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9. ABSTRACT

An efficient cattle industry will use the most nourishing feed at the lowest cost. Choosing this feed will depend on its nutritive density (nutrient to calorie ratio, or the amounts and kinds of nutrients in a feed relative to its energy content). Nutrient density charts will indicate whether a particular combination satisfies an animal's requirements, and prices of various satisfactory combinations can be compared to find the most economical one. To determine the former, nutrient profiles of individual feeds, "finishing" rations, "maintenance" rations, "growing" rations, dairy rations and nutrient balance feeds are offered here, with growing heifers, beef cattle, dairy cattle and finally an actual farm situation, respectively, as examples for the various feeds.

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trees. Sick ornamental trees are usually removed, while trees in abandoned orchards may persist for years.

5. The unsprayed trees must constitute the major source of the pest insects. Frequently, however, pest problems originate from assorted wild and domestic plants rather than specifically from unsprayed fruit trees.

6. Certain beneficial predators and parasites occur in rather high numbers on unsprayed fruit trees. This is especially true of ladybird beetles and green lacewings. If the unsprayed trees are not serving as a major source of some particular pest, they could benefit rather than harm the nearby orchards.

SOME MAJOR INSECT PESTS THAT CAN ENTER ORCHARDS FROM UNSPRAYED SOURCES

Codling moth flight habits have been widely studied, and exact sources of infestations frequently can be determined. Trees not sprayed for the codling moth can create serious problems for commercial orchards. When codling moths emerge as adults, they detect the odors coming from suitable host plants such as apples and pears. They fly into the wind towards the sources of these odors. The distance they travel is set mostly by chance, and they stop at the first suitable site. Flight distances exceeding five miles have been recorded.

Experiments conducted in several parts of the country show that codling moth problems commonly originate outside commercial orchards. A single deserted apple tree on a ditchbank or a crabapple tree in a backyard may produce several hundred adult codling moths, which in turn enter commercial orchards. Each codling moth female can lay several hundred eggs. Each egg has the potential of producing a wormy apple. The traditional solution has been to control any increase in codling moths by spraying more often and using higher dosages of insecticides. This is an unsound practice, however, as it results in more destruction of beneficial insects, more insecticide residues, and a greater cost to the fruit growers. Where major moth sources are eliminated, the number of sprays can be reduced and accurately timed.

The peach twig borer, a major pest of peaches and other stonefruits, also enters commercial orchards from unsprayed sources. The twig borer (also a moth) has been studied less than the codling moth, but the pattern is similar. Twig borer adults probably fly shorter distances than codling moths, and single tree sources appear to be less important. Peaches, apricots, plums, and prunes are the most common hosts of the twig borer. In the spring, the twig terminals are killed by the larvae that have survived the winter; later in the season the fruit is attacked.

In areas where nearly all susceptible trees are sprayed, a single spray applied before blossom will control this pest adequately. Often this is the only full coverage treatment required on stone fruit trees. These pre-bloom sprays do not create residue problems on the fruit, and they exert few adverse effects on beneficial predators, parasites, or pollinators. In areas where many unsprayed stonefruits exist, a second and sometimes a third spray is needed to control the twig borers. These later sprays are applied during the summer and produce many adverse side effects.

The shothole borer is a small beetle that attacks a wide range of fruit trees and a number of ornamentals. The shothole borer normally attacks weakened trees, dead branches, and recently pulled trees. Healthy home orchard or ornamental trees do not create any problems for commercial orchardists. Deserted orchards and run-down home fruit trees are another story, however. These beetles build up tremendous populations in weak and recently killed trees, and then attack any palatable healthy trees within a radius of approximately 100 yards. All weakened trees, recently pulled trees, and large dead branches should be removed inside a month during the growing season and either burned as firewood or hauled to some place well away from susceptible trees.

A single deserted apple tree on a ditchbank or a crabapple tree in a backyard can produce several hundred adult codling moths.

MISCELLANEOUS PROBLEM POTENTIALS

Other pest problems can originate from unsprayed sources, but they are more rare in Utah than the ones just discussed. Most other problems are not as well documented by research work and intensive observations. The effects of unsprayed trees in mite, aphid, and scale infestations are probably minor unless immediately adjacent to the commercial orchards.

Beneficial insects frequently enter orchards from nearby unsprayed vegetation, but no work has been done to specifically define how backyard fruit trees function in this regard. Most studies of beneficial insects that originate from outside the orchards have been confined to the general predators and pollinators that are not limited to specific plant associations.

