MINNESOTA FEED SERVICE

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FULL FEEDING OR RESTRICTION?

Feeding Systems for Pullets

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Should a poultryman "full feed" or "restrict" his pullets? Factors contributing to lack of agreement on this question include varying genetic backgrounds of birds and environmental conditions such as range vs. confinement rearing, temperature, and season of year.

Certainly feed is one of the more costly items involved in producing pullets for the laying house. However, if it were possible to produce superior birds by one way or the other, a small difference in feed cost could probably be justified.

Summary of Research Findings

Let's examine the conclusions of available research on the subject:

1. Birds will mature and come into production at an earlier age on a high efficiency, high energy type of feeding program, compared to systems utilizing reduced nutrient intake.

2. Nutrient deficiency, such as energy restriction, will delay sexual maturity up to several weeks. This restriction may involve controlled intake of the chosen ration, or unlimited consumption of a low energy ration. Birds are restricted successfully using both systems.

3. There is a feeling, based upon some recent work, that heavy broiler stock birds will benefit more from a restricted program than will the smaller egg-producing type. This is apparently due to the increased tendency in the former to deposit excess body fat.

4. Restriction will result in more eggs of hatching size. Egg size seems seems to be regulated mainly by the age of the bird, rather than by the length of time in production. A delay in start of egg production will eliminate some early "pee-wee" and small eggs.

5. Restricted birds weigh less than nonrestricted birds prior to full feeding of the laying ration. Body weight differences then disappear within a few weeks.

6. Total yearly egg production is similar, regardless of the rearing method. However, it appears that nonrestricted birds may lay a few eggs early in the year but fewer eggs late in the production year. Certain feed companies and breeders have found less mortality in the laying house when birds have been restricted, and slightly higher yearly egg production, particularly on a hen-housed basis.

Feeding Systems

It is considered desirable to feed pullets a high efficiency starting feed capable of producing rapid growth for the first 6 or 8 weeks. In some cases cracked corn, oats, or other grains are introduced along with the mash at about 4 weeks of age—but the amount of mash is always continuously available until the birds are at least 8 weeks of age.

After this time, there are about four possible feeding programs for replacement pullets between 8 and 22 weeks of age.

1. **High energy.** The full-feeding of this type of ration to growing pullets is not recommended. It would be similar to a broiler feeding program and would result in this fastest maturing pullets. Recent New Jersey research indicated that pullets fed rations of extremely high energy content gained weight faster and matured earlier but produced fewer eggs than birds receiving a medium energy diet. Minnesota research recently showed that pullets receiving 12 percent added dietary fat contained nearly twice as much abdominal fat at 20 weeks as pullets receiving a medium energy ration, even though calorie-protein ratios were the same.

2. **Medium energy.** This ration contains 15 to 25 percent of low energy grain and wheat by-products. It would be full-fed to the birds, retard growth and sexual maturity somewhat, simplify the feeding program, and be fairly economical.

3. **Low energy-full feeding.** This ration has 30 to 50 percent of a material such as oat hull, which will restrict nutrient intake under full-feeding. Although more economical on a per pound basis, the pullets will eat so much more of this ration that total cost will be higher.

4. **High energy-controlled feeding.** This modification would result in the feeding of a high energy ration but on a controlled basis. This program has been used by Connecticut workers and others, feeling that it is most economical to limit the intake of a high energy feed. This program has been used for many years on pasture, but more recently is also used in confinement rearing, with apparent success.

Feeding Considerations

Work with other animals, particularly with mice at Minnesota and Cornell, shows that early food restriction can increase the life span.

Pullets going into the laying house should not be overly fat, to help avoid such problems as fatty livers and reduced resistance to heat stress. Further, heavier birds require more feed to satisfy their maintenance requirements.

There is at least one disadvantage in producing extremely slim pullets. Workers at Cornell found that birds receiving a restricted type program (30 percent oat hulls) had a lower metabolic rate than birds receiving a diet without oat hulls. This is why chilling

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POTASH PROBLEMS

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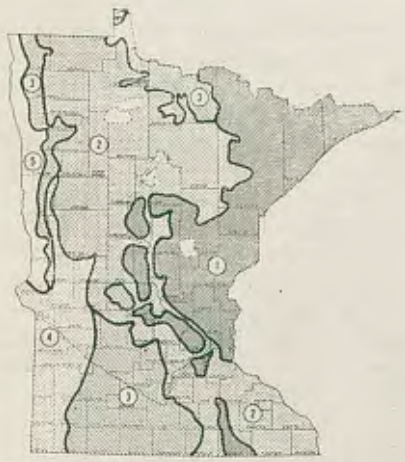
There are really two kinds of potash deficiencies possible in Minnesota soils.

First is the problem due to a low level of potassium in the soil. This is the case in many north central, northeast, and southern counties of Minnesota.

