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Feeding and Management for Egg Production

W. E. Poley

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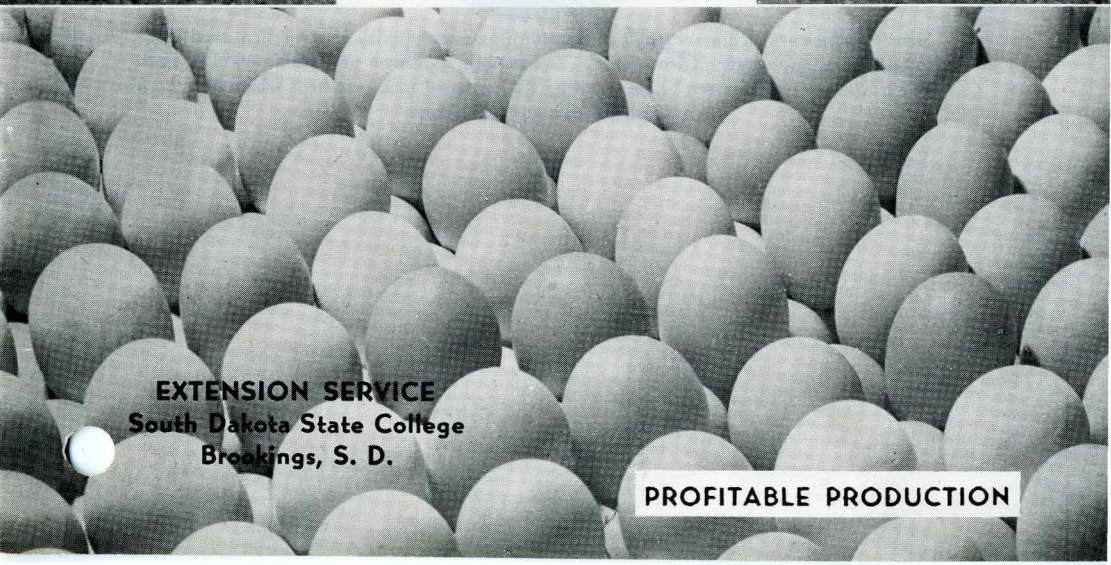
BALANCED RATION *Plus*

GOOD MANAGEMENT *Equals*



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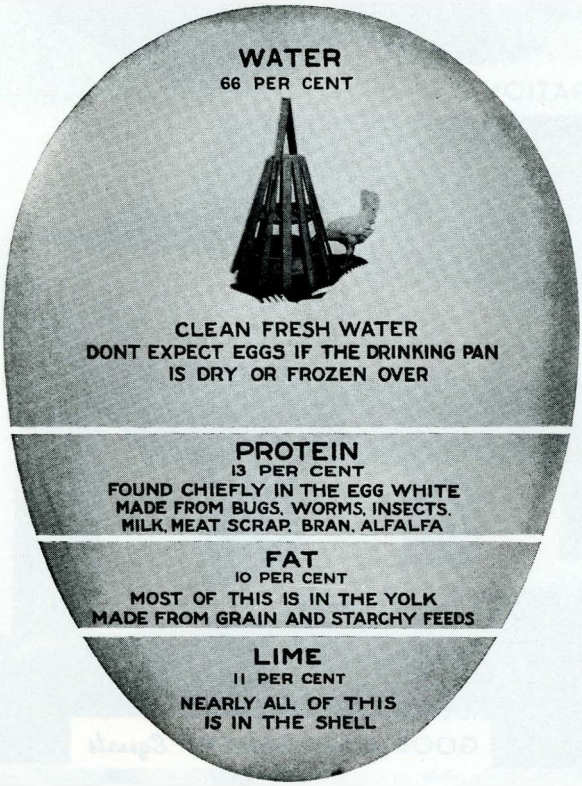

Hens are efficient machines, capable of transforming raw materials into excellent food products. It takes an average of from four to five pounds of feed to produce a pound of eggs. Efficiency in production can be increased by feeding good rations to hens which have been bred for high egg production.

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Food for Thought

About 87 percent of all South Dakota farms grow poultry. No other agricultural product is so extensively grown. The total value of poultry products produced in South Dakota amounts to over thirteen million dollars annually. This represents a value of over 150 dollars per farm.

The production of eggs provides the most important source of revenue for the poultry industry. Over a half billion eggs are produced annually in South Dakota at a value of about six million dollars.

Feed costs comprise from 50 to 60 percent of the total costs of production; therefore, efficient feeding practices have an important influence on profits.

The laying hen represents a compartively small investment capable of making a quick turnover. She performs an important job efficiently and should be given enough of the proper feedstuffs to enable her to produce eggs profitably.

The hen is capable of manufacturing one or more pounds of eggs from every five pounds of feed consumed, and at the same time maintain her body. Feedstuffs which have comparatively little value for human food are converted into one of nature's most perfect foods. Eggs contain all the nutrients required to transform a tiny germ into a baby chick.

The egg is the most universally used of all animal products, except milk. It is one of the most easily digested and assimilated of all foods, being widely used as a food for infants and invalids. Few products can compete with the egg in food value obtained at such a low cost.

By following recommended practices of feeding and management, hens are given an opportunity to perform an important service to humanity and at the same time return a suitable profit.

Feeding and Management for Egg Production

by W. E. Poley, Head State College Poultry Department

Feeds and Feeding Practice

How Feed Is Used

The purpose of a ration for egg production is two-fold. First, it must furnish the heat required to maintain the body temperature of the chicken at about 106.7 degrees. In addition, the birds need feed for energy and other materials necessary for the maintenance of the body and health. After these body requirements are met, and if proper nutrients are available, the remainder of the feed can be used for the production of eggs.

Birds in good production require about two-thirds of all the feed they eat to maintain their bodies. Thus, it can be seen that about one-third more feed will be required to produce 100 to 150 eggs in a year. This amounts to around 30 pounds of feed. If no eggs are obtained, it will take around 50 to 60 pounds of feed to maintain one bird for a year. Most of this is wasted, since the hen will not gain much weight during the year.

It Pays to Feed a Balanced Ration. A balanced ration may be defined as "a combination of feeds which supply all the necessary nutrients in the proper portions to be utilized by the hen for profitable egg production." Nutrients required by the laying hen include several different proteins, fats, carbohydrates, minerals and vitamins. These nutrients are taken out of the feed in the processes of digestion and absorbed by the blood in the maintenance of life and egg production.

While cereal grains are good sources of carbohydrates, they are poor sources of those vitamins, minerals, and proteins which are so essential for the manufacture of eggs. Most cereal grains are deficient in practically the same nutrients, therefore a combination of three or four of these grains will not supplement deficiencies, and it is necessary to use animal or vegetable protein concentrates, additional sources of minerals, and feeds rich in vitamins to supplement home-grown grains if profitable egg production is to be obtained.

In order to intelligently plan a ration which will meet the body requirements of laying hens, it is well to consider the make-up of the hen and the egg. The hen's body with all the feathers, bone, skin, muscles, tendons, fat, and internal organs must be maintained and repaired each day from the nutrients

provided in the ration. If the ration is not balanced, that is, if it does not supply the proper nutrients, it will not be possible for the body to replace the worn-out tissue. The same is true in the production of eggs; without proper nutrients the yolk, albumen, and shell can not be made from the feed consumed.

Table 1. Results of Experiment on Feeding Grain Ration vs. Balanced Ration*

	Ration Fed	Yearly Production Per Hen	Return Over Feed Cost
Pen No. 1	Grain Ration Plus 20% Meat-and-Bone Meal	179	$2.47
Pen No. 2	Grain Ration Only	57	$ .35
Difference	7 lb. Meat-and-Bone Meal at 4c Per lb. Equal 28c Per Hen	122 Eggs per hen	$2.12 Per hen

* Averaged results over period of three years.

The Nutrients

Proteins in Cereal Grains Are of Poor Quality

The value of proteins depends chiefly upon their amino acid make-up. The chicken requires certain of these amino acids for the maintenance of life, health and egg production. Although cereal grains usually contain from 9 to 15 percent protein, this protein is not of the proper quality for egg production; that is, the proper amino acids are not provided for the formation of egg albumen and other egg proteins. All cereal grains are deficient in essentially the same proteins, and must be supplemented with animal or vegetable protein concentrates.

Fats Are Scarcely Ever Lacking

The carbohydrates from cereal grain form the chief source of fat for the body and the egg. The provision of fat, therefore does not present any practical problem.

Carbohydrates Are Abundant in Cereal Grains

This is perhaps the cheapest class of nutrients whose chief function is to supply body heat, energy and fat. Principal sources of carbohydrates include all the cereal grains. These nutrients are not likely to be deficient in poultry rations if the hens are given enough to eat.

Vitamins Are Often Lacking

Vitamins are chemical substances required in very small quantities for normal life, health, egg production and hatchability. In recent years, the chemist has been able to isolate many of the vitamins and determine their specific functions in meeting the requirements of the laying hen. Research has shown that many feeds contain different vitamins in varying amounts, and, although much remains to be learned, our knowledge of vitamins has been greatly enriched in the last few years.

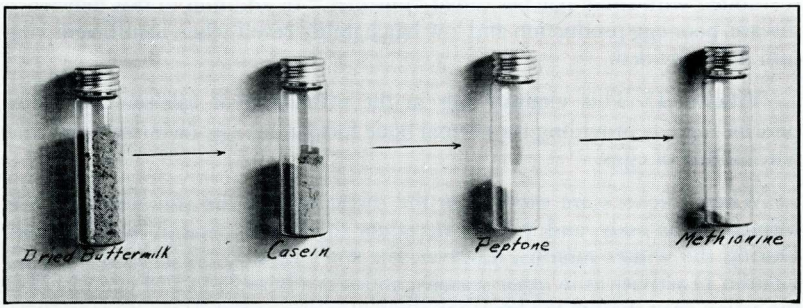

Fig. 1. During the process of digestion proteins are split up into simpler products. The end products are amino acids, which are absorbed by the blood and built up again into tissue proteins and egg proteins. Casein is the chief protein of milk products. Intermediate products of digestion are peptones, which upon further action of enzymes produce methionine as well as other amino acids. Most proteins and amino acids in their pure forms are white, tasteless powders.

The requirements of the chicken for some vitamins have been determined and the estimates of the amounts of these vitamins present in certain feedstuffs are available. By using a tested formula of a balanced ration, one is assured of getting the right amounts of these vitamins for profitable egg production.

Many vitamins are required by layers, but cereal grains and other feeds commonly used provide these, and only vitamins A, D, and G which are most likely to be lacking in farm-mixed laying rations will be discussed here.

Vitamin A. This vitamin promotes growth and is necessary in the prevention of nutritional roup. It is also deposited in the egg and is necessary for the growth of the embryo. True vitamin A is found chiefly in fish oils, but the chicken has the ability to convert carotene into vitamin A, so it is necessary to provide sources of this substance in the poultry ration, especially if fish oils are not used. Sources of carotene commonly used for poultry include alfalfa, clover, and other green feeds. The carotene content of feeds varies considerably as carotene is unstable and is affected by the method of curing green feeds, storage time and conditions. The carotene content of leaves is also usually higher than that of the stems of the same plant. Yellow corn contains a substance closely associated with carotene and this substance is converted into vitamin A. Yellow corn is the only cereal grain known to yield appreciable amounts of this vitamin. It can thus be seen that if cereals other than yellow corn are used, and if no green feeds and cod-liver oil are provided, there will probably be a deficiency of vitamin A.

