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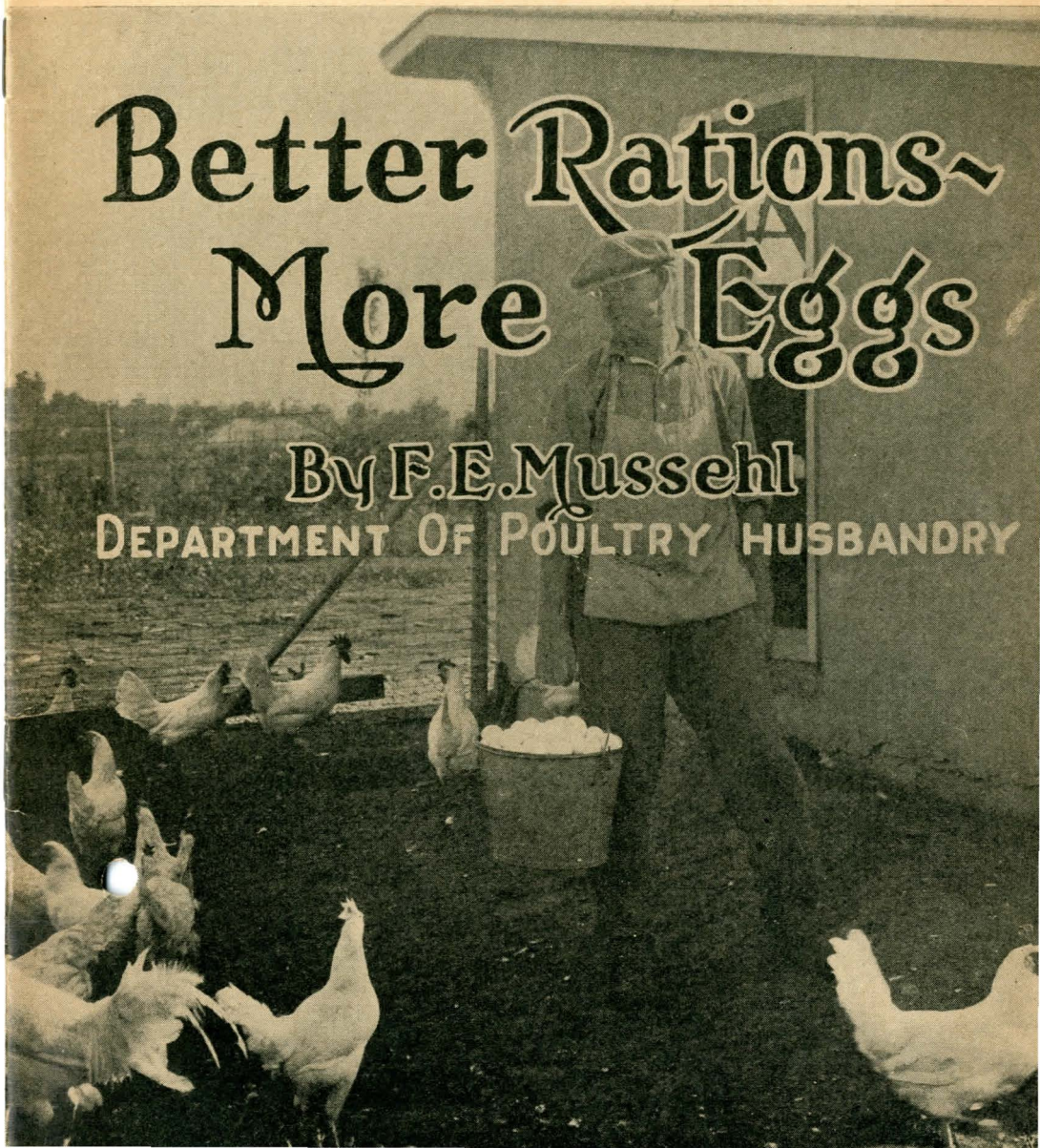
THE UNIVERSITY OF NEBRASKA
AGRICULTURAL COLLEGE EXTENSION SERVICE

July, 1927 Extension Circular 1420 Revised

Better Rations-More Eggs

By F. E. Mussehl
DEPARTMENT OF POULTRY HUSBANDRY



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(Revised 5-27-10M)

Better Rations — More Eggs

F. E. MUSSEHL

Well-bred and well-fed hens are conceded to be economical producers of a very wholesome food product, eggs,— but hens are not miracle workers and they insist on the right kind of raw material for building the egg. Nebraska's poultry growers fortunately have all the natural feeds — corn, wheat, oats, barley, and dairy and packing house by-products — readily available at lower cash prices than prevail in most other states, and so Nebraska's special problem is that of combining them so that eggs may be produced at the lowest cost per dozen.