The second type of potassium deficiency isn't quite so simple and fortunately is not too common in this state. This is when the shortage occurs on high lime soils because of an **imbalance** of potassium with two other nutrients —calcium and magnesium. More about this later.

To start with, let's consider the first type of potassium deficiency.

In northeastern and north central Minnesota (areas 1 and 2 on the map) many fields need liberal doses of potassium to establish legumes and keep them growing well. Generally, this



Average potassium levels of Minnesota soils. (From *Soil Test Summaries*, J. Grava.) *Area 1*—very low. *Area 2*—medium to low. *Area 3*—medium. *Area 4*—medium to high. *Area 5*—high.

calls for 200 pounds per acre of 0-0-60 for establishment and 100 pounds per acre for top-dressing, provided there is enough prosphorus.

Experimental plots don't always show good results the first year potash fertilizer is applied. Corn receiving 200 pounds of 0-0-60 per acre annually for 5 years has been known to yield higher than fields getting 200 pounds for the first time. Apparently, a build-up is necessary over a period of time for best results on these sandy soils.

Here's another point which farmers in northern and northeastern counties must keep in mind: plant species vary in their potash needs. Timothy, brome, and small grains do not respond as well as legumes, potatoes, or corn. The reason is that roots of grasses and grains can forage better for potassium already in the soil. This may also explain why grasses so quickly take over in legume-grass mixtures in this area of the state.

Because of the difference between crops, 30 pounds of potash per acre might be, for example, all that would be recommended for oats seeded alone. But for oats seeded with alfalfa, 80 pounds would be recommended for the same soil.

Southeastern and South central Minnesota soils (area 3 and the southern portion of area 2) usually need potassium in fertilizers. In area 3, however, needs are less serious for the westernmost counties. As a general rule, extra potassium becomes less necessary as you travel from east to west. Or in other words, areas of lower rainfall need less potassium.

Deficiencies from "Imbalance"

Now let's turn to shortages that may occur in high-lime soils. Most high lime areas have abundant supplies of calcium and magnesium. These two nutrients could hold the key to potassium availability, since all three must be "in balance" with each other for crops to make the maximum use of any of the three.

Why is calcium-potassium-magnesium balance so important? **Simply because these elements compete for uptake by the plant and usually enter the plant in proportion to their occurrence in the soil.** This means that if there is an unusually large amount of calcium and magnesium present, these nutrients may "outnumber" potassium and create what amounts to a potassium deficiency.

From research conducted so far, we know different kinds of soil should have these nutrients in the following approximate amounts for proper balance:

Soil texture	Calcium	Magnesium	Potassium
	(pounds per acre)		
Sandy loam	3,000	240	266
Silt loam	4,800	384	312
Clay loam	9,000	720	585

These values usually represent 65-85 percent calcium, 6-12 percent magnesium, and 2-5 percent potassium—based on total nutrients attached to the clay minerals.

Unfortunately, soil tests used at present do not determine the amounts of calcium and magnesium in the soil. But these "necessary" relationships do help show how complicated the problem can become on high-lime soils.

For example, on an "alkali" rim, calcium and magnesium values are usually higher and potassium lower than the above figures. Yet, a soil test may show a high amount of potassium. But since there is an overbalance of the other two nutrients, there would be a potassium deficiency.

On the other hand, the same amount of potassium might be more than adequate for good crop growth on soils with lower lime content. In a careful measurement of a clay loam soil with a pH of 7.9 (alkaline) in Polk county, research workers recently found about 10,700 pounds of combined calcium and magnesium per acre. At these values, 235 pounds potassium—not a particularly high level—would be the minimum to maintain a proper balance. Actually, these soils usually show over 300 pounds potassium.

Fortunately, most soils in regions of limited rainfall—such as western and northwestern Minnesota—have very high potassium levels. So even with high calcuim and magnesium there may be no potassium deficiency because the nutrients are still in balance.

At two locations in western and northwestern Minnesota trials, no serious imbalance has been found. Research at the Morris and Crookston Experiment stations shows no increase in yields from adding potassium. In the Red River Valley, adding potassium has frequently decreased yields of small grains—perhaps because excess potassium has caused an imbalance in the other direction and resulted in magnesium deficiency. However, whether this is actually true is still speculation, since the point has not been demonstrated in research.

Where farmers in western Minnesota actually do get increases from adding potash on a soil testing high in this nutrient, an overbalance of calcium and magnesium is quite likely the reason.

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Protein Feeds with Non-Protein Nitrogen

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Cattle and sheep producers spend more for protein supplements than they do for any feedstuffs used to balance the roughages fed. Protein is usually the most critical nutrient in ruminant rations. It's essential, therefore, that the kind and amount of protein be chosen carefully.