A lack of vitamin A results in poor growth and low vitality. The stomach, kidneys, and ureters are enlarged and congested, and there may be an accumulation of white deposits called urates. Some birds develop eye lesions whereby vision may be destroyed and pus accumulates. In extreme cases, the throat

is studded with small patches called "pustules." In addition to this deficiency disease, poor egg production and low hatchability result when insufficient vitamin A is provided.

Vitamin D. This vitamin aids in the utilization of calcium and phosphorus, thereby providing for normal bone formation, egg shell thickness, and hatchability of eggs.

When chickens are exposed to the direct rays of the sun, vitamin D is formed in the body, and it is not necessary to add this vitamin to the ration. During the winter months, however, the sun's rays do not possess so much vitamin D activity as in other seasons, and it is advisable to add vitamin D to the ration even though the birds are allowed to run out-of-doors. This is especially necessary if there are many soft-shelled eggs and if hatching eggs are kept from the flock. Fish oils are most common sources of vitamin D and should be used especially during the winter months according to recommendations.

Some prefer to use glass substitutes which allow the vitamin D activating rays of the sun to pass through. The ease with which the sun's rays may pass through the glass substitutes varies considerably, depending on the brand, age, and cleanliness of the glass. Dirty or old glass substitutes are of little value. Glass substitutes are of comparatively little value after two or three years of wear. Allowing the windows on the south side to be open on warm, sunny days helps to provide vitamin D, but dangers of drafts and sudden changes in temperature should be avoided.

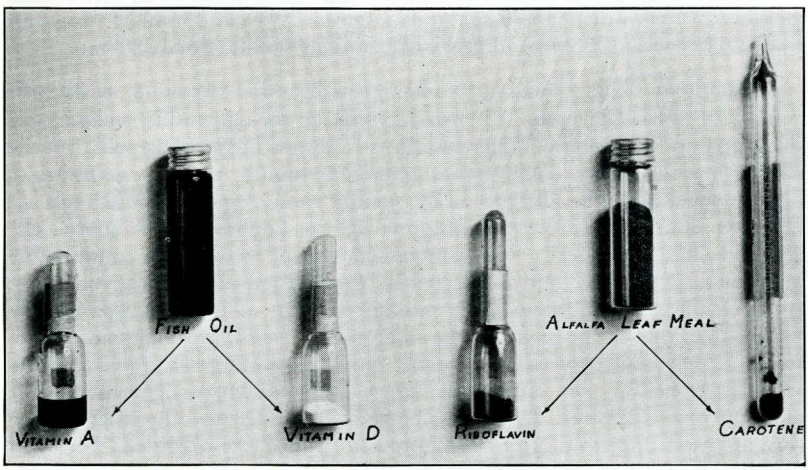

Fig. 2. There are several grades of fish oils which vary widely in price and vitamin A and D content. Vitamin A is a viscous pale yellow oil, and vitamin D is a white powder. Green feeds such as alfalfa-leaf meal are good sources of riboflavin (vitamin G) and carotene. Riboflavin is an orange-yellow powder, while carotene is a dark red colored powder. Carotene is converted into vitamin A by the chicken.

A lack of vitamin D in laying rations results in poor vitality, low egg production, soft-shelled eggs, and poor hatchability. The chicks hatched from such eggs show evidence of rickets, with pliable leg bones and beaks.

Vitamin G. The vitamin G complex is perhaps composed of several vitamins, but the riboflavin or lactoflavin factor is probably most likely to be deficient in laying rations. This vitamin functions in promoting normal growth and hatchability, and it is therefore most important in chick rations and breeder rations. Riboflavin comes from plant sources, while lactoflavin is found in milk products. Both of these sources of flavin are effective in preventing vitamin G deficiency disease.

Common sources of vitamin G include milk products and succulent or dried green feeds, especially alfalfa-leaf meal.

Lack of sufficient vitamin G in laying rations results chiefly in poor hatchability of eggs, although low egg production will result from extreme deficiency. The embryos from low-hatching eggs may show symptoms of paralysis involving a curling of the toes, which is also characteristic of chicks showing this deficiency disease.

Minerals Are Important

The necessity of adding minerals to the laying rations depends entirely upon the amount and kind of minerals already present in the ration as normal constituents. For example, cereal grains contain small amounts of minerals, while meat and bone scraps and other animal protein concentrates are comparatively rich in minerals.

Calcium. Meat scraps containing bonemeal are the chief source of calcium for bone formation, but calcium from this source is not so readily utilized for egg shell formation, and it is necessary to add sources containing 90 to 95 percent calcium carbonate for this purpose. Most laying mashes contain from 2 to 3.5 percent calcium and this, in addition to the calcium from hopper-fed oyster shells, will be sufficient for proper egg shell formation. Some prefer to add ground limestone or oyster shells to the mash at the rate of 5 to 6.5 percent. This amount may be satisfactory when scratch grain is fed with the mash on an equal basis. It would not be necessary to feed oyster shells in hoppers if this amount were included in the mash. The chief advantage of adding oyster shells or limestone to the mash lies in the fact that all the hens are more likely to get a regular supply of calcium. If fed only in hoppers some hens may not eat enough oyster shells or calcium and these birds may lay soft shelled eggs.

Phosphorus. It is not so necessary to add phosphorus to a laying mash if it includes 15 percent of animal protein concentrate such as meat scraps (50 percent protein) which contain about 5 percent phosphorus. The laying hen has a comparatively low phosphorus requirement. Most laying mashes should, however, contain at least 1 to 2 percent phosphorus.

Salt. It is advisable to include one-half to 1 percent of salt in most laying mash mixtures, as this probably adds to the palatability of the ration. Salt is also present in animal protein supplements and other ingredients in variable amounts.

Manganese. It has been recently found that manganese improves egg shell strength and hatchability, and that some laying rations may contain insufficient amounts. The quantity of manganese required depends upon the amount of calcium and phosphorus present in the ration. In general, the laying ration should contain around 50 parts per million of manganese. Common sources of manganese include manganese sulphate, manganese oxide, and manganese carbonate. Ordinarily about one-eighth of a pound of any of these sources in 500 pounds of mash will supply adequate manganese for egg shell formation and hatchability. According to reports from the Wisconsin Experiment Station, sunlight affects the utilization of manganese. In other words, manganese may be present, but the hen cannot make use of it. During the winter months, lower efficiency of utilization has been experienced with some rations. The addition of manganese is therefore most essential during this season.

Grit. There have been several tests made to determine the necessity of providing grit for laying hens and the results have not been very conclusive. There is some indication that grit aids in digestion and in preventing gizzard abnormalities, especially if relatively large amounts of whole grains are used. A hard, insoluble flint or granite grit should be provided in hoppers, especially if the birds do not have access to the soil.

How the Composition of Rations is Determined

NOTE. The following information is not intended to urge poultry growers to calculate the amounts of proteins, minerals, and vitamins in the rations they use. The information is included merely to show that rations must be figured on a scientific basis in order to adequately provide the needs of laying hens. Obviously, a great deal of research has been conducted to learn the composition of feeds and the requirements of hens for these different nutrients.

The percentage composition of the different feeds (Table 7) and the requirements of hens (Table 2) have been taken from the Yearbook of Agriculture, 1939, Practical Nutritive Requirements of Poultry, compiled by Harry W. Titus, and the author is indebted to Dr. Titus for permission to use this information. The protein analyses of grains produced in South Dakota are somewhat higher than for grains produced in some other sections, and these analyses are substituted for those reported in the yearbook. At the suggestion of Dr. Titus some of the vitamin A and D values have been changed to agree with the most recent information available.

The quantity of each of the nutrients present in the ration can be determined merely by multiplying the amount of each nutrient present by the percentage of the ingredient included in the ration; add the products together and divide by 100. For example, there are two sources of vitamin A in a certain mash mixture containing 23 pounds of yellow corn and 7 pounds of alfalfa-leaf meal. From Table 7 it will be noted that corn contains about 3,180 units of vitamin A and alfalfa-leaf meal 32,000 units per pound.

Thus: 23 x 3180 equals 73140
7 x 32000 equals 224000
297,140 total amount of vitamin A in 100 pounds

The average vitamin A content per pound of mash is $\frac{(297140)}{(100)}$ 2971.4 units.

If the birds had access to scratch grain which contained no vitamin A and consumed the same amounts of mash and scratch, this figure would be divided by two and the average amount of vitamin A consumed per pound of mash and grain (total feed) would be 1485.7 units.

If, on the other hand, the scratch mixture consisted of 50 pounds of yellow corn and 50 pounds of wheat, the vitamin A content would be 196,500 units in 100 pounds of grain mixture. By adding the vitamin A content of the 100 pounds each of mash and scratch mixtures together, 297,140 and 196,500 the total would be 493,640 units in 200 pounds of total feed. In one pound of total ration, there would be 2,468 units of vitamin A.

The protein and mineral content of the ration are determined in the same manner.

Table 2. Requirements of Hens for Protein, Minerals and Vitamins*

Class	Protein[1] as proportion of total feed	Calcium as proportion of total feed	Phosphorus as proportion of total feed	Manganese in total feed	Vitamin A per pound of total feed[2]	Vitamin D per pound of total feed	Vitamin G (riboflavin) per pound of total feed
	Percent	Percent	Percent	Parts per million	International units	A.O.A.C. chick units	Gammas (or micrograms)
Laying stock	16	2.4	1.0	50	3,150	360	680
Breeding stock	16	2.4	1.0	50	4,720	540	1,250

1. The protein must be of reasonably good quality; and it is desirable that not less than 20 percent be derived from animal sources.
2. If the feed is to be stored for more than a month before it is fed, not less than 70 percent of the vitamin A should be derived from plant sources.

* Figures taken from U.S.D.A. Yearbook of Agriculture, 1939, page 818.

Cereal Grains and Supplements

All cereal grains are composed of essentially the same nutrients. The ratio of these nutrients may vary somewhat and palatability may be a limiting factor with certain feeds.

Yellow Corn. This is considered the standard and most widely used cereal for poultry feeding. It differs from all other grains chiefly because of its vitamin A content which is deficient in other grains.

White Corn, Wheat, Red or White Proso Millet. These grains are commonly used with satisfactory results to replace yellow corn if properly supplemented with a good source of vitamin A. These grains which are low in

fiber content should be used in combination with more fibrous feeds such as oats and barley, or bran and middlings, as these add to the ration's palatability.

Oats and Barley. These cereals can be satisfactorily used in most laying rations to 30 or 40 percent of the mash mixture and liberal quantities can be used in the scratch mixture. Satisfactory results can be obtained when the test weight of oats is as low as 28 pounds per bushel and 40 pounds per bushel for barley. Even lower grades of these grains can be used satisfactorily if they are not used in excessive amounts.

Rye. Rye is not considered a good poultry feed. Chickens do not like rye and usually will waste it if not fed in hoppers or if included in the scratch mixture. According to the recommendations of the Wisconsin Experiment Station, rye may be used most satisfactorily in the egg mash up to 45 percent. A ration made from yellow corn, bran, middlings, and rye, together with a protein-vitamin-mineral concentrate of dried skimmilk, meat scraps, alfalfa-leaf meal, limestone grit, and salt gave better results than corn plus rye with the same protein-vitamin-mineral mixture. The wheat by-products, wheat, or oats apparently supply something that is lacking or is found in too small amounts in corn and rye.