FEEDING PRINCIPLES

Prices of particular feeds may vary, and as they do, it is sometimes good business policy to vary our mixtures. This we can do safely if we meet certain requirements.

The principles of feeding can best be demonstrated by considering corn as a poultry feed. Corn is, in fact, the basic poultry feed in most sections because of its high palatability, digestibility, and reasonableness of cost. But hens put on a ration of corn alone will not lay eggs, because such a ration is deficient in minerals, in proteins of the right quality, and probably also in some of the vitamins.

If we re-enforce the corn ration with minerals, our hens will lay a few eggs but not many because the ration is still very deficient. When we add to the corn and minerals some good complete animal protein, as is furnished by milk or packing house products, egg production is much improved but is still not at its best. The addition of some succulent green feed like clover will, however, further improve egg production.

The principles of feeding can be represented quite fairly in a table of additions as follows:

	Symbols represent increasing egg production
I. Corn alone	0
II. Corn + ash (mainly calcium, phosphorus and chlorine furnished by salt)	+
III. Corn + ash + animal protein	+ + +
IV. Corn + ash + animal protein + green feed	+ + + +
V. Corn + ash + animal protein + green feed + other feeds which add palatability and attractiveness	+ + + + + +

Practically all grains and grain products are deficient in the same essentials as corn, so that combining grains, tho helpful, does not entirely solve our feeding problem.

VITAMIN REQUIREMENTS OF POULTRY

The term *vitamins* includes a group of substances, the chemistry of which is as yet but little understood. Their importance, however, can be demonstrated very easily by putting hens or chicks on rations which are deficient in these elements. Five members of this nutrient group are now recognized, these being designated by the first letters of the alphabet, viz., A. B. C. D. and E. There is evidence that vitamins A, B, and D are of great importance to poultry. Vitamin C can be synthesized by the hen and is therefore not needed in the ration and no experimental work has yet been reported on the vitamin E requirements of birds.

Vitamin A is one of the fat soluble vitamins. Its chief influence is to promote growth and since egg production is really a growth phenomenon, it is naturally very important in the laying hen ration. A lack of this vitamin affects the secretory glands of the eye, nose, throat, and mouth and results in a condition known as xeropthalmia. The secretions of these glands have a bactericidal value and infections of the eye and head are more common when the ration is deficient in this vitamin. Nutritional roup, which is the name given to the resulting condition can be prevented and cured with rations which are rich in the vitamin A factor.

Egg yolk, milk, butterfat, yellow corn, the green leafy portion of most plants, alfalfa hay and meal, carrots, and millet are rich in this element. Certain of the animal tissues, notably those of the liver, carry it, and cod liver oil is one of the richest sources. This vitamin is unstable when exposed to air, particularly at high temperatures, and consequently when cod liver oil is being fed for its "A" content it should be mixed every week or ten days for best results.

Vitamin B or water soluble factor is in some way correlated with the functioning of the nervous system. Rations deficient in this vitamin result in a disease known as polyneuritis, evidences of which are paralysis of the neck and limbs.

This vitamin is the most widely distributed of them all and furthermore is very stable. Exposure to air, drying, and even heating for several hours does not destroy it. It is found in the germ and bran layer of all grains, in green food, milk, and egg yolk. It is found in greatest concentration in yeast, wheat shorts, and bran; the latter products generally furnish the most practical supply of this essential.

Vitamin C, the antiscorbutic or scurvy-preventing vitamin, is not essential in the hen ration but can apparently be manufactured by the hen.

Vitamin D is the antirachitic or rickets-preventing element. Rickets is a disorder that is due to faulty calcium and phosphorus assimilation. In some manner not yet perfectly understood, the vitamin factor contained in egg yolk and cod liver oil influences the assimilation of calcium and phosphorus and conserves the supply in the blood stream. Certain light rays have the same effect, these rays being known as the ultra violet. Nebraska's experimental work with chicks indicates that when direct sunshine is available for an average of 20 minutes per day, that vitamin D additions are unnecessary with any ordinary ration. During the winter months and during periods of prolonged cloudy weather, however, the providing of vitamin substitutes for radiant energy is advisable.

