

PRESCRIBED GRAZING AND FEEDING MANAGEMENT FOR LACTATING DAIRY COWS



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**NEW YORK STATE GRAZING LANDS CONSERVATION INITIATIVE
IN COOPERATION WITH THE USDA-NATURAL RESOURCES
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This book was written as an attempt to combine the best information from both real-life situations and research so that farmers who are considering or are currently grazing their lactating cows will have a current reference based on the best real-world information we can provide. Too often when an idea is breaking new ground, information abounds which is based solely on one person's experiences or from only one location. Unfortunately, this information may or may not be useful or applicable to anyone else or any other place. Hence, in this publication we have tried to capture the best experiences from as many situations as possible, in order to provide a well-balanced perspective on what should work well for the majority of farmers.

PROLOGUE

Dairy farming is a \$1.7 billion industry in New York according to the 1996 New York State Agricultural Statistics. There are 700,000 dairy cows in the state located on some 9,200 dairy farms. Despite views to the contrary, most dairy farms in the state are family owned and operated businesses. The average herd size is around 75 cows with 96% of all herds having less than 200 cows.

To maintain dairy farm profitability and ensure long term sustainability of the industry, the use of lower cost production methods, increasing milk production at reasonable cost or a combination of both will be the best alternatives available. In the face of rising fuel and machinery costs, stricter environmental regulations, and general inflation in the cost of living, management decisions will need to be based on sound economic as well as environmental planning. While there are production methods which will increase milk production, they can be inappropriate management decisions if they increase costs of production above the rate of expected return and negatively impact the bottom line. Producers need to be looking for methods that can increase production and reduce costs at the same time.

The utilization of pasture as a forage source for lactating cows has been gaining in popularity in recent years. Along with the switch back to pasture have come many questions concerning how to manage the forage to optimize quality, quantity and harvest efficiency as well as what else to feed the cows to optimize milk production. Although each farm represents a unique collection of resource based assets and attributes i.e. soil type, forage species, land base, kind, number, and genetic potential of livestock, many are similar enough that there would be a significant benefit gained from the use of well-managed pasture. The differences from farm to farm simply imply that each farm needs to assess what makes it unique, and creatively apply the principles of prescribed grazing and feeding management.

INTRODUCTION

Pasture is one of the most economical sources of nutrients that can be provided to dairy cows. When properly managed, it is also higher in feeding value than any other forage crop. However, as good as pasture is, it is not good enough to maintain high levels of milk production without proper supplementation. Hence, the challenge faced by dairy producers using pasture is to maintain as consistent a forage quality and quantity as is possible so that an appropriate supplementation strategy can be formulated to optimize milk production and profit.

Lactating dairy cows represent one of the greatest challenges to the grazing manager. While other kinds or classes of livestock can effectively utilize pastures that are less well-managed, dairy cows require pastures which are more intensively managed in order to maintain or increase milk production to a higher level. Lactating dairy cows are very sensitive to, among other things, the quality and quantity of feed available, temperature extremes, water requirements and the amount of distance they have to travel in search of food and water. This is not to say that other classes or kinds of livestock are not sensitive to these factors. However, because dairy cows are generally milked twice a day, the influence of these sensitivities is reflected almost immediately and can be measured in the bulk tank. Hence, in order for dairymen to effectively utilize pasture as the primary forage source for lactating cows, they must first have their pastures under a high level of management to ensure adequate control over the quality and quantity of forage available. Second, they must possess a basic understanding of the factors involved with dairy cattle nutrition in order to balance the remainder of the ration to achieve desired milk production levels.

PREScribed GRAZING AND FEEDING MANAGEMENT continued...

UTILIZING PASTURE AS A FORAGE SOURCE

In the opinion of these authors, the desired result to be obtained through grazing and feeding management strategies for U.S. dairy cows is the optimization of milk production level at the highest economic return. On some farms this may mean higher herd production levels on a per cow basis and on other farms it may mean a lower production per cow but a larger number of cows. The point being that no two farms are alike with respect to goals and objectives and level of best economic return. Where maximum milk production may be both necessary and profitable on one farm, it may not be on another. Likewise, a lower level of production may be acceptable for a farm that is relatively debt-free, has significant off-farm or other farm income, or has a larger land base than necessary. Alternatively, for a farm without these luxuries, a lower level of production simply may not be profitable nor sustainable.

UTILIZING PASTURE AS A FORAGE SOURCE

Pasture differs from all other livestock feeds in three fundamental ways. The first is in the definition. While very little is left to the imagination when references are made to livestock feeds such as corn silage, soybean meal, or whole cottonseed, the term pasture only serves as a general reference to plant communities that are harvested through the efforts of grazing animals. In order for pasture to serve as an effective substitute for confinement-fed forages we must first ensure that the pasture is, by definition, truly a source of dairy quality feed and not a brush, swamp or weed lot that we are calling pasture. A dairy quality pasture is a grass, grass-legume or other forage combination utilized with a sufficient level of management to complement or meet the nutritional requirements of dairy cattle.

Second, pasture is not the same as a forage in storage. While all other feeds are fed in the harvested, preserved and fairly stable form, pasture is utilized while it is alive, actively growing

and therefore unstable in both quality and quantity.

The normal growth and development cycle of pasture plants consists of three general phases. First is the leafy immature phase. Second is the leafy mature phase. Third is the stemmy over-mature phase. During the first phase, the plants are comprised of mostly young or immature leaves. The quality of the forage is at its highest but the yield is at its lowest. During the second phase, the yield continues to increase but the plants are comprised of a greater proportion of older mature leaves and some stems. Although during the early portion of this phase, the plants are mostly high quality leaf, during the latter portion, the quality of the forage begins to rapidly decline. During the third phase, the plants continue to grow from the leafy vegetative phase into a stemmy over-mature condition. In the spring and early summer, this phase is characterized by the appearance of reproductive tillers with seed heads. Later in the summer and fall, although there may be no reproductive tillers present, the forage will consist of coarse, tough growth that is in a state of deterioration. Although yield may be maximized during the early portion of this phase, the quality of the forage tends to be extremely low and, therefore, not suitable for lactating dairy cows. SEE FIGURE 1.

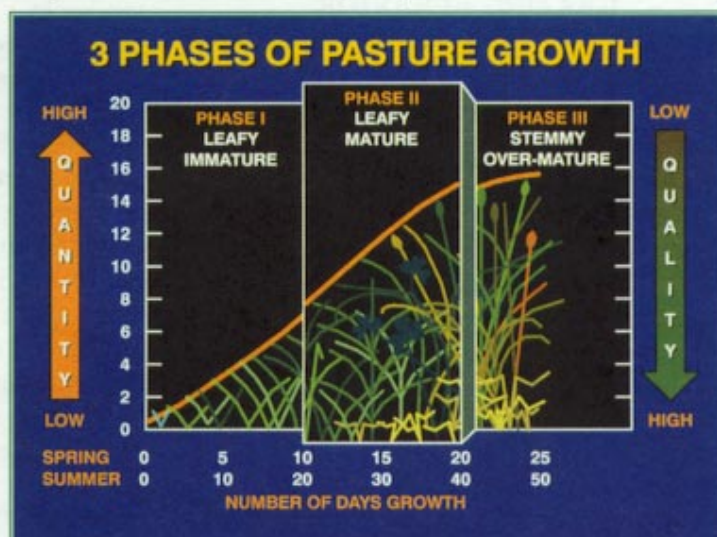


Figure 1 The growth and development cycle of pasture plants is characterized by 3 separate phases. However, to capture the greatest yield of high quality forage, pastures should be grazed during the early portion of Phase II.

The speed at which pasture plants progress through these phases changes with the time of year and environmental conditions. However, these generalized

growth phases are repeated each time a pasture plant is grazed or is harvested. Hence, the high quality pasture observed in Phase II will, if not grazed, end up as low quality forage in a very short time. It has been estimated by Irish researchers that approximately 50 % of the green leaf material, if not grazed, will end up as dead material at the base of the plant in as little as 6 weeks time. Effective pasture management is a classic example of the "use it or lose it" philosophy, and for high animal performance it must be utilized according to a harvest schedule that optimizes the production of high quality green leaf material.

The third way in which pasture differs from all other livestock feeds is the manner in which it is harvested. Pasture is consumed through a highly selective harvesting procedure by animals that have preferences concerning such things as what the forage tastes like, smells like, feels like and how nutritious or toxic it is. Unlike mechanical harvesters that do not care what the forage tastes like, whether or not it meets any particular nutritional requirement, how mature it is or whether or not there are such things as stickers, prickles, toxins or thorns present, it is obvious that grazing animals do care and when they have concerns, it is generally reflected as a decrease in production.

GRAZING BEHAVIOR

In confined feeding operations, dairy cows are fed preserved, conserved and processed feeds with little choice but to eat what has been put in front of them when it is put there. However, dairy cows on pasture are subject to having to make daily decisions on what to eat, how much to eat and when. Considering that a dairy cow's nutritional requirements vary with its age, physiological condition, level of milk production and the influence of their previous meal, this is no simple task. As well, the decision as to what to eat or what not to eat often has to be made from a wide variety of plants and/or plant parts that vary considerably in nutrients, toxins, and digestion inhibitors from one grazing event to the next, as well as by their location across the landscape.

Despite the enormous challenges faced by animals foraging for a living, experimental

as well as observational evidence suggests that when given the opportunity, grazing animals are very adept at selecting feeds that closely meet their nutritional requirements while limiting intake of or refusing feeds that are toxic, nutrient deficient or nutrient excessive. They choose to consume some plants or parts of plants at some times and refuse to eat the same plants or parts of plants at other times. They may also refuse to eat some plants or parts of plants in one location and readily consume the same plants in another. While this behavior is sometimes difficult for us to understand, to the animal, it is a fundamental means to survival in a foraging environment where the only enduring characteristic is change.

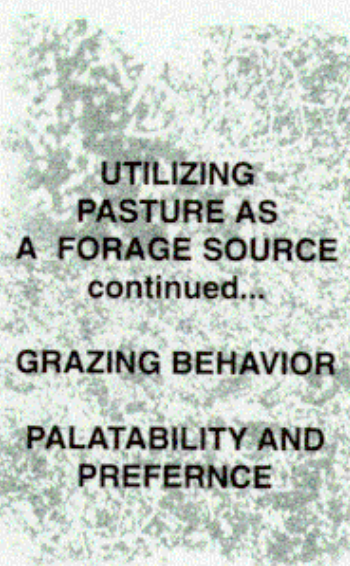
PALATABILITY AND PREFERENCE

Palatability and preference are terms used to describe the relative attractiveness of plants to animals as feed (palatability) and the selection of these plants by animals (preference).

Palatability can be defined as "the relish an animal shows for a particular plant as forage... which varies with succulence, fiber content, nutrient and chemical content, and morphological features such as spines and thorns", and preference is defined as "the relative consumption of one plant over another by a specific class of animal when given free choice at a particular time and place" (Frost and Ruyle 1993).

Historically, palatability has been defined in terms of plant characteristics and preference defined in terms of the inclinations of animals towards plants as though each was entirely independent from the other. However, a more contemporary view suggests just the opposite. Palatability and preference function in a co-dependent relationship, with each contingent on the other in order to have any relevance at all.

Palatability and preference interact simultaneously along the lines of a continuum in a functional relationship that can be described in much the same manner as the relationship expressed in the phrase "beauty is in the eye of the beholder". As the eye (preference) of the beholder undergoes change, so does the beholder's perception of beauty (palatability). Conversely, as that



which is perceived as beauty undergoes change, so must the eye of the beholder continually re-define its perception of beauty.

Contemporary wisdom suggests that palatability is the interrelationship between the taste of a food and its post-ingestive consequences, which is defined by the chemical and physical attributes of the food in relationship to the nutritional requirements of a particular animal. How well the food meets the nutritional requirements of the particular animal, which is dependent on the age and physiological condition of the animal, in turn, determines preference. Hence, it is the collective interrelationships between the two that determine what an animal will actually eat, when it will eat and how much it will eat.

Plants can and do change in how they look, how they taste, and in fiber, nutrient and chemical composition over the course of a growing season, between seasons, and also across landscapes. As well, the nutritional requirements of grazing animals varies considerably. As a result of these ongoing transformations, at any given point in time or space, the palatability of any given plant can range from highly palatable to highly unpalatable and, thus, be preferred or not.

For example, while there are differences among grass species and even varieties within species, most grasses at a 6 to 8 inch height are generally very palatable and, thus, readily consumed (preferred) by lactating dairy cows. However, when these same plants reach a height of 12 or more inches and consist of low quality over mature vegetation, they become very unpalatable, and thus, much less preferred.

The same phenomenon can be observed with plants growing under dissimilar environmental conditions. For example, a plant species that is growing under marginal or less than ideal conditions, i.e., inadequate pH, fertility, moisture or temperature, may vary considerably in its chemical and physical make up as compared with the same plant growing under ideal conditions. Hence, while a plant may be highly nutritious, very palatable and, thus, preferred when grown on a high fertility soil with adequate moisture, it may be extremely unpalatable and, thus, entirely avoided when

grown on a soil low in fertility or with less than adequate moisture.

In these two examples, the "packaging" of the plants is so different that, to a grazing animal, they are essentially two different foods, and thus, exhibit two different palatabilities and subsequent preference rankings.

Another situation that can occur to change palatability and preference rankings is the exact opposite of the previous example. Instead of the packaging being so different, the packaging is exactly the same. While familiar foods that meet nutritional requirements are generally viewed as "good" (palatable) by grazing animals, the same food eaten bite after bite, day after day, week after week, can also be viewed as "not so good" (unpalatable) and subject to a decrease in preference and, thus, in intake.

This phenomenon is known as a conditioned taste aversion. For example, while many of us hold the first hot-out-of-the-oven chocolate chip cookie in extreme high regard (palatable), by the time the third or fourth cookie has passed our lips, most of us are ready to eat something else. In other words, we don't view the palatability of the last cookie eaten in the same manner as the first and, thus our preference for chocolate chip cookies declines. This occurs despite the fact that the last cookie out of the oven is exactly the same as the first. It is believed that conditioned taste aversions are an evolutionary survival mechanism that helps animals avoid over-eating foods that may be nutritious but also contain toxins, or foods that are inadequate (excessive or deficient) in nutritional attributes. Thus, grazing animals, like humans, can over-ingest, even their most preferred or favorite foods, develop aversions to them and subsequently lower their intake.

MECHANISMS OF DIET SELECTION

The ability of grazing animals to sort out and select diets that are on average higher in nutrients and lower in toxins than is generally available in the foraging environment is not simply the "luck of the bite" but rather, the result of a deliberate course of action (behavior) expressed by the animal.

PALATABILITY AND PREFERENCE continued...

MECHANISMS OF DIET SELECTION

Diet selection is governed by two separate but interrelated systems. One system, called the affective or involuntary system, is a subconscious process that links the taste of a food with its postingestive feedback. This is a feedback mechanism that operates between an animal's brain and gut, without any conscious effort on the part of the animal. This process allows animals to sense the nutritional or toxicological properties of a food ingested and adjust their preference and, thus, intake. In other words, if a plant is grazed, it tastes good to the animal and the animal suffers no ill effects and/or experiences the sensation of being satisfied, the animal will continue to select this plant. Conversely, if an animal grazes a plant and becomes ill shortly thereafter, the animal will associate ill health with the taste of this particular plant and, thus, avoid or limit intake of it.

The other system at work in diet selection is called the cognitive or voluntary system. This system integrates the senses of sight, smell and taste with information obtained from mother, other members of the herd or flock or through past trial and error experiences (previous postingestive feedbacks) to allow grazing animals to make conscious choices concerning what to eat or what to avoid eating based on past experience.

In other words, if a grazing animal encounters a plant in a pasture and recognizes the plant as a food it has previously consumed, it will then be in a position to make an "educated" or conscious decision whether or not to consume the plant again. The actual amount consumed, however, will be controlled by the most current post-ingestive feedback. Even if the plant was palatable and highly preferred at a previous encounter, if the most recent postingestive feedback turns up negative, the plant will be viewed by the animal, at this point in time, as less palatable and, therefore, less preferred.

While the affective and cognitive systems operate as two separate systems, information is exchanged between the two through linkages between the senses of sight, smell, taste and postingestive feedbacks. This exchange of information allows grazing animals to continually monitor their food supply and alter their diets in relationship to their own

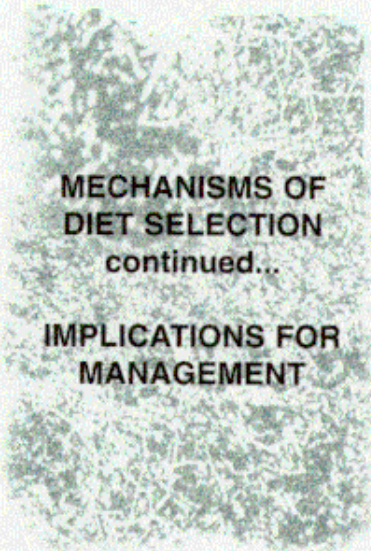
needs as well as to changes in the foraging environment.

In summary, grazing animals learn to identify the basic components of their diets by observing what mom and/or other members of the herd or flock are eating and through "giving it a try and seeing what happens." The affective system evaluates the postingestive consequences of having given the food a try, and based on what happened, the cognitive system adjusts the attitude and behavior of the animal towards that food. If the food tasted good and the postingestive feedback was positive (adequate nutritional attributes and/or is not excessively toxic), most likely the food will continue to be selected. This is known as a conditioned taste preference. If the food did not taste good and the postingestive feedback was negative (inadequate nutritional attributes and/or excessive in toxins), most likely it will not. As previously described, this is known as a conditioned taste aversion.

IMPLICATIONS FOR MANAGEMENT

Grazing animals are creatures of habit. Once they have learned what foods are good and what foods are not so good, or what foods they like and what foods they do not like, they will spend a great deal of time looking for the preferred food items while ignoring those that are less preferred or unknown to them. Keep in mind, in order for a grazing animal to readily consume a particular plant, the plant must be familiar to the animal and be recognized by the animal as containing some desirable characteristic. Familiar foods are viewed by the animal as "safe" while new or novel foods are perceived as potentially "dangerous". Hence, when livestock are placed in pastures consisting of plants that they are not familiar with, the amount of time spent foraging generally increases but the amount of feed actually taken in decreases until the plant or plants have been evaluated and identified as nutritionally adequate or not. During this learning period, milk production will generally decline due to a restriction in dry matter intake.

No two pastures will have the same kind or number of plant species present. However, based on the preceding discussion of animal behavior in relationship to diet



**MECHANISMS OF
DIET SELECTION**
continued...

**IMPLICATIONS FOR
MANAGEMENT**

selection, it is important to attempt to minimize the variability as much as possible. While maintaining diversity in the number of different plant species within pastures allows animals a greater opportunity to select food items that more closely meet their nutritional requirements and, thus, lead to higher levels of intake, this is only true if the animals recognize the plants and readily include them in their diets.

Generally, it is recommended that lactating dairy cows should not be forced to graze distinctly dissimilar plant communities in a short time span. For example, don't graze a clear seeding of reed canary-grass one day followed by an alfalfa-timothy mix the next day followed by an orchard-grass-ladino clover mix the next day, etc. In situations where there is a need to have several different pasture mixes seeded, such as to accommodate dissimilar soil types or to provide a more uniform seasonality in forage production, there should be enough acres of each pasture type seeded to provide at least 10 days to two weeks of grazing before the livestock change pasture types again. This will allow the animals time to familiarize themselves with the new forage species, evaluate its nutrient status as well as toxic properties and to adjust their intakes accordingly.

Animals will learn, over time, what they like and what they do not like and store this in long-term memory. As a result, over the course of a grazing season, losses in milk production, due to changing forage types, generally becomes less noticeable. It is best, however, to avoid situations where you are constantly keeping your animals guessing as to what it is they are eating. The more you keep them guessing, the less likely it will be that you will like their milk production.

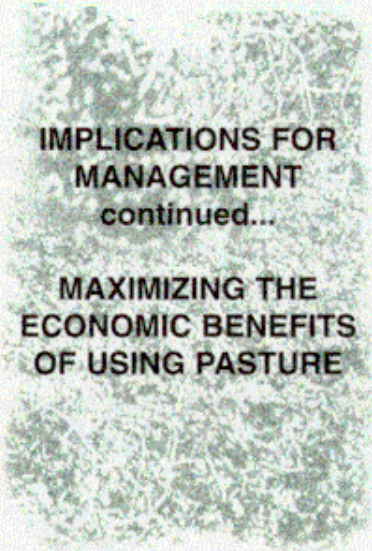
While a pasture consisting of too many unknown plants can result in low or reduced intake so can a pasture with too few plant species. Try to avoid pastures consisting of a single species (monocultures) or pastures possessing only a limited number of species. When you limit the number of plant species in a pasture, you limit the ability of the animal to select what it needs to balance its diet based on its own unique nutritional requirements.

Balance the energy, protein and minerals in your barn ration with your pasture and make any changes slowly. The nutritional profile of a feed fed in the barn can have a major impact on the palatability, preference and, thus, intake of the various plants growing in a pasture. Studies on nutrient to nutrient interactions have demonstrated that feeding high levels of one nutrient can influence the intake of another. For example, feeding high levels of protein at one feeding will generally cause animals to prefer foods high in energy at the next feeding. Conversely, feeding high levels of energy at one feeding will generally cause animals to prefer foods high in protein at the next. As well, feeding high amounts of either energy or protein at one meal will tend to decrease the preference for that nutrient at the next meal.

For example, all animals have a certain need for protein in their diets. While some protein is good, too much protein is not. A well-managed pasture can routinely exceed 25% crude protein on a dry matter basis. If the barn ration is not adjusted to compensate for this, the subsequent over-feeding of protein can result in an excessive production of ammonia. Because ammonia in high concentrations is toxic, it can result in a lowering of intake. In this situation, pasture plants containing 25% crude protein become less desirable (palatable) to the animal and the preference for consuming these plants decreases. Hence, if protein is overfed in the barn ration prior to turning cows out to graze, it can cause a shift in preference to occur and result in a reduction in the intake of pasture.

MAXIMIZING THE ECONOMIC BENEFITS OF USING PASTURE

In order to maximize the economic benefit of using pasture as a source of feed for lactating dairy cows, pastures must be managed with grazing prescriptions that seek to accomplish four main goals. The first goal is to ensure that the quality of the forage available is both high and as consistent as possible. The second goal is to optimize forage dry matter yield on a per acre basis. The third goal is to ensure a high efficiency of harvest. The fourth goal is to ensure a high efficiency of forage conversion.



**IMPLICATIONS FOR
MANAGEMENT
continued...**

**MAXIMIZING THE
ECONOMIC BENEFITS
OF USING PASTURE**

The Need for High Quality Forage

The provision of consistent high quality forage is a key to achieving high and uniform levels of milk production from dairy cows whether on pasture or in confinement. Hence, when developing grazing prescriptions for lactating dairy cows, management for consistent high quality forage should receive the highest priority.

The reason for placing such a high priority on consistent high quality is that pastures managed for consistency of quality are much easier to balance rations around to achieve a particular level of production. Anytime the quality of pasture goes from high to low and back again, milk production can be expected to follow the same trend. Hence, grazing pastures that are managed to maintain a relatively consistent high quality results in less variation in daily milk production.

Furthermore, unlike in countries where pasture is relied upon as the sole source of feed for livestock during the pasturing season, most dairy cows on pasture in the U.S. are supplemented with additional feeds in order to achieve higher levels of milk production. As a result, should a shortage in dry matter availability occur, it can be compensated for through increased supplementation.

The Need to Maximize Dry Matter Yield on a Per Acre Basis

In grazing situations, whether the animals are wild, free-ranging herbivores or domestic livestock makes little difference. They are all influenced in their search for nutrients by the "Law of Least Effort". The basic tenet of this law is simply that animals cannot, in the long term, expend a greater amount of energy in the search and acquisition of food than they will obtain from the food once it is consumed. This is why in classic predator-prey relationships, the predator (lions, tigers, bears and the like) seek out the young, old, sick or injured to prey upon while generally

ignoring the most fit, strong or agile. It makes no energetic sense to be involved in a long energy consuming chase when the outcome is questionable. The same concept applies to grazing animals, including lactating dairy cows. SEE FIGURE 2.

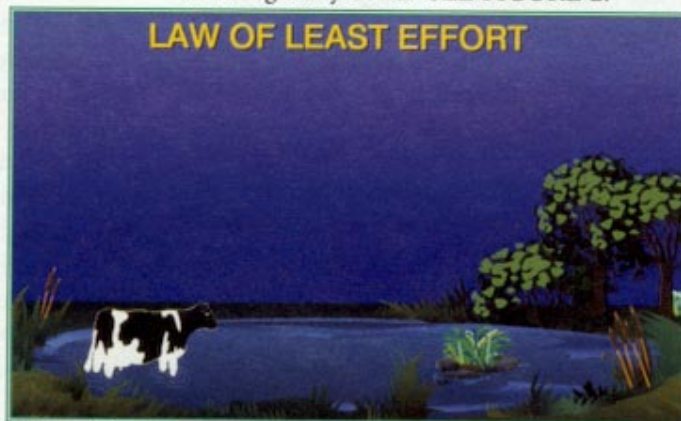


Figure 2 The more difficult it is for an animal to get to, find and consume its food, the lower will be its intake per unit of time spent grazing.