Sorghums are Popular for Poultry

Comparatively little experimental work has been reported on the use of sorghums in poultry rations. The Kansas and Oklahoma Experiment Stations have been most active in determining the value of certain sorghums in poultry rations. Sorghums are deficient in vitamin A and therefore vitamin A supplements should either be used in the mash mixtures or the birds should have access to green feed.

Kafir and Milo. These grains compare very favorably in feeding value with corn and can be used to replace corn in both the mash and scratch mixtures, but alfalfa-leaf meal or other green feed should be used in the mash, or the birds should have access to green range.

Cane and Feterita. Even less experimental information is available on the feeding value of these grains compared with kafir and milo. However, both cane and feterita are used extensively for layers on South Dakota farms.

When to Use Bran and Middlings

In some sections of South Dakota, bran and middlings are readily available at low cost, and it will be more economical to use these by-products to replace ground cereal grains. It has been found at the South Dakota Experiment Station that 30 percent of ground wheat can be used to satisfactorily replace 15 percent each of bran and middlings in laying mash mixtures. This is not true for starting rations for chicks. If bran and middlings are the same price as wheat, it is recommended that these by-products be used instead of wheat, as they have a slightly higher feeding value than wheat.

Not much is known of the relative nutritive value of the different grades of bran and middlings in laying rations. It is not probable that the most costly

wheat mill feeds are justified in preference to cheaper grades of mill feeds when used in most laying rations which are otherwise adequately supplemented.

Protein Supplements

Animal Proteins. Proteins may be classified as to their origin from animal or vegetable protein concentrates. Animal protein supplements are usually more efficiently utilized than proteins from vegetable sources. Failure to provide adequate animal proteins results in low egg production and small eggs. Animal protein supplements commonly available include meat-and-bone scraps, dried milk, fish meal, and tankage. Ordinarily, either at least 5 percent of dried milk, or liquid milk, is used with all laying rations. In addition, 10 to 15 percent of meat scraps or fish meal, or a combination of these, is used in most laying mash mixtures. Tankage is not generally so palatable or uniform in composition.

Price and availability are the chief considerations in determining which protein supplement to use.

Vegetable Proteins. While not as efficient as animal proteins, vegetable proteins may be used satisfactorily to replace at least half of the animal protein in the mash. Vegetable protein supplements commonly used include soybean meal, (soybean oil meal), corn gluten meal, and cottonseed meal. The last two mentioned probably are not quite so good as soybean meal, which can be used satisfactorily when the price per pound of vegetable protein is appreciably lower than animal protein. When more than 10 percent of cottonseed meal is used in the mash, the eggs do not keep very well. Corn gluten meal may be used up to 10 percent of the laying mash. In order to determine price per pound of protein, it is necessary to divide the price per 100 pounds of supplement by the percentage of protein. For example, if soybean meal were $2.20 per hundred pounds, and it contained 44 percent protein, the cost would be 5 cents per pound of protein.

Ground soybeans which contain the oil, and are not processed, are not satisfactory in any poultry ration. They should not be used. It is possible that the oil or raw beans contain some undesirable factor. With soybean oil meal, the oil is removed and processing makes this a desirable feed for poultry.

Linseed oil meal is not recommended in laying rations. It is not very palatable and is inferior to most other vegetable protein supplements. The reason for this has not yet been adequately explained.

Milk Products for Poultry

Milk products are good sources of certain vitamins, particularly vitamin G. They also add considerably to the palatability of the ration. Some form of milk is included in most all poultry rations. The use of excessive amounts, however, is not justified because the costs are usually relatively high.

The farmer who has plenty of skimmilk or buttermilk of little market value will find it an economical protein supplement for both chicks and laying hens. However, best results are obtained when liquid milk is supplemented with mashes containing meat scraps.

Perhaps the biggest disadvantage in the use of liquid milk products lies with the extra labor required in feeding and the diffculty in keeping surroundings sanitary. Milk attracts flies and the consumption of excessive quantities creates a laxative effect in the hens, requiring frequent cleaning.

Table 3. Analyses and Relative Costs of Protein

	Average Percentage Composition[1]						Cents
	Water	Ash	N-free extract	Fat	Protein	Price[2] 100 lbs.	per lb. protein
Meat-and-bone scraps	6.0	29.9	6.1	8.0	50.0	$2.40	4.8
Liquid whole milk	87.2	0.7	4.9	3.7	3.5	----	----
Liquid skimmilk	90.1	0.7	5.2	0.2	3.8	.25	6.6
Liquid buttermilk	90.6	0.7	5.0	0.1	3.6	.25	7.0
Liquid whey	93.4	0.7	4.8	0.3	0.8	.10	12.5
Condensed buttermilk	65.0	2.7	15.9	3.0	13.4	1.50	11.2
Dried skimmilk	4.0	8.1	49.3	1.3	37.3	5.50	14.7
Dried buttermilk	4.5	8.1	50.9	1.9	34.6	5.00	14.5
Dried whey	4.3	9.6	72.4	0.9	12.8	4.00	31.2

1. These analyses are taken from Henry and Morrison's, "Feeds and Feeding," and other sources, and they are only averages. Samples of these products may vary.
2. Prices vary according to time and locality. These prices only illustrate relative differences. The price per pound of protein in a product equals the price per 100 pounds of product divided by its percentage protein. The cost of liquid milk depends on price at place of purchase, quantity and distance hauled, and extra labor in feeding.

The relative feeding value of liquid, condensed, and dried milk, based on their protein content, is as follows: One pound of dried milk equals about three pounds of condensed milk; one pound of condensed milk equals approximately three pounds of liquid milk; and one pound of dried milk equals 9 or 10 pounds of liquid milk.

The choice of a milk product may be based on the price per pound of protein. Table 3 shows the approximate analyses as well as relative costs of protein (disregarding other nutrients) from various products.

Several Forms of Milk Used

Liquid Milk. Laying flocks at the Kentucky and Washington Agricultural Experiment Stations were fed whole grains and supplied with liquid milk but no water. With such rations, it was of no advantage to feed mashes of ground grains and grain by-products, unless the mash contained meat scraps. Since milk consumption varies, it seems well to include from one-fourth to one-half of the customary amount of meat scraps in the laying mash even though milk is given as the drink.

Liquid buttermilk and liquid skimmilk are usually considered equal in feeding value, but liquid skimmilk is often superior because of the variation in the water content of liquid buttermilk. Liquid skimmilk may be fed either sweet or sour. If sweet milk is used, it usually turns sour before the birds have consumed it all.

Much has been said concerning the danger of feeding milk in galvanized vessels, because of the chemical action of the acid in milk upon the metal.

Metallic vessels have been used for milk for many years without any evidence of harmful effects upon chickens. Sour milk does, however, shorten the life of such vessels by "eating off" the galvanizing. Any drinking vessel, regardless of the material, should be cleaned daily—particularly if milk is used. If one prefers, glass or earthenware fountains may be used.

Condensed Buttermilk. A convenient method of feeding condensed milk is to spread the "paste" on boards. One pound of condensed milk diluted with two and one-third pounds of water gives a solution of approximately the same protein content as liquid buttermilk. One objection to mixing water with condensed milk is that the milk settles out; another is the extra labor involved in feeding.

With some laying rations the daily feeding of two and one-half pounds of condensed buttermilk per 100 hens increased production enough to justify the cost. When the buttermilk was fed at this rate, the meat scraps in the mash could be reduced one-fourth without decreasing egg production.

Dried Milk. Dried buttermilk and dried skimmilk are of practically equal nutritive value. The choice between the two is based on cost. Either is very convenient to use, since it can be mixed with the other ingredients of the mash. In a laying mash it will probably not be economical to use more than 5 to 7 percent of dried milk. With breeder mash somewhat more may be used in order to provide more vitamins for hatchability.

Whey. Milk is fed to poultry primarily for the protein and vitamins it contains. Liquid milk contains about 3.5 percent of protein while liquid whey contains less than one percent of protein. Liquid whey is a good source of lactoflavin, but it is probable that other milk products will be found cheaper.

Dried whey is used chiefly for its vitamin content, since it contains practically as much lactoflavin as dried skimmilk and buttermilk.

Green Feeds

Alfalfa-Leaf Meal. Compared with other alfalfa products, this is perhaps the richest source of vitamins. There are two kinds, namely, sun-cured alfalfa-leaf meal and dehydrated (artificially dried) alfalfa-leaf meal. The hen utilizes the carotene of alfalfa in the manufacture of vitamin A, therefore the value of alfalfa as a vitamin A supplement is based upon its carotene content which may vary considerably. The carotene in alfalfa is rapidly destroyed by exposure to sunlight and high temperature during the curing process, therefore rapid drying with the least possible exposure to direct sunlight preserves carotene as a vitamin A source. The dehydrated alfalfa is dried quickly and should usually have more carotene present than sun-cured alfalfa. The leaves of alfalfa contain more vitamin A than the stems, so attempts should be made to prevent the loss of leaves during the curing and harvesting process. Dehydrated alfalfa may be slightly higher in riboflavin content.

Alfalfa Meal. This includes a higher percentage of stems than alfalfa-leaf meal and is therefore higher in fiber and lower in protein value. Because alfalfa meal has a lower precentage of leaves, it is not considered so good a source of vitamins as alfalfa-leaf meal. It is also possible that alfalfa meal is less palatable and generally lower in total feeding value than the leaf meal.

Alfalfa Hay. The use of the leafy third-crop of alfalfa hay provides a good source of vitamin A because it is usually cured under cooler weather conditions with less destruction of carotene. Good quality alfalfa hay may be fed in racks to laying hens and if a regular supply is available, it will be unnecessary to provide additional sources of vitamin A.

Other Green Feeds. Good quality clover hay, carrots, cabbage, and sprouted oats may be used to advantage as a source of vitamins, but it is often difficult to secure a regular supply of these feeds and in addition, the vitamin content of these feeds is quite variable.

Grass Silage. There is a growing interest in the use of grass silage for poultry. More information is needed before definite recommendations can be made. It is, however, probable that a good grade of silage can be used to replace green feed in poultry rations, and this will help to keep down feed costs.

Green Range. By providing a good green range, the amount of feed required can be reduced somewhat and it is easier to keep the hen house clean. The birds will also be healthier and there may be less cannibalism trouble. Several different grasses and cereal grains may be used for range with equally good results. For example, rye may be seeded late in August and provide good fall pasture or this may be used for early spring pasture. In the early spring, either rye or oats may be planted. Later in the spring, sudan grass and rape may be planted, and they will do well under relatively dry conditions if they get a good start. Sweet clover and alfalfa make good poultry range, but they are best utilized the following year after planting.

Green range is more nutritious and more palatable when young, that is, when just a few inches tall. As green range matures, it becomes tough, and it is of comparatively little value. Some poultrymen follow a plan of keeping the range cut short or reseed to crops which do well later in the season. For example, rye and oats may be cut or plowed under after they have been used for range several weeks, and rape or sudan grass may be planted in the same ground. Table 6 on page 31 gives a plan for providing hens with a regular supply of green range.