Cod liver oil is the most practical source of vitamin D. There is still some debate as to the relative value of different grades of oils and it is unfortunately very hard to standardize or determine their nutritive value. The general conclusion is that the light lemon colored oils are higher in vitamin content than are the darker oils. Cod liver oil can be mixed with the dry mash ingredients, about one pint per 100 pounds of feed being sufficient. It can be worked into the mixture with the hands or it can be warmed slightly and added with a sprayer as the mash is being mixed. Vitamin D is more stable than vitamin A but is also affected by high temperature and aeration.

A by-product of the making of cod liver oil known as cod liver meal is also being offered as a high vitamin D feed. The high vitamin content of this feed has not yet been definitely established and until more research work has been done the University advises the use of cod liver oil as the source of this essential.

Vitamin E is the last of these elements to be discovered and its necessity in the diet for hens has not yet been established. It is found in many plants and in the germ portion of most seeds.

PROTEIN REQUIREMENTS

The word protein is derived from a Greek word meaning *of the first importance.* Neither growth, egg production, nor maintenance are possible on a ration lacking protein and so this element is truly of first importance.

Proteins are very complicated substances built up of simpler compounds which are known as amino acids. Certain of these amino acids are more important from the standpoint of feeding practice than are others and some of the important ones are lacking in the proteins from plant sources. For this

reason best results are obtained when the laying hen ration contains at least some animal protein material like meat scraps, tankage, skimmilk, dried buttermilk, etc. The illustration (Figure 2) shows the remarkable effect on egg production which resulted from the addition of tankage and meat scraps to a typical grain ration. The addition of six pounds of a high grade tankage to the year's ration per hen increased egg production from 59 eggs per hen in the check pen to 183 eggs per hen in the tankage fed lot.

Skimmilk and buttermilk are also excellent sources of protein and when these are available on the farms or can be purchased at practical prices they should by all means be used. Milk contains other nutrients besides proteins but when milk is used for the chief source of additional protein about 110 pounds of milk are needed per hen per year. About three gallons of skimmilk per 100 hens per day will meet the supplemental protein needs when ordinary grain rations are used as the base.

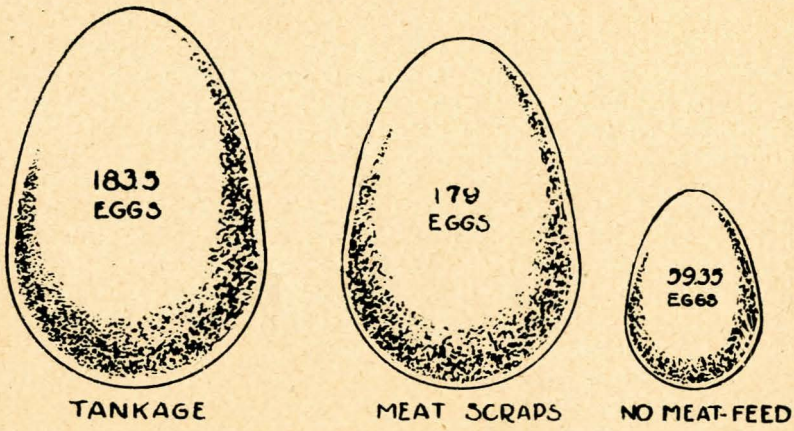

FIG. 1.—Comparative egg records of hens fed tankage, meat scraps, and no animal protein feed. From Circular 101, Purdue Agricultural Experiment Station.