From a behavioral perspective, the amount of forage an animal can consume from pasture can be expressed as the product of the amount of time spent grazing, the rate of biting during the time spent grazing and the amount of pasture taken in with each bite. When plant densities and, hence, pasture yields are low, the amount of feed taken in with each bite is also low. To compensate for this, livestock increase the amount of time they spend grazing and are forced to cover more ground in search of food. However, oftentimes this increase in grazing time is not long enough to compensate for low pasture yields and they do not meet their intake requirements. In essence, when plant densities and pasture yields are low, livestock work harder and longer but get less from their efforts. Under these conditions, lactating dairy cows have a difficult time consuming enough forage to meet maintenance requirements let alone maximize milk production.

Unfortunately, on many dairy farms, it is fairly common to see the lands with the most severe site, soil and, hence, production limitations viewed as good enough for pasture. The thought is usually, "I pay taxes on all of that swamp, hill, shrub or woodland and I can't grow crops on it, so why not use it for pasture". The problem with this strategy is, simply, the "Law of Least Effort". You cannot obtain the same amount of milk per cow per day by substituting two acres of low yielding sparse

**MAXIMIZING THE
ECONOMIC BENEFITS
OF USING PASTURE
continued...**

**The Need for High
Quality Forage**

**The Need to Maximize
Dry Matter Yield on a
Per Acre Basis**

pasture for one acre of dense high yielding pasture. On low yielding sparse pasture, livestock are forced to work twice as hard to obtain their feed and, in a classic example of the "Law of Least Effort", this is guaranteed to result in lower milk yields.

There are no free lunches when it comes to maximizing milk production from pasture. In order to produce the large volumes of feed that are required to support high milk yields, you may need to use some of the best land on your farm. In particular if this land is close to the barn and has good access. These lands, based on site, soil and production characteristics, have a superior ability to produce crops of all kinds including the dense, high yielding and high quality grasses and legumes necessary to maximize milk production. However, in order to obtain the benefits of using these high quality lands as pasture, they must be utilized with an extremely high level of management. For example, this kind of land should be seeded to genetically superior modern forage varieties in order to maximize yield and quality. Soil fertility and pH levels should be routinely monitored and maintained at appropriate levels and, most important, the intensity of grazing management should be at an extremely high level.

The Need to Maximize Dry Matter Yield on a Per Acre Basis continued...

The Need for Enhancing Harvest Efficiency

The Need for Enhancing Harvest Efficiency

Harvest efficiency is simply an evaluation or relative measure of how good a job we are doing of utilizing the forage crop that we have grown and is available for grazing. For example, if a pasture contains 1600 pounds of available dry matter on a per acre basis but through implementation of a lax grazing prescription only 400 pounds of dry matter is actually harvested, the apparent harvest efficiency is 25%. In other words, 75% of the forage available for grazing is being wasted. A very inefficient system. If a producer's herd had a forage demand of 1200 pounds of dry matter per day, with a 25% harvest efficiency, the producer would need to allocate three acres of pasture

containing 1600 pounds per acre to meet the herds forage demand. However, if through the implementation of a grazing prescription that specifies a higher rate of utilization, a 75% harvest efficiency is attained, then only one acre of pasture containing 1600 pounds of dry matter would need to be allocated. Simply through doing a better job of harvest management, producers can reduce the number of acres that will need to be allocated to pasture.

Another reason for striving to achieve fairly high utilization rates is the influence on long term pasture quality. While forcing dairy cows to graze too tight (residual pasture heights of less than 2 inches) limits intake and reduces milk production in the short term, lax grazing (residual pasture heights of greater than 4 inches) will provide good milk production in the short term, but in the long term will cause a decrease in milk production due to ever increasing declines in pasture quality.

Pasture plants are alive and actively growing. They change in yield and quality very quickly. Hence, if the herbage in a particular paddock is not adequately utilized by livestock during the initial encounter, by the time the livestock return to that same paddock, the plants or parts of plants that were not utilized the first time around will have continued to grow and mature well past the point of use. As a general rule, if these plants or parts of plants were not utilized the first time they were encountered, they will not be utilized the second time around either. SEE FIGURE 3.

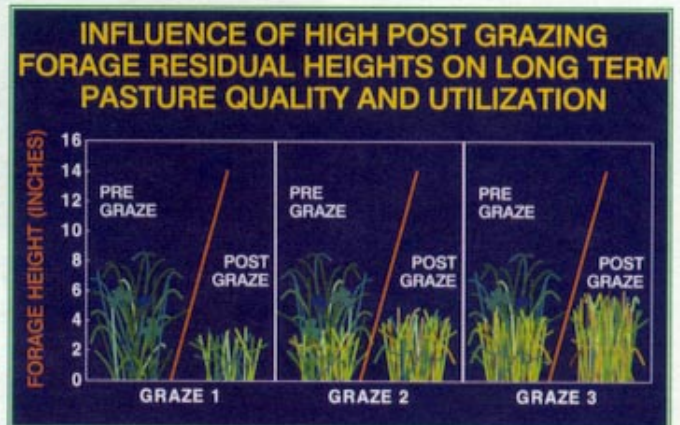


Figure 3 The more ungrazed plants or parts of plants that remain in a pasture post grazing, the lower will be the overall quality of the pasture at the next grazing and the greater the amount of forage refusal.

Herbage quality is primarily related to plant growth and stage of maturity. Generally, the younger the plant or plant parts, the higher the quality and thus, the higher the intake. Conversely, as individual plants and plant parts increase in age, they tend to decrease in quality. Hence, to maintain high and consistent quality pasture herbage, over time, grazing must be undertaken with the intent to achieve high rates of utilization. In other words, if the goal is to have a pasture consist of high quality new leaf material at the next grazing, the current growth must be grazed off. Simplistically, you must get rid of the old to make room for the new. SEE FIGURE 4.

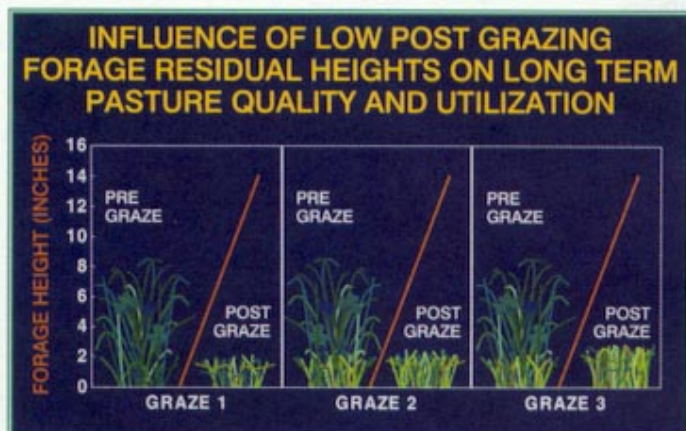


Figure 4 The fewer ungrazed plants or parts of plants that remain in a pasture post grazing, the higher will be the overall quality of the pasture at the next grazing and the greater the amount of forage utilized.

It makes little economic sense to provide the monetary, physical and managerial inputs to produce 4 or more tons of forage dry matter per acre of pasture if the quality of the forage produced is so poor that milk production is compromised or the cows refuse to eat it and half of the feed is simply clipped and left to decompose in the field. Every effort should be made to control the quality and quantity of feed on offer so that livestock refusal and, hence, waste is minimized during pasturing. Pastures that have become too tall for efficient grazing should be allocated to grass silage or hay and harvested mechanically.

While pasture plants in the vegetative or early growth stage are comprised of mostly leaves, as they progress through their normal growth and development cycles to maturity, there is generally an increasing amount of stems, and a decreasing amount of leaves in the forage mass. This is because once a tiller is triggered to move into the reproductive stage, generally no new leaves or tillers will be produced until after flowering has taken place or the seed head is removed by grazing or mechanical harvest.

To a point, the longer a pasture is allowed to grow prior to grazing or between subsequent grazings, the taller will be the plants and the greater will be the amount of forage accumulation. However, if the period of growth is extended for too long, the quality of the forage will peak and then deteriorate into a low quality feed. For a milking dairy cow, low quality feed simply manifests itself as a loss of milk production. SEE FIGURE 5.

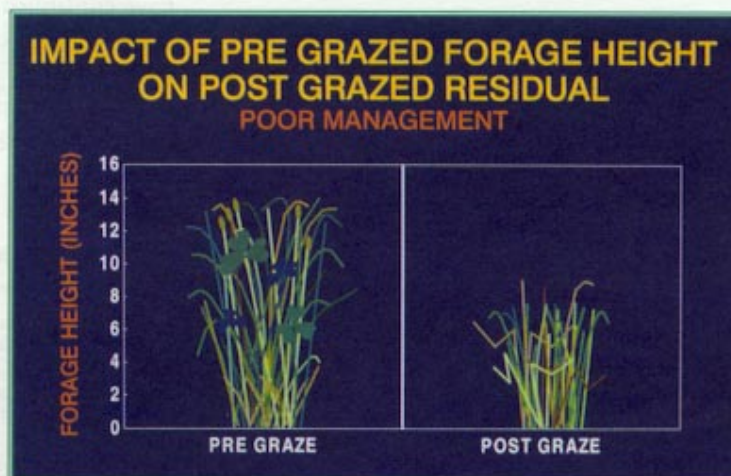


Figure 5 Grazing pastures that are taller than 12 inches in height generally results in low utilization of the existing forage which in turn results in a long term decrease in overall pasture quality.

In order to maintain pastures at their highest quality and to obtain the greatest utilization, they should be grazed when the plants are in the vegetative stage at heights of 6 to 8 inches.

The Need for
Enhancing Harvest
Efficiency
continued...

When grazed from this height to a 2 to 2.5 inch residual, new growth can be continually initiated over time which results in high pasture quality and milk production. SEE FIGURE 6.

the efficiency of converting the nutrients that are contained in grazed forages to milk, there is a need to supplement the nutrients that are known to be in limited supply.

PRESCRIBED GRAZING MANAGEMENT STRATEGIES FOR LACTATING DAIRY COWS

The 1996 and 1997 Cornell University Dairy Farm Business Summary (DFBS) reports on Intensive Grazing Farms provides economic information on the use of pasture by New York dairy farmers and provides an economic rationale for their prescribed use and management.

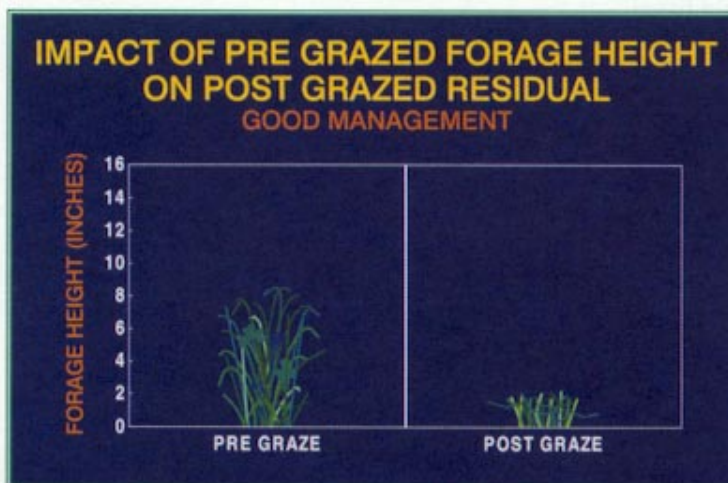


Figure 6 Grazing pastures that are 6 to 8 inches in height generally results in a high utilization of the existing forage, which in turn results in the long term maintenance of high pasture quality.

The Need for Enhancing the Efficiency of Forage Conversion

While pasture is an excellent source of forage for lactating dairy cows, it is not a perfect feed. In order to maximize the economic benefits of using pasture as a feed, supplementation strategies must be employed that optimize the animal's ability to utilize the nutrients contained in high quality forage.

The ability of a dairy cow to convert the nutrients contained in pasture to milk depends upon whether or not she is fed an appropriate complement of nutrients which pasture is lacking. For example, the crude protein in a well managed pasture exceeds the dietary requirements of the cow. To utilize this protein efficiently for milk production, the cow will require a certain level of sugars and starches in the diet. Pasture is low in sugars and starches, and thus supplementation of these nutrients is necessary to maintain milk production and body condition.

While the "take what you get and like it" approach to using pasture may be appropriate in countries where the cost of providing supplemental nutrients to cows on pasture exceeds the value of the additional milk produced, this is generally not the case here in the United States. Hence, to maximize

The state average net farm income without appreciation per cow (NFI/COW) for all dairy farms in New York using the DFBS was \$390 in 1996 and \$194 in 1997. On farms where pasture was utilized with a high degree of control and management and where it was integrated with supplemental feeding management strategies designed to maintain high production, the NFI/COW was \$729 in 1996 and \$454 in 1997. However, on farms where the use of pasture was undertaken as a low input feeding management strategy with little to no supplemental feeds utilized and with less management applied to the pastures, the NFI/COW was \$-141 in 1996 and \$-164 in 1997.

This study clearly indicates that there is a lot more to pasturing lactating dairy cows than simply turning cows out on grass and waiting for the milk check to arrive. We cannot afford to forget everything we have learned over the past fifty years about the basic principles involved with production agriculture just because we are grazing. The concepts and practices involved with animal husbandry, dairy nutrition, agronomy, soil science, economics and ecology are just as important on grazing farms as they are on any other farm. They cannot be dismissed, they cannot be denied, and ignoring them will not make them go away. These concepts and practices must be understood and

appropriately applied just as they would be on any other progressive farm, whether grazing or not.

The following guidelines and strategies for grazing lactating dairy cows are based on many years of science-based research and critical observations from various locations in the United States, Ireland and New Zealand which have been blended with the practical experiences of hundreds of New York dairy producers. They are not provided as the end point in your knowledge, understanding or application of grazing management, but rather a starting point.

Kind of Livestock

Everybody has their own favorite kind of cow. But the truth of the matter is, despite the controversial nature of this issue, there is no one best breed of cow for grazing. There are good grazers and there are not so good grazers within all breeds and in individual herds. If your market is for fluid milk, select a cow that produces a lot of fluid milk. If your market is for milk solids, select a cow that produces a lot of milk solids. Cull your herd heavily to select the cows that perform the best on your farm, on your forages and under your management.

Additionally, you should also look at the genetic merit or production level of your livestock in relationship to the kind of land and forage that you are grazing. The poorer the quality of land and forage you are grazing or the more inaccessible it is due to distance, steepness of slope, wet soil, etc., the harder your animals will have to work to obtain feed, and the lower will be their production. Generally, high producing or high genetic merit live-stock have higher feed requirements than livestock with lower genetic potentials for production. Hence, in order for them to be able to attain their production potentials, they need to graze high quality forages on high quality land. Conversely, if most of your farm is comprised of soils and forages that are not overly productive or have limitations to their ease of grazing, you should consider using livestock with lower feed requirements.

Kind of Plants

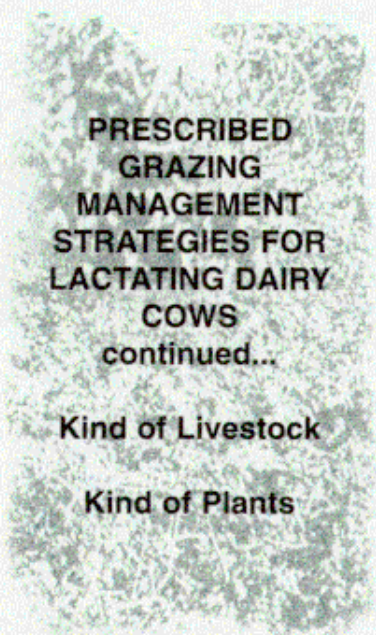
If you are expecting your pasture to serve as a substitute for feed that would normally

be fed in the barn, then you need to ensure that the land you are pasturing really is growing a source of dairy quality feed and not some other kind of plants, shrubs or trees that are simply holding the earth together.

To achieve the highest levels of milk production over the course of an entire grazing season, dairy pastures should consist of fairly uniform mixtures of grasses and legumes that are adapted to your particular soil type and growing conditions. Keep in mind there are no "silver bullets." As previously discussed, mixtures add diversity to an animal's diet and allows them to better balance their own rations in light of changing environmental conditions as well as their own nutritional requirements. In addition, mixtures tend to provide a more uniform availability of feed over the course of a grazing season.

Other suitable forages may include annuals such as brassicas and chickory. In addition, commonly occurring pasture plants such as dandelion, yarrow and plantain may also be grazed by lactating dairy cows. There are very few pastures that don't have at least some of these kinds of plants present. Although the good news is these plants can be very nutritious and cows will readily consume them, the bad news is they do not yield very well over the course of a season. Hence, although having some dandelion, yarrow, and plantain present in a pasture adds to the diversity of the feed source, you should try to ensure that the primary forage base is comprised of adapted grass and legume combinations.

As a general consideration, legumes should comprise 25 to 40% of the herbage in your pastures. Legumes are a higher quality feed than grasses due to their greater digestibility and, hence, rate of passage through the animal. Generally, the higher the rate of passage, the more an animal can consume. The more feed an animal consumes, the greater will be its production. Studies have shown that cows grazing pastures consisting of grass-legume combinations can produce between 6 and 10 pounds more milk per cow per day than cows grazing all grass pastures fertilized with nitrogen.



**PRESCRIBED
GRAZING
MANAGEMENT
STRATEGIES FOR
LACTATING DAIRY
COWS**
continued...

Kind of Livestock

Kind of Plants

Pastures consisting of all legume, such as alfalfa or red clover, like pastures consisting of all grass, such as perennial ryegrass or reed canarygrass, are acceptable but generally not recommended. As previously mentioned, the grazing of monoculture pastures will, in the long term, generally result in decreases in dry matter intake and, thus, in milk production. In situations where an all legume pasture is used (such as when grazing an alfalfa hay field in lieu of taking a second or third cut) producers must also be aware of the potential for bloat. This is discussed in greater depth in a later section of this book. Another consideration is standard longevity. Alfalfa in particular is not tolerant of frequent grazing, and red clover and trefoil do not live as long as grasses. The cost of re-establishment simply increases your cost of production. Hence, with few exceptions, grass-legume combinations will prove to be a better choice.

Kind of Land

In recent history, pasture has generally been defined as land that is not good enough to use for anything else. Unfortunately, just as the use of lands with site and soil limitations results in reduced crop yields, so will the use of these kinds of lands negatively influence milk production. We can no more expect lactating dairy cows to achieve high levels of milk production from grazing low quality land than we can expect to produce a decent stand of alfalfa without paying attention to the soil type or its fertility status. Swamp lands, mountain lands, low fertility lands or other marginally productive lands will not yield good crops nor will they produce high milk yields.

In order to obtain the greatest benefit from pasturing, you will need to use land possessing fairly high production capabilities. Keep in mind, you are not taking "good land" out of crop production when you pasture it. You are simply changing the way in which the crop on this "good land" is harvested. Good land will still produce high yields of forage and through the implementation of a well planned system

of grazing management, you will still obtain a very high harvest efficiency but at a much reduced cost.

Kind of Water

Water is covered in greater detail in a later section of this publication. However, it is of such importance that it is also included here as a prescribed component of a grazing system.

The need for water is not a debatable issue. Water, along with food, shelter and space are required to sustain life. Lactating dairy cattle need to have water provided to them in both sufficient quantity and quality to meet their requirements. SEE FIGURE 7.

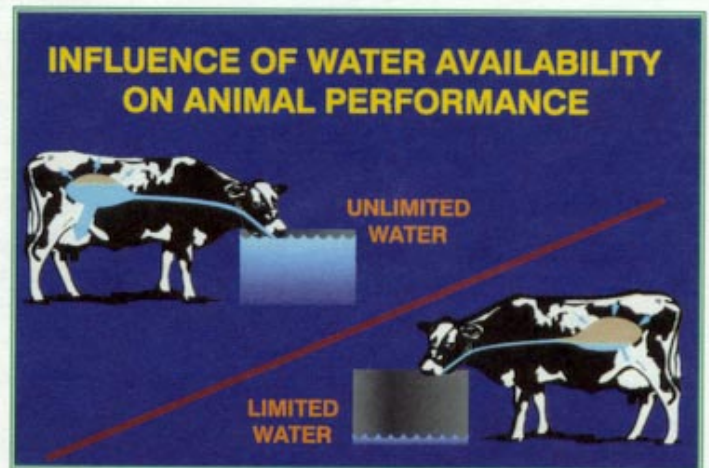


Figure 7 When water is limited, milk production is also limited. When an animal consumes food, body fluids pass into the rumen to assist in the digestion process. If these fluids are not replaced, the net result is dehydration and a loss of milk production. When water is not limited, fluids pass out of the rumen to rehydrate the animal and for milk production.

It is recommended that water be pumped from a clean reliable source and provided in stock tanks of an appropriate size. The use of streams, ponds and wetlands is not recommended.

Method of Stocking

To create and maintain the consistency of forage quality and quantity that is required to support high levels of milk production in lactating dairy cows, as well as provide a mechanism for enhancing overall harvest efficiency, it is recommended that a rotational stocking method be utilized incorporating the following harvest management criteria.

Kind of Plants
continued...

Kind of Land

Kind of Water

Method of Stocking

Frequency of Grazing

When using a rotational stocking method, the interval of time a pasture is allowed to regrow between successive grazings is referred to as the rotation length. The length of rotation serves as the primary mechanism controlling the frequency at which a pasture is grazed. Subsequently, the frequency at which a pasture is grazed controls the quality and quantity of feed on offer. Unfortunately, due to ever changing pasture growth rates, selecting an appropriate length of rotation is easier said than done.

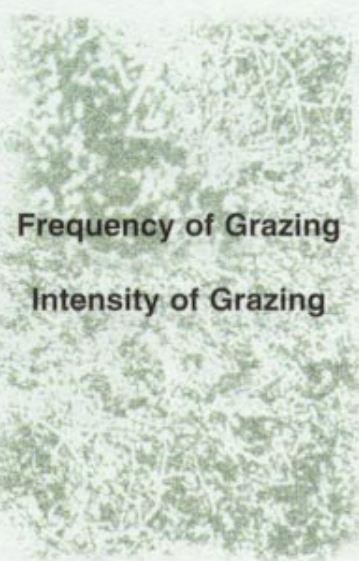
Pasture growth rates are in a constant state of flux. Spring and early summer are generally times of extremely high rates of growth. During the heat of summer, pasture growth rates tend to be at their lowest. As a result, there is no ideal rest period or rotation length to allow pastures to grow and recover between grazings. The time period between grazings should be long enough to allow the plants to achieve their maximum rates of growth, but not so long that forage quality is compromised.

In order to create and maintain consistent high quality forage, pastures should be grazed as often as every 10 to 15 days during the early spring, every 15 to 20 days during late spring and early summer and 25 to 30 days during summer and fall. Although extending rotation lengths for longer than the time periods indicated may result in a greater accumulation of dry matter, the quality of the forage generally declines so quickly that any increase in yield will be offset by lower feed quality and subsequently lower dry matter intake. SEE FIGURE 8.

Generally, when pasture sward heights are less than 2 to 3 inches, intake will be compromised due to a lack of volume of feed which reduces the cows intake per bite. The situation is made even worse when plant densities are low. Keep in mind there is not a lot of dry matter on bare ground or in open space. Although the quality of this short pasture may be very high, there is just not enough feed available to meet livestock dry matter requirements. This is referred to as a non-nutritional reduction in intake. As forage height increases to 4 to 10 inches (depending on plant species and densities) the range of the optimum is reached. At this height, intake is maximized. In other words, intake increases with increasing sward height and yield. Unfortunately, this relationship does not continue. Once the pasture sward height gets taller than 10 to 12 inches (depending on plant species) the quality of the plant material generally begins to decline. Along with the decline in quality comes a decline in intake. Keep in mind grazing animals are selective grazers. They take the best and leave the rest behind. The harder they have to work to separate the good from the not so good, the lower will be the amount of feed consumed. This is referred to as a nutritional reduction in intake.