Mineral Supplements

Calcium Products. Sources of calcium should contain 90 to 95 percent calcium carbonate and should be low in magnesium content. Experiments conducted at the South Dakota Experiment Station indicated that there was no significant difference, in the results obtained when oyster shell, clam shell, chalkstone, Black Hills limestone, dolomitic limestone, calcite or commercial limestone were used. Results were judged on the basis of egg production, egg weight, and egg shell strength. It was noted, however, that dolomitic limestone was not economical because of excessive consumption. Two or three percent of a good calcium supplement such as ground limestone or ground oyster shells may be used in the laying mash to insure a regular supply of this mineral. In addition, oyster shells are kept before the birds in hoppers.

Bone Meal. This is essentially calcium phosphate and is perhaps the most economical source of phosphorus. It is included in meat-and-bone scraps at the rate of about 25 percent, so it is not necessary to add any other source of phos-

phorus if 15 percent meat scraps is used in the mash. If no meat scraps or other supplements containing bone meal are used, the mash should contain 2 or 3 percent of bone meal.

Mineral Mixtures. It is poor economy to purchase expensive mineral mixtures because of the "wonders" which are often claimed for such mixtures. Simple mixtures are recommended if vegetable protein supplements are used. An economical source of minerals would include a mixture of 60 pounds of bone meal, 20 pounds of ground limestone, and 20 pounds of common salt. Two or 3 percent of this mixture could be used in the mash. Even though minerals may be added to the mash, it is advisable to keep oyster shells before the birds in hoppers.

Manganese Supplements. Manganese is available in several different compounds in combination with other elements and the amount of manganese present varies considerably. Probably the most common sources of manganese include anhydrous manganous sulphate and manganous sulphate tetrahydrate. The tetrahydrate contains only about two-thirds as much manganese as the anhydrous form. It is recommended that if manganese tetrahydrate is used, two ounces should be mixed with five pounds of common salt and the salt in turn may be mixed with the other ingredients of the mash to make up 500 pounds, or one pound of this salt mixture may be used for every hundred pounds of mash. This amounts to the addition of 62 parts per million of manganese. This is probably somewhat more manganese than is necessary in view of the fact that the other ingredients used will include from 10 to 30 parts per million of manganese. If the anhydrous form of manganese sulphate is used, about one ounce in five pounds of salt would be adequate. These estimates are based upon the fact that the anhydrous manganese sulphate contains about 36 percent manganese and the tetrahydrate form of manganese sulphate contains about 25 percent manganese. Other manganese compounds such as manganese oxide and manganese carbonate are available. The amount to use would depend upon the percentage of manganese present. Manganese compounds usually can be procured from drug stores.

Vitamin Supplements

Fish Oils. The most common source of vitamin D used in South Dakota is cod-liver oil. Other fish oils are also available to some extent. Most fish oils are also rich in vitamin A, and they are biologically tested for their vitamin A and D content. The minimum number of units of each vitamin contained in the oil is usually stamped on the container.

Fish oils of two qualities or grades are commonly available:

1. The ordinary, natural cod-liver oil which has a minimum of 85 U.S.P. vitamin D units and 600 or more vitamin A units per gram. Since there are about 454 grams per pound, there would be 38,590 units of vitamin D and 272,400 units of vitamin A per pound of oil.

2. The other grade includes the fish oil concentrate, or fortified fish oil, which has a minimum guarantee of 400 vitamin D units and 3,000 vitamin A units per gram. This grade is four or five times as rich in vitamin A and D as the ordinary cod-liver oil, therefore one can afford to pay considerably more for the concentrate, as only about one-fourth the quantity of this oil is needed.

Only fish oil having a minimum guarantee of vitamin A and D stamped on the container should be used, as there has been a great deal of low quality oil sold.

Wheat Germ Oil. This has been widely advertised by commercial companies as a necessary source of vitamin E. Several Experiment Stations have attempted to prove the value of vitamin E as a necessary addition to rations commonly used but generally have not found adding wheat germ oil necessary. Cereal grains and green feeds commonly used in poultry rations are considered good sources of vitamin E and, in the light of present knowledge, when a large percentage of these feeds is used, it appears unnecessary to add wheat germ oil as a vitamin E concentrate.

Commercial Preparations. There are many kinds of commercial vitamin concentrates on sale which are widely advertised as necessary additions to poultry rations for profitable results. Probably in some cases where these preparations are used in rations deficient in the nutritive factors present in these products, beneficial results will be obtained by their use. It should be borne in mind, however, that the indiscriminate use of such preparations often adds excessive costs to feeding. In addition, it has been noted that sometimes such preparations do not contain the quantities of the vitamins advertised, and there is no law in South Dakota protecting the buyer in such cases. Generally, it will not be found necessary to use expensive vitamin concentrates if recommendations are followed in the use of cheaper, more commonly available products containing the same vitamins or other nutrients.

Quantity of Feeds Required

Leghorns laying an average of 150 eggs will each consume 70 to 85 pounds of feed per year, while Plymouth Rocks and other breeds of similar size will consume from 80 to 95 pounds of feed per year. Approximately half of the feed consumed will be mash and half scratch grain. This amounts to about 22 pounds of feed daily for 100 Leghorns and 24 pounds for heavier breeds. In addition, three or four pounds of oyster shells will be eaten by each bird in production during the year. It is interesting to note from Table 4 that the amount of feed required to produce a dozen eggs is directly related to the average egg production of the flock. The information in Table 4 was compild by R. H. Waite of the Maryland Agricultural Experiment Station, and is based on the feed required during six Maryland egg laying contests.

Table 4. Pounds of Feed Consumed per Dozen Eggs Produced According to Average Egg Production Per Bird for White Leghorns

Average egg production per bird	Average No. lbs. feed consumed per bird	Average No. lbs. feed per dozen eggs
117.7	69.3	7.0
136.6	71.4	6.2
156.3	75.3	5.7
175.0	77.8	5.3
194.4	80.9	5.0
214.8	81.8	4.5
234.1	84.2	4.3
253.9	87.0	4.1

Quality of Feeds Required

There has been much speculation concerning the quality of feeds to use in poultry rations. Of greatest interest to farmers, in view of the large quantities of light weight grains frequently available, is whether or not it is necessary to feed grains having a high test weight per bushel. Experiments are in progress at the South Dakota Experiment Station to determine the feeding value of low test weight corn, wheat and barley. While the results of these tests are not yet available, the indications are that low test weight grains can be used to advantage, and egg production will not be greatly different from the use of grains having higher test weights. It certainly seems questionable whether it is advisable to use the best quality grains if lower quality grains are readily available at appreciably less value.

Very little information is available on the feeding value of diseased or moldy grains. There are, of course, many different kinds of molds and plant diseases, and to determine their affects on poultry would be a very difficult task.

Reasonably good quality feeds should be used, and they should be fed in clean hoppers. Efforts should be made to keep the birds from contaminating these feeds with droppings and dirty litter. The mash and grain mixtures should be stored in a dry place away from rodents and other animals.

How to Tell the Practical Value of Feeds

Limitations of a Chemical Analysis. Each year, several samples of poultry feed mixtures are received by the college for chemical analysis. Although most of these feeds appear clean and wholesome, it is impossible to tell whether or not they are well balanced mixtures. A chemical analysis may be made, but this will not reveal the true nutritional value.

The percentage of protein may be determined by calculating from the amount of nitrogen present. In addition, the percentage of fat, fiber, ash and nitrogen-free extract may be determined. This analysis tells nothing about the palatability, and the effect upon egg or meat quality is not revealed. Neither is the presence of toxic or poisonous substances readily detected and no information is given relative to the presence of plant diseases such as molds, or other contamination. Any one of these limitations, which will not be detected by chemical analysis, may cause considerable trouble in a laying flock.

The presence of selenium can be detected quite easily by chemical analysis, and experiments completed at the South Dakota Agricultural Experiment Station answer the question of how much selenium can be tolerated by chicks and laying hens. It was found that starting or laying rations should not contain more than five parts per million of selenium.

At the present time, methods for determining the amounts of certain vitamins are being developed, but most laboratories are not yet properly equipped to make these determinations.

How Feeding Troubles Are Detected. It is human nature to first blame the feed whenever expected results are not obtained. In most cases, however,

especially where feeding recommendations are followed carefully, the trouble can be traced to poor breeding, poor management, poor housing, or lack of sanitation. If the feed is suspected, a biological test can be made by feeding a number of healthy birds of good breeding quality for a certain period of time under practical conditions. A second group of equal quality should be placed on a standard ration of known value and given the same housing, care, and management. Results can be compared in terms of egg production, maintenance of body weight, and health. If hatching eggs are saved, the hatchability of eggs produced from both rations can be compared. This is the only satisfactory way of determining the feeding value of a laying ration.

If a large amount of moldy grain is available for feeding, it may prove practical for a farmer to conduct such a feeding test, comparing the results with those obtained with grain which is not moldy. It certainly would be wise to first try this moldy grain on a small group of birds, and if found unsatisfactory, the whole flock would not be affected.

Most colleges are not equipped to conduct such biological tests on the feeding value of the many feed mixtures that are blamed for poor results on farms, nor is it usually practical for the poultry raiser to conduct such tests, because of the expense and inconvenience involved and also because of the remote possibility that the feed can be found to be actually at fault. One should use only well recommended mash and grain mixtures, which have been previously tested and found satisfactory. If a commercial mixture is desired in preference to feed mixtures recommended by College Experiment Stations, care should be exercised to select an economical mixture which is commonly used by successful poultry producers, and then carefully follow the feeding instructions.

How Much Protein Should be Fed?

The protein content of the total ration (mash and scratch) consumed usually amounts to 16 to 18 percent. It doesn't make so much difference how much protein is included in the mash. If grain is provided, hens in good production will adjust the proportions of grain and mash consumed to meet their requirements. It is, of course, essential that proteins of the proper quality be used. Laying mashes ordinarily contain 18 to 20 percent protein, and hens in good production will eat approximately equal amounts of mash and grain. If a mash or concentrate containing a higher percentage of protein is used, proportionately less mash than grain will be consumed.

Table 5. Ratio of Grain to Mash Consumed*

Protein content of mash or concentrate (Percent)	Approximate percentage of total feed consumed as mash
18	40 to 55
28	20 to 35
38	10 to 25

* These figures are calculated on an average protein content of 14 percent for the scratch grain used. It has been found that cereal grains produced in South Dakota contain somewhat more protein than cereals grown in some other sections of the country.

Methods of Feeding

There are six common methods of feeding laying hens, which include: 1, All-mash; 2, mash and grain in hoppers kept before the birds, free choice; 3, mash kept before the birds, grain limited; 4, concentrate, with grains kept before the birds, free choice; 5, the pellet system; and 6, the grain-milk system. Which method to use will depend upon farm conditions. In general, good results can be expected with any of these systems of feeding.

All-Mash. With this system of feeding, egg production may not be quite so good as when the mash and grain system is followed, according to experiments reported by the Agricultural Experiment Station at Washington State College. In addition, there is an added cost of grinding all the feed that the birds consume. The all-mash system may be most convenient and produce less variation in egg yolk color, but the disadvantages more than offset the advantages, therefore it is not recommended for South Dakota, where whole cereal grains are readily available.

Mash and Grain Free Choice. When both mash and grain are kept before the birds in hoppers, some birds may eat excessive amounts of grain and put on fat. With birds that are from higher egg producing strains, there is, of course, less tendency toward this, and relatively more mash is consumed to meet the requirements for good egg production. This system is, of course, very convenient and sanitary, and works out well with many flocks.