Protein supplements are usually put in two categories: (1) Pre-formed protein, such as soybean oil meal; and (2) protein supplements containing non-protein nitrogen, such as urea or ammoniated molasses.

The ruminant requires amino acids just as do swine. Fortunately, the rumen microorganisms can synthesize these amino acids from nitrogen sources, whether those sources are pre-formed proteins or non-protein nitrogen compounds. Therefore, both types of "protein" contribute a source of nitrogen to the ruminant and/or the microorganisms. The question in the animal nutritionist's mind is whether the rate of synthesis of the essential amino acids is rapid enough for maximum production.

The protein requirement for maintenance is less critical, quality- and quantity-wise, than that for the production of meat and milk. Equally important is the difference in response obtained by different species from certain types of protein supplements. For example, an imbalance of amino acids and an inadequate supply of vitamins in a given protein supplement would be more damaging if it were fed to hogs than if fed to yearling steers.

Non-protein nitrogen compounds contribute neither energy, vitamins, nor minerals to the ration. A failure to provide these essential nutrients in adequate amounts would result, therefore, in a less favorable response from such supplements than if pre-formed protein supplements were fed. Cottonseed and soybean oil meal, for example, are also good sources of phosphorus, contributing a source of phosphorus as well as nitrogen.

With this brief background, let's consider specifically protein supplements containing non-protein nitrogen.

Urea

Urea is the best known and most widely used non-protein nitrogen source. From the research data available, we may draw two general conclusions:

1. If the ration fed to wintering calves, fattening steers or lambs, pregnant ewes, or lactating cows does not contain sufficient protein, adding urea to the ration invariably increases production.

2. Conversely, if the ration is already adequate in all nutrients including protein, adding a supplement that contains urea to it will not increase average rate-of-gain to as great a degree as will the addition of a preformed type of protein supplement, such as soybean oil meal.

Consider two rations equal in energy and nitrogen—with the source of nitrogen in the first largely supplied by urea, in the second by soybean oil meal. When fed to fattening cattle, the largest production will be obtained with the second ration. What's more, fattening cattle can use urea supplement more advantageously than fattening lambs can. There will be, therefore, an even greater advantage in favor of soybean oil meal when two such rations are fed to the lambs.

But another factor may enter the picture. Urea contains nitrogen equivalent to 262 percent protein. Thus it is often possible to formulate supplements using urea, vitamins, minerals, and local grains more economically than it is possible to formulate conventional types of protein supplement. Here is the chief advantage of all non-protein sources of nitrogen, including urea. If such supplements can be formulated and sold for 15-20 percent less, the stockman can then afford to accept slightly less production. It is at a time when soybean oil meal is high-priced in relation to grains, therefore, that urea has its greatest advantage as a source of nitrogen for ruminants.

Ammoniated Molasses

A mixture of cane molasses and ammonia (33 percent protein) has been used as a protein supplement for cattle and sheep. Since it is self-fed, the amount consumed per head varies from one animal to another. This may result in either over- or under-consumption, resulting in inefficient use in either case.

With wintering or fattening cattle, data from the Kansas and Oklahoma Agricultural Experiment Stations indicate that pre-formed protein or a mixture of urea and molasses supplements are somewhat superior to mixtures of ammonia and molasses. In one test at the Kansas Station, ammoniated molasses supplement resulted in a nervous disorder in cattle.

Urea-Molasses and Urea-Molasses-Alcohol Mix (Morea)

Self-feeding protein supplements to ruminants in liquid form may reduce labor costs, so it appeals to many stockmen from that standpoint. "Morea" is urea-molasses-mineral mix, with ethanol added to enhance the utilization of the urea by the animal. This type of "protein supplement" is very palatable, and consumption by either cattle or sheep is sometimes excessive. In University of Minnesota tests with lambs, for example, average daily consumption of "Morea" ranged from 0.4 to 0.8 pound per lamb. In both tests, decidedly greater and more economical gains were made when soybean oil meal was the source of protein. The large amount of molasses consumed was actually detrimental to the ration.

At Cornell University, adding ethanol to a molasses-urea mixture increased the retention and biological value of the ration's nitrogen to about the same extent as adding an amount of starch containing the same amount of energy. In general, experiment station data indicate that ethanol does not improve the rate-of-gain or have any influence on the carcass composition of beef animals. Ethanol as such appears to contribute nothing more to the ration than a ready source of energy. It does, however, make the molasses type of supplement less viscous and somewhat easier for the stockman to handle in cold weather.

Dicyandiamide

Dicyandiamide is a material that is extremely unpalatable. It must therefore be mixed with feed that cattle like to eat. In tests conducted at the University of Minnesota, lambs fed 2½ percent dicyandiamide and 97½ percent ground corn made very poor gains and had poor appetites for the first 4 weeks of the experimental feeding period. After that, appetite and average daily gain improved—which suggests that an adjustment period is needed by the rumen microorganisms. Studies at the University of Kentucky showed that dicyandiamide was slightly inferior to urea as a source of nitrogen for dairy cattle.