Intensity of Grazing

The term "intensity of grazing" is a general reference pertaining to the amount of forage mass removed or utilized from a plant or pasture during a grazing event. Functionally, grazing intensities are based on relative differences between pre-grazed and post-grazed pasture sward heights and serve as an indicator of forage utilization. The greater the difference between pre-grazed and post-grazed heights, the greater the grazing intensity and, hence, the higher the utilization. For example, a pasture that has been grazed from a pre-grazed height of 8 inches to a post-grazed height of 2 inches represents a high amount of utilization with approximately 75% of the forage mass removed. While a pasture that has been grazed from a pre-grazed height of 8 inches to a post-grazed height of 4 inches



Frequency of Grazing
Intensity of Grazing

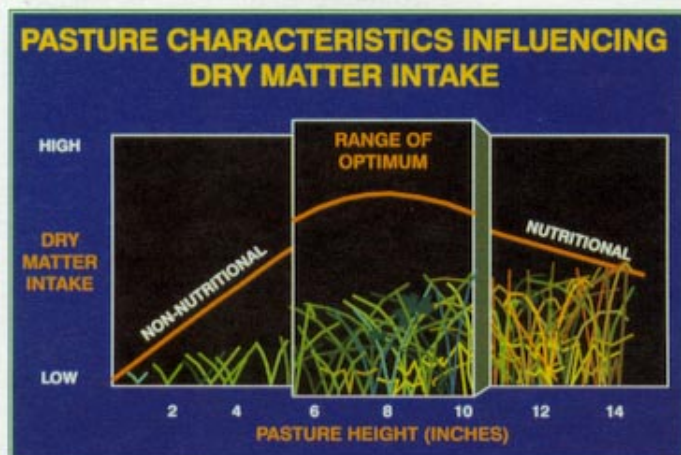


Figure 8 Dry matter intake from pasture varies considerably based on the quantity and quality of forage available.

represents a moderate amount of utilization with approximately 50% of the forage mass removed.

As a general recommendation, pastures consisting of orchardgrass, timothy, bromegrass, reed canarygrass, perennial ryegrass, tall fescue and legumes such as white clover, red clover, trefoil, etc. should be grazed from an initial height of 6 to 8 inches to a residual stubble height of 2 to 3 inches. Pastures consisting of low growing plants like bluegrass, redtop, sweet vernal grass, fine-leaved fescues and white clover should be grazed from an initial height of 5 to 6 inches to a residual stubble height of 2 inches. There are, however, several exceptions to these guidelines.

The first time a pasture is grazed in the spring should occur long before pastures reach the above mentioned heights. In most instances, grazing should begin when new spring growth reaches about 3 inches in height and stop when the pasture has been grazed to a residual height of 1.5 inches. Grazing at this intensity is designed to keep pastures from getting too mature too fast, improve plant densities through increased tiller production and allows for the initiation of a staggered forage regrowth pattern. Collectively, these actions help condition the pasture to provide the highest quality feed for the longest time interval possible.

An exception to the recommended grazing heights also occurs when soils are so wet that severe punching or poaching is a problem. Although a little surface punching or poaching is an acceptable part of harvesting forages through grazing, deep punching should be avoided. When wet soil conditions are a problem, let the forage get a little taller than what is normally recommended prior to grazing and then leave a little more of the forage behind post-grazing. This strategy allows enough of a forage mat to form and be maintained that hoof penetration is minimized.

Another exception to the general grazing height recommendations concerns hot, dry weather conditions. During these times, cool-season forage plants are under a great deal of stress and should not be severely grazed. Rotation lengths need to be extended to the maximum time interval indicated,

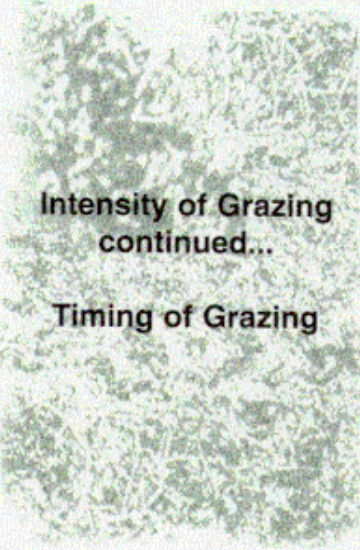
and residual forage heights need to be increased by about 50%. Leaving a greater amount of forage behind insulates the soil from the heat of the sun, helps maintain soil moisture and allows for a quicker regrowth.

The above two scenarios represent a planned or deliberate under-utilization of the forage supply to accomplish two different short-term management goals. However, in most cases, under-utilizing forage in the short-term leads to a different set of problems in the long-term. Forage that is left behind post-grazing will still be present in the pasture at the next grazing. However, because it has continued to grow and age, it will exist as an over-mature low quality feed. In turn, low quality feed will reduce intake and thus, animal performance. In order to prevent this from happening, any grazing prescription that includes the deliberate under-utilization of forage to remedy a short-term problem, must also include a provision for clipping the pasture as soon as conditions warrant.

Timing of Grazing

According to Webster's dictionary, timing is a reference to "selecting the best time or speed for doing something in order to achieve the desired or maximum result". Hence, timing of grazing refers to synchronizing the frequency, intensity and duration of grazing with the right season and/or environmental conditions to meet a particular goal or objective.

Within the overall context of prescribed grazing management, timing of grazing is, fundamentally, a matter of when should grazing start and when should grazing stop. However, because prescribed grazing management is a goal driven approach to grazing management, before timing considerations can be addressed, you have to know what it is you are trying to accomplish. For example, in some situations the timing of grazing might relate to environmental management concerns such as reducing soil erosion, maintaining or improving water quality or manipulating wildlife habitat. However, in other situations the timing of grazing may simply be in reference to forage management criteria for the purpose of enhancing forage quality, quantity or harvest efficiency. Generally, this will be the situation with lactating dairy cows.



**Intensity of Grazing
continued...**

Timing of Grazing

There are two primary concerns relating to the timing of grazing with lactating dairy cows. The first is the loss of pasture vigor and yield from grazing too early and the second is loss of forage quality from grazing too late.

Each spring, one of the first decisions a producer has to make is when to turn the cows out. While there is no definitive answer to this question, the timing of first grazing has a major influence on forage quality, quantity and harvest efficiency. If grazing commences before the pasture is ready, plant vigor and subsequent yield can be lost. If grazing commences too late, forage quality and harvest efficiency are reduced. Generally, spring turn-out should occur when the soils are firm enough to support livestock without undue poaching and the average height of the forage reaches about 3 inches. In wet years, this may mean the average forage height will be closer to 4 or 5 inches before cows can graze without damaging the pasture. As a practical matter, this means that the date that cows actually start grazing may vary by as much as 2 to 3 weeks from one year to the next.

Keep in mind, spring is a time of renewal. Plants have been photosynthetically dormant all winter long and are now in need of replenishing carbohydrate reserves. This process can only occur if there is an adequate amount of leaf area present to convert energy from the sun into energy for growth. If grazing begins too soon after green up and is too severe, yields may be substantially reduced and plants may even be killed.

Conversely, if grazing is not initiated early enough in the spring, a significant amount of the forage in the pasture will end up growing through the ideal grazing height and be of such low quality that much of it will be wasted through animal rejection and trampling. However, in wet years, you may have no choice but to wait for the soil to dry out before grazing begins. In this situation, lower quality feed and increased trampling losses become a short-term cost of doing business.

However, to prevent this short-term cost from becoming a long-term loss in production, it is recommended that the pasture be grazed as soon as possible followed by an

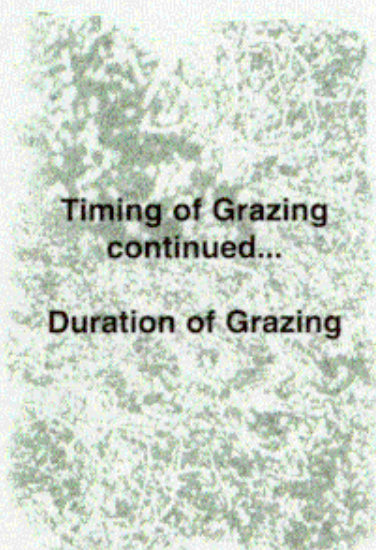
immediate clipping to a residual of 3 inches or less. Keep in mind, plants or plant parts that were not consumed the first time they were encountered by livestock will generally not be consumed the second time around either. Hence, these plants must be clipped or mowed immediately post-grazing to allow the growth of new high quality leaf material.

The same considerations apply to the timing of grazing in the summer and fall as they do with the first grazing in spring. Although rotation lengths are planned for 15 days in the spring and 30 days for summer, these are just planning guidelines, not predictions. The actual time to graze a paddock or pasture is not based on any set number of days, it is based on the pasture being ready to be grazed. Hence, while it is normally recommended that, after the first grazing in the spring, pastures attain a 6 to 8 inch height before being regrazed, this height may be attained in about 10 days in early spring but may take as long as 40 days in late summer.

Duration of Grazing

The length or duration of time that livestock have access to an individual paddock is referred to as the residency period. Residency periods are based on balancing the forage supply with the forage demand so that a desired amount of use can be obtained during the time period selected. To be effective at providing the level of control required to maintain consistent dairy quality pasture, it is recommended that residency periods for lactating dairy cows not exceed one day in length with one half of one day residency periods preferred. In other words, lactating dairy cows should be provided with a fresh paddock after each milking.

While some producers may find a one day residency period adequate to start with, keep in mind, the more often livestock are moved to fresh grass, the more uniform the quality and quantity of feed on offer and, thus, the higher will be their intake. Additionally, shorter residency periods promote higher utilization rates. The longer the period of time that livestock have access to a particular paddock, the greater will be the reduction in forage utilization due to increased amounts of trampling and fouling



**Timing of Grazing
continued...**

Duration of Grazing

with dung and urine. In other words, the more the forage in a paddock is walked on, slept on, urinated on and defecated on, the less likely it is that livestock will want to eat it. For lactating dairy herds using one day residency periods, 12 to 15 paddocks are recommended for spring and early summer conditions. While during periods of above average growth perhaps only 10 paddocks are all that will be required, a grazing system should not be planned around maximum growth rates.

In fact, grazing systems should be planned around having enough forage available to meet dry matter demand during the periods of least growth. Hence, while 15 paddocks is the recommended number to plan on having available during the spring, 30 paddocks are recommended for summer.

On farms where livestock are rotated to fresh paddocks after each milking i.e., residency periods of one half of one day, it is recommended that paddock size be calculated for a one day residency period and then simply cut the paddock size in half.

The number of paddocks in a grazing plan is primarily based on the need to have enough paddocks available to provide plants with adequate regrowth and recovery intervals between subsequent grazings. A secondary reason is to have enough so that they can be grazed at the proper time in order to maintain a forage quality base suitable for a particular kind or class of livestock and hence, promote higher utilization rates and harvest efficiencies.

Clipping of Pastures

Pasture growth rates and seasonal yields are not only extremely variable, they are also inherently unpredictable. As a result, even when you have implemented a grazing plan that attempts to optimize harvest efficiency through a combination of grazing and mechanically harvesting all forage that is seasonally in excess to your grazing needs, it is likely that at some point during the grazing season, you will also need to clip your pastures.

Dairy quality pasture is best described as a forage mass that is leafy, bright green and between 6 and 8 inches tall. It should not consist of stems, seed heads or pale green, yellow or brown leaves greater than

12 inches in height. Hence, anytime that a pasture becomes too tall to be efficiently grazed but is too short for mechanically harvesting, it should be clipped.

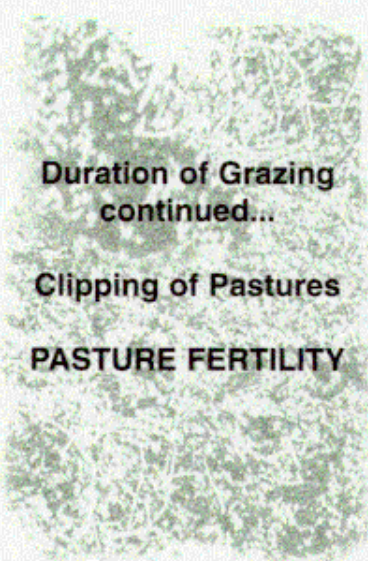
To enhance the utilization of forage from a pasture that has become a little too tall, it is recommended that you go ahead and graze the pasture anyway. Through selective grazing, the livestock will harvest the best of the forage from that which is available and will leave the rest behind. Once the pasture has been grazed, it should then be clipped to a height of less than 3 inches and the livestock turned back in. While livestock prefer not to eat standing stems, stalks and mature vegetation, once it has been clipped off, they will generally consume a large portion of it. Keep in mind, if your cows reject the forage in a pasture because of it being over-mature the first time they come in contact with it, chances are very good that they will reject even more of it the next time they encounter it. Generally, it is recommended that all pastures be clipped or mechanically harvested by the start of the third rotation and no later than the last week of May or first week of June.

PASTURE FERTILITY

Although farm to farm differences in soil type, management and plant species composition preclude the making of specific recommendations concerning the kind and amounts of fertilizers to apply to pastures, suffice it to say, forage plants require the same essential macro- and micro-nutrients for growth as any other green plant. Hence, if your pasture is low in plant nutrients or the pH is inadequate to support high levels of forage production, then neither you nor your livestock are getting all that you could from pasture.

It takes feed to produce milk and it takes available nutrients in the soil to produce the feed. When cows are forced to graze pastures depleted of soil fertility consisting of sparse, low yielding forages, they work harder and longer, ingest less feed and as a result, produce less milk than cows grazing on fertile, productive pastures.

Appropriate levels of plant nutrients are required to maintain plant densities, high yields and long-term persistence.



**Duration of Grazing
continued...**

Clipping of Pastures

PASTURE FERTILITY

Fertilization also improves the overall nutritional value of pasture by influencing the quality of individual plants as well as the entire forage base. For example, while nitrogen is known as the element that promotes leaf growth and dry matter yield, it also increases the protein and digestibility of grasses. As well, applications of lime and phosphorus promote plants with higher mineral concentrations. Higher fertility levels also allow for a greater diversity of plant species to survive in your forage base. For example, legumes have higher pH and fertility requirements than most grasses. However, they are higher in protein, are generally more digestible and are higher in minerals and some vitamins compared with grasses. For this reason, they are highly desirable in a dairy pasture. Hence, to successfully maintain legumes in your pasture, you will need to maintain a fairly rigorous soil fertility program.

Generally, pasture pH should be maintained between 6.0 and 6.5. Plant nutrient availability and soil microorganism activity are near optimum in this range. Because surface-applied lime does take several years to move into the soil profile, it is recommended that you not apply more than 2 to 3 tons of lime per acre per year. Keep in mind, due to the slow reaction time of lime, if you do have a problem with low pH, you should lime at least a year ahead of doing a seeding and two years is probably better, especially for legumes.

If nitrogen is used to boost pasture yield, care must be taken to ensure that the forage produced can be utilized in a timely manner. Otherwise, several different negative consequences can result. First, if the pasture is a grass-legume combination, applying too much nitrogen will tend to cause the grass to out-compete the legumes. Where the stand is comprised of greater than 40% legume, nitrogen applications should generally be limited to less than 100 pounds of actual nitrogen/acre/year and should not exceed 30 to 40 pounds of actual nitrogen/acre/application. Second, applying too much nitrogen at the wrong time can cause the majority of your pasture to end up as standing hay in a very short time. In all grass pastures or pastures with few to no legumes, nitrogen applications of up to 200

pounds/acre/year may be justified. However, do not apply more than 50 to 75 pounds of actual nitrogen/application. Keep in mind, if you are not able to efficiently utilize the forage grown from this nitrogen, you will have simply wasted your money. Hence, do not apply more nitrogen than you can keep up with, which generally means do not apply nitrogen to more than 25% of your pasture acres at any one time.

Phosphorous and potassium are essential nutrients in the production of forages. Phosphorus helps plants to establish more quickly, promotes root growth, seed formation and flowering, and may improve disease resistance and forage quality. Although potassium is not part of any particular plant constituent, it is involved with many plant functions including the formation of starches and sugars and their translocation within the plant, protein synthesis, and gaseous exchange.

Because applying more nutrients than are necessary for plant growth is a waste of your time and money and can cause serious water quality and animal health problems, it is recommended that you soil test your pastures at least once every 3 years and then only apply the nutrients that are necessary.

PLANNING PROCEDURES FOR BALANCING FORAGE SUPPLY WITH LIVESTOCK DEMAND

One of the most critical aspects of efficient pasture utilization is the maintenance of an appropriate balance between the amount of forage required by the grazing herd and the amount of forage that is actually available for grazing. If a herd's forage demand exceeds the amount of forage available, over-grazing is likely to occur along with a decrease in milk production and a shortened grazing season. Conversely, if the amount of forage available for grazing exceeds the herd's demand, while milk production may remain high in the short-term, a high percentage of this forage will be trampled, fouled and, thus, wasted. Unless this forage is clipped post-grazing, the forage that was not utilized will continue to grow and eventually exist as low

**PASTURE FERTILITY
continued...**

**Planning Procedures For
Balancing Forage Supply
with Livestock Demand**

quality over-mature vegetation at the next grazing. In the long-term, this will cause a decrease in the amount of forage actually utilized and result in a compromised level of milk production. Thus, while it is extremely important to ensure the adequacy of the forage supply, it is equally as important to minimize the occurrences of surpluses and deficits.

Although our knowledge of pasture-growth and animal intake rates is never complete, and will always be subject to the vagaries of chance and change, the following procedure adapted from D.L. Emmick and D.G. Fox Prescribed Grazing Management to Improve Pasture Productivity in New York September 1993, has been developed as a planning tool to help determine the size of individual paddocks as well as the number of acres required to meet the season-long forage demand of a specified number of cows.

Step 1. Determine Your Herds' Forage Demand

Forage demand is estimated by calculating the forage requirement per animal per day and then multiplying this value by the total number of animals that you are planning to graze.

Assume that each animal you are planning to graze will need to have available 3% of its body weight in forage dry matter per day.

Next, calculate the daily herd forage requirement.

$$\text{ANIMAL WEIGHT} \times 0.03 = \text{DAILY FORAGE REQUIREMENT / ANIMAL}$$

Step 2. Estimate Your Forage Supply

$$\text{FORAGE REQUIREMENT / ANIMAL / DAY} \times \text{NUMBER OF ANIMALS} = \text{DAILY HERD FORAGE REQUIREMENT}$$

There is no way in which to predict the amount of forage that will be available for grazing unless you actually go out in the pasture on the day you plan on grazing and measure it. However, in order to provide a place to start, estimated grass-legume hay yields based on soil type may be substituted. This information is available in most county

soil surveys which can be provided by the Natural Resources Conservation Service (NRCS), County Soil and Water Conservation Districts (SWCD) or Cornell Cooperative Extension (CCE).

The following table provides an estimate of the amount of forage available for grazing using grass-legume hay yields. Grass-legume hay yields are used as indicators of relative soil productivity rather than providing an actual yield estimate.

FORAGE AVAILABILITY ESTIMATES BASED ON HAY FIELDS	
Hay Yield Tons/Acre/Year	Forage Availability Pounds/Acre/Rotation
5.5	2,200
5.0	2,000
4.5	1,800
4.0	1,600
3.5	1,400
3.0	1,200

In other words, the assumption is the higher the yield in tons/acre/year the more productive the pasture and the higher the rate of growth. It follows then that the higher the rate of growth, the greater the amount of forage available for grazing. Actual yields in tons /acre/year will generally be higher than what has been reported.

To use this table, first locate your pasture on a soil survey map and determine the major soil type. Second, obtain the grass-legume hay yield estimate from the NRCS, SWCD, CCE or provide your own estimate from actual hay yields. Third, locate the hay yield estimate in the above table and reference it to the corresponding forage availability estimate.

Step 3. Determine The Paddock Residency Period.

Lactating dairy cows should not remain in a paddock for longer than 1 day. Moving cows to a fresh paddock after each milking is recommended. Longer residency periods serve to increase the amount of feed lost to trampling, defecation and urination and as a result reduces production on a per acre basis. Additionally, high producing cows tend to lose production very quickly with diminishing forage quality and quantity.

**Planning Procedures
for Balancing Forage
Supply with
Livestock Demand
continued...**

Step 4. Calculate the Paddock Size

Paddock size is calculated by dividing the forage demand by the forage supply and multiplying by the residency period selected.

$$\text{(FORAGE DEMAND} \div \text{FORAGE SUPPLY)} \times \text{RESIDENCY PERIOD} \\ = \text{PADDOCK SIZE}$$

Step 5. Determine the Number of Paddocks Required

The number of paddocks required is based on having enough available to provide an adequate regrowth interval during the slowest growth period of summer. Generally, a 30 day maximum regrowth interval is recommended.

To calculate the number of paddocks required, divide the maximum regrowth interval (30 days) by the residency period and add one additional paddock.

$$(30 \div \text{RESIDENCY PERIOD}) + 1 = \\ \text{NUMBER OF PADDOCKS} \\ \text{NEEDED}$$

Step 6. Estimate the total number of acres required

To estimate the total number of acres of pasture that you will need, simply multiply the calculated paddock size by the number of paddocks required.

$$\text{PADDOCK SIZE} \times \text{NUMBER OF} \\ \text{PADDOCKS} = \text{NUMBER OF ACRES} \\ \text{PLANNED}$$

See Appendix 1 for a prescribed grazing management plan worksheet to be used with the rotational stocking method.

In using the methodology described to calculate the total number of acres required, keep in mind, the number of acres planned is for mid-summer when forage growth rates are at their slowest and the forage supply is at the minimum. During the spring and early summer there will be approximately twice as much forage available as can be effectively grazed by the number of livestock planned. Hence, to efficiently utilize this forage, you should plan to mechanically harvest between 40 and 60% of the planned acreage as an early cut hay or silage.

Although it is impossible to predict exactly when you should begin to mechanically harvest your surplus forage, we generally recommend that it be done prior to the start of your third rotation and definitely before you begin your normal hay harvesting activity. Mechanically harvesting early in the season allows ample time for re-growth to occur before you need this land for grazing.

IMPLEMENTING THE PLAN

Grazing plans should be designed and implemented with as much flexibility in mind as forage growth rates are variable. However, they should be substantive enough in design and construction to ensure that successful management can occur.

Although some folks like to use all temporary wire and put up new fence every day, in the long-term, this practice simply adds another chore to an already busy schedule. Hence, it is recommended that systems be constructed with enough permanent or semi-permanent wire to provide an adequate structural integrity that allows the use of temporary wire to facilitate managerial integrity.

The following plan is presented as a conceptual model that puts into practice the science based information outlined in this publication. Although no two farms will layout exactly the same, the general principles and concepts provided here have a universal application.

To maximize the efficiency of forage harvest, once the total number of acres required for the system has been determined, the land should be divided into two separate management units. For example, all of the land that will be harvested through grazing during the first two months of the grazing season should be identified as Management Unit I. At spring green up, this will be the land where the livestock go first. All of the land that is surplus to the spring grazing needs, but will be required for summer and fall grazing, should be identified as Management Unit II. Generally, one cut of hay or silage will be taken from this land before it will be needed for grazing. SEE FIGURE 9. (See pg. 21)

**PLANNING
PROCEDURES FOR
BALANCING
FORAGE SUPPLY
WITH
LIVESTOCK DEMAND
continued...**

**IMPLEMENTING THE
PLAN**

IMPLEMENTING THE PLAN continued...

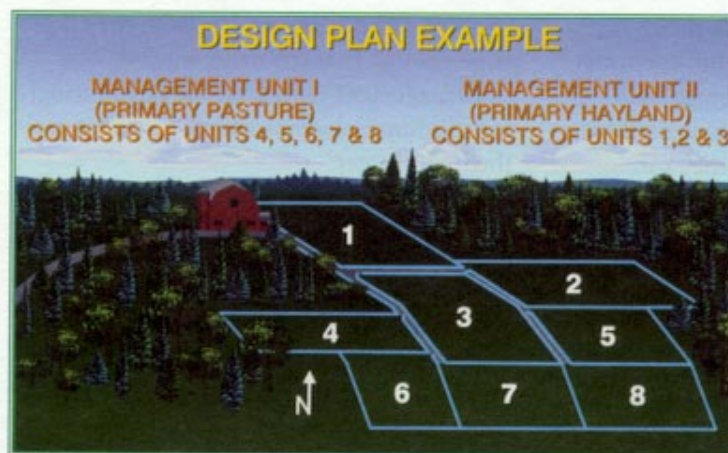


Figure 9 Generally, each management unit should consist of 3 to 5 major subdivisions created with permanent or semi-permanent steel wire (—). To maintain flexibility of management, within each subdivision, there should be enough forage planned to provide from 3 to 5 days of grazing.

In some situations, Management Unit I will be land that due to some constraint to mechanical harvest (too steep, too rocky or has no machinery access) can only be harvested through grazing. In other situations this land will be delineated based on ease of grazing, such as proximity to the barn and water, etc. or timeliness of grazing. Keep in mind, pastures on well-drained soils or lands that slope to the south or southwest will green up faster in the spring and will be ready to graze sooner than pastures on poorly drained soils or on slopes that face to the north or northeast.

Land that is in Management Unit II is land that can be either mechanically harvested or grazed depending on the need. However, keep in mind, this land is part of the planned acreage required to meet the forage demand for the herd in mid-summer. Hence, fencing designs must be planned so as to accommodate both ease of mechanical harvest as well as efficient grazing.

Once the major subdivisions have been created with permanent or semi-permanent steel wire, temporary wire can be used to further divide these units into individual paddocks. SEE FIGURE 10.