Mash Free Choice, Grains Limited. With lower producing strains, it may be more profitable to keep mash before the birds and limit the grain allowed. Often the practice of providing a warm, moist mash is followed, especially during the fall and winter months. This is to increase the consumption of mash which produces more eggs. It is essential, however, that sufficient grain be provided to maintain body weight. Some prefer to feed grain only in the evening, giving as much scratch grain, either in hoppers or in the litter, as the birds will clean up. Others prefer to give two or three pounds of scratch grain per hundred birds in the morning, and as much as they will consume for the evening feeding. There is perhaps little difference which method is followed.

Concentrate and Grains Free Choice. The use of a concentrate fed in hoppers and grains also kept before the birds provides an opportunity to use maximum quantities of whole home-grown grains. However, with low producing strains there is a possibility of some birds eating excessive amounts of grain and becoming fat instead of consuming the concentrate which stimulates egg production. If this is the case, the grain supply could be limited. This system is widely used with good results.

The Pellet System. Feeding pellets has been quite widely advertised in some sections of the country. Pellets are nothing more than an all-mash ration made into pellets. In some cases higher protein mash mixtures may be made into pellets for use with home-grown grains. The advantages claimed are that the use of pellets does not permit the birds to pick out some of the ingredients and leave the others, and that it tends to reduce wastage. The use of pellets

does insure that the ration consumed is uniform in composition, but does not always insure against wastage. There is also the added cost of grinding and processing the feed used in the pellets, and it is doubtful whether this additional expense is justified under South Dakota conditions.

The Grain-Milk System. Many farmers have liquid skimmilk or buttermilk available for feeding livestock and usually it will be found profitable to give the chickens their share. With this system, the birds are usually given all the whole cereal grains they will eat and in addition they are given oyster shells. If enough milk is available so that it can be kept before the birds at all times, it is not necessary to provide water since liquid skimmilk or buttermilk contains about 90 percent water. With the grain-milk system it is advisable to allow the birds plenty of green range.

When the birds are confined during the fall and winter, it will be found profitable to use a laying mash containing meat scraps and alfalfa-leaf meal. Grit should also be used. Any simple mixture of feeds can be used to advantage with liquid milk, but it is advisable to follow recommendations in selecting a formula for this purpose.

Wet Mash Feeding

Many poultrymen follow the practice of feeding a moist mash to increase consumption. This practice may stimulate egg production if the birds consume more mash because this is the chief source of proteins, vitamins and minerals. Usually the laying mash mixture is moistened just to the point where it is crumbly. Too much water added to the mash makes it sticky, and it freezes more quickly if not used immediately. Chickens do not seem to eat the mash so readily if it is too wet. Generally about as much of the moistened mash as the birds will clean up in a half hour is given once a day during the fall and winter months. If the birds are laying well, they will eat much more mash. When not in production, only small amounts of mash will be consumed.

It is good practice to feed the moistened mash to the birds that have practically completed their growth, as forcing immature pullets into early production will result only in the temporary production of smaller eggs. A good feeder watches his birds' body weight and when they have made their growth, he forces them into production and at the same time attempts to keep up their body weight. It should be kept in mind that mash makes eggs and that whole or ground cereal grains make fat. By feeding a proper balance of mash and grain, egg production and body weight can be maintained. If the proper balance is not maintained, the birds may go into a molt lasting from 6 to 10 weeks or longer, and it is often very difficult to get the birds back into production in extremely cold weather.

Some prefer to moisten the mash with liquid skimmilk or buttermilk which increases palatability and stimulates consumption. In cold weather, it would be advantageous to have the milk or water warmed before mixing with the mash. In general, the more mash that the birds can be encouraged to eat, the greater will be the egg production. Moist mash should not be fed in warm weather as it spoils quickly and may cause digestive disturbances.

Fig. 3. Feeds can be readily mixed with a scoop shovel. There are, however, many small feed mixers available at a reasonably low cost. It may prove profitable to own such a mixer.

When to Use Commercial and Home-Mixed Rations

Feeds and feeding methods probably have the most important influence on the cost of production and profits. It is, therefore, very essential that care be exercised in the selection and use of rations. There are a great many possible combinations of feeds which would give good egg production, but in selecting a ration to use, cost and availability are the most important considerations—aside from the fact that only recommended combinations should be used. Whether to use a commercial mixture or a home-mixed ration depends upon several factors discussed in the next two paragraphs. Precautions should be followed in either case.

Commercial Mixtures. Only well-known brands of commercial mixtures should be used. One should be guided in his choice by the results secured by others and by the reputation of the local distributor. In addition, cost should be considered, both in comparison to other commercial mixtures of good standing and in comparison with home-mixed rations. Commercial mixtures are per-

haps most often used with small flocks and where feed mixing facilities are not available, or where there is insufficient time for mixing. In addition, the commercial mixture is used to advantage where there is a limited supply of home-grown grains or inadequate feed grinding facilities. If there is plenty of home-grown grain, it may be more practical to use a concentrate instead of a laying mash. Some hatcherymen prefer to have their flock owners use a certain commercial mixture which is believed to give good hatchability, and, in return, a premium is offered for the hatching eggs produced.

Home-Mixed Rations. It is very important to follow directions carefully in the use of home-mixed mashes, as every ingredient serves a particular purpose in meeting the requirements for health, maintenance and egg production. Substitutions of one ingredient for another may lead to considerable trouble unless these substitutions have been previously tried and recommended. Home-mixed mashes may be used to advantage where there are plenty of grains available. Milk products and green feeds ordinarily available on many farms may be used to advantage, and it is considered poor economy to purchase commercial mixtures which already have these ingredients included. Although home mixtures are not so convenient to use, they are often cheaper and give just as good egg production as commercial mixtures. In addition, one will know what is in the mixture and can depend upon the composition and quality of the ingredients used.

Grains Should be Coarsely Ground

It is very important that the grains be ground to the proper degree of fineness. If a hammer mill is used, a one-eighth inch screen will be a satisfactory size for all cereal grains used in growing and laying rations. If wheat is too finely ground and if a large percentage is used, it is likely to stick to the birds' beaks, causing serious disturbances in the circulation of the blood in the mouth. For starting rations, it is essential that the more fibrous feeds such as oats and barley be ground over a one-sixteenth inch screen in order to reduce the size of the hulls to prevent wastage. If the ration is not properly ground, the birds will not eat it readily and production will be retarded.

Mix Mash Regularly

Elaborate feed mixing equipment is not necessary. The feed may be mixed with a scoop shovel on a clean floor. The different ingredients of the mash should be well mixed so that each day the flock will receive uniformly the same feed. Well mixed rations are most palatable and insure a regular supply of nutrients daily.

A mechanical power mixer may prove practical under certain conditions and will save labor. Suitable mixers are now available at very reasonable prices. Sometimes arrangements for mixing can be made with the local elevator operator.

A fresh supply of feed should be mixed at least every two or three weeks. If feed is allowed to remain mixed for a long period, it is likely to become stale and less palatable. There is also some deterioration in vitamin value with excessive exposure.

*Management of Hens**

Good Breeding is the First Essential

While this circular deals primarily with feeding and management, the importance of having hens which have been bred for egg production cannot be overlooked. It frequently happens that poor egg production is obtained even though the best feeding and management practices are followed and the birds are kept in a healthy condition. If this is true, the trouble probably lies with poor breeding. Important decisions must be made before buying chicks. If

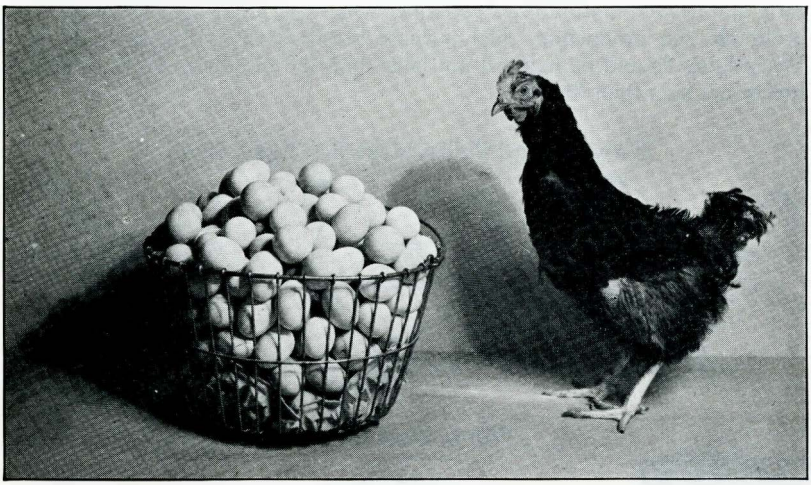

Fig. 4. Good family records provide the best assurance of good breeding quality. This Rhode Island Red hen laid 300 eggs in her first year of production at South Dakota State College. Her sire's dam produced 268 eggs in the first year and a total of 611 eggs in three years. Her dam produced 332 eggs in two years. This hen's sisters also have good production records. This picture was taken just after this hen completed her first year of production. Note the worn appearance of her plumage.

cheap chicks which are usually of low breeding quality are purchased, time and effort will be wasted in trying to get profitable egg production. If, on the other hand, the decision is made to get chicks which have been bred for egg production, it is important to select a reliable hatcheryman who can provide assurances of the quality desired. Usually it will not be found necessary to have chicks shipped in from several hundred miles, as there are many hatcherymen in South Dakota who can supply chicks that will prove to be profit-

* The writer is indebted to M. H. Simonson, extension poultryman for permission to use considerable information on poultry management practices from South Dakota Extension Circular 386.

able for egg production. It takes only a very few eggs to pay the difference between the cost of a good chick and a poor chick. Beware of bargains—the best poultrymen do not take chances.

Early Hatched Pullets are Most Profitable

It takes from 5½ to 7½ months for dual purpose breeds and egg breeds to make sufficient growth before egg production starts. If birds are forced into production when they are too small, a much greater proportion of small eggs will be laid. Production in immature pullets usually stops at the end of two or three months and there is often a partial molt in the fall and early winter. During this time, the birds complete their body growth and grow new feathers. In order to avoid this period of non-production, the pullets should be hatched early and be well matured by September when egg prices are increasing. For profitable egg production, dual purpose breeds such as Rocks, Reds, and Wyandottes should be hatched not later than the middle of April, and egg breeds not later than May 1.

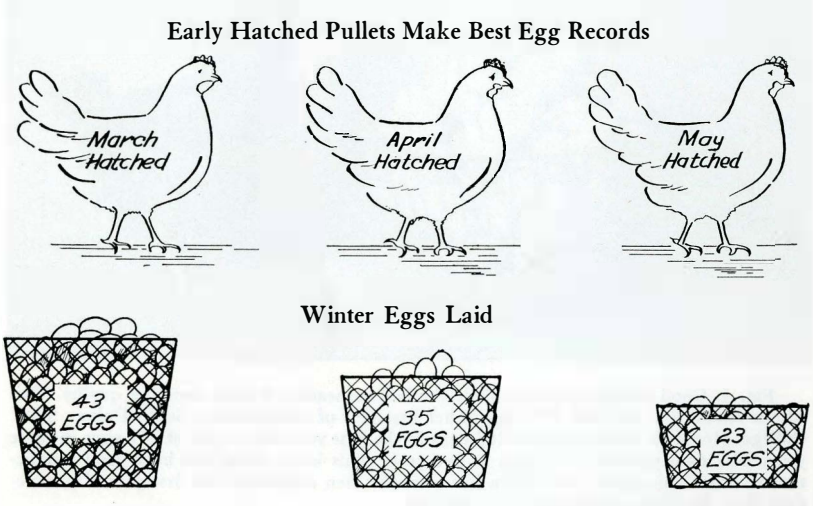

Fig. 5. At the Massachussetts Agricultural Experiment Station, Rhode Island Red pullets hatched in March and April produced more winter eggs than pullets hatched in May.