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ASSESSING FEED QUALITY

R. GAURTH HANSEN AND LORIN E. HARRIS[1]

In the cattle business — whether growing out heifers, milking cows, operating a feedlot, or running a cow/calf operation — an efficient manager will want to feed the best possible ration at the lowest possible cost. The concept of nutrient density can help you do a better job of defining that ration.

Nutrient density (nutrient to calorie ratio) refers to the amounts and kinds of nutrients in a feed, relative to its energy (kilocalorie) content. An animal's energy requirement is taken as the base, and its other nutrient requirements are calculated in proportion to the energy.

By using nutrient density charts, the need to correlate the diverse units that occur in various agricultural bulletins is eliminated. Currently available charts cover the ration ingredients most commonly used in the Intermountain West, and show at a glance whether a particular combination satisfies an animal's requirements. Prices for different satisfactory rations can then be compared and the best price per ration combination is easily derived.

NUTRIENT DENSITY OF INDIVIDUAL FEEDS

The nutrient density concept can be illustrated by considering individual feeds as sole sources of nutrients for a growing heifer. In the figures, vitamin A designates both carotene (from plant sources), and vitamin A from supplements.[2]

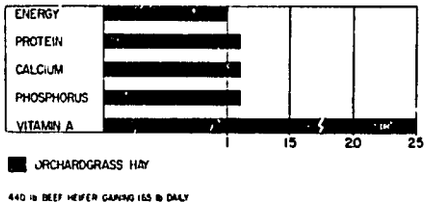
When feeding a beef heifer to maturity, its average attainable growth rate is an important variable. A heifer should gain at least 1.65 pounds per day when fed on an orchard grass

[1]Acknowledgment is made to Clair R. Acord, George E. Stoddard, and C. Dennis Funk for providing data, and to Lois Cox for editorial assistance.

[2]Carotene is converted to international units (i.u.) of vitamin A by assuming that 1 milligram of carotene is equal to 400 i.u. of vitamin A for cattle. Energy is shown in the charts as metabolizable (feed energy — fecal energy — urine energy — methane energy).

hay (Figure 1) that contains the necessary nutrients in good balance. When the animal's energy needs are met, as illustrated in Figure 1, its requirements for protein, calcium, and phosphorus are also met while, in good quality hay, the vitamin A exceeds the heifer's actual needs.

NUTRIENT PROFILE

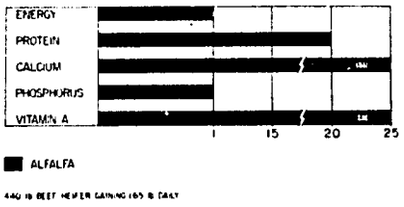


440 lb BEEF HEIFER GAINING 1.65 lb DAILY

figure 1

When the same growing heifer is fed sun-cured alfalfa hay as its sole source of nutrients in a quantity that meets its energy needs, she will obtain double the amount of protein required for the stated growth rate, and more than three times the calcium Figure 2). The heifer's phosphorus needs will be just met, and, if it is a high quality alfalfa, the vitamin A will be present in several-fold excess. This example shows that these excess nutrients are in a sense wasted. In other words, growing heifers can be adequately fed with feeds containing less expensive protein.

NUTRIENT PROFILE

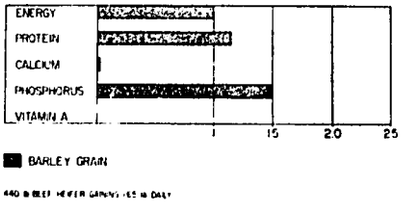


440 lb BEEF HEIFER GAINING 1.65 lb DAILY

figure 2

Figure 2 also shows that although alfalfa is a superior feed because of its available protein, calcium, and vitamin A, its extra nutrients are largely wasted on growing heifers. In cases where high protein and vitamin A feeds are needed, however, it provides an excellent supplement to high energy feeds such as grains. Barley as a sole source of nutrients is noticeably deficient in calcium and carotene relative to the required energy intake (Figure 3). Phosphorus is in excess, and protein is adequate. Forages usually are high in calcium and low in phosphorus (Figure 2), while grains usually are high in phosphorus and low in calcium (Figure 3). Thus ruminants (cattle and sheep) usually need a phosphorus supplement and non-ruminants (poultry and swine) need a calcium supplement. In addition, when cattle are on a high grain diet, a calcium supplement is needed.

