that is suitable for ordinary fowls, but for profitable production it is advisable to feed largely on coarse, bulky feeds.

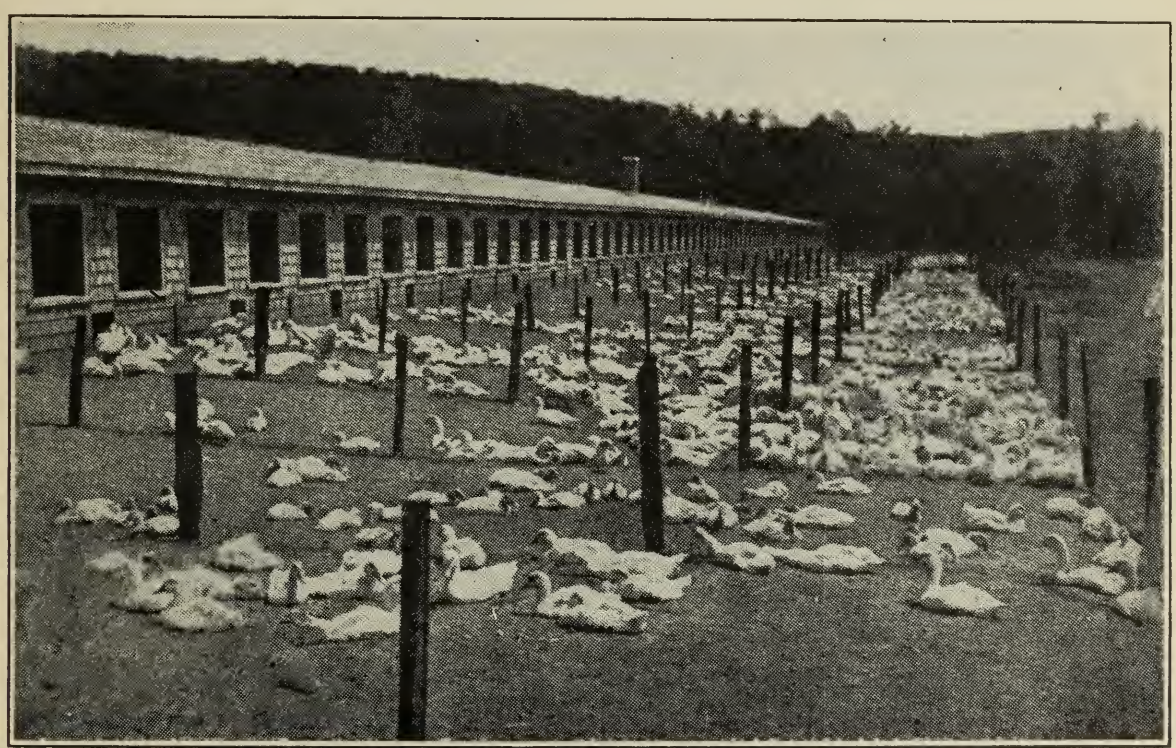


Fig. 17.—Scene at Brome Lake Duck Farm, Knowlton, Que., where 20,000 to 30,000 ducks are raised annually.

Ducklings.—When the ducklings are put into brooding quarters they are supplied with fresh water and for the first couple of days moistened mash is kept before them all the time; this is changed from time to time so as not to allow it to become stale. When the ducklings have learned to feed properly regular feeding times are established, the rule being about five feeds a day.

The mash used at the Central Experimental Farm is made up of equal parts bran, shorts and ground corn, 10 per cent meat meal, 2 per cent fine oyster shell, and 2 per cent fine salt. A sprinkling of coarse sand is added to the mash at moistening time. Tender greenfeed, chopped fine, should also be added after the

ducklings have learned to eat well. The greenfeed should be added gradually and care taken to make sure that the greenfeed is being eaten with the moist mash. By the beginning of the third week the greenfeed may have reached 20 per cent of the mash ration which is about the maximum amount that the ducklings will consume. Green alfalfa or clover provide excellent material for duck mashes. Where the material cannot be obtained in its green form, alfalfa leaf meal may be used.