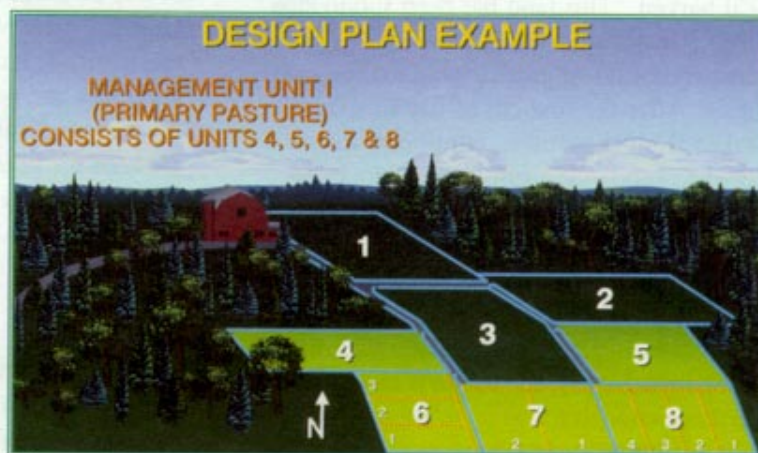


Figure 10 Management Unit I consists of 5 major subdivisions created with permanent or semi-permanent wire. Each major subdivision is planned to provide forage for approximately 3 days of grazing. Temporary wire (---) is used to further divide the units into individual paddocks.

In this example of a farm sitting on a hill with land gently sloping to the south, Management Unit I (the primary pasture) has been identified as the portion of land with the southernmost exposure. South facing slopes are generally warmer and dryer than lands with other aspects. As a result, in the spring, this land will green up the quickest and provide forage for grazing the soonest. This land has been subdivided into 5 major units (4,5,6,7, and 8) with 3 days of grazing planned for each unit. Temporary wire is used to subdivide the main units into individual paddocks of the appropriate size to meet the forage requirements of the herd. If the system operated just exactly as planned, by the time all five of the units have been grazed, approximately 15 days will have passed since the first paddock was grazed.

Should an individual paddock prove too large to graze efficiently within the time period allotted (contain more forage than planned), because temporary wire is used to create the individual paddocks, they can simply be made smaller. Each unit would then contain 4 or 5 paddocks instead of 3. Conversely, should the paddocks prove too small (contain less forage than planned), again, because temporary wire is used to create the individual paddocks, they can simply be made larger. Each unit would then contain 2 paddocks instead of 3.

Management Unit II (the primary hay land) is located on the flatter portion of land that offers no constraints to mechanical harvest. This land has been subdivided into 3 major units (1, 2, and 3) with approximately 5 days of grazing planned for each unit. After the first cut of hay or silage is taken from these units, temporary wire is used to subdivide them into paddocks of the appropriate size for grazing. As in Management Unit I, this land will provide approximately 15 days worth of grazing. Because the first harvest of Management Unit II will be accomplished through the use of machinery, the subdivisions should be large enough to easily accommodate the equipment on your farm. SEE FIGURE 11.

In some cases, however, herd size may be large enough that the main subdivisions in Management Unit I will be large enough for machinery harvest without making them any larger.

The plan is primarily designed to facilitate the harvest of forage through grazing. Hence, making all of the primary subdivisions large enough to easily harvest with machinery may make fencing into paddocks more challenging or at the least, more time consuming.

During the spring of the year, Management Unit I is grazed on a maximum rotation length of 15 days. A first cut of hay or silage is taken from Management Unit II. After Management Unit II is mechanically harvested, it is subdivided into paddocks and provides an additional 15 days of grazing. When both management units are used for grazing, the rotation length increases from a maximum of 15 days, when only 50% of the acreage is being used, to a maximum of 30 days when the entire planned acreage is grazed.

Keep in mind, planning is not the same as application. We do not have the capability or the luxury of being able to predict the weather. As a result, we cannot

actually predict the amount of dry matter that will be available in a pasture, how many acres will be required or even when a pasture will be ready to be grazed. What we can do, and have done, is combine research based information on pasture growth rates and yields with actual producer experiences to arrive at reasonable estimates of growth and yield, and based on these estimates, developed a conceptual model designed to optimize harvest efficiency.

**IMPLEMENTING
THE PLAN
continued...**

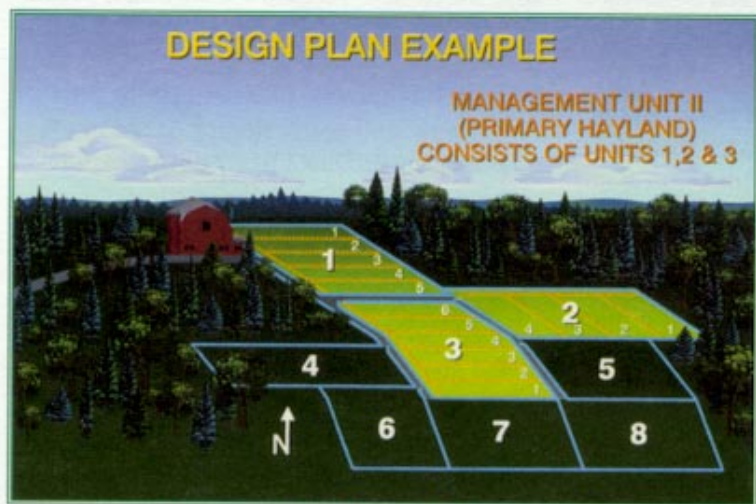


Figure 11 Management Unit II consists of 3 major subdivisions created with permanent or semi-permanent wire. Each major subdivision is planned to provide forage for approximately 5 days of grazing. Temporary wire is used to further divide the units into individual paddocks.

The primary organizational difference between the management units is that the main subdivisions in Management II are purposefully made larger than the primary subdivisions in Management Unit I in order to facilitate machinery harvest.

INFRASTRUCTURE CONSIDERATIONS

Managing livestock and forage resources compatibly is the backbone of a successful grazing system. These resources are more easily and efficiently managed, however, when the proper infrastructure is in place on the farm and is matched to the grazing system. Infra-structure includes fencing, watering systems and laneways.

Infrastructure will probably be the most costly and permanent part of a grazing system. Consequently, it is important to plan well ahead before setting posts in the ground and laying down pipe for watering. Most farms do not start planning a grazing system with bare fields, but rather have existing fences and buildings to work around. A new high-tensile fence or new livestock watering system is not a prerequisite for starting to graze, but invariably as grazing management improves, most facilities on a farm will be enhanced or expanded.

Fencing

Even when livestock are provided with ample and high quality forage while grazing, it is unrealistic to expect them to remain, on their own accord, in the area allocated to them. Proper fencing provides improved control and ease of handling when containing, excluding and moving livestock. In order to accomplish this, fencing should be effective, durable, economical and easy to maintain.

Traditional approaches to fencing relied upon barbed wire, conventional smooth electric, or woven wire. Thankfully, more advanced fencing technologies are currently on the market and offer superior performance, dependability and adaptability. There are basically two classifications of modern fencing used in grazing systems: permanent and temporary. Each grazing system should contain a balance of both permanent fencing (to provide structural integrity) and temporary fencing (to provide flexibility for changing conditions of forage production and/or livestock requirements).

Currently, the best choice for permanent fencing is electrified high-tensile fencing. This is used on perimeters, lane-ways and

for major subdivisions. High-tensile wire yields upwards of 3 times the breaking (i.e., tensile) strength of equivalent gauged barbed wire and does not stretch when pulled. These two characteristics permit spacing of line posts upwards of 75 feet on straight runs. Maintenance is straight forward and negligible. Tensioning devices are permanently installed on each strand and set for between 150-250 pounds per strand. On short runs, tensioning springs are generally utilized.

Two critical requirements for this type of fencing are 1) allowing all wires to "float freely" at every contact point except at the ends, and 2) providing solid supports at all ends, gates, and corners. Achieving the latter requirement typically involves using a hydraulic post driver to set larger blunt ended posts (minimum 6" diameter) deeper (at least 3.5') into the ground. Depending on how many strands are needed for effective livestock control, further bracing may be warranted for ends, gates and corners. Live trees should not be used for line posts since they rarely line up straight and the trunk's growth will inevitably engulf the strands (unless preventative measures are taken and perpetually maintained).

High-tensile fencing can be constructed by either a qualified and experienced contractor or you can do it yourself. Built properly with suitable components and materials, high-tensile fences last well over 25 years. For more information, consult with fencing dealers, contractors, manufacturers, USDA Natural Resources Conservation Service, County Soil and Water Conservation Districts and Cornell Cooperative Extension.

Temporary fencing, used to divide pastures into individual paddocks, can be constructed of portable electric twine and/or ribbon. These products are composed of a polyethylene cord or tape interlaced with 6 or more strands of very thin metal wires, as opposed to high-tensile wire, used as a physical barrier. Electrified temporary fence is strictly a psychological barrier. It must be electrified in order to provide a lasting unpleasant experience (electrical shock) when an animal challenges the fence. This material is held off of the ground at the appropriate height by either light-weight fiberglass or molded plastic posts. A reel is

INFRASTRUCTURE CONSIDERATIONS

Fencing

a convenient way to store and dispense the portable electric twine or ribbon. Due to its small conductors, electric twine or ribbon should only be deployed in reaches of about 1,000 to 1,500 feet. In addition, temporary fencing is not suitable in perimeter applications, especially adjacent to hazardous land uses (i.e., public roads).

Since both high-tensile wire and portable twine/ribbon are electrified, a fence charger or "energizer" is necessary. Along with the recent advent of improved fencing materials has come a new generation of fence energizers, described generically as "low impedance." These energizers are vastly superior to the older "weed choppers" which become ineffective when loaded down with weeds or branches. Low impedance energizers emit a different type of electrical pulse capable of passing beyond (i.e., not impeded by) even a moderate load on the fence line.

Electric fencing systems are like other electrical circuits requiring a complete, low resistance pathway to function properly. SEE FIGURE 12.

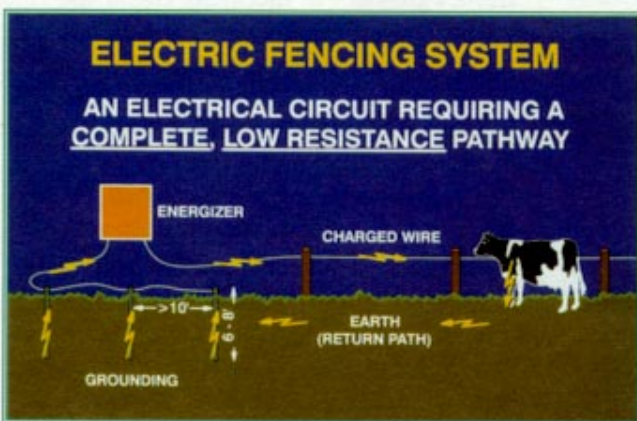


Figure 12 All electrical circuits require a complete, low resistance pathway to operate properly. Since the earth serves as the other conductor in an electric fencing system, a well designed and installed grounding (a.k.a. earth return) system is essential for optimal fence energizer performance.

One part of the circuit consists of the hot (electrified) wires on the fence. Another part is the earth and associated grounding system which must also permit easy passage of the electric pulse. When an animal touches the hot wire, its body conducts the pulse from the fence to the ground. The pulse travels through the ground to the ground rods and attached wire. To complete the entire circuit, the energizer must have excellent contact with the ground.

The importance of an adequate grounding cannot be over-emphasized. Most energizer manufacturers stipulate a minimum of three 8' long by 5/8" diameter ground rods spaced at least 10 feet apart and fully embedded in the ground.

Isolate the energizer from lightning strikes coming from both the fence and the electric utility. This can be accomplished with a surge protector at the 115 VAC outlet in combination with a lightning choke, arrestor and separate grounding system appropriately placed and wired. Keep in mind, you should choose electric carrying fencing components of the same composition; otherwise a process known as electrolysis will occur between dissimilar metals, ultimately causing a corroded (i.e. high resistance) connection.

For livestock inexperienced with electric fences, a brief training period should be given under highly controlled conditions (i.e., barnyard, pen, corral, etc.) to imprint a healthy respect for such unfamiliar fencing.

Watering

Animal performance in any production system is critically dependent on providing water of adequate quality, quantity and ready accessibility.

To ensure good quality, periodically test the water for toxic chemicals and pathogens. If these are in high enough concentrations, they will lead to poor livestock health and performance. A veterinarian or Cornell Cooperative Extension can provide guidelines for pollutant thresholds.

When determining the quantity of water that needs to be provided on pasture, consider all the different contributions of water livestock receive to meet their total daily requirements. Between free choice water available in the milking or housing facility, moisture in supplemented feed, water contained in the tissue of the fresh forage, and rain or dew on the plants, a large portion of their daily needs can be met. SEE FIGURE 13. (See pg. 25)

**Fencing
continued...**

Watering

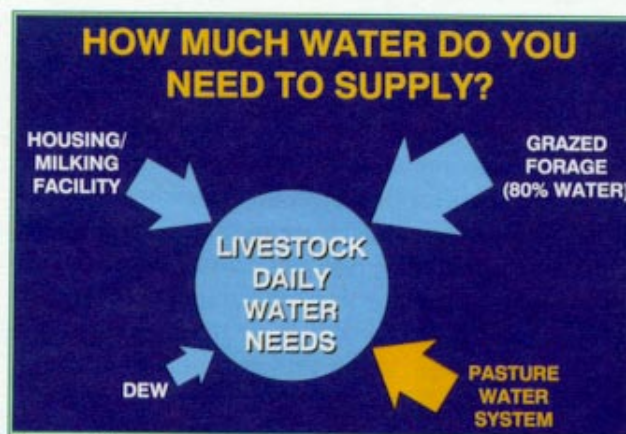


Figure 13 Lactating dairy cows draw water from a variety of sources. These include free choice water from bowls or troughs in the milking and/or housing facility, water inside the plant tissue of the pasture they consume, and dew or frost on the outside surface of pasture forage.

The remaining balance of their water needs must be provided in the pasture.

A 1999 study of lactating Holstein cows on rotationally stocked pasture without shade reveals cows drink an average and high of only 5.2 and 7.9 gallons/head/day, respectively. As an average over the course of 9 rotations, these cows obtained 31% more water from the pasture forage itself during this drought year than the water trough in the pasture. If animals consume large quantities of water immediately on returning to the barn, chances are, they may not be getting enough water in the pasture.

A fully integrated watering system is comprised of 1) a water source, 2) a distribution network, and 3) dispensing facilities. Whether the source is a pond, stream or well, it should not only contain water of high purity, but dependably yield sufficient volume throughout the entire grazing season. Generally, streams are not desirable for watering due to inconsistent quality and potential for livestock to pollute the stream. Ponds, streams and springs should always have livestock excluded and be protected from incompatible land uses. Drilled wells that provide water for the farmstead are the preferred source, where available, because they typically supply potable quality, yield reliable volume and are pressurized. Existing or boosted pressure must be great enough to lift water to the highest dispensing facilities in the pasture and overcome friction generated by water flowing within the pipes.

Most farmers choose black (clear or white allows algae growth) polyethylene water pipe placed on top of the ground at the base of fence lines to distribute the water to the paddocks. The water will remain relatively cool once vegetation grows over and shades the pipe from sunlight and the pipe is partially engulfed by the surrounding soil due to frost action. Metal or heavy plastic sleeves protect the pipe at heavy animal and/or equipment traffic sites like gates or laneway crossings. To supply water outside of the typical growing season, pipes must be trenched below the frost line and connected to either geothermally heated (i.e., "energy-free"), electrically heated or continuous flow water troughs.

Pipelines, fittings and valves must be large enough to reduce friction loss out to the furthest reach. For example, a 3/4" pipe may permit more than ample water flow within the first 50 feet of the pump, however the further the water travels, the more friction builds up and pressure drops. At 500 ft. from the pump, a mere trickle of water may be all that will come out. Increasing the pipe size to 1" or greater diminishes this problem.

Water dispensing sites consist of a valved connection to the distribution pipe, a section of durable rubber hose and a light-weight water trough outfitted with a full-flow water level control device. Portable troughs can easily be moved to different locations to reduce trampling and manure concentrations in one spot. Make sure that all these components of the system (hoses, pipe connectors, manual valves and float valves) permit minimum flow, otherwise the resulting flow at the far ends will be limited by the smallest opening or pipe. For example, if all the pipes leading up to a float valve allow for a 5 gallons/minute flow, but the float valve has an opening that only allows 2 gallons/minute, the amount of water flowing into the water tank will only be 2 gallons/minute.

There are two approaches to providing water to livestock. One way is to have a smaller trough with a water delivery system designed for rapid recovery. Without a high flow of water to keep up with the demand,

Watering
continued...

the animals will quickly drink a small tank dry and invariably tip it over. The other way is to have a larger trough but with a slower recovery from a lower flow of water coming into it. The goal in either situation is to ensure that the livestock have a continuous supply of water when they want it. SEE FIGURE 14.

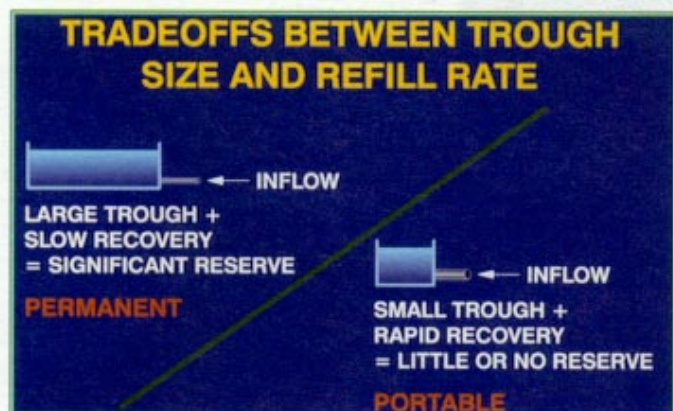


Figure 14 There are two opposite approaches to dispensing water. One is providing a large trough with a low flow of water to replenish draw down by cows. A contrasting approach is a small trough with a quick recharge capability, which allows more management flexibility due to the trough's portability.

An alternative to laying out a system of pipelines is to harness a large capacity tank onto the running gear of a wagon. Fill it up at some reliable source, tow it to the site where livestock are grazing, and park it. A short section of high capacity hose links the tank with a trough outfitted with a full-flow water level control device. This setup is commonly referred to as a "water wagon". It is typically used as a short-term fix to providing water, however, it can also be used on a long-term basis for a portion of a grazing system where a permanent water system cannot ordinarily provide service. While making water available in this way is initially low cost, it is very labor intensive.

Water should be easily accessible for the livestock. Where watering sites are available nearby, livestock tend to visit the trough in smaller numbers and return to grazing once their thirst is quenched. This is in marked contrast to traditional pasture watering scenarios where only one or two fixed sites are available and once a single animal decides to head for a drink, the entire group follows. Generally, water should be available within 300 feet of where the cows are grazing. It is better to have the water closer rather than further away.

The specific site chosen for dispensing water to livestock receives considerable abuse from animal traffic and manure buildup creating the potential for this area to turn into a mud hole. There are a variety of factors which affect the suitability of a site for dispensing water such as the type of soil, topography, type and class of livestock and

intensity and duration of use. Portable water troughs can be readily relocated between grazings to a slightly different location. This will disperse the impact. For permanent troughs, development of a durable base may be necessary if the existing site cannot provide long term support.

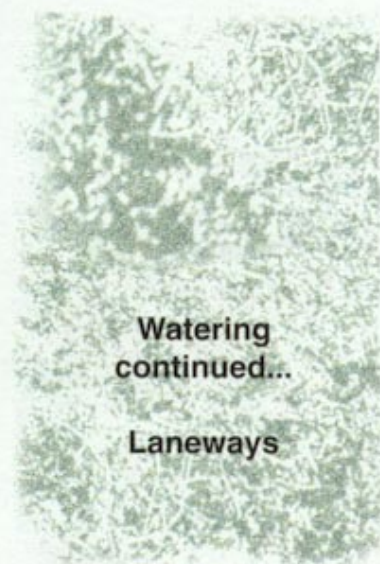
Where conventional means of obtaining water are not practical or cost-effective, a wide assortment of alternative pumps are currently available on the market. These include hydraulic ram, "sling", nose, solar, petroleum-fueled and windpowered pumps. Each has its own unique advantages, limitations and requirements. A thorough evaluation of these options is essential to determine which most appropriately matches the farms needs and resources.

Laneways

Indispensable to effective grazing management is the capability to reliably and simply move livestock to different paddocks, water dispensing sites, barns and other facilities on the farm. A well designed, constructed and maintained laneway facilitates these moves.

The laneway is generally located in the central part of the grazing system enabling it to serve the greatest amount of acreage for the least distance. When planning the specific path of the laneway, try to keep it on high ground or at least avoid swales, draws and known wet areas. Once the alignment is determined, attempt to preserve natural drainage patterns and take preventative measures to reduce the potential for erosion.

Laneways should be no wider than absolutely necessary to allow unrestrained passage of livestock. However, if field



Watering
continued...

Laneways

equipment cannot access the pastures by any other means, then the laneway must be wide enough for your equipment to pass through as well. Whenever a laneway serves this dual purpose, the greater impact to the lane requires extra attention to avoid developing a problem with erosion or mud holes.

When streams must be crossed, two basic approaches are available: above-grade or at-grade crossings. Smaller streams and creeks can be crossed by installing culverts or bridges. By keeping animals out of the stream, the lane and the animals stay drier and manure is kept out. This approach is generally too costly for wider streams. Instead, a spot in the stream where the banks are low is selected. A shallow sloping ramp is dug out of the banks on either side and stabilized with stone, timbers or concrete so that livestock can safely advance to and cross the stream bed. When planning the laneway, it is best to cross the stream in only one place.

Especially for dairy operations, the laneway by the barn gets the most traffic. Since this area is often a quagmire, it should be the first part of the laneway to be improved. At a minimum, this involves capturing roof and other surface water coming into the area and redirecting it to a less troublesome spot. Frequently, a concrete pad with board fencing will also be required.

The section of laneway directly off the barnyard would likely be the next most heavily trafficked areas. It is important to establish a reliably firm surface for the animals to travel on. They will be cleaner and it will be easier and faster for them to travel to and from the pasture. Improving the lane surface may require laying down a geotextile fabric and hauling in gravel to build up a base, topping it with lime dust and finally packing it down.

The geotextile material keeps the mud from seeping up through the gravel and permits vertical drainage. SEE FIGURE 15.



Figure 15 Where the native soils in a laneway cannot support constant heavy traffic, one improvement option is to create a firm layered foundation of successively smaller aggregate, placing it on geotextile material at the bottom of a shallow excavation. The final surface must be above normal grade, crowned to shed rain water, and capped with a fine material to avoid stone bruises to feet.

A less expensive solution where the site has hardpan is to have a bulldozer mound up the subsoil into a berm and then compact it. An important consideration on any laneway improvement is to make the final surface crowned, permitting it to shed water to the sides, keeping it dry. This is true even for laneways composed of gravel or crushed stone. Manure is very effective at plugging up the pores of even the coarsest material, despite their well drained characteristics. Further out on the laneway as the frequency of animal traffic diminishes, there is less need to make costly improvements and there are more management options to deal with troublesome spots. SEE FIGURE 16.

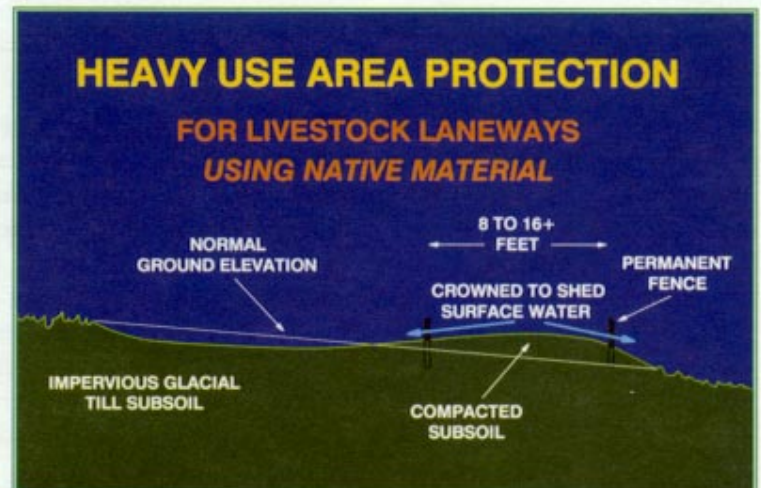


Figure 16 Where suitable soils exist on the site, shaping the hardpan subsoil into a crowned berm, packing it down adequately, and installing appropriate surface water control measures provides a durable and low cost improvement option for problem laneways.

Laneways
continued...

Paddock Shape and Orientation

Livestock like to cruise fence lines to locate their boundaries and escape routes. While doing so, they trample and waste forage. To reduce these impacts, paddocks should be made as square as possible. Rectangular paddocks are also acceptable as long as they are no more than four times as long as they are wide. Avoid fencing from tree to tree, circles, triangles or other odd shapes. Just because a fence is already in place does not mean that it is in the right place.