NUTRIENT PROFILE



440 lb BEEF HEIFER GAINING 1.65 lb DAILY

figure 3

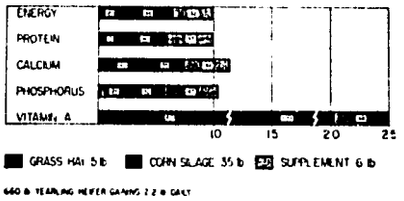
Obviously, not only availability and price are factors in the use of concentrates. Other considerations are also important, such as the age at which the rumen of the calf is sufficiently developed to digest enough energy from all roughage sources. As calves shift from milk to forage, some concentrate is needed in the diet. From the time they are 6 months old, almost to first parturition, however, many heifer calves have only pasture or hay as their principal feed. With the onset of lactation, the rumen cannot digest sufficient energy from such sources to meet all needs, and efficient productivity requires the inclusion of a concentrate as an energy source.

The practical value of the nutrient density concept can be further illustrated with common ration combinations that display a complementary relationship between individual feed ingredients.

BEEF CATTLE

The nutrient density of a well-balanced finishing ration for yearling beef heifers weighing about 660 pounds and gaining 2.2 pounds per day is illustrated in Figure 4. The ration includes grass hay — 5 pounds, corn silage — 35 pounds, and grain supplement — 6 pounds. At this point, a decision has to be made. If the animals are to be used as replacement heifers, the grain supplement may soon be decreased and the forage increased, since the animals are gaining in their capacity to utilize forage. If they are going to the feedlot to be finished as beef, the grain supplement should be increased and the forage reduced proportionately to promote fast gain.

NUTRIENT DENSITY OF FINISHING RATION



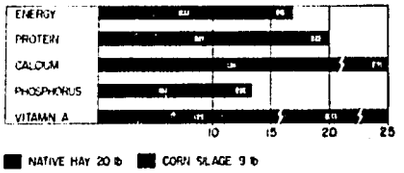
660 lb YEARLING HEIFER GAINING 2.2 lb DAILY

figure 4

All the nutrients are in good balance in this ration (Figure 4) except that the vitamin A, as in many rations, is in excess. Since the grass hay and silage provide protein not quite in proportion to the amount of energy required by the heifer, urea can be added to bring the protein intake in balance with the energy. The grain supplement thus supplies energy and brings the protein, calcium, and phosphorus into balance.

The nutrient density ratings of a maintenance ration for a mature beef cow weighing 1,000 pounds that is dry and pregnant are shown in Figure 5. The native hay itself supplies all the nutrients required by the cow. In fact, if the cow were not pregnant, the rated amount of feed would provide a considerable excess of nutrients. In an on-farm situation, the indicated amount of grass hay may be too much, but if the cow were being fed in an open field, there would be wastage. If the stack in the field is small and exposed to the weather, a significant amount of the hay may be spoiled and not consumed.

NUTRIENT DENSITY OF MAINTENANCE RATION



1000 lb DRY PREGNANT MATURE COW

figure 5

If the hay intake were reduced and barley added to just meet the energy needs of the animal, phosphorus obviously would be deficient (Figure 6). To assure adequate phosphorus with this amount of hay and barley, a phosphorus supplement would be required. This would improve the calcium-phosphorus balance and bring the phosphorus intake more nearly up to that recommended for the pregnant cow.

NUTRIENT DENSITY OF MAINTENANCE RATION

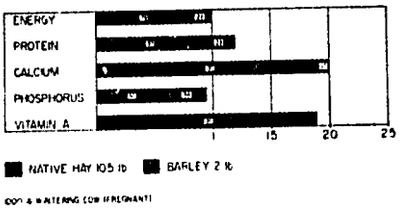


Figure 6

The usual cow-calf operation relies mainly on range or meadow pasture, with some winter supplement. For the most part, these winter pastures are deficient in protein, phosphorus, and energy. In general, winter range forage supplies about three quarters of the energy needs, 87 percent of protein, and 66 percent of phosphorus (Figure 7). On the other hand, it supplies about 13 times the calcium requirement. Since range cows store vitamin A in the liver during the summer, a vitamin A supplement is usually unnecessary; however, commercial supplements usually contain added vitamin A.