This ration is continued for about seven weeks when the flock is divided and those ducks to be reserved for stock purposes are given a large run where they have access to a stream and where they can forage for much of their feed, while those intended for market are put on a fattening ration.

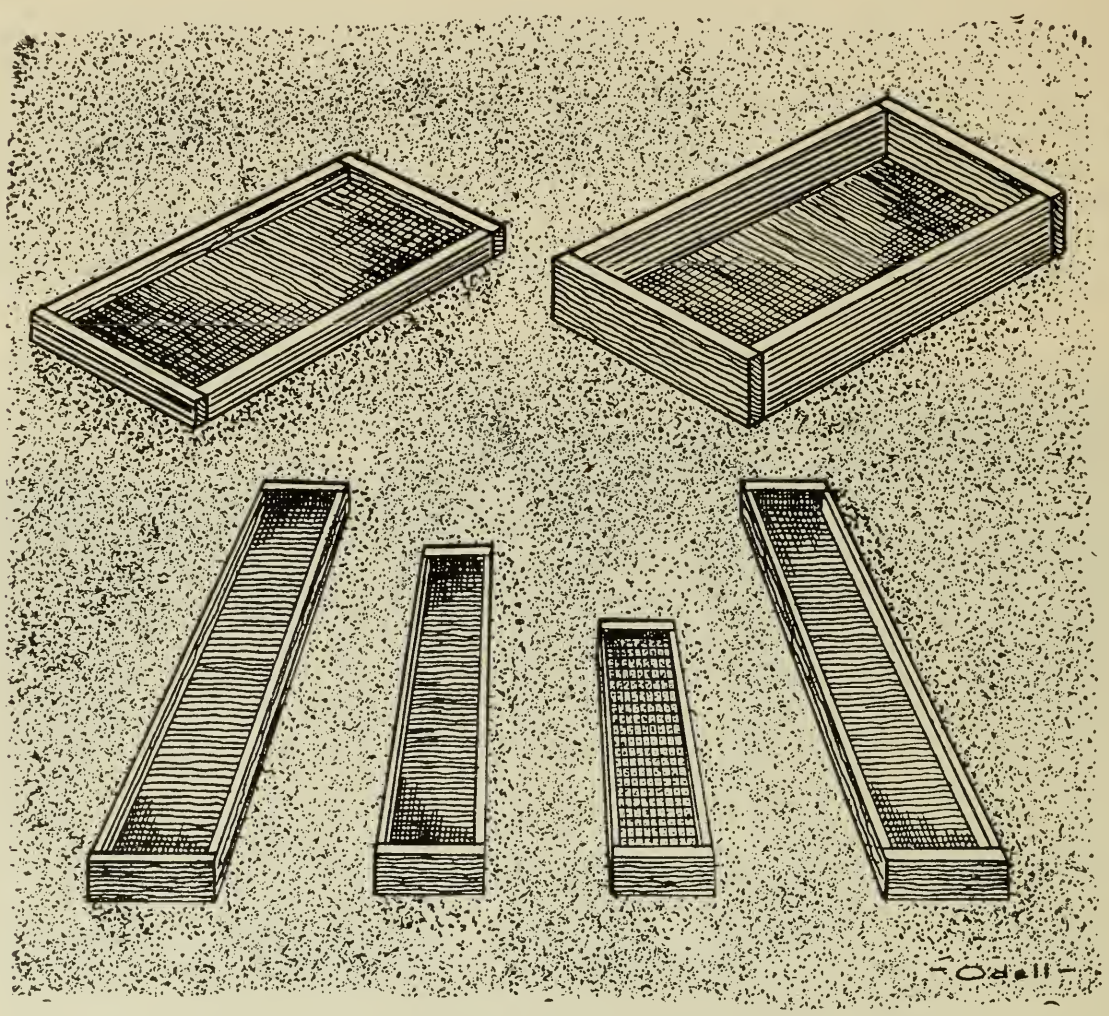


FIG. 18.—Simple troughs—This type of trough has been found very useful. Those on the top which are made out of 10 or 12-inch boards about 12 or 15 inches long are convenient for feeding mash to chicks or hens. For chicks a strip about 1½ inches high is nailed around the board, for hens a strip 3 or 4 inches wide is used. Those on the bottom row are similar except that they are made long. They are used for duck feeding. The third trough from the left illustrates how the same type of trough may be arranged for feeding chicks dry mash. A strip of ½ inch mesh wire is laid over the feed to prevent the chicks from scratching it out.