Forage growth rates, seasonal availability and forage utilization are impacted by differences in forage type, soil type, topography and aspect. As a result, paddocks should be laid out and oriented in such a manner as to reduce this variability as much as possible. For example, a single paddock should not include steeply sloping land with flat land, north facing slopes with south facing slopes, soil types that vary significantly in production or use potential or forage species that vary significantly in growth, yield or quality characteristics.

In addition, paddocks should not be oriented so as to extend up and down hillsides; in particular, if the slope is long and steep and the only source of water is at the bottom. In this situation, livestock will generally over-utilize the bottom of the hill and under-utilize the upper slope. To minimize this concern, whenever feasible, paddocks should be oriented on the contour with upper slopes separated from lower slopes.

Gate Location

Gates need to be located so they do not interfere with the natural movement of livestock as they travel to and from the barn or water. Generally, gates should be located in the corner of the paddock that is closest to the direction the livestock need to travel. If not, there will always be a few livestock that end up trapped in a gateless corner trying to figure out how to destroy a fence.

PRESCRIBED FEEDING MANAGEMENT FOR LACTATING DAIRY COWS

Lactating dairy cows are a classification of livestock with nutritional requirements that are far more complex than almost any other. This is because their requirements are based upon several needs: maintenance, production, reproduction and growth, and they are prioritized physiologically as listed above. Thus, a lactating dairy cow will maintain herself first and produce milk second when her nutritional status becomes compromised. This is why milk production goes down when forage quality declines or when a grain supplement is not formulated correctly. Other classes of livestock also respond to poor nutrition, but generally the effects are not noticeable until the nutritional problem has become somewhat long term.

A lactating dairy cow on pasture may be even more sensitive in her production response when the ration is not balanced properly or management of the pastures is inadequate. She is now responsible for harvesting much of her own feed, and will seek out the highest quality plants to harvest. If what she has chosen to harvest is not complemented properly with supplemental feeds in the barn, milk production will decrease. Thus, it is essential that the ration be balanced properly based upon what the farm manager's "best guesstimate" is of her harvest preferences. Also, if there is not enough high quality plant material for harvesting, milk production will decrease unless intake of other feeds is increased in the barn.

A prescribed feeding management plan should be based upon level of milk production, pasture quality and quantity, additional forages available, feeding and housing systems, and the goals and objectives of the farm manager. Once again, each farm will have a different feeding prescription rather than a specific recipe for all farms to follow. The guidelines here are given as factors to consider in developing a prescription for your farm's feeding plan.

Pasture Quality

Pasture quality can be variable throughout the grazing season and from year to

Paddock Shape and Orientation

Gate Location

PRESCRIBED FEEDING MANAGEMENT FOR LACTATING DAIRY COWS.

Pasture Quality

year. This is not unlike stored forages, which can vary tremendously depending upon harvest date, handling and storage. Most dairy producers regularly have their stored forages analyzed for quality so that a properly balanced ration can be fed. Likewise, for a ration to be properly balanced for cows grazing pasture, forage samples should be taken at times that best reflect pasture quality.

Those producers who have gained a few years of experience with grazing management will attest to the fact that their pastures are high in protein and low in fiber content. This is generally true for pastures that have been improved through introduction of new species, application of lime or fertilizer, and/or a few years of good grazing management. However, these trends will not be seen in pastures that are sparse, weedy, and improperly managed.

Most first year graziers are pleasantly surprised at the results of their forage tests. Traditionally, we have not thought about pasture as being a high quality source of feed for our cows. When excellent grazing management principles are applied, however, we can capture the plants at the stage of growth when the nutrients needed for high feed value are present. This stage of growth is much earlier than the time frame when these plants would be harvested for either hay or silage, because the plants would be too short to make machine harvest economical. Thus, most producers, veterinarians, and nutritionists that are not experienced with pasture generally think of grasses and grass-legume combinations as being low in quality.

Those with little to no experience with prescribed grazing might quickly assume that putting cows on pasture is a mistake, because of the idea that it's lower in quality than alfalfa. This can be a real stumbling block for a producer who is committed to the system, but has a nutritionist or veterinarian who doubts the value of pasture. The best way to convince those individuals is to take a sample of the pastures, and show them the results.


Taking a Forage Sample

During the first 2 weeks of grazing after spring "green up" pastures need not be sampled. This is because pastures are short (3-4 inches) and forage availability is limited. After the first rotation when the intake of pasture is not limited (6-10 inches) a sampling program should be initiated. This will begin to provide information that can be used to develop a properly balanced feeding program.

From the time of the first sample, a schedule whereby analysis of the pastures are obtained at least once every rotation is highly recommended, especially during the first few years. This will result in samples generally being taken every 15 days in the spring, and 25-30 days thereafter. Over time, a database for your farm will develop and the need to sample frequently will decrease.

In the case of stored forages, it has always been emphasized that a representative sample should be taken. Usually samples from dry hay are taken by coring several bales, and from silage are taken by grabbing handfuls of freshly unloaded feed and compositing. A similar method should be used when sampling a pasture for analysis.

A common question that producers ask is how to sample their pastures so that a representative sample is obtained. Paddocks that are in similar stages of growth and are due to be grazed soon are the best candidates for sampling. Alternatively, when cows are turned into a new paddock there is an opportunity to sample from right under their noses. The best way to determine which plants to sample is to watch the cows grazing to see what plants they are selecting to eat. A sample should represent what is going to be consumed by the cow, not what she is going to leave behind because of maturity, fouling, or trampling. Once you have determined the types of plants that should be sampled, you can walk through the paddocks and essentially act as if you were a grazing cow. Take the tops of the plants in your hand and wrap them as if your hand was a tongue. Then rip off the plant at a height typical of the grazing animals and place in a bucket. If you tend to also pull the roots up while sampling,



**Pasture Quality
continued...**

**Taking a Forage
Sample**

it may be wise to use a pair of shears to cut the grass at the post-grazing height rather than ripping it off. Several samples from throughout the paddocks should be composited in the bucket and subsampled as you would with a sample of a stored forage.

The subsample can then be placed in a plastic bag, packed well to exclude air, and frozen for at least 12 hours before being sent or taken to an analysis laboratory. You may want to take a cooler and a few ice packs with you while you're sampling, so the samples can begin to be cooled before you put them in your freezer.

If there is a forage testing lab close to your farm, a fresh sample may be taken there if there is a short lag time between the time you take the sample and when it is delivered. Samples should not be allowed to sit in a hot vehicle for more than 30 minutes, because the plants will begin to ferment and analysis will not be accurate. If sending samples by mail to a lab, it is recommended that they be sent while still frozen and early in the week to avoid mail delays. A final option for quick shipment of samples is to send them on a DHIA route truck, where they will remain frozen for the entire time. If on DHIA testing, samples may be sent with the DHIA representative. Otherwise, you will need to find out when and where the route truck picks up milk samples, and take your pasture samples to that location.

It may be wise to check with the forage testing lab to find out how they are analyzing the sample. If using near infrared reflectance spectroscopy (NIRS), make sure that the calibration equations they are using have been developed using actual pasture samples analyzed by wet chemistry methods from the region. Some labs may use equations developed from hay or silage samples, or they may purchase software developed in another part of the country. If this is the case, the accuracy of the results may be questionable.

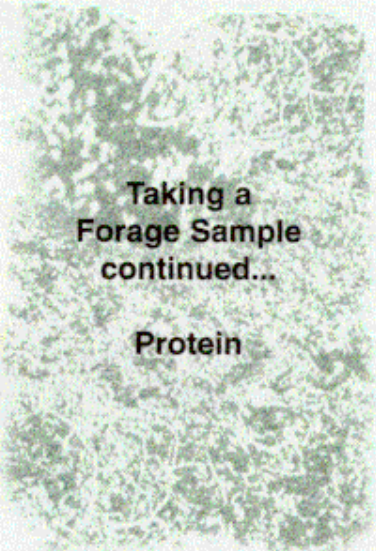
It may seem strange that samples would be taken from paddocks that are about to be grazed, because by the time the results arrive back in the mail, the paddocks that were sampled will have already been grazed. However, if all the paddocks are being

grazed at a similar stage of growth, the paddocks that are sampled should be similar in quality to paddocks to be grazed in the future. If there are paddocks, however, that differ greatly in some way (i.e. fertility levels, differing plant species, differing topography), then each area should be sampled separately. For example, you would not want to sample from paddocks that are flat, close to the barn, well-drained and fertile, and then move the cows onto a poorly drained hillside that hasn't seen any lime, fertilizer or seed in 20 years. The chances are good that the sample results would show higher quality feed than what is actually available on the hillside, and milk production would drop.

Throughout the first 3 years, it is recommended that a frequent sampling schedule be maintained. This is because the quality of the pasture is likely to improve each year as both management and the plants improve. With better management, there will be an increase in plant species that tend to be higher in quality and a decrease in weed populations. This will be especially true with pastures that have not been improved for many years. There can also be variation in quality due to different weather patterns, and it is critical to be aware of these changes so that rations can be changed to reflect this. This is similar to the need to sample stored forages on a regular basis to monitor changes in moisture content, cuttings, or fields. After the first 3 years, it is still recommended that pasture samples be collected on a regular basis. However, the frequency with which they are taken should be based on the manager's judgement of weather conditions and if management has influenced any potential changes in quality. After 3 years of grazing experience, most managers find that they are attuned to any changes that are happening and sample when they believe it is necessary.

Protein

In describing the quality attributes of their pastures, most producers will emphasize that the protein content is quite high. The research data does show that crude protein contents will range from 18 to 26% depending on species and month of the grazing season. However, protein contents have been reported to reach as much as 35%



**Taking a
Forage Sample
continued...**

Protein

from pastures that have been managed well, especially in the early spring. This protein tends to be very degradable in the rumen, which makes the task of balancing rations somewhat challenging. Although high crude protein levels are certainly impressive, other quality factors should also be considered, such as protein solubility and degradability.

In the plant, protein can be found as part of the cell wall or inside the plant cells. Proteins are made up of nitrogen molecules (in combination with other molecules such as oxygen and hydrogen) which are grouped together in many different ways by chemical bonds to form different amino acids. The amino acids are then further grouped together in different combinations to form proteins. Usually when protein is in the plant cell wall, some of the protein is attached by a chemical bond to the molecules that make up the cell wall. Some of these bonds are weak and thus are easily broken by either bacteria in the rumen or other chemicals (such as an enzyme or acid) and the protein is made available in the rumen. This is known as degradable intake protein (DIP), and pastures are very high in this type. Some of the degradable protein can also be found in the plant cell solubles, and may have different rates of uptake by the bacteria in the rumen.

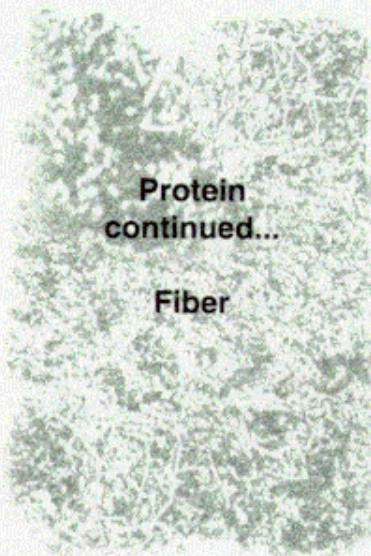
When the protein is not made available in the rumen and the bacteria do not use it, but it is used in the lower gut by the animal itself, it is known as undegradable intake protein (UIP) or bypass protein. Pastures are very low in this fraction (because it is essentially the opposite of degradable). Soluble protein is the fraction of the degradable protein that is immediately available in the rumen because it is not bound to any other plant components. Other non-protein nitrogen sources, such as urea, are also completely soluble in the rumen. Pastures can be somewhat low in soluble protein (25 to 30%), but can vary by plant species and weather conditions. At times, pastures have been found to also be high in soluble protein (40 to 45%). Thus, it is important to have pasture samples tested for soluble protein.

Fiber

Fiber levels tend to remain low due to the vegetative state of the plants. Acid detergent fiber (ADF) levels stay in the mid to high 20's and neutral detergent fiber (NDF) stays in the mid to high 40's in grasses and under 40% in legumes. This means that as a forage source, pasture is a highly digestible feed. This results in cows being able to consume large quantities of pasture, because it is digested quickly and almost completely. Also since most analysis laboratories use ADF levels to predict energy values, it is not unusual to have estimated NE₁ values of .70 to .85 Mcal/lb on pasture samples. Although this also is quite impressive, the values may present a challenge when balancing rations. The energy levels that are predicted are very similar to the levels in corn silage. However, there is a fundamental difference which is important to keep in mind -- pasture grasses don't grow ears of grain. Pasture energy levels are high because ADF is fairly low. Corn silage energy values are high because the grain fraction, which is high in sugars and starches, essentially "dilutes" the ADF fraction from the corn stover. As evidence of this, remember that pasture non-structural carbohydrate (NSC) levels are typically in the range of 15-25%, whereas corn silage NSC is 35-40%.

One compounding factor in determining the true energy value of pasture is the pectin content. In addition to cellulose, hemicellulose and lignin, plant cell walls also contain pectin, a simple sugar. The pectin contributes some energy to the diet, but to what extent the energy value as predicted from ADF should be adjusted is not known. Unless a pasture sample is analyzed for pectin content, it is merely guesswork. As with other factors, it will depend upon the time of year, stage of maturity, and plant species. Fortunately, the pectins can serve as a rapidly available carbohydrate source for the rumen bacteria, which is important in relation to protein and energy interactions as will be discussed later.

Pastures are comprised of actively living and growing plants which are constantly changing. Young, actively growing plants are lower in fiber and higher in both protein and digestibility than are plants that have



Protein
continued...

Fiber

become older and more mature.
SEE FIGURE 17.



Figure 17 A young, vegetative plant will be higher in feed quality than an older, more mature plant.

As a plant grows and becomes more mature, the proportion of lignin increases and the cell walls become thicker. As the plant becomes more lignified it becomes less digestible. SEE FIGURE 18.

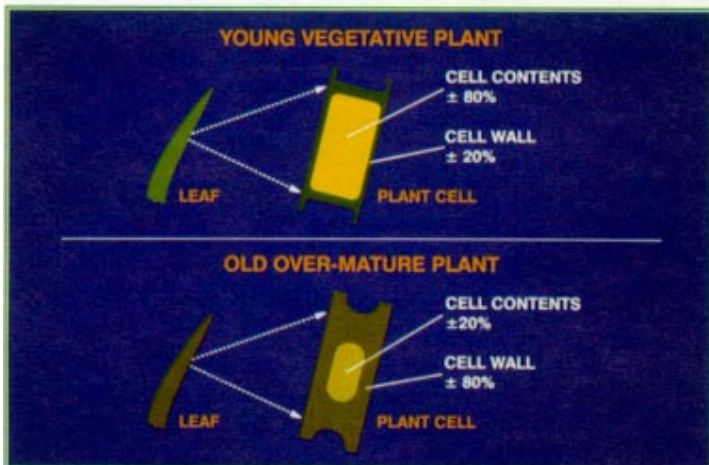


Figure 18 The rumen bacteria look at the plant from a cellular viewpoint. A young vegetative plant has thinner cell walls, which is easier for the bacteria to digest. The older, mature plant has thicker walls which are less digestible.

By maintaining the plants in the vegetative state, there is little opportunity for them to grow to the point where they start to become lignified and decline in quality. Plant cell walls are made up of three primary components - cellulose, hemicellulose, and lignin. In a younger plant, the cell walls are thin and are made up mostly by cellulose and hemicellulose. Both of these components are relatively easy for the rumen bacteria to digest, because both are essentially a string of sugar molecules linked together. Hemicellulose is slightly more complex,

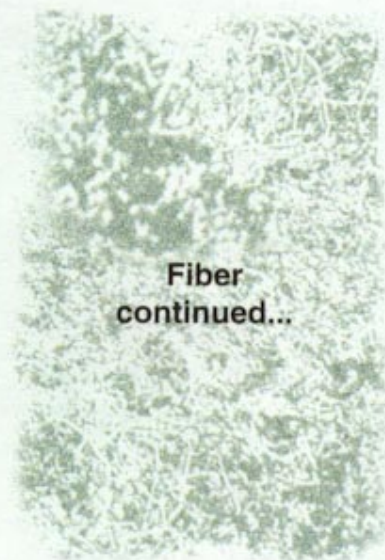
as it is a chain of sugar molecules with a few side branches. Lignin, on the other hand, is indigestible by both the animal and the rumen bacteria.

Fiber levels in plants are measured by estimating the amounts of cellulose, hemicellulose, and lignin. Frequently the results are reported as either "ADF" or "NDF". The acronym "ADF" stands for "acid detergent fiber", and is a measure of how much cellulose and lignin are in the plant sampled. In the laboratory using wet chemistry analysis, the sample is boiled

in a detergent solution that is high in acidity -- thus the "acid detergent". After boiling, the only parts of the plant that should remain are the cellulose and lignin, because everything else gets dissolved and washed away by the solution. Likewise,

"NDF" stands for "neutral detergent fiber", and is determined using a neutral detergent solution. After boiling, the hemicellulose as well as the cellulose and lignin will remain. An easy way to remember the difference between the two analyses is that NDF will always be higher than ADF.

SEE FIGURE 19 (Pg.33)



Fiber continued...

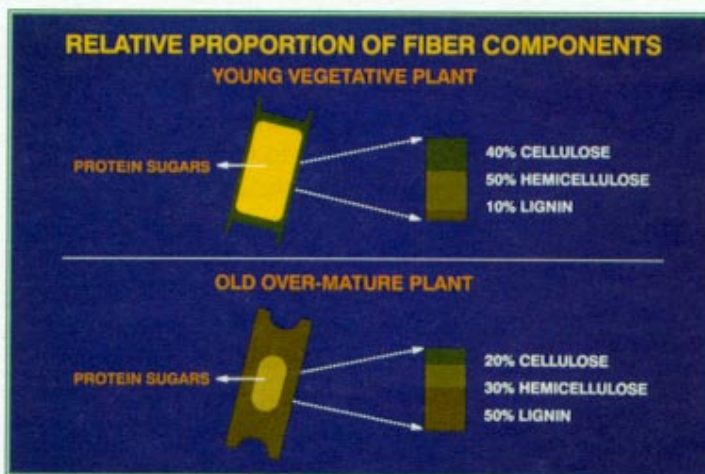


Figure 19 Proteins and sugars are contained inside the cells. The cell walls are comprised of cellulose, hemicellulose, and lignin. The vegetative plant has a higher proportion of cellulose and hemicellulose, which are digestible. The mature plant has more lignin, which is completely

There are times of the year when lignification may occur faster than normal because the plants grow so rapidly, especially in the spring. It is important that the manager be aware of this and keep up with the grass. This is why it is recommended that some acres of the system be harvested in the spring as hay or silage.

Properly managed pasture is higher in quality than any other forage not only due to stage of growth at harvest, but also because it is immediately consumed. The process of harvesting dry hay involves cutting the plant and drying it before baling. Putting up silage cuts the plant, wilts it, chops it, and ferments it.

The plant is at its highest state of quality while it is growing, and anything else that is done to it in the process of harvesting will decrease quality to a greater or lesser degree. The only stored forage that approximates the quality of pasture is baleage, because there is very little wilting time and the fermentation length tends to be shorter.

The tables below show some average values that have been obtained from analysis of rotationally grazed pastures in both New York and Pennsylvania. The samples were collected during field research on commercial dairies and research with university herds. There are not significant quality differences due to geographic location, and thus the data has been combined into ranges. There tend to be more differences due to species and management intensity. Although these are the values that have been found under

research conditions, they are realistic values for well-managed pastures. However, it is still recommended that each pasture on the farm be sampled to account for on-farm variability.

Fiber
continued...

AVERAGE NUTRIENT CONTENT OF GRASS AND MIXED MOSTLY GRASS STANDS

ROTATIONALLY GRAZED PASTURES

NUTRIENT	MAY	JUNE	JULY	AUG	SEPT	OCT
PROTEIN, %	22 - 26	18 - 24	18 - 22	20 - 25	21 - 28	21 - 26
SOLUBLE, % OF CP	25 - 30	22 - 31	23 - 25	21 - 27	21 - 29	24 - 34
DEGRADABLE, % OF CP	75 - 80	70 - 80	68 - 75	65 - 71	71 - 73	65 - 74
NE _L , MCAL/LB	.70 - .74	.64 - .72	.63 - .68	.65 - .69	.66 - .75	.67 - .75
ADF, %	22 - 25	24 - 32	28 - 32	27 - 34	24 - 28	22 - 28
NDF, %	48 - 52	50 - 58	49 - 56	54 - 60	53 - 58	50 - 56
% DIGESTIBLE	83 - 85	73 - 83	75 - 77	73 - 75	72 - 74	72 - 74

Table 1

AVERAGE NUTRIENT CONTENT OF LEGUME AND MIXED MOSTLY LEGUME STANDS

ROTATIONALLY GRAZED PASTURES

NUTRIENT	MAY	JUNE	JULY	AUG	SEPT	OCT
PROTEIN, %	24 - 26	21 - 24	22 - 24	21 - 24	21 - 26	24 - 26
SOLUBLE, % OF CP	32 - 34	30 - 34	28 - 32	25 - 27	29 - 31	33 - 37
DEGRADABLE, % OF CP	74 - 77	72 - 74	66 - 74	69 - 72	70 - 71	71 - 77
NE _L , MCAL/LB	.74 - .81	.69 - .74	.68 - .74	.70 - .71	.66 - .80	.72 - .76
ADF, %	19 - 23	23 - 27	25 - 28	27	20 - 30	23 - 25
NDF, %	24 - 38	38 - 45	32 - 44	40 - 44	26 - 45	31 - 38

Table 2

FORMULATING RATIONS

Protein and Energy Relationships

In the last several years, there has been a substantial amount of research conducted on protein and energy in cattle diets. This includes research on the various fractions of protein, such as degradable, undegradable, and soluble protein. Along with this work has been a concurrent interest in sources of energy from both structural (fiber) and non-structural (sugars and starches) carbohydrates. It has become evident that these two components of feeds have a very close relationship in determining the relative success of rations formulated for lactating cows.

Formulating rations for cows in a grazing management situation is not that much different than rations under other management systems. However, as discussed previously, pasture presents some unique challenges in terms of protein and energy relationships. For example, one consideration that is especially important is the cows will require more energy for walking. Thus, according to the National Research Council, energy requirements for maintenance should be increased by 5% per mile the cows walk. It also states that, "to support grazing, maintenance allowances may be increased by 10% for good pasture and up to 20% for sparse pastures". For general ration balancing purposes, an increase of 15% in maintenance net energy requirements should result in a ration that more than adequately meets the increased need for energy. Obviously, this is generally not a concern when cows are fed in the barn because they are not walking large distances.

Pasture in a well managed system will yield very high levels of protein, which is also very degradable in the rumen. These high levels of protein are in excess of the protein requirements of lactating cows, as is the proportion of the pasture protein which is degradable.

A basic understanding of the function of bacteria in the rumen is necessary to fully appreciate why protein levels are a critical issue. In a nutshell, the rumen bacteria are actually comprised of many different species of bacteria. Some digest fiber, others digest

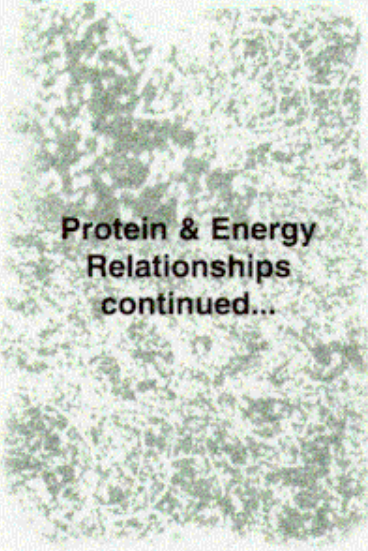
sugars, and yet others digest proteins. It is a complex and highly interactive environment in the rumen, because some bacteria require the by-products of others (such as volatile fatty acids) in order to function. The cow benefits from all of these interactions because not only does she use the by-products of the bacteria, she also uses the bacteria themselves. Nutritionists frequently refer to "optimizing bacterial crude protein" for two reasons. First of all, the bacteria constantly have to make more bacteria so that the cow doesn't digest them all and kill them. Secondly, bacteria are mostly made of protein, which when digested in the lower part of the digestive system provides the cow with more protein, and thus she is able to make more milk. The way to optimize the bacteria is to provide the proper ratios and amounts of protein and protein fractions and the correct type and degradability of carbohydrates in the diet.

In reality we are feeding the rumen bacteria. They are affected by what the cow consumes, and must use the nutrients that are available. When there is far more protein available than what they are able to use, the excess protein is converted to ammonia nitrogen ($\text{NH}_3\text{-N}$) and then to urea, and excreted. The process of converting the excess protein to ammonia and ammonia to urea requires energy. This energy comes from either stored body fat or energy that would otherwise be used for milk production. Overall low body condition scores may result in herds when energy from the body is used and when dietary energy is inadequate.