NUTRIENT DENSITY OF MAINTENANCE RATION

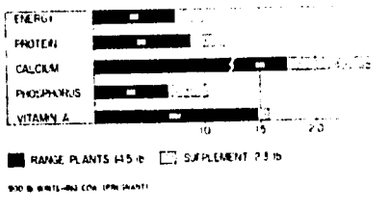


Figure 7

Figure 7 indicates that 2.3 pounds of a supplement containing 1320 kilocalories per pound, 12 percent protein, and 0.35 percent of phosphorus brought the ration into balance and satisfied the cow's requirements for these nutrients.

Forages are usually low in phosphorus and high in calcium. Feed tables contain data on these minerals; however, feed tables have limited information on trace minerals. In addition, feeds may vary in trace elements according to the region. The forage in the intermountain region is deficient in iodine so it is recommended that iodized salt be used. Data are lacking in other trace minerals. Commercial supplements usually contain trace mineralized salt as an insurance against deficiencies.

As tables of feed composition expand to reflect new research, the list of nutrients will be extended to include the trace elements by regions. Some manufacturers give the specific amounts of each trace elements in mixtures they design to supplement the farm ration. This labeling practice should, of course, be encouraged, as it helps the rancher calculate the amount of a feed to meet the nutrient requirements of his animals. Thus, manufacturers who do not list precise quantitative amounts of nutrients in their feed supplements should be avoided in favor of those who do. Admittedly, the precise requirements of animals for trace minerals is not known. However, they can be inferred within reasonable limits and compared with the composition of the ration.

DAIRY CATTLE

When a dairy heifer weighs about 200 pounds, milk or milk replacers can be dropped from its diet. Alfalfa hay and grain then become the usual sources of energy. To make a daily gain of 1.65 pounds, a 200-pound dairy heifer requires about 3 pounds of alfalfa hay and 3.5 pounds of barley (Figure 8). This combination meets all the nutrient requirements. The alfalfa hay provides more than enough protein and calcium for a calf this size and about the right amount of phosphorus in proportion to energy. The principal reason for the barley is the limited development of the rumen. A 200-pound heifer cannot consume enough energy from alfalfa hay to grow at a reasonable rate. Further, all the nutrients are in reasonably good balance with this proportion of alfalfa and barley. The vitamin A intake depends largely upon the quality of the forage. Since this quality varies with storage conditions, it should be emphasized that growing calves, particularly, are in need of adequate vitamin A. Alfalfa hay cut at an early stage of maturity may contain even more vitamin A than is shown on the chart, depending on the curing process and conditions under which it has been stored. With extended storage, however, hay may become deficient in carotene.

NUTRIENT DENSITY OF GROWING RATION

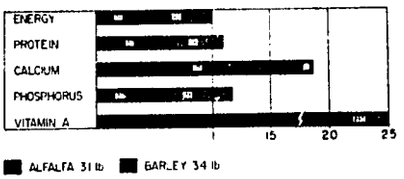


Figure 8

The ratio of calcium to phosphorous is important even though ruminants are reportedly relatively insensitive to a wide calcium to phosphorus ratio. Some feeds contain inadequate quantities of phosphorus, especially for animals experiencing stress such as rapid growth or pregnancy. Under these conditions, a phosphorus supplement should be provided. By charting the nutrient density of the feeds being used, deficiencies can be easily recognized.

AN ACTUAL FARM SITUATION

The owner of a 40-cow dairy herd grows most of his feed and prepares the supplement mix on the farm (Figure 9). The estimated consumption of supplement mix and alfalfa hay is reasonably accurate, but the estimated consumption of corn silage is subject to more error. The chart data are based upon silo capacity and days fed.

NUTRIENT DENSITY OF DAIRY RATION

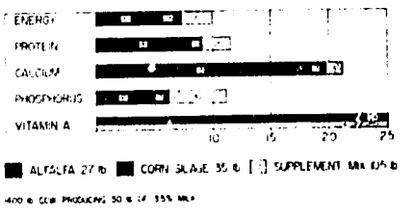


Figure 9

Corn silage is both appetizing and a good energy source for producing dairy cows. Except for calcium, the ration is in excellent balance, and the ratio of calcium to phosphorus of 2 to 1 (expected with such a high intake of alfalfa) is well within the limits of a good ration. Furthermore, one can see the contribution of the individual components in meeting the nutrient needs of the cow. The 27 pounds of alfalfa hay satisfies half the energy needs. On the other hand, this same amount of alfalfa hay provides 81 percent of the protein requirement and 1.8 percent times the calcium, but only 45 percent of the phosphorus requirement. Twenty-three percent of the energy in this ration comes from corn silage, but only 10 percent of the protein. Since more than adequate protein is provided by the alfalfa hay, however, the corn silage is a good supplementary energy source for these lactating cows. The grain supplement, composed of barley, wheat bran, molasses, trace mineralized salt, and vitamin A, contributed 27 percent of the energy, a quarter of the protein requirement of the cow, and half of the phosphorus needs.