Housing the Laying Flock

Proper housing is necessary for winter egg production in South Dakota. Insulation and adequate ventilation must be provided to keep the flock healthy and comfortable throughout the winter months in order to maintain good egg production.

Clean and Disinfect. Before the pullets are housed in the fall, the laying house should be thoroughly cleaned and disinfected. All inside equipment

including roosts, dropping boards, nests, feeders, water containers, and stands should be removed. The walls and ceiling should be swept and all litter and dirt removed. In houses not having permanent floors, at least 6 to 8 inches of the old soil should be replaced with clean cinders or gravel.

After the equipment has been removed, the floor, walls, and sills should be thoroughly scrubbed with boiling lye water, using one pound of lye to 10 gallons of water. All of the inside equipment should be thoroughly scrubbed with lye water and allowed to remain outside in the sun for 12 hours.

Why Inadequate Equipment Cuts Down the Profits

Laying hens should not be crowded. Adequate equipment must be provided if good egg production is to be expected. Overcrowding lowers the vitality of the hens, prevents the birds from getting plenty to eat and drink, and makes it almost impossible to keep the house clean and dry. The South Dakota type poultry house is 16 feet by 32 feet, which has a total of 512 square feet. This house will accommodate 175 Leghorn hens, or 130 Plymouth Rocks, Reds, or similar heavy breeds. This allows three square feet of floor space for Leghorns and four square feet for heavier breeds. The following equipment should be provided for 150 hens.

22 nests—1 nest to every 7 hens
3 five-foot mash hoppers—1 lineal foot of space for every 5 hens
4 three-gallon water containers—1 quart of water for every 3 hens
112 linear feet of roosts—9 inches for each hen
2 oyster shell and grit hoppers—1 shell hopper to every 75 hens

Litter. Proper litter for the laying house is important. The litter should be kept clean and dry at all times and should be replaced as often as necessary. This will vary, depending upon the number of birds in the house, the system of ventilation used, and weather conditions. From 6 to 12 inches of clean straw on the floor provides excellent litter.

Dropping Boards or Dropping Pits. During the past three years, many poultrymen have built dropping pits in their laying houses and are well pleased with the results. Dropping pits can well be recommended for houses with dirt floors, as the moisture is readily absorbed. The pits help keep the house dry, since the droppings fall beneath the wire netting at the back of the house. Dropping pits also help in keeping the house clean and more sanitary, since the birds cannot get at the droppings. The droppings should be cleaned out every two or three weeks.

Dropping boards have been recommended for several years and have proved very satisfactory. Many prefer the dropping boards to the pits, since they can be cleaned much more easily. They also have the advantage of forming a roosting alcove in the South Dakota type house. This alcove helps keep the birds warm when they are inactive at night, since the heat is kept near the hens.

Hens should be trained to use the roosts as soon as they are placed in the laying house. Birds that crowd into corners on the floor, and roost on nests and feeding equipment, become chilled, and are more susceptible to colds and other diseases.

Keep the Hens Comfortable

Variable and extremely low temperatures in South Dakota will greatly influence winter egg production unless good housing is provided and proper feeding and management of hens is employed. Poultry houses with high roofs can be made warmer by the installation of a straw loft 6½ to 7 feet from the floor. Information concerning proper housing can be obtained from Extension Circular 362, "Poultry Houses for South Dakota."

During cold, changeable weather, daily regulation of the windows is necessary in order that the house temperature and ventilation be maintained. During cold weather, the fresh air should be admitted by lowering one or two windows (from the top) so that a small amount of fresh air is admitted several feet from the floor. On extremely cold days, it is best to close all windows. It is important that no drafts be permitted on the floors, as this will cause colds and other diseases.

Fig. 6. Improved poultry house equipped with dropping boards. Note deep litter, water stand, nests and egg basket.

Using Electric Lights in the Poultry House

Purpose. Lights are used chiefly for the purpose of getting more fall and winter eggs at a time when eggs bring the highest prices. Lights are also used to hasten body maturity among pullets, encourage early egg production, prevent molt in old and young birds and maintain egg production. Lights are most commonly used, for pullets, from October to March, and for hens from September to March.

Lighting Practices. Lights are used to provide a 13 to 14 hour day. To accomplish this, the following systems are practiced:

Morning Lights Only—Lights turned on at 3:30 a.m. and off at daylight. Preferred to other systems.

Morning and Evening Lights—Lights turned on at 4:30 a. m. and off at daylight, and also turned on at dusk and off at 6:00 p. m. Dimmers of lower wattage would be required in the evening with this method.

Evening Lights Only—Lights turned on at dusk and turned off at about 8 p. m. Dimmers required.

All Night Lights—Light is available at all times, but a lower wattage is used than with other methods. This is more costly than other methods.

Evening Lunch—Lights turned on at 8:00 p. m. and off at 9:00 p. m. No dimmers required. Before lights are turned out, chickens soon learn to go back to roost after getting their feed and water. This is perhaps the most economical method so far as cost of electricity is concerned.

Amount of Light and Equipment Required. A 40-watt lamp should be equipped with a cone-shaped reflector 16 inches in diameter at the base and four inches high. The reflecting surface is covered with aluminum bronze. At the height of six feet, this light gives the desired intensity over an area of approximately 200 square feet. To arrive at the number of lights required in a given pen, divide the number of square feet of floor space by 200. The nearest whole number obtained will give the number of lights required. Lights should be located in a line, midway between the front of the house and the dropping boards, and spaced so that the distance between lights is twice the distance from the end lights to the end of the pen. This system of lighting the whole pen is used with all methods except where all-night lights are used.

Management Practices With Lights. Plenty of feed and water should be available at all times. Water should be heated if this is necessary to keep it from freezing. Birds will not eat much mash if water is not available. If early morning lights are used, some method should be devised to insure a regular supply.

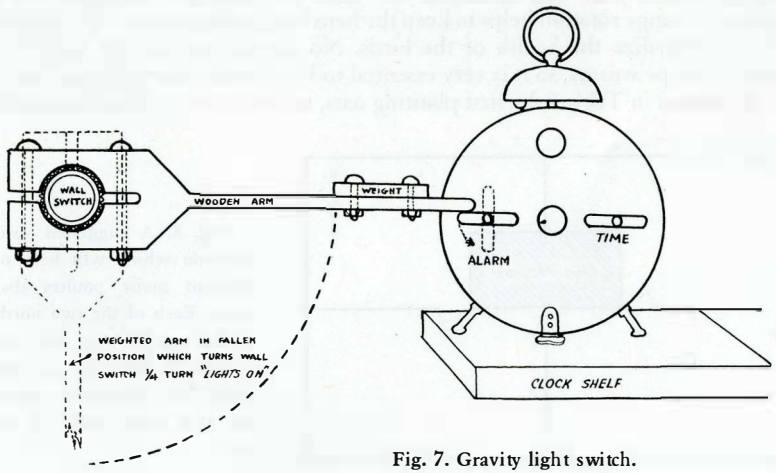

Fig. 7. Gravity light switch.

Regularity both in the use of lights and feeding is very important. When evening lights are used, dimmers are required so that the birds will be given time to get up on the roosts before the house is dark.

Electric Clocks. The diagram in Figure 7 will suggest how an alarm clock may be used to turn on the lights. A clock is especially desirable when early morning lights are used. It also helps to maintain regularity.

Keep the Flock Healthy

Practice Good Range Rotation. The best protection of laying flock health can be obtained by following recommended practices of range rotation during the chick growing period. Chicks should have access to plenty of green range and shade during the summer months. Ground should not be used two years in succession, even though it is freshly planted and cultivated each year. Farmers may get by for several years by using the same ground continuously, but eventually this ground becomes contaminated with disease germs and internal parasites. When this happens, it is usually too late to correct this unhealthy condition, as so-called remedies will not cure most diseases, and when a disease once gets established it is often very difficult to eliminate it from the premises.

At the end of the growing season, pullets should be carefully selected for size, vigor, and good egg production qualities. These young birds should not be put with old birds, as frequently old hens are carriers of disease germs, although they show no ill effects. The pullets should either be confined to the laying house, or it would be better for them to have access to clean yards adjoining the laying house. They should not be permitted to run on contaminated ground around the farm buildings. This is how a great many diseases get started in laying flocks.

A good plan is to fence off the north and south sides of the laying house. The birds should be allowed access to the south side for one year and the north side the second year. The third year the south side may be used again. This method of range rotation helps to keep the hens free from round or tape worms which jeopardize the health of the birds. No satisfactory remedy has been found for tape worms, so it is very essential to keep birds from being infested.

As shown in Table 6, by first planting oats, followed with sudan grass, and

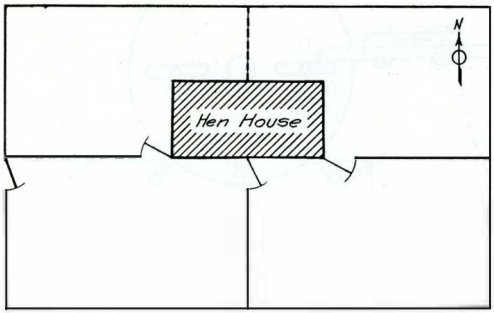

Fig. 8. A suggested yard rotation which will help to prevent many poultry diseases. Each of the two north yards can be used for one season by the hens in two pens. The following season the two south yards can be used.

later rye, a steady supply of young green feed is provided from early spring to late fall. Green feed is of comparatively little value when old and tough.

If it is not possible to provide good green range for the layers, a small yard adjoining the laying house can be fenced off and the ground covered with a few inches of gravel which can be replaced each year. It would be better, however, if a concrete sun porch were built, as this could be cleaned often thoroughly and used continuously.

Table 6. A Plan for Providing Laying Hens with Regular Supply of Green Range

Location of Yards	Range Crop Planted	Time of Seeding	Months Pastured (First year)	Year Pastured
South yards	Rye	Aug.-Sept.	Sept.-Nov.	First year
South yards	Clover or alfalfa	May	Do not pasture	Second year
North yards	Oats	April	April-May	Second year
North yards	Sudan or rape	May	June-July	Second year
North yards	Rye	August	Sept.-Nov.	Second year

During the third year, the hens can be confined to the south yards, in which clover or alfalfa was planted in the spring of the previous year.

Allowing the hens to have access to outside yards insures a regular supply of sunshine, and it is easier to keep their quarters clean.

Lice and Mites Lower Egg Production

Lice and mites cause birds to be unthrifty and are likely to reduce egg production. It is comparatively easy to eliminate these parasites, and there is really no excuse for having them. In order to determine what treatment to use, it will be first necessary to determine which of these two parasites is present. There are, of course, many different species of lice and mites, but only the two most commonly found on laying hens will be discussed here—the body louse and the red mite.