An implication of the high levels of protein in the pastures is that if any additional protein is fed in the barn, the amount of nitrogen being excreted in the form of urea can be substantial. From a nutrient management standpoint, this can cause environmental concerns related to nitrogen leaching into groundwater or running off in surface waters. It is strongly advised that protein levels in the diet be monitored to reduce this potential concern. Many a nutritionist unfamiliar with pasture diets has "discounted" the protein levels in the pasture, and fed additional amounts in the barn-fed part of the diet.

FORMULATING RATIONS

Protein & Energy Relationships



Protein & Energy Relationships continued...

For the rumen bacteria to utilize protein from the pastures, they also require a source of energy. The more energy that is available, the more efficient they are at using the protein that is available in the rumen. When they are able to use more of the protein, less is converted to $\text{NH}_3\text{-N}$ and urea, and thus less energy is used by the cow to excrete it.

The best sources of energy for bacteria to use are sources that are higher in non-structural carbohydrate (NSC) content. These sources provide energy that is easily and rapidly utilized by the bacteria. Corn products are an excellent source of NSC's for rations which include pasture. Corn meal, steam-flaked corn, hominy, and corn silage provide NSC's which have different rates of availability and digestibility in the rumen. High-moisture corn products also provide NSC, however, they tend to be very rapidly available. Ideally the rate of availability should be matched with the timing of pasture consumption, so that NSC is available near the time when the cow is consuming pasture.

Rates of availability and digestibility also vary with the particle size of the feeds. For example, corn meal can be ground to a wide range of particle sizes - from extremely fine to very coarse. Also, high-moisture corn products are variable in particle size from farm to farm depending on harvest management and processing at the silo. The best particle size for your particular ration may need to be adjusted based on how much corn comes through in the manure (indicating extent of digestion of the feed), as well as what other feeds are in the ration. For example, many herds that do not feed any other forages have found a finer grind works well, whereas with additional forages in the ration a medium to coarser grind is preferred.

As mentioned previously, pectins from the plant cell wall provide rapidly available carbohydrates. This may benefit the rumen bacteria because as the pasture plants are being digested in the rumen, the pectins are becoming available at a similar rate as the protein. This factor may help to explain why in some rations which should have a significant problem with excess protein, we do not see any of the clinical signs such as

low body condition, lower milk production, or reproductive problems. Keep in mind that this does not mean that the pectins can provide a significant source of energy, and thus there is no need to supplement.

Other sources of NSC can be used, such as barley or oats. However, the use of these as a major source of NSC is somewhat limited, and a corn product should be combined with the feeding of these other cereal grains. The total NSC in the diet should range from 38 to 42% of total ration dry matter. This range is slightly higher than NSC recommendations for cows fed in the barn, but may be necessary to provide the energy needed to handle the excess protein. As will be discussed later, this high level of NSC is oftentimes difficult to attain in real life due to several "cow factors".

Another source of energy to the cow could be provided by feeding some added fat. Added fat in a pasture ration may help to alleviate some of the loss of body condition, however, this does not help to minimize the effect of the excess degradable protein on the rumen bacteria. Further, there is a limit as to how much fat can be fed without impairing rumen function by suppressing the activity of the bacteria. A limit of 4 to 5% of the total ration dry matter is recommended, with this author preferring the lower limit or less. Bypass fat sources can be fed according to manufacturer's recommendations, but the cost of this ingredient should be considered. Natural fat sources such as whole cottonseed or whole soybeans may also be fed as long as the limit of 5% fat is not exceeded.

During the ration formulation process, nutritionists follow many different guidelines to balance nutrients provided with those needed by the animal. One general rule of thumb is that of the total crude protein in the ration, 60 to 65% should be degradable and 35 to 40% should be undegradable. When pasture is the primary forage source, this rule of thumb is difficult to follow because of the high levels of DIP. Some nutritionists have been known to attempt to meet the guideline by using ingredients in the grain mix which are very high in UIP such as meat and bone meal, blood meal and fish meal.

(Note: As of September 1997, the feeding of meat and bone meal from ruminants has been banned due to concerns with bovine spongiform encephalitis.) All of these ingredients are expensive, and the absolute UIP requirements can be met with plant protein ingredients such as roasted soybeans, soybean meal, and distiller's grains. Rather than looking at the protein fractions as a percent of the total crude protein, the total daily requirement in terms of quantity of DIP and UIP should be balanced for. In some high producing herds that have been using rendered protein products over the long term, a very small amount is usually kept in the ration (not more than 5% of the grain mix). This is because these products contribute amino acids which may be more critical in the diet at higher levels of production.

Although degradable protein levels tend to run high, soluble protein in pastures can be relatively low (25-35% of crude protein). This surprises many nutritionists, because typically when a forage has high degradable protein the soluble fraction is also high. Thus, there are times when a small amount of urea will help to boost milk production in pasture-based rations. It is recommended that urea be included at 1 to 1.5 ounces per cow per day (.06 to .09 lb). Urea may not be needed in rations that include some haylage as a supplemental forage, as soluble protein may be provided by this feed. However, soluble protein also may be higher in pastures, depending on weather conditions, fertilizer management, and time of year. Thus, it is important to take pasture samples and find out the soluble protein levels before considering the use of urea.

Estimating Intake

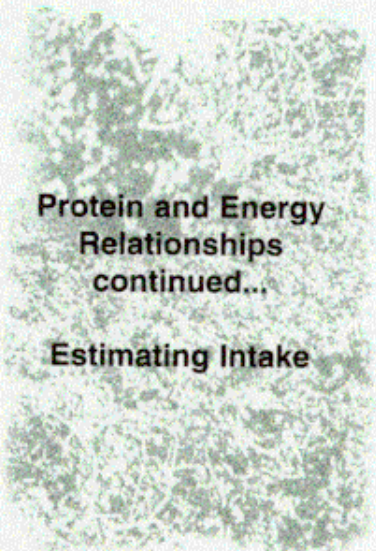
When cows are fed stored forages under confinement situations, it is quite easy to determine their dry matter intake (DMI). If a known quantity of feed is placed before them as either total mixed ration (TMR) or individual feeds, and a quantity of feed is refused at the end of the day, the estimation is a simple math problem. However, in a grazing situation, it is not always known exactly how much is available or how much has been eaten.

This apparent "black hole" of feeding cows on pasture is a frustration for many producers and their nutritionists. There are many theories on how to estimate the amount of pasture consumed. Some of them involve using formulas to predict intake or herbage availability, while others involve some general "artwork" using common sense and back calculations. In other words, this is where prescribed feeding management is both an art and a science.

For those who only want a general idea of pasture intake, the easiest way to estimate it is to assume the cows will eat to their dry matter intake requirements. Whether or not this happens will depend on 2 factors; 1) there is enough forage in the paddock for every cow to eat to her fill, and 2) the cows are not being fed so much in the barn that they're not hungry enough to eat from the pastures. The second one is critical when considering how much supplemental forage to feed in the barn, because there is a substitution effect of other feeds in the diet. If the amount of dry matter being fed in the barn is known or can be estimated by use of scales or a mixer wagon, calculating pasture intake is a simple subtraction. Dry matter intake requirements for a given level of production minus dry matter fed in the barn results in the amount of pasture the cows are consuming.

Another way to obtain a fairly general estimate of intake is to follow the thumb rule that the pastures will yield 250-300 lbs. of dry matter per inch of herbage height per acre. This is based on research with fairly dense swards, and adjustments may need to be made in swards that are less dense. If an estimate can be made pre-grazing of the amount of forage available in a paddock and then again post-grazing, an estimate of the amount of dry matter consumed can be made.

The use of measuring devices, such as rising plate meters, sward sticks, and pasture probes can be helpful in determining dry matter intakes. However, it is important to remember that these tools need to be calibrated to each specific farm and plant species by actually clipping and weighing samples of pasture forage. Also, there is an expense that is incurred with each measuring



Protein and Energy Relationships continued...

Estimating Intake

tool, and this needs to be taken into consideration and compared to "homemade" methods of estimation which may be less expensive. Each of these devices in itself is excellent to use as a means of teaching oneself how to estimate forage availability, however.

More specific methods of determining intake are also used. Research studies at Penn State and the University of Vermont have been done that have attempted to measure the dry matter intake of grazing cows. Generally, it has been found that forage dry matter intakes will range from 25 to 35 lbs per cow when the cows are fed a supplement. These levels of intake are dependent upon the same factors as discussed previously, such as amount of dry matter fed in the barn. It is possible for cows to eat more pasture dry matter, especially if body capacity (and therefore rumen capacity) is large enough and level of milk production is very high. In recent research trials at Penn State, Kolver and Muller found that high producing cows fed only pasture consumed 48.1 pounds of dry matter. The ability of cows to exceed predicted dry matter intake levels can occur in any feeding management system and is not unique to pasture based systems. However, it may happen more often in pasture feeding systems due to the higher rates of digestion and passage in the rumen of fresh forage.

There are formulas commonly used to estimate intake based on body weight (BW) and 4% fat-corrected milk production levels (FCM) that can also be utilized to obtain more specific predictions. One formula commonly used is as follows:

$$DMI = (.0185 * BW) + (.305 * FCM)$$

As can be seen, this formula helps to determine a fairly exact prediction. The limitation of using this formula is much the same as discussed before in relation to the quality of the forage being grazed (i.e., higher digestibility, higher rates of digestion and passage, etc.). Using the NDF values of the pasture forage can also give a

more specific estimate of intake. The general rule of thumb is that cows will consume 1.1 to 1.2% of their bodyweight as NDF from forage. Once again, however, this may underestimate intake of pasture.

SUPPLEMENTATION STRATEGIES

There are many different options to choose from when deciding how to supplement the grazing cow. Many producers find that the easiest and most economical supplementation strategy is to feed a grain mix that is formulated to compliment pasture quality. The biggest advantage to this strategy is that it reduces the time needed to feed one or two other forages, or to mix a batch of TMR. Most producers would prefer to make fewer trips around the barn with feed carts, or spend less time running silo unloaders, skid steers, and mixer wagons. SEE FIGURE 20.

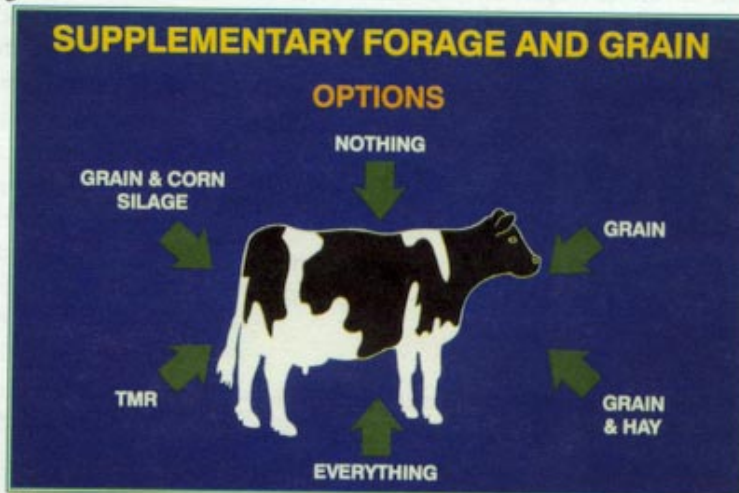


Figure 20 There are many options for how to supplement the grazing cow. Which one you choose depends on your farms resources and goals.

Supplementing With Grain Only

Some popular opinion in the field is that we do not need to feed grain to cows on pasture, because it is thought to be not economical. However, it has generally been shown in research that for every pound of grain fed there is an increase in milk production of 1 to 1.2 pounds above the milk produced from a forage-only diet with high producing cows in early to mid-lactation. If milk is worth \$0.12 per pound and grain costs \$0.08 per pound, there is a net profit on that grain of \$0.04 to \$0.07 per pound, depending upon the level of milk response. At the higher milk response level, this is almost like doubling your money!

Estimating Intake
continued...

SUPPLEMENTATION STRATEGIES

Supplementing With Grain Only

There is a point of diminishing returns, where additional grain feeding does not result in an economical milk response. The milk response per pound of grain may diminish to 0.6 pounds, which is not economical.

The determination of when that point of diminishing returns is reached will change from year to year and even farm to farm based upon the price of grain, price of milk, production level, and the unique financial position of the farm. Generally, however, feeding grain at a grain to milk ratio of 1:3 or lower will be economical.

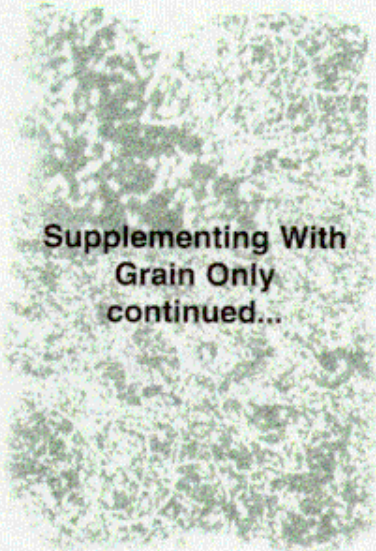
In formulating a ration using grain as the only source of complimentary nutrients, there are several factors to consider. As discussed, pasture is a source of high amounts of protein which is rapidly used in the rumen, but is low in readily available carbohydrates (sugars and starches). The end result of this is an excess of urea being absorbed into the blood stream with energy being used from body reserves or milk production to do so. Thus, a grain mix should have a high proportion of ingredients which supply NSC's as an energy supply for the rumen bacteria. Also, the mix should have a small amount of a bypass protein source, since pasture is low in undegradable protein.

When contemplating feed ingredients to be included as an energy source, particle size, processing method, and rate of digestion are important. If we were to spend time watching how and when our cows graze, we would see that grazing activity takes place at various times during the day and night. When they are first presented with new, fresh forage they will have a high level of grazing activity. Once they are full, they will lie down to chew their cud. However, when they become hungry again they will resume grazing. As we consider this cycle of forage intake, it is evident that nutrients from pasture are becoming available through the process of digestion at different times during the day. Thus, carbohydrates need to be available on a continual basis, and this is influenced by particle size, processing method, and rate of digestion of the feed ingredients we choose. Ideally, a grain mix would have equal proportions of every particle size (and thus rate of digestion of

NSC's), so that NSC's would be available on a continuous basis.

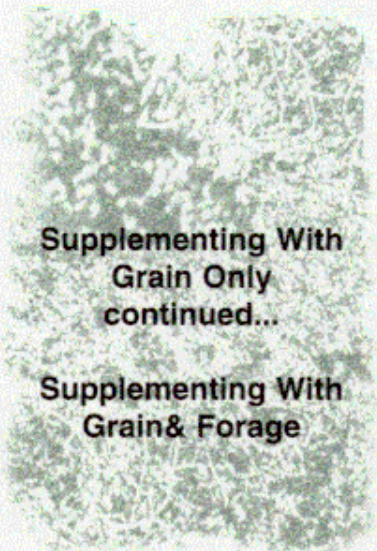
The amount of grain that should be fed has also been a topic of debate. Typically when cows are kept in a confinement feeding system grain is fed on a grain to milk ratio of anywhere from 1:2.5 to 1:4, depending on forage quality, level of milk production, etc. For some high producing cows this can be as much as 30 to 35 pounds of grain per day. In a grazing system, however, many producers have reported that there is a maximum amount of grain their cows will eat. In some herds it is a grain to milk ratio of 1:5 or 1:6, and in others it is a maximum of 16 or 20 pounds per cow per day. This is most likely a result of the fact that the cows have a very high dry matter intake from the pasture, and thus their rumens are full when they come back to the barn. This is why it may be difficult to reach a NSC level of 38 to 42% in the diet, because the cows simply won't eat that much. When this situation occurs, it is important to remember to increase mineral concentrations in the grain mix so that deficiencies do not occur. There are also other farms that report no problems with cows eating grain at the usual levels. It is not clear why there are differences from herd to herd, but it may be due to management, environmental conditions (barn design, cow comfort, etc.), forage species, or pasture intake differences due to varying levels of pasture availability.

Research at Penn State looked at feeding grain at different grain to milk ratios. They found that milk production was similar for cows fed grain on ratios of 1:3, 1:4, and 1:5, but that body condition score was lower for cows fed lower levels of grain (1:4 and 1:5). This was most likely due to a less energy dense diet combined with lower levels of NSC's in the ration. This led to energy from body reserves being used to excrete excess nitrogen. If low body condition is a concern in a herd, then feeding grain at the higher level is justified. For others, however, body condition can be managed through observation, higher fat feed ingredients, or late lactation management, and the additional savings generated by a lower grain feeding rate is justified. The amount of grain fed is a decision best left to the individual farm manager based upon his or her goals for the herd.



**Supplementing With
Grain Only
continued...**

In the situation where the decision has been made to feed grain at a higher level, slug feeding of the grain should be a concern. Cows on pasture generally only have access to grain when they return to the barn for milking. When cows are being fed more than 10 pounds of grain at each feeding, there is the potential for them to consume the grain very quickly. This can cause a sharp drop in the pH of the rumen, due to an increase in acid production. This may cause some short-term acidosis, which could lead to other problems such as laminitis and lower butterfat production. It is advised that for cows requiring more than 10 pounds of grain per feeding, the grain should be split into smaller amounts and fed more times.



**Supplementing With
Grain Only
continued...**

**Supplementing With
Grain & Forage**

As an example, we will look at the feeding schedule for a cow making 75 pounds of milk being fed grain at a 1:3 ratio. She would require 25 pounds of grain per day, or 12.5 pounds per feeding. Rather than feeding her the full 12.5 pounds when she comes into the barn, she could be fed a smaller amount in two meals. When she first comes in from pasture, she would be fed a maximum of 8 pounds of grain. After milking but before turnout to pasture, the remaining 4.5 pounds of grain would be fed. By splitting it into four feedings of smaller amounts, the impact of slug feeding is minimized. This example would need to be adapted to fit each farm's individual circumstances. The maximum amount fed at the first feeding would be different depending on the number of cows being fed more than 20 pounds of grain per day, and how much time is reasonable to make another trip around the barn "topdressing" the higher producers. Also, this example works well for a stanchion or tie-stall barn, but may not be feasible for a freestall barn. Some producers have found that it is easier to feed grain out in the pasture twice a day on the ground or in a feed wagon, rather than feed it in the barn twice during each milking.

Supplementing With Grain and Forage

The next option for supplementing the grazing cow is to add some other type of forage to the diet in addition to grain. This could include dry hay, haylage, baleage, corn

silage, or a combination of any of them. Which forages are chosen as a supplement will depend upon the type, availability, quality, and need for utilization of various forages. For example, on one farm there may be a high amount of corn silage that needs to be fed out from a silo before fall, whereas on another farm there may be both corn silage and dry hay. Amounts of the ensiled forages that are fed will also depend upon how much needs to be re-moved from a silo to keep it fresh. Also, on some farms there may be limited acreage that can reasonably be allocated towards a grazing system, and feeding additional forage is necessary to maintain total dry matter intake and milk production.

This problem of limited acreage can be adjusted for in the planning process for the grazing system. Typically we plan the system based upon the pasture providing 3% of the animal's body weight from forage. As an example, where acreage is somewhat limited and supplemental forages have to be fed, the planning process can be based on 2% of body weight from pasture and 1% from stored forage. Using this strategy would result in a prediction of fewer acres and slightly smaller paddocks.

When feeding additional forages as a supplement, it is important to remember that there is a substitution effect on the intake of pasture. As more forage is fed in the barn, dry matter intake from pasture will decrease. Again, this is one of the most difficult things to change in the first year of grazing. Most producers are in the habit of trying to feed their cows as much forage as they can in a confinement system. When the cows are turned out to harvest their own forage, it can be difficult to break the habit of feeding a lot in the barn. Those who cannot break the habit often complain that their cows won't, can't, or don't graze very well, when in fact it is because they have eaten too much forage before being turned out. In general, every pound of forage fed in the barn substitutes for between .8 and 1.2 pounds of pasture DM. This is not the case with grain feeding, due to a higher rate of digestion and lower volume of feed. Thus in grain feeding the rate is one pound of grain substitutes for .5 to .75 pounds of pasture. Another common problem occurs

when a silo needs to be fed out at a certain rate to keep it fresh, but the amount is too high on a per cow basis. In this situation it may be better to simply cap off the silo and wait until fall to re-open it.

Dry hay is the most popular forage supplement for grazing cows. In general, most producers will only feed 5 to 10 pounds of hay per cow per day because it requires a minimum of labor and time. The hay serves as a source of fiber in a diet which is usually low in total fiber due to the low fiber content of the pasture. Also, hay does not usually contribute a significant amount of degradable protein to a diet which already has too much. Many producers find that a butterfat depression is alleviated by feeding dry hay, while others feed it simply as a precautionary measure against potential displaced abomasums (twisted stomachs). Hay can also be used as a measurement of pasture availability or correct paddock sizes. If cows come into the barn and consume their grain plus little hay, it is an indication that there is probably adequate dry matter available from the pasture. However, if the cows consumed all of the hay and began bellowing for more, it would indicate that there was not enough pasture available and an adjustment is needed in management.

Corn silage is another common forage supplement for cows on pasture. The biggest advantage to feeding corn silage is that it provides NSC's which are more slowly digested in the rumen. Usually the amount of corn silage which is fed varies anywhere from 10 to 25 pounds per cow per day as fed depending on the necessary rate of feed out from the silo, pasture availability, body condition, and other feed ingredients in the grain mix. Dry matter intake from pasture may become limited when higher amounts are fed. Many farms that have converted to a completely grass-based production system may not grow corn. In this situation, corn silage can be purchased from a neighboring farm if the grass farm determines that it needs to be a part of the ration.

Feeding haylage is an option which is used as a feeding strategy on many farms that have all their land in grass meadows and pasture. The most important factor

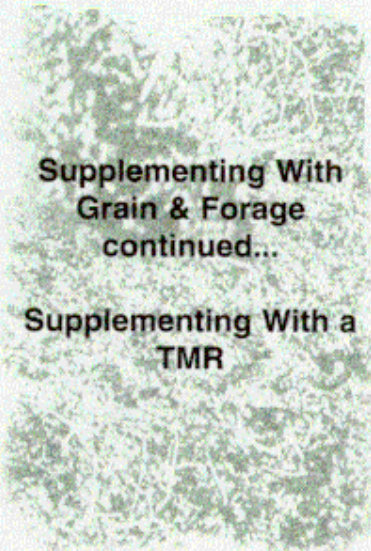
to consider with this option is how much additional protein the haylage would contribute to the diet. A grass haylage with lower protein would also have lower degradable protein levels, and may not be a problem. However, a high quality legume haylage with high total and degradable protein may add too much to the diet. An even higher level of NSC would need to be fed with the legume haylage. Once again, the amount fed should not be so much that intake from pasture becomes limited.

Supplementing With a TMR

Over the last 10 to 15 years the introduction of total mixed rations on dairy farms has improved the efficiency of feeding cows. Mixer wagons are commonly found on many farms, regardless of herd size or housing system. The advantage of using a TMR system is that the feed ingredients are blended together so that every bite a cow takes is nutritionally balanced to meet her needs. If the investment of a mixer wagon has been made, it should not be abandoned when the decision is made to use a grazing system. A TMR system works well in a grazing situation, even though the pasture forage cannot be added to the mix. In reality, the mixer wagon can be used to make a "PMR", or partially mixed ration. A PMR gives the best of both worlds in that supplemental forages and grain can be mixed together to avoid slug feeding, and the lower cost ration on pasture can be taken full advantage of.

There are 2 basic methods used to formulate PMR's for pasture-based feeding systems. In the first method, the ration is balanced by using pasture as the primary forage source and then formulating the remainder of the ration by adding other forages and grain ingredients. This method ensures that all nutritional requirements are being met and that pasture intake is being optimized. If pasture availability is limited, this method can also be used to set proper levels of pasture and other forage so that the paddocks are neither over nor under grazed.

The other method is a fairly simple one that has proven itself on numerous farms. Many farmers have discovered that if they simply keep the same TMR mix that they



**Supplementing With
Grain & Forage
continued...**

**Supplementing With a
TMR**

feed in the winter, but mix for fewer cows, that milk production from pasture is equal to or greater than that achieved in the barn. This concept is a difficult one for many nutritionists, because on paper the ration would appear to be slightly unbalanced. However, in practice the nutrients from pasture forage appear to substitute adequately for those reduced by lowering the TMR amount. If the decision is made to use this method of feeding TMR, the producer and the nutritionist should keep in mind that mineral levels may be significantly reduced in the diet and need to be supplemented.

Also, it is important to remember that this method may be slightly more expensive than reformulating the TMR, as discussed above. A critical eye should also be kept on manure consistency and body condition, as there is a high risk of accidentally overfeeding protein. Further-more, those that have tried this method have met with variable results and found it necessary to reformulate the TMR.