It is the general practice of many operators to feed commercial vitamin A supplements to mature cows, and even growing animals on pasture. The particular ration shown in Figure 9 contained a supplement that was four-fold over the stated requirements of the animal. Since cows have some capacity to store excess carotene as vitamin A in their livers to be used in times of deficit intake, if the hay being fed is alfalfa and obviously of good quality and less than 1 year old, the need for vitamin A supplementation is questionable.

High producing dairy cows are commonly fed plentiful amounts of forage. The practical definition of how much forage can be fed to milk cows depends on management costs, feed ingredient costs, and the amount of milk produced and the price it commands. With alfalfa hay as her sole source of nutrients, a lactating dairy cow would have to consume 30 or more pounds of hay per day. Thirty-one pounds of alfalfa hay satisfies the energy requirement of a 1300-pound cow producing 20 pounds of 3.5 percent butterfat milk (Figure 10).

NUTRIENT BALANCE-LACTATING DAIRY COW

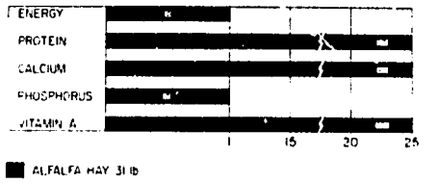


Figure 10

Relative to the amount of energy thus provided, however, there is almost a three-fold excess of protein and four-fold excess of calcium. The vitamin A provided is more than adequate, but the phosphorus intake is just adequate. The limitation, obviously, is in the energy that must be consumed for a cow to produce milk economically. Under most circumstances, 20 pounds of milk won't pay the cost of production. Expensive protein is wasted, even with the limitation of forage intake. As concentrates are added to the ration, the milk yield can be expected to increase if the cow has the genetic potential for high production. With more concentrate and less forage being fed, less protein is wasted. With alfalfa hay fed alone, phosphorus intake is marginal at best. When concentrates are added to the ration, this nutrient is usually adequately supplied. When fed 10 pounds of supplement, our 1300-pound cow will still consume 29 pounds of alfalfa, but she will produce about 40 pounds of milk (Figure 11). In other words, with 10 pounds of concentrate, the milk yield is doubled over what was produced with alfalfa hay as the sole nutrient source. With 16 pounds of concentrate, the same cow would reduce her alfalfa intake to 26 pounds, while producing 50 pounds of milk with a resultant improved utilization of protein in the ration (Figure 12).

NUTRIENT BALANCE-LACTATING DAIRY COW

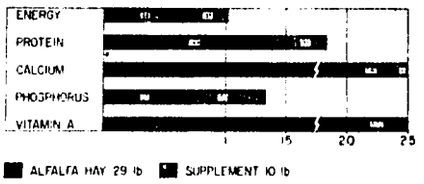


Figure 11

NUTRIENT BALANCE-LACTATING DAIRY COW

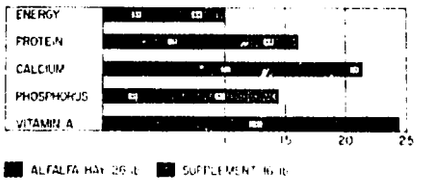


Figure 12

With 22 pounds of supplement, the ration balance is further improved and the cow would consume 24 pounds of hay and produce 60 pounds of milk (Figure 13).

NUTRIENT BALANCE-LACTATING DAIRY COW

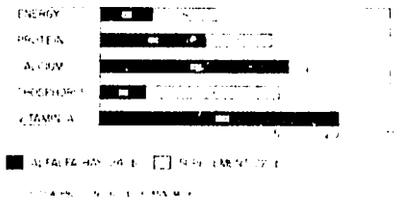


Figure 13

As shown, the cost of ration ingredients can now be easily compared with the price of milk to provide some immediate economic answers.

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LORIN E. HARRIS is a Professor in the Department of Animal Science.

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