Although it is not deemed advisable to rely on plant proteins for the main supplemental supply, nevertheless a share of these can be used and if packing house by-products are hard to obtain and high in price, it is recommended that a small quantity of cotton seed meal, linseed oil meal, corn gluten meal, soybean meal, and similar high protein plant products be used. When a mash mixture, for instance, calls for 15 per cent of meat meal, good results will also be obtained by using 10 per cent meat meal plus 5 per cent of cotton seed meal or a mixture of 10 per cent meat meal and

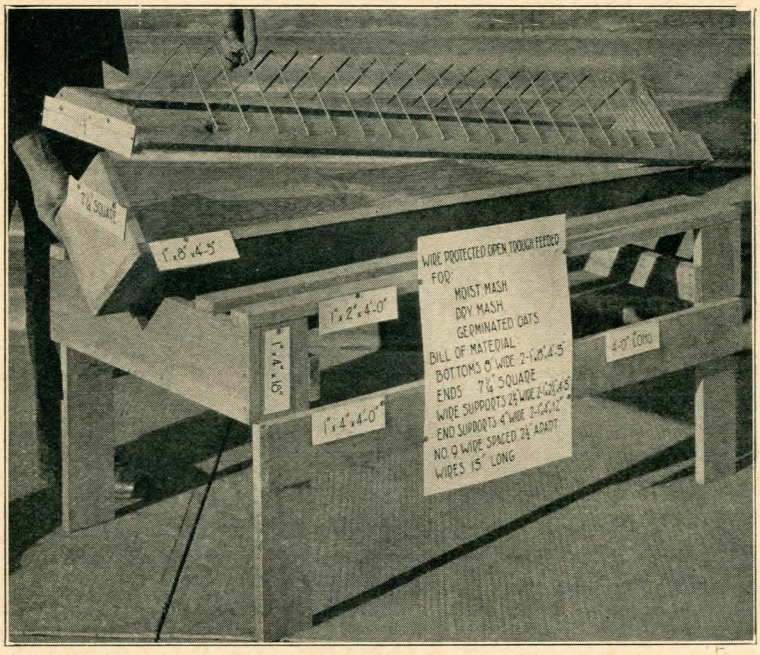

FIG. 2.—The trough type of dry mash feeder is easy to make. A trough seven feet long with feeding space on both sides will serve for 100 hens.

5 per cent linseed oil meal. When cotton seed meal and linseed oil meal are much cheaper in price than meat meal, a partial substitution of the meat meal with the products mentioned or of other high protein feeds is good business policy. When comparing the cost of protein feeds remember to take into account the difference in protein content of the various protein feedstuffs.

FEED DRY MASH

A program for "150 eggs per hen" production must be planned around a good, complete dry mash mixture. Several satisfactory dry mash formulas are listed on the middle pages of this circular. A dry mash mixture, being made from ground grains, milling by-products, and usually packing house products, is less palatable because of its finely ground form than is the scratch feed. For this reason it is safe to keep it before the hens at all times without danger of overfeeding. Dry-mash feeding saves labor and is positive insurance against underfeeding.

Dry Mash Formulas

(1000 lbs. mixture)

*Formula No. 1.	lbs.
Yellow Cornmeal	400
Shorts	250
Bran	100
Meat Meal or Tankage †	100
Alfalfa Meal	90
Cotton Seed Meal	60

Protein Content—19.7 per cent.

*Formula No. 2.	lbs.
Yellow Cornmeal	400
Ground Oats	250
Ground Wheat	200
Meat Meal or Tankage †	150

Protein Content—18.6 per cent.

*Formula No. 3.	lbs.
Yellow Cornmeal	400
Shorts	350
Bran	100
Meat Meal or Tankage †	150

Protein Content—20.7 per cent.

*Formula No. 4.	lbs.
Yellow Cornmeal	250
Bran	200
Shorts	200
Pulverized Oats	200
Meat Meal or Tankage †	150

Protein Content—20.6 per cent.

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* Include one pound finely pulverized salt in each 100 lbs. of all dry mash mixtures.

† When plenty of skim milk or buttermilk is available lower the meat meal or tankage in all mash mixtures to 50 pounds.

Winter Feeding Schedule

All Day: Dry Mash in Feeders

14 feet of feeding space per 100 hens
For breeders, 1 lb. Cod liver oil per 100 lbs. mash

***5:00 a. m. Lights On**

Fresh water available

7:00 a. m. Germinated Oats

3 lbs. dry weight per 100 hens

10:30 a. m. Moist Mash

Feed in clean, protected feeder
Soak mash 18 hours in sour milk or water

3:30-4:30 p. m. Scratch Feed

Cracked yellow corn, 5 to 8 lbs. per 100 hens
Enough to keep up body weight but not make birds overfat

When Weather Permits: Windows open daily to obtain benefits of direct sunshine

* If lights are not used, feed scratch lightly first thing in morning and germinated oats one hour later. Use no lights or at most very moderately on birds to be used for breeders.