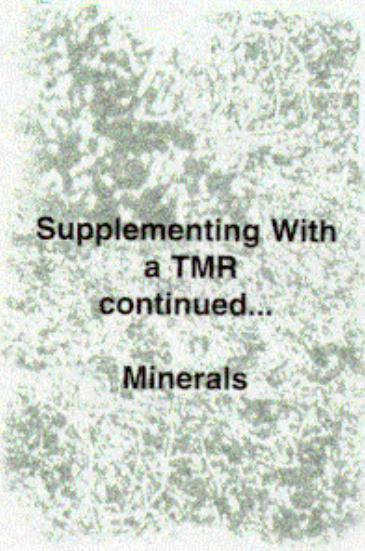
Minerals

Mineral supplementation is another area of dairy grazing nutrition around which there is significant controversy. There is much popular opinion among some nutritionists (who may or may not also sell minerals), and many farmers, that minerals can be offered free choice to grazing cows. The theory of free choice minerals is that the cows will obtain certain minerals from the pasture, and that some is also obtained from soil particles that may be on the plants or by the cows actually eating soil. However, it is difficult to ascertain exactly which minerals and how much they may be consuming in this fashion. Thus, it is thought that if a variety of minerals are simply made available on a free choice basis, that the cows will consume those minerals for which the diet is deficient. However, many free choice mixes have salt, sodium bicarbonate or molasses added to stimulate consumption. There are various combinations of minerals that are recommended, but usually at a minimum they include salt, limestone, sodium bicarbonate, magnesium oxide, bentonite and a high phosphorus mineral. It is also generally felt that this method is most economical.

The fundamental flaw with this theory is that research has consistently shown that cows do not have the ability to self-regulate mineral intake over the broad spectrum of minerals that they need. For example, if a cow's diet is deficient in magnesium, she does not instinctively "know" that she needs to find a source of magnesium. However, research has shown that cows will consume salt if they need more in their diet, and they will eat bicarb if they have even a mild case of rumen acidosis. It is recommended that minerals be included in the grain mix or TMR at levels which meet daily requirements. Salt and sodium bicarb can and probably should be offered free choice, as cows under heat stress will eat salt and consumption of the sodium bicarb will give an indication of general rumen health.

From an economics standpoint, free choice minerals may not save much money. The economics of the free choice theory is based on the idea that the cows are only consuming the minerals that they need and therefore the farmer is only paying for what the cows use. It is also thought that when minerals are mixed into a grain mix many of the cows are consuming minerals they may not need, and therefore money is being wasted. Since it is usually less expensive to buy minerals in bulk quantities as compared to blending it into a grain mix, there are additional savings by buying in bulk. However, if there is waste created in a free choice system, such as cows playing in the mineral feeders or some cows consuming minerals in quantities above their needs due to taste or palatability, then the economics gained may not be significant.

Why does this free choice mineral theory appear to be so effective on so many farms? In many cases, there is a low level of minerals that are actually added to the grain mix or TMR as an "insurance policy" against severe problems associated with mineral deficiencies. Where minerals are provided free choice with no insurance policy, there may be an underlying mineral deficiency which does not express itself (or the effects are slight and barely noticeable) during the grazing season. Unfortunately, in this situation the free choice program appears to be working when it's really not. Based on testimonials one would never know "the rest



Supplementing With
a TMR
continued...

Minerals

of the story", which could be anything from poor reproductive performance (blamed on other factors) to metabolic diseases caused by insufficient mineral intake. By the time these deficiencies became pronounced enough to be investigated as a cause of other health problems, the cows may be in the barn on a winter ration. A mineral program in the winter ration would be adequate to meet requirements and a previous deficiency may be undetectable. Finally, it is possible that a free choice program works based on the curiosity factor. If a cow is at the mineral feeder eating salt, she may become curious about the other feeders, stick her nose in, get minerals on her nose, lick her nose, and she's met part of her requirement!

There are certain minerals to which special attention should be paid in formulating a ration. Magnesium is a mineral which tends to be low in early spring grasses. Lack of magnesium causes a condition known as grass tetany or grass staggers, which causes the cow to stagger about as if she is disoriented. Although the occurrence of grass tetany is significantly lower now as compared to many years ago, it should still be a priority in a mineral program. Magnesium oxide, or another magnesium source, should be added to the ration at a level of 1 to 1.5 ounces per cow per day.

Selenium is another mineral which needs to be supplemented. Most soils in the Northeast are low in selenium, which results in forages with a low selenium content. Many breeding problems are associated with low selenium in the ration, especially when Vitamin E is also low. A management strategy whereby a shot of selenium and Vit. E is given prior to calving, as well as a small amount added to the ration from a trace mineral salt after calving is recommended.

Attention should also be paid to the amount of phosphorus being supplemented. Earlier in this book, we discussed the implications of overfeeding protein (nitrogen) on environmental concerns. As nutrient management planning concerns evolve, there will be increased attention paid to the amount of phosphorous being land-applied on farms. As with nitrogen, phosphorous leaching into groundwater or running off

into surface waters is a concern. It is critical that attention be paid to feeding only the necessary amount of phosphorous to lactating dairy cows, and not overfeeding by even a small amount. This applies to both grazing and confinement feeding systems.

Cows on pasture spend a lot of time walking through laneways and in paddocks. While this tends to improve the condition of feet and legs compared with standing on concrete, it is still important for their hooves to be strong. For this reason, a small amount of a zinc supplement should be included. This would be more important in a herd that has a history of poor hoof growth.

Another mineral which deserves special consideration is potassium. However, this is one which probably should not be supplemented. On most farms there is a constant net increase in potassium which comes from bringing both feed and fertilizer onto the farm. Generally there is more potassium in the grass plants than what the cows' requirements call for, and much is excreted back onto the land. If dry cows are also going to be grazed, this is a mineral that should be monitored closely. Too much potassium in the diets of dry cows causes milk fever-like symptoms at calving.

For examples of rations for various types of feeding systems and production levels, please see Appendix 2.

ANIMAL MANAGEMENT

Transitioning Period On and Off Pasture

In the early spring, cows should be turned out to pasture when the grasses are three to four inches tall. Turning them out this early accomplishes two things; (1) it conditions the pasture to allow for staggered regrowth on the second rotation and (2) it helps the rumen bacteria make the transition from stored forages to pasture.

Over a period of seven to ten days, intake of pasture by the cows should increase. Increasing levels of intake from pasture will occur as pasture becomes more available. Although this is a normal process, it can be facilitated by increasing the amount of time cows spend out on pasture each day combined with feeding less forages in the barn. As a general recommendation,

**Minerals
continued...**

ANIMAL MANAGEMENT

Transitioning Period On and Off Pasture

reducing forages in the barn by about 3 pounds of dry matter per day seems to work well. This would be approximately 10 pounds as fed of a forage that was 30% dry matter, or 6 to 7 pounds as fed if dry matter was in the 40-45% dry matter range. If you attempt to transition the cows too quickly, there may be a temporary loss of milk production. This is similar to what happens when feeds are changed abruptly in a confinement feeding situation, such as when a silo runs out.

Cows that have never grazed before generally have a more difficult time in making a smooth transition. These animals have been conditioned to expect feed to be provided in the barn. On the first day of grazing they will likely be uninterested in consuming much pasture. Most likely they will spend much of their time testing the fences and laying down to chew their cud on the nice soft green bedding that you have provided. Thus, when turned out to pasture for the first time they may not instinctively know that they will need to graze to obtain feed. After spending some time out in the paddock, they will become hungry. Since they have always had feed brought to them, they will expect that someone will either bring feed out to them or bring them back to the barn to eat. When this doesn't happen, a few animals will become impatient, stand at the gate, and begin to bellow. Unfortunately, while they are standing there bellowing, they are not eating, and when they do not eat, they do not make milk.

The relative success or failure of transition time feeding can be predicted by the decision that the farm manager makes in this situation. If the cows are brought back to the barn and fed stored forages the act of standing at the gate and bellowing is reinforced. However, if the cows are left out, they will begin to graze. Some herds will take longer than others to get through this process. Also during this process there will be a temporary loss of milk production. However, once the cows have learned to graze and are maximizing dry matter intake of pasture, milk production will meet or exceed their level of production while they were in the barn. After the first year of grazing, the transition to pasture becomes much easier; the cows are familiar with the

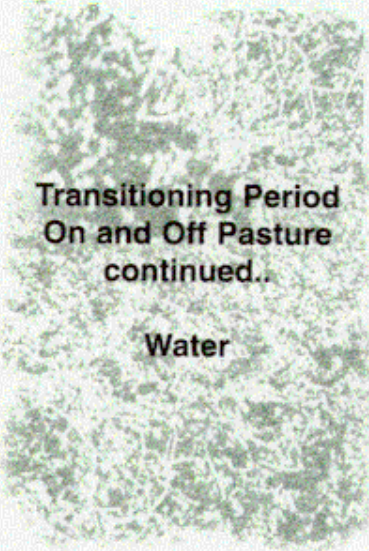
grazing system and would rather consume pasture than forage from stored feeds.

Another period of transition occurs in the fall. However, this transition is more normal in that with the onset of cold temperatures the amount of forage available for grazing declines. As pasture becomes more limiting, more feed needs to be supplemented in the barn. In general, cows could be kept in the barn at night when nighttime temperatures consistently fall significantly below 40 degrees as a way of making the transition. However, if there is forage available, they may still be able to graze during the day. Many people are experimenting with the idea of "outwintering" their cattle. In this situation cows would be left out at night to adapt to the colder temperatures and feed brought to them.

A factor to consider in the fall transition is that if stored, fermented forages have not been fed through the grazing season they will become a novel food source to the cows. That is, they will need a period of time to "relearn" what these feeds are and adjust to eating them again. Furthermore, if this is the first time since harvest that these feeds have been fed, it will take some time to adjust the ration for intrinsic differences related to growing conditions. The advantage for those who have fed their "winter feed" all summer is that they have been able to make all the fine-tuning adjustments to their rations all summer and fall. A grazer will just begin to learn if the corn kernels in the silage are indigestible or the haylage didn't ferment properly, at the time of transitioning into the barn. Many grazers have lost some milk production in the fall due to these two factors.

Water

In as much as milk is approximately 87% water, it should be apparent that the provision of it is extremely important for lactating dairy cows. On average a cow requires a total of 4.5 to 5 pounds of water per pound of milk produced, or 25 to 50 gallons of water per day. This fluctuation depends not only on such things as production level, but air temperature and humidity also. Fortunately, not all of it needs to come from a stock tank in the pasture because some water is supplied by the forage. For example, pasture is 80% moisture.



**Transitioning Period
On and Off Pasture
continued..**

Water

Therefore, a cow consuming 125 pounds of forage will obtain about 100 pounds of water, which is equivalent to 12 gallons. The remaining 13 to 38 gallons will be met by a combination of water available at the barn during milking and water that is available on pasture.

It is critical to have water available on pasture, and not rely solely on the barn as a source. Cows are much like people in that they prefer to have a drink with their meal, which is easier for them to do if the water is in the pasture. If the barn is the only source, a loss of milk production may result for two reasons. First, with water at the barn, livestock will have to travel from the pasture to get it. In many situations, once the cows go back to the barn they will not return to the pasture. If they are standing around the stock tank in the barnyard with nothing to eat, a lower dry matter intake will result in reduced levels of milk production. A similar

situation will occur at a stock tank located near the pasture which does not have sufficient recharge rate. The cows will spend more time standing at the tank, fighting with each other waiting for water to become available and less time grazing, thus lowering dry matter intake.

The second cause of lowered milk production occurs when the cows are kept out on pasture with no access to water except in the barn during milking. In this situation, the cows are in the barn for such a short period of time that they cannot meet their water intake requirements.

Although water needs to be accessible to every paddock, not every paddock needs to have a separate stock tank. Many producers are using plastic pipe to pump water from the barn and use a portable stock tank that can be moved from paddock to paddock. The most important point is that it must be accessible within a maximum distance of 500 feet. However, it is preferable that it be within 200 to 300 feet.

If pumping water from the barn is not an option, there are other means that can be utilized. For example, spring developments, water wagons or pumping from a stream or pond. It is not recommended that you allow livestock to have direct access to streams or ponds due to environmental, human, and animal health concerns.

Shade

Heat stress is caused by a combination of high ambient air temperature and humidity. SEE FIGURE 21.

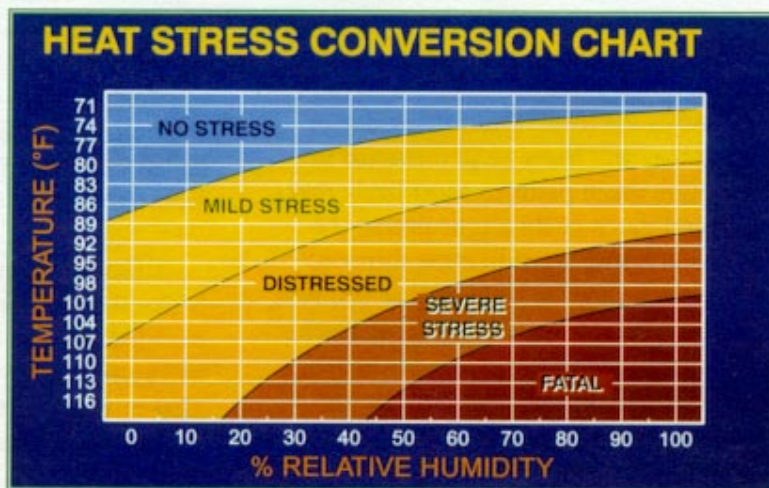


Figure 21 The amount of heat stress a cow feels depends on the combination of temperature and humidity.

The higher the temperature and humidity, the greater the stress on the animal. The effect of heat stress on the animal is an increase in her maintenance requirements, because she needs to use extra energy for panting and other heat dissipating activities.

Providing shade to grazing animals is a concern expressed by almost every dairy producer considering the use of pasture. However, in most situations shade will be a detriment to high levels of milk production. When shade is provided, animals will use it whether they need to or not. Even on days when the temperature is 70 degrees, humidity is low and a cool breeze is blowing, cows in a shady pasture may be found in the shade rather than actively grazing. If they are in the shade and not grazing then dry matter intake will be reduced, which will result in a lower milk production. Another factor to consider on shade is that in the wild, cows would be the prey in the predator-prey relationship. It may well be that their desire to stand in the shade is really more a natural

Water
continued...

Shade

instinct to "hide out" from the predators by blending into the trees.

There is no set "stress point" for the temperature, humidity, or combination of heat and humidity at which cows feel heat stressed. However, it is fair to say that a cow's thermo-neutral zone (temperature at which she is comfortable) is between 50 and 68 degrees Fahrenheit, regardless of the humidity level. As the heat stress conversion chart shows (FIGURE 21), at lower temperatures high humidity will cause mild stress, whereas at lower humidity a higher temperature will affect comfort levels. Some research has shown that above 68 degrees, a cow will begin to decrease her dry matter intake in comparison to normal. However, the depression in intake does not become significant until around the 90 degree mark. Above 90 degrees, a cow's intake will be reduced to approximately 40 to 65% of normal. Obviously, the higher the humidity climbs at any of these temperatures, the more pronounced the effect on dry matter intake will be. Also, cows will reduce intake of forage before reducing intake of grain, because digestion of forage creates more body heat than the digestion of grain.

On the days that the combination of temperature and humidity falls in the area of the chart labeled "distressed", it is advisable to move cows from open pastures to an area where they can access shade or put them into the barn, with fans blowing over them. By doing this and providing other feeds, you may be able to keep intake from falling too much. You will probably still lose some milk production, but not as much as leaving them out in the hot sun.


Bloat

One concern commonly expressed by dairy farmers considering implementing a grazing system is the possibility of bloat. If pastures are comprised primarily of alfalfa or clover then bloat is a factor which needs to be managed. However, if pastures are primarily grass or a mixture of grasses and legumes then bloat is less of a concern. It seems that bloat is more of a concern than a reality, as most producers report that it is a rare occurrence. Unfortunately, when it does occur it is usually not a pleasant experience, and therefore the concern is one which needs to be addressed.

The best management strategy to use when pastures are primarily comprised of legumes is to make sure that the cows have been fed other forages before being turned out to pasture. This will accomplish 2 things; it ensures that they will not begin to gorge themselves when they first reach the pasture and it also provides a dilution factor which reduces the chance of bloat-causing gasses forming. Dry hay or corn silage are the preferred forages to feed before turnout, as these forages are not as quickly fermented in the rumen and generally do not contribute to bloat. An additional consideration in the fall is turning cows onto clover or alfalfa that has been frosted. The strategy here is to wait until the plants have begun to dry and wilt before grazing paddocks that are predominantly legumes.

Another strategy which can be used in conjunction with feeding other forages is to wait in the morning to turn cows out until after the dew is off the plants. Bloat is more likely to occur in the early morning when plants are still wet with dew. If some pastures on the farm are mostly grass and others mostly legume, grass pastures can be grazed in the morning rather than waiting for the dew to evaporate. Then in the afternoon or early evening the legume pastures can be grazed. This requires some time spent planning out paddock rotations and regrowth patterns to ensure that there are always grass and legume paddocks that can be grazed on the same day.

Many producers have tried commercially available bloat preventatives, such as poloxalene lick blocks. These work well if you can be sure that every cow will stop to lick the block. However, if this is the only strategy you decide to use there may be a few cows through the grazing season that have problems with bloat. Other producers have tried a variety of products which act as surfactants, or chemicals that break down the froth created in a bloated rumen. These products include free choice bentonite, vegetable oil, liquid dish detergent, mineral oil, and other soapy or oily substances, usually as a drench. Some producers have tried using the water system to the paddocks as a delivery system for bloat prevention products. This seems to be more effective in ensuring that all the animals receive the product as compared with a lick block.



**Shade
continued...**

Bloat

Unfortunately, many of the commercially available products in many other countries as bloat preventatives are not approved for use in this country. Therefore, we must use alternative management techniques as precautions against any suspected chance of bloat.

Displaced Abomasums

Another common concern is that cows will have a higher incidence of twisted stomachs when they are out grazing pasture. This concern stems from the fact that vegetative grasses and legumes have very low fiber contents. Many producers have had bad experiences with displaced abomasums (DA's) when stored forages that were low in fiber and chopped too fine were fed in confinement. Fortunately, even though pasture forage is low in fiber the cows are harvesting it at a longer length. This results in a very thick mat of forage in the rumen, and incidences of DA's are rare with grazing cows. Most farmers report that they never have had a cow with a DA during the grazing season. In cases where DA's have occurred, it has been caused by feeding too much grain, low available forage in the pasture, or grazing plants that are too short.

Flies

Face flies, horn flies, and barn flies are one of those summertime nuisances of farming that will never completely be eliminated. However, they can be managed to reduce the populations and increase cow comfort.

Since face flies and horn flies breed in fresh manure, one advantage of a grazing system is that a majority of the manure is dropped out in the paddocks resulting in fewer flies around and in the barn. Cows will not be bothered by low levels of flies, and using measures to reduce fly populations should be based on how many flies are present. If there are more than 50 horn flies on average present on the sides of the cattle or more than 10 face flies on average on their faces then fly control measures should be taken. There are a variety of products used with different rates of success.

Generally, space sprays which would be sprayed in the barn are the least effective because the cows spend so little time in

the barn. Whole-animal sprays are fairly effective, but require some time to apply with enough frequency to be effective. The least labor-intensive methods are self-applicating devices (such as a dust bag) and feed-through insecticides (in mineral blocks, feed additives, or boluses), and both are effective in controlling flies. Feed-through insecticides are more effective on horn flies than on face flies, and affect the young larvae rather than the adults. Unfortunately the feed-through products also affect the beneficial insects such as dung beetles which help to break down the manure in the pasture. Ear tags and tapes are usually most effective if used in combination with another method such as a feed-through insecticide. New products on the market include a variety of pour-on insecticides. Typically these are effective for 4-6 weeks in controlling most types of flies, but is somewhat dependent upon weather conditions (i.e. rain). Farmers who have tried them have reported good success.

In practice, many farmers report the highest level of success with a combination of strategies used at different times of the summer. It is important to read the label on insecticides to determine whether or not the product is approved for lactating cattle.

Mastitis

One of the benefits of having cows out on pasture is that fresh grass is a relatively clean environment. Since most mastitis causing organisms come from bedding, manure, or muddy barnyards, these environmental sources are almost entirely eliminated with a grazing system. The majority of grazers report a decrease in somatic cell counts, bacteria counts, and new mastitis cases during the grazing season.

However, there are a few isolated cases in which better udder health is not seen. These situations usually involve either unimproved laneways or barnyards, where the cows pick up organisms as they wallow through the mud and mire. In these situations it makes no difference how clean the pastures may be, the only solution is to fix the source of the problem. There have been isolated reports of higher levels of mastitis as a result of cows "camping" in the same area of the paddocks and laying in manure or mud. Also, if very



**Bloat
continued...**

Flies

Mastitis

high SCC's and bacteria counts are the result of poor milking procedures, an improvement may not be seen by going to pasture. Contagious mastitis causing organisms (Strep ag., Staph. aureus), or chronic subclinical cases also will not decrease as a result of pasture.

Feet & Legs

One of the unfortunate consequences of keeping cows in confinement has been the lack of adequate exercise. Even in a freestall housing system, poor feet and legs have resulted from spending so much time standing and walking on concrete. If we view where a cow would be in her natural state, we can easily see that a cow on pasture would likely have very few problems with sore feet and legs. This in fact is the case, and the result of putting cows back out to pasture has been dramatic decreases in feet and leg problems. The need for regular hoof trimming in the summer has been reduced on most farms, and injuries to hocks and pasterns are seldom.

Not directly related to the issue of feet and legs, but in the area of general health is cow comfort. Cows on pasture have plenty of lunging room, they rarely step on their teats, and they're always breathing fresh air. In general, cows on grass rarely see the veterinarian for anything more than a pregnancy check.

Heat Detection & Reproductive Performance


Heat detection is one aspect of management that has the potential to either improve or deteriorate when a grazing system is adopted. In circumstances where heat detection has been difficult because cows have been standing on concrete or another surface which provides inadequate footing, there will be an improvement by grazing the cows. This is due to not only a better material for standing on, but also the improvements in foot and leg health. Heat detection may also improve simply because more time is spent watching cows as they come and go from the barn. This is especially true in cases where cows have always been turned out into a barnyard or exercise lot while the barn was being cleaned, but very little time was spent watching cows for heat.

Likewise if heat detection is fairly good when the grazing system is implemented, there is a potential for problems to occur. Having a grazing system on the farm potentially means that less time is spent in the barn and around the cows. If the individual responsible for heat detection simply sends the cows out to pasture and does not spend time observing them, obviously fewer cows will be seen in heat. Likewise, if heat detection is done at the wrong time of day (i.e., the hottest part of the day instead of in the morning or early evening), heat detection rate will probably be poor. On many farms, everyone is responsible for reporting cows that are in standing heat. When cows are on paddocks where very few people can see them and nobody takes the time to go and watch, chances are very good that many heats will be missed. Thus, it is important that this daily activity not be forgotten or minimized.

There are numerous alternative methods available for heat detection, such as heat-mount detectors, pedometers, cow-side milk progesterone tests, and others. While all of these methods have varying degrees of effectiveness, it is recommended that visual observation of heats continue in conjunction with these others. The other methods can be used to help identify which cows may have been actively exhibiting signs of heat, but they should never be relied upon entirely.

Above and beyond the issue of heat detection, there are other effects of a pasture-based diet on the reproductive performance of cows. It has been shown in research that high levels of urea nitrogen in the bloodstream can be detrimental to conception rates. It is believed that when blood urea nitrogen (BUN) levels exceed an average of 18 or 19 mg/dl that the pH in the uterus is lowered to a point where an embryo may not survive. As previously discussed, pasture based diets tend to be high in degradable protein. When the ration is not properly balanced and excess urea is taken up in the blood, BUN levels may reach that critical level. Thus, although cows may show good heats and a breeding takes place, the embryo may not survive.

Dietary energy can also exert an influence on reproductive performance. In early



**Mastitis
continued...**

Feet & Legs

**Heat Detection &
Reproductive
Performance**

lactation, cows cannot eat enough to satisfy the need for energy that is a result of increasing level of milk production. During this time they will mobilize fat reserves from their bodies to meet the milk production needs. Until appetite and intake can meet energy requirements, the cow is in a negative energy balance state. SEE FIGURE 22.