Fattening.—For fattening the proportion of corn is increased and the greenfeed gradually eliminated. At the beginning of the eighth week the mash is made up in the proportion of 50 pounds of ground corn, 32 pounds of shorts, 15 pounds of meat meal, 2 pounds of fine oyster shell and 1 pound of fine salt. A sprinkling of coarse sand is added at mixing time.

By the time the ducklings are ten weeks old they should be in prime condition for market. If they are kept past this period they will go into a moult,

with a consequent loss of weight and will not again be in fit condition to dress until the moult is completed. This will mean that any profit will be greatly reduced if not entirely eliminated.

Stock Ducks.—After ducks intended for breeding purposes are separated from the market stock at seven weeks of age, they are given a light feed in the morning and a full feed at night of the following mash: bran 3 parts, shorts 2 parts, ground corn 1 part, with 5 per cent meat meal and 3 per cent sand, and as much greenfeed as they will eat. One of the feeds or at least a part of it, should consist of mixed grains, principally oats and barley. If the range is good, the morning feed is omitted altogether. They are continued on this ration until a few weeks before eggs are wanted, when they are given a mash consisting of 4 parts ground corn, 2 parts bran, 2 parts middlings, 1 part meat meal, 3 per cent sand, equal parts of either boiled or finely pulped vegetables, and of cut clover or alfalfa as much as they will consume. The mixed grain is also continued.

Changes from one ration to another are made gradually; the rations are varied according to conditions.

GEESE

Geese, like ducks, require a large proportion of roughage in the ration. This is best supplied in winter by the use of alfalfa or clover hay and roots, and in summer by grass. Given the range of a good pasture, a flock of geese require little else unless it is desired to force rapid growth.

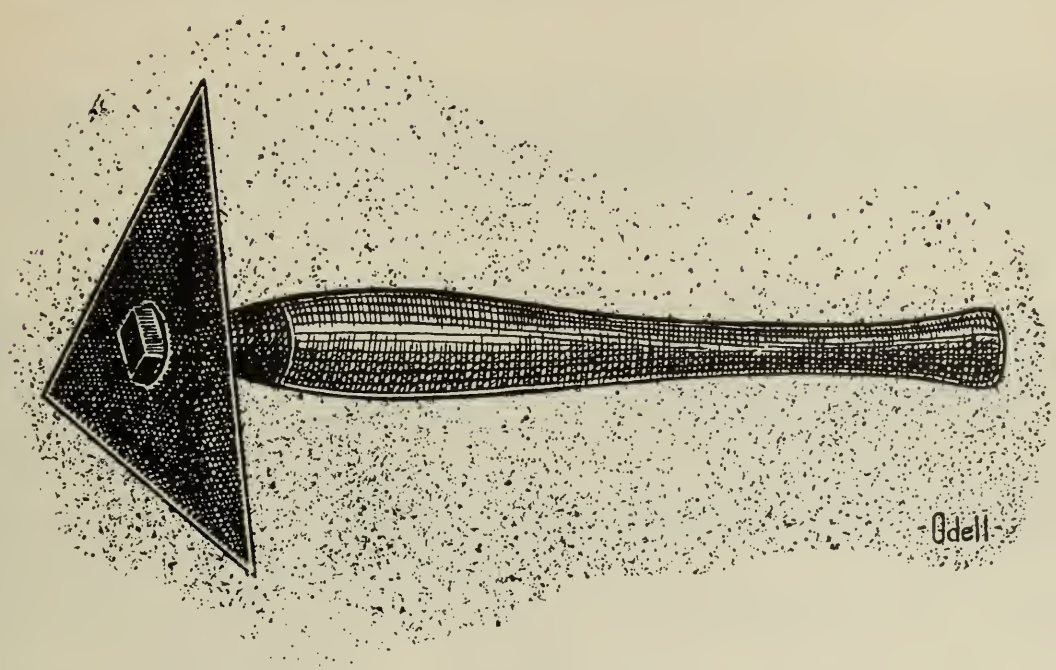


Fig. 19.—Convenient Tool—A scraper similar to that shown in the illustration will be found to be very convenient for cleaning out troughs and doing similar work.