SCRATCH FEEDS

Much has been written recently about the all-mash method of feeding laying hens. At the Agricultural College Poultry Farm the all-mash method of feeding baby chicks has been successful, but experience with this method of feeding laying hens during the winter months has not been so satisfactory. Perhaps it is true that exercise has been overemphasized but when the thermometer hovers around zero it has been much easier to keep hens in good laying condition if part of the ration is fed in a *clean* straw litter. During the spring and summer months a shift to the all-mash feeding program is more feasible, especially for birds that are kept only for egg production and not for breeding purposes.

Whole or cracked corn is usually the foundation of the scratch feed mixture, in fact if the dry mash mixture is well balanced and made of a variety of feeds, cracked corn alone will serve as a satisfactory scratch feed. Wheat, barley, kafir, and heavy oats can also be used in the scratch feed mixture if prices on these feeds are favorable. As to wheat, however, it is generally possible to obtain wheat proteins and vitamins at a lower cost in the form of the wheat milling by-products, bran, and shorts, than as whole wheat. It will generally be good business policy to sell wheat and buy milling by-products. Relative prices should of course be the determining factor.

The amount of scratch feed to be given the flock will be influenced by weather conditions and the general condition of the birds. The feeding of scratch feed during cold weather will help to keep up body weight and this should be one of the feeding objectives. A light feed (2 to 3 pounds per 100 hens) of cracked corn in the litter early in the morning and a heavier feed (from 6 to 8 pounds per 100 hens) half an hour before the birds go to roost is recommended.

SUCCULENCE AND WATER

Succulent feeds like alfalfa, clover, blue grass, sprouted oats, etc., are rich in the vitamins which have assumed great importance as knowledge of feeding essentials has increased. These feeds have a good effect on the digestive system and many poultrymen are finding succulent feeds more beneficial than drugs and tonics in this respect.

Alfalfa hay and alfalfa meal are not exactly succulent feeds but they contribute some of the same essentials to the ration and should be used whenever available. A good grade of third or fourth cutting alfalfa hay may be fed in a simple rack or feeder and may be kept before the hens at all times during the fall and winter months. Alfalfa meal may also be

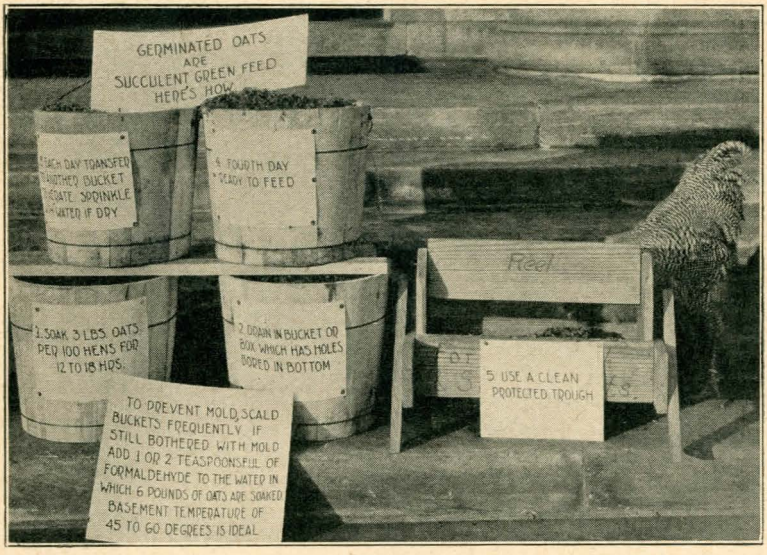

FIG. 3.—Oats and barley can be sprouted easily in candy pails or lard tubs. Expensive equipment is not necessary.

included in the dry mash mixture in quantities up to ten per cent. When more than this is included the palatability of the mash mixture is lowered and as a matter of practice the amount of alfalfa meal is usually limited to from 6 to 8 per cent. The more alfalfa that can be included without markedly lowering the palatability the better.

The alfalfa leaf meal which is available in limited quantity is a very good product containing about 22 per cent protein and 12 per cent fibre. Standard alfalfa meal which can be obtained in almost unlimited quantities, usually averages 14 per cent protein and 36 per cent fibre.