Lice have biting mouth parts and irritate the bird by crawling and biting the old scales which serve as food. Lice spend their entire life on the fowl. Their eggs are laid around the base of the feathers, usually just below the vent and under the wings. Lice vary in size, some being very small and some one-eighth inch long, or longer.

Red mites are very small and difficult to see during the afternoon or toward evening. At this time they are gray. After feeding, they are full of blood and are red. Mites do not stay on the birds constantly. They spend the day on the underside of the perches or in nearby cracks and crevices. At night, they crawl on to the birds and fill themselves with blood by piercing the skin with their sucking mouth parts. Before morning they leave the bird, spending the day nearby digesting the blood.

Lice Treatment. There are several treatments which are quite effective in controlling body lice:

1. **Nicotine sulphate or Black Leaf 40**
2. **Sodium fluoride in the powder form**
3. **Sodium fluoride used as a dip**

Nicotine sulphate or Black Leaf 40 has been widely used as a treatment of body lice on poultry. The solution is placed in an ordinary oil can similar to any used to lubricate farm machinery. A narrow but continuous ribbon or stream of the solution is applied to the upper side of the perches about one-half hour before the birds go to roost. The perches should be cleaned before the Black Leaf 40 is applied. The heat of the fowls' body causes the fumes of the nicotine sulphate to rise and penetrate the feathers which kills the lice. A second treatment is necessary 10 days later in order to kill the young lice which may have hatched after the first treatment. Care should be taken to see that all the birds are on the treated perches because one or two birds that are not treated will reinfest the flock.

Black Leaf 40 can be used to treat individual birds by using a small dropper and applying one drop of this liquid on the head, under each wing, on the back, on the breast, and under the vent. This method is preferred by many poultrymen.

Sodium fluoride may be purchased at most drug stores and is commonly applied by what is called the pinch method. Place the powder in a bowl, take a liberal pinch between the thumb and four fingers, and apply to the birds as follows: One pinch on the head, one on the neck, two on the back, one on the breast, one below the vent, one on each leg, and under each wing. Care should be taken to see that the powder is distributed among the feathers next to the skin.

When used as a dip, two level tablespoons or one ounce of sodium fluoride is required to each gallon of water. The water should be warmed to a temperature of 100 to 105 degrees. Soft water is preferable. Dipping is not satisfactory unless it is done in the forenoon of a very warm day, which will allow the birds to dry thoroughly before going to roost. In dipping be sure that the feathers are thoroughly wet. Place the thumb and index finger over the nostrils of the bird and dip the head, holding it under for three or four seconds. Change the water frequently enough to keep it reasonably clean. Stock dip is not suitable for this purpose.

Black Leaf 40 and sodium fluoride are poisonous and should be kept away from children. Both the nicotine sulphate and the sodium fluoride can be procured at most drug stores.

Treatment for Mites. To combat mites, an application of oil insecticide must be made in the poultry house or brooder house. First, thoroughly clean the house to be treated. Remove all loose equipment. Paint or spray the dropping boards, roosts, the walls immediately back of the roosts, and the nests with carbolineum or wood preserver. If recommendations are followed, one application of this material will usually rid the houses of mites for one year. Three parts of waste motor oil and one part of kerosene can also be used, but this is not so effective and the application must be repeated every two to three weeks during the warm months. It is usually neglected and for this reason generally proves unsatisfactory.

Look for mites in the poultry house early in the spring. They may be detected by a grayish scale found at the point where the roosts rest on the cross member, or by holding a lighted match at this point. If the mites are

present, they will be driven out by the heat. Mites multiply very rapidly in warm weather and by treating them early in the spring the trouble is greatly lessened in the summer. Mites are very hardy and may live in a poultry house for six months to a year without food.

Keep Feed Costs Down

Eliminate Non-Producers. A good way to keep down feed costs and increase profits is to maintain a high standard of egg production by keeping feed requirements as low as possible. Birds will consume an average of around seven pounds of feed per month. Obviously, it is a waste of feed to keep non-producers. The flock should be culled once a week. In this way, birds can be identified as rapidly as they stop laying, and they should be removed from the flock.

It is well to recognize that if proper feeding, management, housing, and sanitation are provided, there is no excuse for having these parasitic boarders. If production stops, there must be a reason. Very often cessation of production is an indication that something is going wrong in the bird. Perhaps there is a weakness in the reproductive system, or possibly the birds do not have sufficient vitality to produce eggs over a long period and maintain health. Consequently, certain hens may be more susceptible to diseases and with the onset of disease, their production ceases. In any event, when a bird stops laying, she should be removed from the flock immediately: First because it takes feed to keep her; secondly, if in a healthy condition she can be salvaged for meat; and thirdly, if kept, symptoms of disease may appear and spread to the other birds.

Fig. 9. How to tell a good layer from a poor one by head points. Note the large comb, thin lean face, and full white ear lobes on the hen to the left.

How to Distinguish the Layer From the Non-Layer

The Good Hen	The Poor Hen
The Comb	
Large, red, glossy, warm and full	Small, scaly, round, dry
The Vent	
Large, moist, dilated, white	Small, contracted, dry and yellow
Wattles and Lobes	
Prominent, soft, smooth	Small, dry, rough
Pelvic Bones	
Thin, flexible, wide apart	Thick, rigid, close together
Abdomen	
Soft, pliable, and deep as measured from keel to pelvic bones	Hard, thick, contracted and small distance from keel to pelvic bones.

Birds out of production can be easily recognized by their appearance and by the fact that they are frequently seen on the roosts. Such birds consume comparatively little mash or shells, but if healthy they seem to have an appetite for scratch grain.

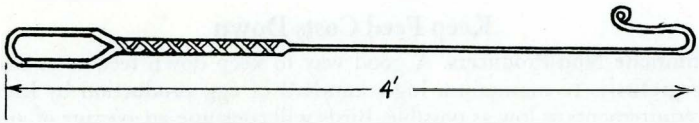

Fig. 10. Catching hook made from heavy wire.

By keeping a record of daily egg production, it is easy to determine whether a good job of culling is being practiced. A good standard to maintain is an average of 50 eggs daily for 100 hens.

A catching hook, as shown in Figure 9 is a handy article to have in the poultry house for the purpose of catching one or two individual birds. This hook is made by fastening a piece of heavy wire to the end of a broom handle or stout stick about that length. It is not advisable to use this type of catcher when the entire flock is to be handled.

Break Up Broody Hens. Broody hens should be quickly segregated from the flock, as they are not only unprofitable but occupy the nests needed by the layers, and cause a deterioration in egg quality. If permitted to remain broody, they often lose weight and decline in market value. Broody hens should be confined to small coops with wire or slatted bottoms and they should be fed a good laying mash so as to get them back into production soon. It is harder to break up broodiness if this is not detected early and the hens removed from the nests.

Dispose of Males Early. There is no need for keeping any male birds in the laying flock unless hatching eggs are saved. At the end of the hatching season males should be promptly separated from hens. This helps keep down feed costs and improves egg quality. Fertile eggs deteriorate in quality much more rapidly than infertile eggs. It takes only about three or four days of summer temperature to produce a blood ring, which makes the fertile egg unfit for human consumption.

Prevent Feed Wastage. Feed hoppers should be built so as to prevent the hens from scratching in the feed, as this is not only wasteful but unsanitary. The use of a good ration will help to prevent wastage as the birds will not try to pick it over so much. Hoppers should not be set outside in the wind unless they are well covered and protected.

There are numerous types and styles of mash hoppers for use in the laying house. The open trough type protected by wires and which holds sufficient quantity to last for about two days has been found very satisfactory. The mash being visible in the open hopper and the fact that it is fresh, being replenished frequently, may encourage greater consumption with correspondingly greater egg production. The hopper should be long enough to afford plenty of feeding space for the flock. A hopper which allows the hens to eat from both sides should be one foot long for every 10 birds in the flock. The

mash hopper should be raised about 20 inches from the floor. This prevents the hens scratching litter into the mash and also conserves valuable floor space. Figure 11 shows a very satisfactory indoor mash hopper for the laying house. If grain is hopper-fed, an additional feeder will be required.

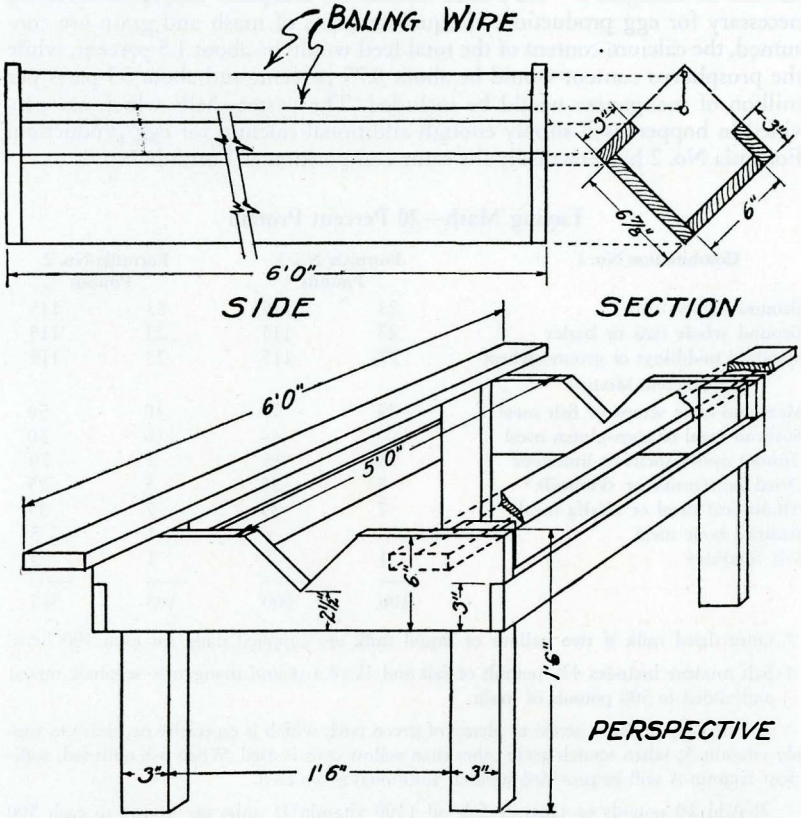

Fig. 11. Practical reel type mash hopper for laying hens.

Recommendations for Laying Rations

There is no best ration or system of feeding layers, but there are many good rations, and the choice of the formula to use will depend largely upon which grain and other feeds are available and their relative costs.

Oyster shells and grit should be kept before the birds in hoppers, but if the birds have access to a sandy or gravelly soil it will probably not be so necessary to supply grit.

Liberal quantities of water must be available at all times unless liquid milk is used.

Rations for Layers. If eggs are not saved for hatching purposes, good results will be obtained at a lower cost with a somewhat simpler mash mixture than is used for breeders. The mash mixtures recommended below contain approximately 2.9 percent calcium, 1.2 percent phosphorus, and 105 parts per million of manganese. They also furnish an adequate supply of vitamins necessary for egg production. If equal amounts of mash and grain are consumed, the calcium content of the total feed would be about 1.5 percent, while the prosphorus content would be about 0.75 percent, and about 53 parts per million of manganese would be included. The oyster shells which are provided in hoppers will supply enough additional calcium for egg production. Formula No. 2 has practically the same composition as Formula No. 1.