In summary, it might be said that provided the ration (a) contains a ready source of energy such as grain, (b) is adequate in minerals (particu-

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PULLET FEEDING

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is exceptionally hard on the restricted animals with both chickens and mice. Thus one must be more cautious of chilling birds on a restricted program because of danger from crowding and smothering.

Effect on Egg Production

It is apparently little realized that during the short period in which a pullet matures and begins laying eggs, her weekly feed consumption increases dramatically. A pullet going from 0 to 80 percent production (20-ounce eggs) increases her weekly feed intake from about 1.10 to 1.75 pounds. This is approximately a 60 percent increase in feed consumption. Thus, a system of forcing the bird to eat more feed may help develop a digestive tract capable of handling more feed. Perhaps birds conditioned to greater feed intake during the growing period are better able to consume the greater amounts of feed required for egg production during periods of cold weather.

With the available information, it seems undesirable to feed pullets on a plan which will produce extremely rapid sexual maturity and growth rate. We should realize that full feeding of a high energy ration can be the only program which we call "non-restrictive." Anything which we do to limit nutrient intake will result in some degree of restriction.

Which of the feeding programs listed above is the best to use? The author prefers a moderate amount of lower energy ingredients in the growing ration, thus retarding growth and maturity somewhat but not severely.

How Much Restriction?

While much research must be done on the relationship of degree of nutrient restriction upon laying house performance, there are a few factors which would regulate the degree of restriction desired in any flock.

1. **Breeding.** It was mentioned earlier that some nutritionists feel restriction has more benefit with heavy broiler stock type of birds than with egg-production types. Beyond this, there are genetic dispositions toward fatness, and therefore it is very likely that different birds will require different programs. Also, certain egg production stocks may have an inherent tendency toward early maturtiy and production of small eggs. Therefore it is not beyond the calling of the breeder to determine for his own stock which program will be more profitable to the user of his birds.

2. **Environment.** The author feels that "stimulighting" (special program of darkening pullets during rearing), must be somewhat interrelated with feed restriction. The season of year in which pullets are hatched has an important bearing on sexual maturity rate. Birds hatched in December or January mature considerably sooner than birds hatched in June or July. This, we believe, results from variation in the amount of daylight at the time when the birds are in the maturing stage. Thus, retarding maturity might be more necessary during the time of the year when pullets tend to mature earlier. We urgently need experimental work on this problem.

3. **Disease.** Unhealthy birds frequently do not eat normal amounts of feed. The restriction program should be temporarily discontinued when there is a disease in the flock. It would be unwise, when a bird is having difficulty maintaining its body temperature, to keep it on a restricted program.

In conclusion then, the feeding program for replacement pullets should be tailored to meet the requirements of the particular strain in question. It does not seem desirable to give pullets unlimited access to a high energy program, but rather to use either full-feeding of a medium energy ration or to use more extreme restriction obtained by the use of an extremely low energy feed or controlled feeding of a high energy feed.

The author prefers a program of semi-restriction rather than severe restriction. If severe restriction is required to bring out the best in any particular strain, however, it is probably the thing to do. Certainly this will be an active area for research in the next few years.

POTASH PROBLEMS

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This matter of nutrient balance naturally results in some misunderstanding. For example, crops often respond to added potassium on "alkali" rims around low, poorly drained spots in southern Minnesota (area 3). The fact that these are high-lime areas sometimes leads to the incorrect idea that all high-lime soils are potassium deficient. But as already pointed out, this isn't so. The balance of the three nutrients is the crucial point.

Other Points on Potash

Potassium is readily removed from residues by rains. And since it doesn't become part of organic compounds, stalks or straw don't have to decompose before their potassium becomes available. Potash in manure is all available during the year it is spread, compared to only 30-60 percent of the phosphorus and nitrogen in manure. Peat soils, too can release and lose their potassium rapidly, so potassium is perhaps the most important nutrient for organic soils.

Potassium generally costs a third as much as nitrogen and half as much as phosphorus. Being inexpensive, potash fertilizer will make economical gains where it is definitely needed. In areas where needs are critical—recognized by soil tests, deficiency symptoms or poor stands of legumes—it may be much more expensive to omit potassium than to include it in fertilizer.

NON-PROTEIN NITROGEN

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larly phosphorus and sulfur), and (c) is palatable, the above-named sources of non-protein nitrogen may be used in most ruminant rations. However, (1) in no case are non-protein sources of nitrogen superior to pre-formed proteins, and (2) they must be bought on a competitive price basis.

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