Sprouted oats are one of the best forms of succulence, and these can be prepared very easily without buying expensive equipment. At the Agricultural College Poultry Farm the box-method of sprouting is used. The oats are soaked in a large tub or barrel for about 12 hours. They are then drained and shoveled into shallow boxes to a depth of 3 or 4 inches, water being sprinkled over them as they become dry. In a basement room in which the temperature can be kept between 50° and 80° F., sprouting proceeds rapidly, and the oats are ready to feed in five days. The hens like them best when the sprouts are about one-half inch long. Mangel beets, sugar beets, and similar root crops can be used as succulent feeds, but recent experimental work at the California Experiment

Station indicates that they are not as valuable as field-grown greens. Carrots are, however, considered the equal of field-grown greens.

A dozen eggs contain about a pint of water, and a hundred hens in good production will require about 4 gallons of water per day. Good, clean, fresh water should be available at all times.

MINERAL FEEDS

The mineral requirements of laying hens are relatively great, the finished egg itself consisting of over 10 per cent of ash. The calcium which is needed for egg shell building can usually be furnished best with oyster shell. Our hens should have free access to this at all times in addition to grit which is needed for grinding feeds in the gizzard.

Recent experimental work has indicated not only that it is necessary to provide sufficient calcium and phosphorus for egg building but that a certain kind of radiant energy or its vitamin substitute is essential for proper assimilation of these elements. Fortunately, this form of energy, known as ultra-violet radiation, is furnished by the direct sunshine which is liberally provided under Nebraska conditions. The sunlight which comes thru glass has most of the ultra-violet radiation filtered out of it, however, so that our management should be planned to get the hens into direct sunlight whenever possible. Certain glass substitutes which are now being manufactured permit ultra-violet radiation to pass thru, and these will likely find wide use in poultry houses.

Another mineral which hens need in small amounts is common salt. The only safe way to feed this element, however, is to include it in the mash mixture and when so included, care must be taken to see that the salt is finely granulated and thoroly mixed with the rest of the mash. One pound of salt per 100 pounds of mash is recommended.

More recent experimental work points to a possible harmful effect from the overfeeding of mineral elements. It is advised that calcium be furnished laying hens in the form of oyster shells or high grade crushed limestone in a separate feeder or box, kept before the birds at all times. Neither the addition of ground limestone to the dry mash mixture nor the indiscriminate addition of so-called complete mineral mixtures to the mash formula are advised.

ARTIFICIAL LIGHTING IN WINTER

Winter egg production can be considerably increased by artificial lighting. Two flocks of 90 Leghorn pullets each were given the same kind of feed and were housed in the

same kind of poultry houses at this Experiment Station. One lot was, however, lighted from 5 a. m. until daylight. The lighted lot laid 3,407 eggs during the same time that the unlighted birds laid 2,559. The additional eggs produced by the lighted flock during the period of lighting (from December 18 to March 1) sold for $25.44.

Lights are used of course only during the fall and winter months, when the hen's working day is comparatively short. The lighting period covers a time from about October 1 to March 1 each year, and well-developed pullets which are ready to start laying about November 1 usually respond best to lighting. When lights are used on yearling hens their use should be postponed until about January 1.

Two common methods of lighting are practical, these being morning lights (from 4:30 a. m. until daylight) and evening

FIG. 4.—The dry-mash ingredients can be well mixed by turning them over on the floor about four times. Whether to buy prepared feeds or mix rations at home is a question of cost, quality, and convenience. Figure the cost of the ingredients in the ration, add a reasonable charge for mixing, and then compare the price of home-mixed feeds with commercial feeds.

lights (from sunset to about 9:00 p. m.). Morning lighting seems to give best general satisfaction because of greater ease in working out a feeding and management schedule. The morning feed of scratch grain can be thrown in the litter the evening before and an alarm clock operated switch will turn on the lights at the desired time. The points which must be emphasized when lights are used are regularity in their use, proper feeding, and a good supply of water.

TOTAL FEED REQUIREMENTS

Accurate records which have been kept at the Vineland, New Jersey, Egg Laying Contest indicate that birds of the general purpose type, Plymouth Rocks, Reds, and Wyandottes, will consume about 85 pounds of feed per bird per year. Leghorns consumed 76 pounds per bird. The total feed consumption was about equally divided between scratch and mash feeds, tho the proportions of these varied depending on the season of the year. The pounds of feed required to produce a pound of egg were 4.6 for the general purpose breeds and 3.5 for the Leghorns.