Goslings.—Goslings require warmth and rest the first day, and it advisable to leave them undisturbed. On the second day they should be placed where they will have free access to a plot of tender grass, otherwise they should be supplied with all the succulent greenfeed they will eat, together with mash fed three times a day. The feeds recommended for ducklings are equally suitable for goslings. If it is intended to market the goslings as green geese, it is advisable to feed them mash heavily from the start. If they are intended for stock purposes, it is better, as soon as the goslings get strength enough, that they be

FIG. 20.—A Pair of Breeders. Canada (Wild) Geese at the Central Experimental Farm.

FIG. 21.—Stock Ducks on Range at the Central Experimental Farm. An ideal place to raise the breeders.

allowed freedom to range on the pasture lands, where they will pick up most of their feed, requiring only a light feed of mash in the morning and grain at night.

Fattening.—At six or seven weeks of age, goslings that have been forced from the very start are put on a ration similar to the one recommended for fattening ducks, and should be ready to market at about 12 weeks of age.

Where geese have been kept on pasture all summer, they are penned in the fall and fed heavily on mash feed composed of whatever grains are most available (corn being in especial favour for this purpose), and an occasional feed of whole grain to whet the appetite. The fattening period usually lasts from three to four weeks.

Stock Geese.—After the breeding season the geese on range may subsist practically on the pasturage. If the grass gets short or dried up, it may be supplemented with mash or greenfeed, but so long as there is good pasturage no other feed is necessary.

During the winter, the breeders should be fed all the clover or alfalfa hay and roots they will eat, but grain should be fed sparingly (just a light feed morning and night), dependence being placed largely on the coarse grains like oats and barley, only enough wheat and corn being allowed to add variety to the ration. As laying time approaches, a light mash may be added, and when in full lay, the mash feed may be increased.

Poultry Publications Available

The following publications dealing with poultry are free upon request and should be ordered by publication number (if shown) and title from the Information Service, Department of Agriculture, Ottawa.

Publication No.

41 Grow Healthy Chicks
57 Conservation of Egg Quality
64 The Range Rearing of Chicks
482 Improved Market Type in Poultry Breeding Stock
500 Farm Flock, The
511 Goose Raising
541 Poultry Feeds and Feeding
581 Poultry, Preparing for Market
587 Turkeys, Their Care and Management
594 Poultry, Standard Methods for the Preparation of Market
640 Colony Houses
671 Incubation, Natural
675 Control of External Parasites of Poultry and Control of Mites and Lice on the Poultry Plant
682 Incubation, Artificial
683 Poultry Handbook, Canadian
718 Chicks, Sight Sexing Barred Rock Baby
745 Poultry, Fattening for Market
782 Eggs, The Production, Identification and Retention of Quality in

Regulations

Regulations Respecting the Production and Marketing of Chicks
Regulations Respecting the Grading and Marking of Eggs
Regulations Respecting the Grading and Marking of Dressed Poultry

Reports

Canadian Record of Performance for Purebred Poultry
Egg and Poultry Market Report (Weekly)

Charts and Folders

Graded Chicks
Grading, Packing and Marking of Canned Poultry
Chicken and Turkey Recipes
Dressed Poultry, Standards of Quality for
Egg Grades
Egg Recipes

Plans and Specifications

Colony House 10 x 12
Double Deck House
Farmers' Poultry House 16 x 32
Farmers' Poultry House 20 x 36
Range Shelters
Turkey Paddock
Poultry Range Feed Hopper
Laying Pen Feed Hoppers (Wall type and Floor type)
Laying Pen Feed Hopper (Floor type)

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