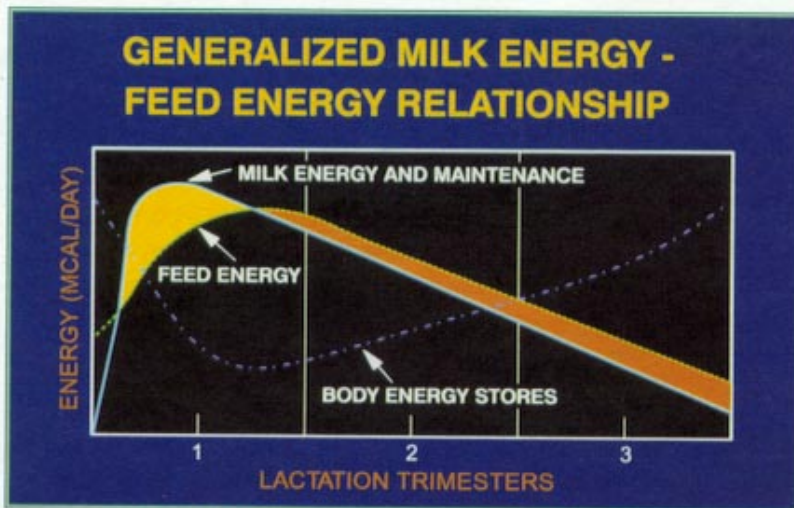


Figure 22 In early lactation, a cow cannot eat enough for the amount of milk she is producing. The needed energy comes from body stores, and cows lose condition. After peak milk production, her energy intake equals or is greater than her need for milk production and she gains body condition.

While in this negative energy balance, the hormones which regulate the reproductive cycle prevent the cow from coming into heat. It is not until after she has "turned the corner" where energy intake exceeds requirements that she will be able to start showing heats. Thus, the longer she is in a negative energy balance, the longer it will be before she comes into heat and can be bred. For this reason, the nutrition of early lactation animals on pasture becomes even more critical. Adequate energy in the diet will not only help to minimize body condition loss and excess urea in the blood, but also will ensure that they return to a normal heat cycle.

The effects of hot and humid days on grazing dairy cows has been discussed in relation to dry matter intake and cow comfort. There is also a slight effect of heat stress on reproductive performance. Whether cows are in the barn or out on pasture, generally a hot day will result in a significant decrease in activity. Even when cows are actually in heat, they will decrease the amount of mounting and other activities normally used as indicators of being in heat. As a result, many times a heat will go

undetected on a hot and humid day.

A management strategy to consider is to keep track of cows that should be coming into heat on any particular day, and putting those cows in a cooler or shadier area of the farm so that heat behavior is more likely to occur.

Another factor to consider on hot days is that a cow's body temperature will generally be elevated. This may influence the viability of an embryo, because it is known that an embryo will not survive an elevated body temperature. Thus, there may be some benefit to isolating cows that have recently been bred and keeping them cooler than the rest of the herd either with fans or putting them in a shady area.

A common question from producers considering a seasonal calving schedule is how to get all the cows bred in a short, specified period of time. More specifically the interest lies in how New Zealanders are able to keep a seasonal schedule so successfully. One difference in breeding strategies is the time of year the cows are being bred. The seasons in New Zealand are the reverse of ours, as they are in the southern hemisphere.

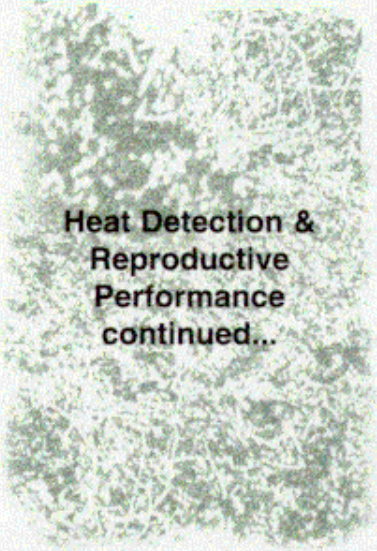
Cows are generally calved during August and September, which is equivalent to February and March in this country. They begin to breed cows in October through November, which is still early in the spring. Thus, they are not trying to breed cows during hot weather. Also at this time the grass growth rates start to increase, which helps to bring the cows quickly into a more positive energy balance and they begin to have regular heat cycles.

Dairy farmers in New Zealand also utilize a few other management strategies to

Heat Detection & Reproductive Performance continued...

keep their breeding window short. If a cow has not shown a heat after the first half of the breeding window, a hormone treatment of progesterone administered intra-vaginally may be used. Also, culling decisions are based mostly on the ability to breed back quickly. Fertility is a trait which has been selected for, as they only keep the first 20% of heifer calves born each spring. Thus, they only keep daughters out of the most fertile cows.

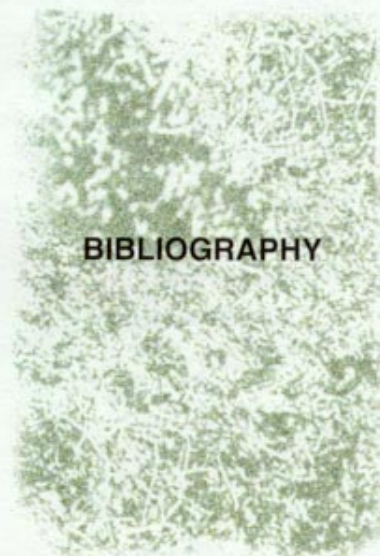
For dairy farmers here in the United States, seasonal calving may be a viable management strategy. However, it is important to remember that not all technology is 100% transferable between countries, and that it may be better to make adaptations based upon local factors. Many producers have successfully adopted seasonal calving, while others have tried and then struggled with many management problems related to breeding. Before making a decision such as this, it is always wise to gather input from those who have had both positive and negative experiences.



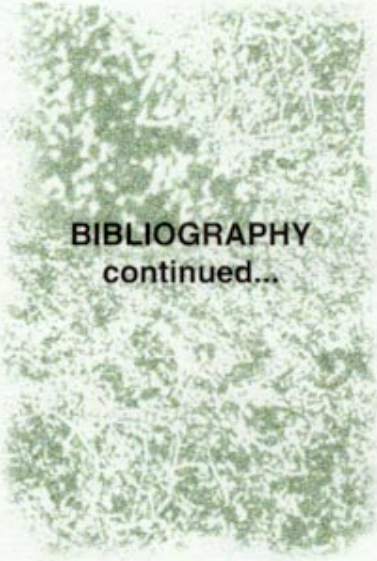
**Heat Detection &
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Performance
continued...**

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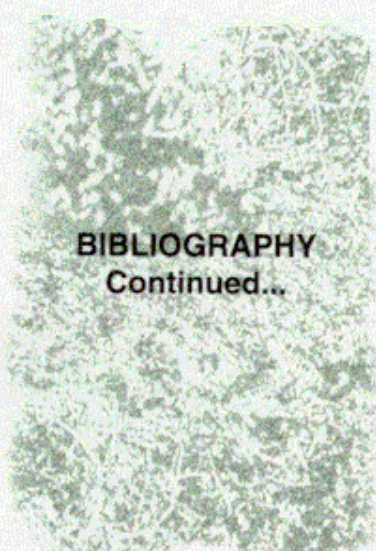
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Appendix 1.

Prescribed grazing management plan worksheet to be used with rotational stocking methods.

Step 1. Estimate the Forage Demand:

The forage demand is the amount of forage dry matter (DM) required to feed the herd for one day. It is calculated based on the rule of thumb that lactating dairy cattle require an amount of forage dry matter equal to about 3% of their body weight per day.

$$\text{Average Weight/Animal (lbs)} \times .03 = \text{lbs DM/Head/Day}$$

$$\text{# of Animals} \times \text{lbs DM/Head/Day} = \text{Total Forage Demand (lbs/day)}$$

Step 2. Estimate the Forage Supply:

This is the amount of forage dry matter that is estimated to be available after a 15 day growth period in the spring and a 30 day growth period in the summer and fall.

Note Actual pasture growth rates are extremely variable. As a result, the numbers presented are for planning purposes only. Actual growth periods and yield estimates may be different than those provided.

Unless actual measured yields are available, use estimated hay yields obtained from the Natural Resources Conservation Service or Cooperative Extension and use the following table to convert annual hay yields to forage availability on a rotational basis.

FORAGE AVAILABILITY ESTIMATES

Hay Yield Tons/Acre/Year	Forage Availability Pounds/Acre/Rotation
5.5	2,200
5.0	2,000
4.5	1,800
4.0	1,600
3.5	1,400
3.0	1,200

Forage Supply _____
Lbs/Acre/Rotation

Step 3. Select Residency Period:

Lactating dairy cows should not remain on a particular paddock for longer than 1 day. Half day residency periods are recommended. In other words, move the cows after each milking.

Residency period _____
days

Step 4. Determine Paddock Size:

The paddock size is based on meeting the forage demand of the herd for the time or residency period selected.

$$\text{Forage Demand} \div \text{Forage Supply} =$$

$$\times \frac{\text{Paddock Size (Acres)}}{\text{Residency Period}} =$$

Step 5. Calculate the Number of Paddocks:

The number of paddocks required is based on meeting the longest regrowth interval recommended i.e., 30 days.

$$30 \div \text{Residency Period} + 1 = \text{Number of Paddocks}$$

Step 6. Estimate the Total Number of Acres:

$$\text{Paddock Size} \times \text{Number of Paddocks} = \text{Acres Planned}$$

****NOTE**** This planning procedure is designed to balance the forage supply with the forage demand during the mid-summer period when forage growth rates are generally 50% less than what they are during an average spring and early summer, only about 40 to 60 % of these planned acres will be required for grazing. The remaining 40 to 60% should be mechanically harvested or planned to be grazed by another group of livestock following their own prescribed grazing management plan.

APPENDIX 1

APPENDIX 2. EXAMPLE RATIONS

The question "what should I feed my cows on pasture?" necessitates the answer "it depends". As we have emphasized throughout this book, each farm is unique, so therefore their feeding program will be unique. However, we would likewise be remiss if we were to not provide at least a few examples of what people with experience have fed to their cows. The following rations are not intended to be used as a blanket recommendation for all farms that graze their milk cows. As you will see, there are unique things about each farm that contributes to making the ration work for that farm. Hopefully by reviewing these rations you will be able to use the experiences of other farmers and apply what might work for you. Please note that the farms are real, but names have been changed to protect the inexperienced!

EXAMPLE 1: Joe Smith's farm:
50 cows, tie-stall barn, pasture, grain and corn silage

Joe and his wife, Mary, milk 50 cows on a limited land base in Northern New York. They have been grazing for 2 years, and their pastures are not as dense as they would like. They decided not to reseed their "native pastures", which are a mix of Kentucky bluegrass, quackgrass, and wild white clover. This land makes up about half of their grazing system. The other half is former hayland, and is mostly timothy, a small amount of alfalfa, and some orchardgrass and ladino white clover they drilled in to try and fill in the bare ground. The topography of the pastures is a combination of rolling hills and fairly level ground surrounding the barn.

Joe and Mary have just started their third year of grazing, and feel that the pastures have thickened up since last year. However, they still feel that they should supplement with some forage just in case the pastures don't grow as well as expected. They still have some corn silage

available from last year in their 20 x 60 silo, and would like to feed about 15-20 pounds per cow per day to ensure that the silo is almost empty by filling time. Also, they feel the energy from the corn silage will help to maintain body condition.

Forage samples were taken on the pastures and the corn silage, and the results were as follows:

	Pasture	Corn silage
% Dry Matter	17.7	33.0
% Crude Protein	22.3	9.0
NE _l , Mcal/lb	0.60	0.63
Soluble Protein, %CP	29.6	45.0
Degradable Prot., %CP	78.0	69.0
%NSC	13.4	32.4
%ADF	32.5	28.0
%NDF	52.6	51.0

As you can see, the corn silage is a little bit below average quality. Joe said that he felt the cows did not do as well over the winter with this corn. However, the majority of his cows freshen in early March, April, and May, so many of them were late lactation or dry during the winter. He feels with so many fresh cows, they should be able to average between 60 and 70 pounds per day on pasture. Thus, the ration will be balanced for 70 pounds of milk, and can be adjusted later if they do better than expected. Average body weight on the herd is 1350 pounds, and average days in milk is 130.

The ration would be comprised of the following amounts of feeds on an as-fed basis:

Pasture	140.0 lbs
Corn silage	15.0 lbs
Corn meal	17.1 lbs
Distillers	2.4 lbs
Minerals	.52 lbs

(minerals include dicalcium phosphate, magnesium oxide, salt, limestone, sodium bicarbonate)

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The total dry matter intake is 47.39 pounds. The nutrient analysis including requirements is as follows:

Nutrient	Supplied	Required	Difference	Density(%)
DM, lbs	47.39	45.37	2.01	27.07
NE ₁ , Mcal	32.91	32.98	0.07	0.69
CP, lbs	7.98	7.39	0.58	16.83
SolP, lbs	2.15	2.14	0.01	26.96
DIP, lbs	5.34	4.28	1.06	66.94
UIP, lbs	2.64	2.65	-0.01	33.06
ADF, lbs	11.46	9.53	1.93	24.18
NDF, lbs	20.69	13.50	7.19	43.67

(DIP = degradable intake protein,
UIP = undegradable intake protein)

According to this analysis, the cows would only be limited in their production by a slight shortage of Net Energy for lactation (NE₁) and undegradable protein (UIP). However, the level of NSC (not shown above) is only 29.14% in the diet. This is probably related to the low NSC content of the corn silage. Thus, with an excess of degradable protein of 1.06 pounds, Joe and Mary might want to consider adding more corn meal or another high-carbohydrate feed to the ration. Since the grain to milk ratio of this ration is at 1:3.5, there is some room to add more grain. However, they also need to look at the economics of feeding more grain. The cows will probably lose some condition, but not as dramatically as Joe and Mary saw their first year of grazing when they didn't feed corn silage. Joe and Mary decided to use the ration as is. However, they kept a close eye on body condition and changed the grain to milk ratio to a 1:3 on higher producing cows and cows that were a little too thin. In fact, the pastures produced more than enough forage in the third year of grazing, and paddock sizes were made a little bit smaller to get a more even grazing. Mid-summer when the protein in the pastures dropped, they added about 1 pound of soybean meal per cow to the grain mix.

EXAMPLE 2: Eden's Breath Farm, Adam and Eve Brown: 100 cows, tie-stall barn, grain only (fed individually)

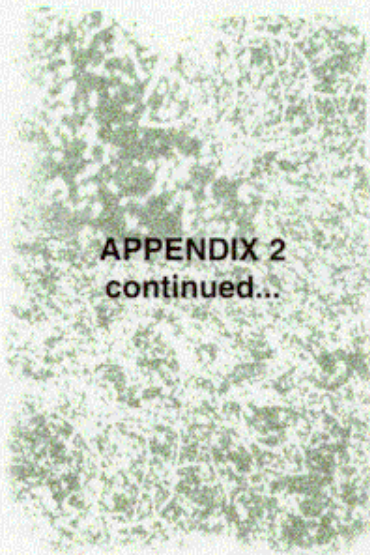
Eden's Breath Farm is nestled in a small valley in the hills of Central New York. Adam and Eve Brown bought this

farm 10 years ago when they sold their farm in New England due to development pressure. They knew right from the start that they would have to graze much of the land because the steep slopes weren't suited to driving tractors on. Most of their land is uphill from the barn, with some flat across from the barn where they grow corn for silage. There are a few fields up on top of the hills that they use for haylage and baleage, because it is too steep and too far for the cows to walk to them. They have 100 cows milking on a year round calving schedule.

When Adam and Eve first started grazing there weren't many others around who were doing the same. Most of their neighbors thought they were crazy New Englanders who "didn't know any better" and would eventually go broke. Much of what they did on their farm was by trial and error, because there wasn't anybody around to advise them. The first few years their feed salesman formulated a grain mix for them with about 18% protein in it, since they weren't sure how good the pastures were. Each year in the fall, however, it seemed that the cows came off pasture on the thin side.

In recent years, they have come to realize how important it is to provide energy to the cows. They have sampled their pastures each year at least 3 times, and found that most of the time there was over 25% protein in the grass and clover. Also, energy is important because their cows have to climb a hill twice a day to get to the pastures, which adds to their maintenance requirements.

Since they are somewhat limited on corn ground they don't want to feed corn silage in the summer. They feel it makes a good winter feed in combination with the baleage they are currently making. They are looking for a ration that is high in energy and can support 60 pounds of milk per cow per day, at as low a cost as possible.



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The current forage sample from the pastures came back as follows:

% Dry Matter	17.9
% Crude Protein	26.8
NE _l , Mcal/lbs	0.75
Soluble Protein, %CP	33.0
Degradable Prot., %CP	70.0
%NSC	21.0
%ADF	22.2
%NDF	40.6

This is fairly high quality pasture, and for the level of milk production they are hoping for the ration should balance relatively easily. Adam has found a relatively low cost source of barley, and would like to use a few pounds in the grain mix along with some corn meal. The barley is whole, and there is a possibility of some passing through in the manure. This is because the pasture is digested and passed through so quickly that the barley may not spend enough time in the rumen to be digested completely. Since he has never used barley before, we decided to start out with a relatively small amount and then monitor milk production, manure consistency and feed refusals by the cows before increasing it.

The ration was initially balanced for 60 pounds of milk for cows that were 180 days in milk. The ration on an as fed basis was as follows:

Pasture	162.0 lbs
Corn meal	13.0 lbs
Barley grain	2.0 lbs
Molasses	.5 lbs
Minerals	.45 lbs
(minerals include salt, limestone, and trace minerals)	

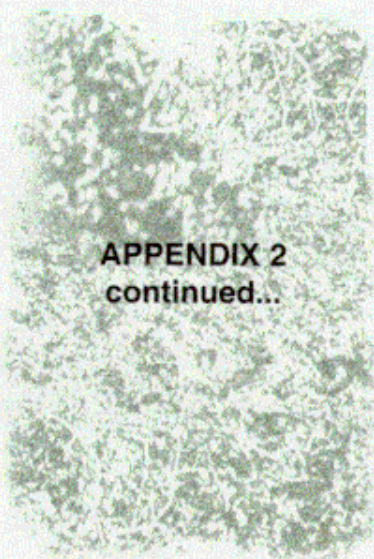
The total dry matter intake is 43.01 pounds. This is actually 1.6 pounds under requirements, which the cows will probably compensate for by consuming more pasture. The nutrient analysis including requirements is as follows:

Nutrient	Supplied	Required	Difference	Density(%)
DM, lbs	43.01	44.61	-1.60	24.2
CP, lbs	9.20	6.70	2.50	21.3
NE _l , Mcal	33.87	30.79	3.08	0.79
SolP, lbs	2.80	2.10	0.70	30.3
DIP, lbs	6.20	4.30	1.90	67.8
UIP, lbs	3.00	1.80	1.20	32.2
ADF, lbs	6.90	7.10	-0.20	16.1
NDF, lbs	13.20	13.40	-0.20	30.6

The major difference between the analysis of this ration and our previous example is that there is quite an excess of crude protein (2.5 pounds). This could potentially cause problems with body condition and reproductive failure, as discussed in the text of this book. However, the NSC content of this diet is 37.4%, which is at the lower end of the recommended range for pasture diets. It may be enough to counteract the high level of protein. Another factor to consider is this farm has very steep hillsides on which the cows are grazing. Although the NE_l level is 3 Mcal over requirements, much of it will be used for the extra energy of walking. The grain to milk ratio is 1 to 3.75, so there is opportunity to feed a little more grain to help with this situation.

Adam and Eve were happy with the low grain to milk ratio, and didn't want to change it. They felt that the extra cost of grain for those cows would not have an economical return. However, they would be having fresh cows throughout the summer, and felt that a little extra grain for those cows would have long term benefits from a body condition and breeding standpoint. A new, but similar ration was run for cows at 100 days in milk at a production level of 80. By changing the amount of grain to a total of 26.5 pounds, thus increasing the ratio to a 1 to 3, NSC levels increased to 43% and the protein excess dropped to 1.8 pounds over requirements. Fresh cows on this higher grain ration would hopefully not lose too much condition at the peak of their lactation, and would breed back much more easily.

The one potential problem they would have to watch for would be acidosis which would lead to laminitis (sore feet).



APPENDIX 2
continued...

This turned out not to be a problem, because they had very few cows that would actually eat their full allocation of grain.

EXAMPLE 3: Noah Jones & Sons:
175 cows, freestall, TMR and pasture

Noah's family has been farming in Western New York for 4 generations. Currently the farm is made up of 400 tillable acres and they milk approximately 150 to 175 cows, depending on the time of year because of slight seasonality. The farm is rather diverse, which is why his three sons are also involved in the farm. They have a small cow-calf operation, raise corn silage to sell, and have a small roadside fruit and vegetable stand.

Five years ago they started to experiment with the idea of grazing. Although they didn't do it exactly right the first 2 years, they have since set up their system with the help of their local SWCD office. In those first 2 years they made a lot of mistakes, like letting the grass get too tall, not clipping, and not providing water in the paddocks. To their credit, however, they were only grazing tail-end cows and dry cows, so they made their mistakes with a "low-risk" group of cows.

They have 120 acres in their system now, and half is cut in the spring for haylage. Almost all the land they graze is around the barn, and distant fields are used for haylage, corn for grain, and corn silage production. They are grazing the whole milking herd now, but high production is an issue for them. They have some valuable Registered Holsteins in their herd, and like to keep a high herd average to bring cattle buyers and investors to the farm.

Forage samples on the pasture, corn silage and high-moisture corn samples were taken and the results were as follows:

	Pasture	Corn Silage	HMSC
% Dry Matter	18.9	35.0	73.0
% Crude Protein	21.3	8.4	10.0
NE _L , Mcal/lb	0.70	0.73	0.92
Soluble Protein, %CP	38.0	30.0	40.0
Degradable Protein, %CP	75.0	72.0	58.0
%NSC	32.3	42.0	74.8
%ADF	21.1	24.3	2.8
%NDF	35.6	44.7	9.3

Noah and his sons do a very good job with their cropping program, as reflected in the results above. They are not planning to feed any haylage because they feel the pasture more than adequately substitutes for it. They are looking for high production and they have a large group of fresh cows in the spring. They like to have the ration balanced for 100 pounds of milk at 75 days in milk to be fed as a TMR.

The ration would be as follows (as fed):

Pasture	100.0 lbs
Corn silage	25.0 lbs
HMSC	20.0 lbs
Corn meal	5.0 lbs
Expellar soy	5.0 lbs
Cottonseed	3.0 lbs
Molasses	0.5 lbs
Minerals	1.0 lbs
(minerals include salt, trace mineral salt, dicalcium phosphate, limestone)	

The total dry matter intake is 55.27 pounds. Although this may seem somewhat high, it is actually only over requirements by .73 pounds because of the high milk production level and early stage of lactation. The nutrient analysis including requirements is as follows:

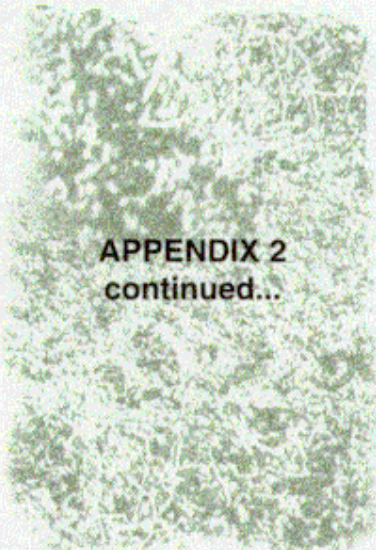
Nutrient	Supplied	Required	Difference	Density(%)
DM, lbs	55.27	54.54	0.73	34.7
NE _L , Mcal	44.13	42.17	1.95	0.80
CP, lbs	9.50	9.80	-0.30	17.1
SolP, lbs	3.00	2.90	0.10	31.5
DIP, lbs	6.10	5.90	0.20	64.4
UIP, lbs	3.40	3.20	0.20	35.6
ADF, lbs	8.00	8.70	-0.70	14.6
NDF, lbs	14.30	14.70	-0.40	25.9

For this level of milk production, it is rather amazing to some that the ration can be balanced with a pasture-based system. The analysis shows clearly that there are a few minor shortages in protein and fiber, but with good pasture management the cows may eat more than 100 pounds of pasture and thus make up the difference. The NSC level in the diet is 42.2%, which is about where it should be.

APPENDIX 2 continued...

When the high-moisture corn is adjusted to a dry corn equivalent basis of 16 pounds, the grain to milk ratio is calculated to be 1 to 3.3 which again is reason able. The only potential problem with the total amount of grain being fed is that if the cows are fed twice daily, some cows are being expected to eat 15 pounds of grain at one feeding. Fortunately, Noah has a TMR mixer and the grain is blended with the corn silage to avoid slug feeding. The cows are also kept in the barn a little bit longer than "ideal" so that all cows have a chance to eat before heading back out to pasture.

Actual records from this farm showed that production averaged between 85 and 90 pounds of milk per cow per day for the first two months of the grazing season. Average peak production on the mature fresh cows was 130 pounds, and on first calf heifers was 96 pounds. Noah was happy with production but one of his sons questioned whether they were saving any money. After a financial analysis they found that their costs per hundred weight had gone down only slightly, but other areas showed major improvements. They had more corn silage to sell, which brought in extra cash, and they didn't have to harvest as much haylage which reduced machinery costs. Their vet bill and hoof trimming bill went down significantly because with the cows outside they were getting more exercise, their hooves wore down naturally, and other than monthly herd checks there were few calls to the vet for sick or downed cows.



APPENDIX 2
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