It is estimated that, with good birds given good care so that the total annual production averages 150 eggs per hen, a $10 per ton fluctuation in feed prices represents a fluctuation of 3½ cents per dozen in the cost of the eggs produced. In other words, when feed goes up $10 per ton eggs must sell for 3½ cents per dozen more, to make the same labor and managerial income.

TABLE 1.—*Average Composition of Common Poultry Feedstuffs* *

Feedstuff	Water	Ash	Crude Protein	Crude Fibre	N. Free Extract	Fat
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Corn Dent (No. 2 grade)	14.4	1.4	9.8	2.1	67.6	4.7
Wheat	12.0	1.8	12.0	2.6	69.7	1.9
Wheat Bran	10.0	6.2	15.9	9.8	53.6	4.5
Wheat Shorts	10.0	4.3	17.3	6.9	56.4	5.1
Wheat Mixed Feed (bran and shorts)	10.0	5.2	16.7	7.9	55.6	4.6
Oats	10.0	3.1	12.3	9.1	60.7	4.8
Oats (sprouted 5 days)	51.5	2.2	4.8	7.5	32.6	1.6
Oatmeal	8.0	2.0	15.2	1.3	67.5	6.0
Barley	11.2	2.2	11.4	5.2	67.8	1.9
Emmer	8.2	3.8	11.6	11.0	63.0	2.1
Rye	10.4	2.0	11.7	1.7	72.8	1.7
Millet	8.2	3.1	27.4	12.3	44.3	5.5
Kafir	10.3	1.6	10.1	2.0	72.2	2.9
Buckwheat	12.1	2.0	10.8	10.5	61.3	2.4
Soy beans	10.1	5.2	35.6	4.7	26.9	17.4
Cowpeas	12.3	3.3	21.8	4.1	55.7	1.5
Sunflower Seed	7.9	2.9	16.2	29.3	22.2	21.0
Corn Gluten Feed	8.9	2.2	24.9	7.0	52.8	3.7
Corn Gluten Meal	9.0	1.4	35.4	2.0	48.2	4.5
Linseed Oil Meal (O.P.)	9.2	5.3	33.6	7.9	35.2	7.6
Linseed Oil Meal (N.P.)	9.7	4.9	37.2	8.6	36.2	2.8
Cottonseed Meal	7.8	6.5	38.6	10.3	30.2	6.6
Alfalfa Meal	8.9	9.1	16.4	29.1	33.2	2.3
Alfalfa Leaf Meal	8.1	12.9	22.6	12.4	40.6	3.2
Meat Meal	8.9	16.9	60.8	1.8	4.1	6.8
Meat and Bone Meal	8.8	23.4	53.8	2.1	3.8	6.5
Blood Meal	9.8	3.2	81.6	.....	3.5	1.0
Raw Bone Meal	7.5	59.0	25.2	1.8	3.7	3.1
Steamed Bone Meal	8.5	66.1	17.9	1.9	2.8	1.8
Green Cut Bone	31.1	19.3	21.9	.....	3.0	23.1
Fish Meal	9.5	28.9	53.1	.....	.....	8.0
Cod Liver Meal	4.9	2.9	40.6	.....	14.9	40.8
Skim Milk	90.1	0.7	3.8	.....	5.2	0.2
Buttermilk	90.5	0.7	3.7	.....	5.0	0.1
Cottage Cheese	72.0	1.8	20.9	.....	4.3	1.0
Dried Buttermilk	11.5	9.1	31.1	.....	41.9	6.1
Semi-Solid Buttermilk	65.1	2.8	13.3	.....	15.7	3.1
Mangel Beets	90.6	1.0	1.4	0.8	6.0	0.1
Carrots	88.2	1.2	1.1	1.1	8.1	0.2
Potatoes	78.7	1.1	2.2	0.4	17.5	0.1
Cabbage	91.0	0.8	2.2	0.9	4.8	0.3
Oyster Shell		95.7 $CaCO_3$				

* Averages determined from analyses reported by State Feed Control Laboratories, Agricultural Experiment Stations, and United States Department of Agriculture.