Laying Mash—20 Percent Protein

Combination No. 1	Formula No. 1 Pounds		Formula No. 2 Pounds	
Ground yellow corn	23	115	23	115
Ground whole oats or barley	23	115	23	115
Standard middlings or ground wheat	23	115	23	115
Supplement Mixture				
Meat-and-bone scraps or fish meal	15	75	10	50
Soybean meal or corn-gluten meal	—	—	6	30
Ground oyster shells or limestone	3	15	4	20
Dried buttermilk or skimmilk*	5	25	5	25
Alfalfa-leaf meal or alfalfa meal	7	35	7	35
Steamed bone meal	—	—	1	5
Salt mixture†	1	5	1	5
	100	500	103	515

* Omit dried milk if two gallons of liquid milk are supplied daily for each 100 hens.

† Salt mixture includes 4⅞ pounds of salt and ⅛ of a pound manganese sulphate mixed and added to 500 pounds of mash.

1. Birds should have access to plenty of green feed, which is especially necessary to supply vitamin A, when scratch grain other than yellow corn is used. When fish oil is fed, sufficient vitamin A will be provided without additional green feed.

2. Add 10 pounds or pints of fish oil (100 vitamin D units per gram) to each 500 pounds of mash during the fall and winter months. If fish oil concentrate is used, less will be required, depending upon the amount of vitamin D present. (See page 17)

3. Enough scratch grain should be supplied so that the hens will consume approximately equal quantities of grain and mash.

Concentrate for Layers and Breeders. The advantage of using a concentrate lies in the fact that relatively more grain than mash will be consumed. Formula No. 1 contains approximately 4.5 percent calcium, 1.5 percent phosphorus, and 120 parts per million of manganese. Formula No. 2 contains approximately 4.9 percent calcium, 1.8 percent phosphorus, and 113 parts per million of manganese. If formula No. 2 is chosen, the ratio of grain to mash consumed will be higher than with formula No. 1.

Concentrates for Laying Hens

Mill Feed or Grain Mixture	Formula No. 1 26 Percent Protein Pounds		Formula No. 2 32 Percent Protein Pounds	
Wheat bran or ground oats	19	95	—	—
Wheat middlings or ground barley	19	95	29	145
Supplement Mixture				
Alfalfa-leaf meal or alfalfa meal	15	75	10	50
Meat-and-bone scraps or fish meal	15	75	25	125
Dried buttermilk or skimmilk*	15	75	10	50
Soybean meal	10	50	20	100
Ground oyster shells or limestone	6	30	5	25
Salt mixture†	1	5	1	5
	100	500	100	500

* If liquid milk can be kept before the birds at all times, omit the dried milk and reduce the amount of meat or fish meal in the mash by one-half, and add 2 percent steamed bone meal.

† Includes 4⅞ pounds of salt mixed with ⅛ of a pound of manganese sulphate and added to 500 pounds of mash.

1. Add 10 pounds or pints of fish oil to each 500 pounds of mash during the fall and winter months. If fish oil concentrate is used, less will be required, depending upon the amount of vitamin D present. (See page 17)

2. If the concentrate is to be fed to breeders from which hatching eggs are saved, 20 pounds of fish oil should be added to each 500 pounds of mash.

3. Scratch grain and oyster shells should be kept before the birds in hoppers at all times. Some prefer to mix the fish oil with the scratch grain. If this is done, enough should be added so that 100 breeding hens will consume about three-fourths of a pound daily. Only half of this amount would be required if the eggs were not used for hatching purposes.

Rations for Breeders. If eggs are to be saved for hatching purposes, a breeder mash should be used. This mash has somewhat better quality proteins and contains more of the vitamins which are essential for good hatchability. The following mash mixtures contain about the same amount of calcium, phosphorus and manganese as the laying mash given on page 36.

Breeder Mash—22 Percent Protein

Combination No. 1	Formula No. 1 Pounds		Formula No. 2 Pounds	
Ground yellow corn	18	90	18	90
Ground oats or barley	18	90	18	90
Standard middlings or wheat	18	90	18	90
Supplement Mixture				
Meat-and-bone scraps	10	50	5	25
Fish meal	—	—	5	25
Steamed bone meal	1	5	1	5
Soybean meal	10	50	8	40
Alfalfa-leaf meal	10	50	10	50
Dried buttermilk or skimmilk*	10	50	10	50
Ground oyster shells or limestone	3	15	3	15
Salt mixture†	1	5	1	5
Fish oil 100 vit. D units‡	3	15	3	15
	102	510	100	500

* Omit dried milk if three gallons of liquid milk are supplied daily for each 100 hens.

† The salt mixture should include 4⅞ pounds of common salt and ⅛ of a pound of manganese sulphate, carefully mixed to insure uniform composition.

‡ If fish oil of higher vitamin D potency is used, proportionately less will be required.

The amount of scratch grain provided should be regulated so that approximately equal amounts of grain and mash will be consumed.

How to Utilize Farm Grains. If the birds have access to plenty of green range, any of the following combinations of ground grains may be added to the laying mash mixture instead of grain combination No. 1. The same grains may also be used in the scratch mixture in equal quantities. For example, with combination No. 3 in laying mash formula No. 1, 115 pounds each of ground millet, ground wheat, and ground oats may be used in the laying mash, or if combination No. 9 is selected, 172 pounds each of yellow corn and oats may be added to the supplement mixture of the laying mash.

If the breeder mash formula No. 1 is used, as shown in the third system, and milo, oats, and wheat are available for feeding, combination No. 4 could be selected, adding about 90 pounds of each of these three grains to the supplement mixture. The same proportions might also be used in the scratch mixture. No substitutions are recommended in the mill feed or grain mixture given in the concentrate formula.

No. 1	No. 2	No. 3	No. 4
Yellow corn	Yellow corn	Millet	Kafir or milo
Oats or barley	Wheat bran	Wheat	Oats or barley
Middlings or wheat	Wheat middlings	Oats or barley	Wheat

No. 5	No. 6	No. 7	No. 8
Wheat	Oats	Yellow corn	Cane or feterita
Oats	Barley	Oats	Oats or barley
Barley	Millet	Millet	Wheat

No. 9	No. 10	No. 11
Ground yellow corn	Ground yellow corn	Coarsely ground wheat
Pulverized oats	Ground barley	Pulverized oats

No. 12	No. 13	No. 14
Coarsely ground wheat	Ground proso millet	Ground proso millet
Ground barley	Pulverized oats	Ground wheat

If there is insufficient green range, or if the birds are confined to laying houses without additional green feed and no cod-liver oil is fed, yellow corn should be included in all mash mixtures and also used to the extent of at least half of all scratch mixtures. If cod-liver oil is used in the mash as recommended during the fall and winter months, yellow corn need not be provided in either the mash or scratch grain. It is essential to recognize the need for adequate vitamin A and directions should be carefully followed since cereal grains other than yellow corn contain very little of this vitamin.

Table 7. Average Protein, Mineral, and Vitamin Content of Some Feedstuffs Used in Poultry Rations

Feedstuff	Crude Protein Percent	Calcium (Ca) Percent	Phosphorus (P) Percent	Manganese (Mn) Parts per million	Vitamin A Int'nat'l Units Per lb.	Vitamin D A.O.A.C. Chick Units* Per lb.	Vitamin G Riboflavin Microgram, gammas† Per lb.
Green Feeds							
Alfalfa-leaf meal (dehydrated)	(1)	(1)	(1)	(1)	95,000	(2)	8,000
Alfalfa-leaf meal	20.4	1.90	0.22	30	32,000	14	7,000
Alfalfa meal	16.0	1.44	0.21	26	13,000	—	5,000
Grains and Seeds							
Barley, (3)	13.2	0.05	0.36	16	400	trace	400
Corn, yellow	10.8	0.01	0.29	5	3,180	—	450
Corn, white	(1)	(1)	(1)	(1)	—	—	450
Corn-gluten meal, yellow	43.0	0.06	0.40	4	6,800	—	(1)
Cottonseed meal	41.8	0.23	1.18	18	600	—	300
Kafir	11.5	0.03	0.35	16	250	—	(1)
Linseed meal (old process)	35.3	0.33	0.74	40	200	—	900
Millet (proso)	14.6	0.01	0.33	35	(1)	—	(1)
Milo	11.0	0.04	0.32	15	250	—	400
Oats	14.7	0.10	0.36	34	80	—	400
Soybean meal	43.9	0.29	0.69	30	170	trace	1,400
Wheat	17.2	0.04	0.39	39	750	—	400
Wheat bran	15.6	0.11	1.21	119	150	—	1,000
Wheat flour middlings	17.0	0.07	0.69	113	100	—	700
Wheat middlings, standard	16.9	0.08	0.93	119	120	—	900
Feeds of Animal Origin							
Buttermilk, liquid	3.2	0.18	0.10	trace	25	—	1,200
Buttermilk, condensed	10.6	0.56	0.33	0.2	(1)	—	—
Buttermilk, dried	33.4	1.56	1.05	0.4	200	trace	9,000
Cod-liver oil	(3)	—	—	—	385,550	38,560	—
Cod-liver oil, fortified	—	—	—	—	1,360,000	181,600	—
Fish meal, whitefish, low ash	60.9	5.84	3.04	(1)	(1)	(1)	4,500
Fish meal, whitefish, high ash	61.6	9.09	4.70	(1)	(1)	(1)	—
Fish meal, sardine	67.0	4.73	2.63	40	(1)	(1)	3,200
Fish meal, menhaden	57.5	—	—	—	(1)	(1)	2,250
Liver meal, Argentine	65.4	0.11	0.90	4	(1)	(1)	18,500
Meat-and-bone scraps (50% protein)	50.0	10.20	4.91	10	(1)	—	Meat scraps 2,700
Meat-and-bone scraps (55% protein)	55.2	8.25	4.00	18	(1)	—	—
Pork liver dried	63.7	0.06	1.12	4	47,670	200	45,360
Sardine (pilchard) oil	—	—	—	—	52,000	38,560	—
Skimmilk, liquid	3.5	0.13	0.11	trace	15	—	1,000
Skimmilk, dried	35.0	1.27	0.96	0.6	130	—	9,500
Tankage (60% protein)	59.8	7.16	3.53	14	(1)	—	800
Whey, dried	12.5	0.83	0.70	14	(1)	—	12,000
Mineral Supplements							
Bone meal	—	27.00	13.00	13	—	—	—
Bone meal, steamed	13.0	28.80	13.34	5	—	—	—
Limestone, high calcium	—	39.20	—	200	—	—	—
Oyster shell, washed	—	38.00	trace	100	—	—	—
Manganous sulfate, anhydrous	—	—	—	36.3%	—	—	—
Manganous sulfate, tetrahydrate	—	—	—	24.6%	—	—	—

* This is the official unit of the Association of Official Agricultural Chemists, and is equivalent to one international unit of the kind of vitamin D found in pure cod-liver oil.

† The microgram, or gamma, is one millionth of a gram, which is about one twenty-eight millionth of an ounce.

(1) This symbol means that information is lacking.

(2) Leaders (—) mean that the feedstuff contains no appreciable quantity.

(3) The protein analysis for barley, yellow corn, millet, oats, and wheat are analyses made by the South Dakota Agricultural Experiment Station Chemistry Department.

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