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Pasture and Grazing Management

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Introduction

The challenge of managing a grazing system for dairy cattle is quite different than managing a confinement dairy. The manager of a grazing system must be flexible and constantly adjusting to changing environments. Managers of confinement systems are usually very production oriented, seeking profit from high levels of output. Grazing systems are characterized by lower production per cow than conventional confinement systems. Instead, the focus is on high production per acre at reduced costs. A startup-grazing dairy can be established at a far lower cost than a startup confinement dairy. Most graziers are focused on cost control and making innovative use of the unique features of their farm.

The main nutritional influences on high milk yield from pasture are the amount of high quality pasture forage grown per land unit, the amount of pasture allocated per cow, pasture management, and amount and quality of supplement that is provided. Questions and opinions abound concerning whether pasture management should emphasize high utilization of pasture forage or increased pasture allocation, which can lead to increased amounts of refused forage and lower forage quality in subsequent rotations (Johnson, 2009). Grass-based dairy production involves a number of factors that producers try to manage: genetics, pasture quality, supplementation, management of pasture plants, nutrient cycling, and stored feeds. In this review, we will emphasis pasture management and forage quality.

Grazing systems

Over the years, many US dairy farmers have probably grazed their dairy animals in an uncontrolled or continuous pasture system for a long-time period. However, research has documented that pastures have higher quality forage and are more productive with rotational grazing management. There are two types of grazing management: continuous or controlled (MDA, 2011). Continuous grazing allows dairy animals to decide when and what to eat, and pastures are not divided into smaller paddocks. Controlled grazing allows the farmer to manage and control pasture use. An outline of the options and management characteristics of continuous and several types of controlled grazing are summarized in Table 1. Continuous grazing is a one-pasture system where livestock have unrestricted access to pastures throughout the grazing season. Management intensive rotational grazing is a system with many paddocks where cattle are moved frequently from paddock to paddock based on forage growth and use.

Table 1. Types of grazing systems

Continuous grazing	Livestock graze for extended periods of time confined by a single perimeter fence.
Controlled grazing	Producers manage forage availability, quality, and utilization.
Rotational grazing	Livestock graze from 2 to 40 or more sub-pastures or paddocks in sequence.
Management intensive grazing	A rotational grazing system in which the grazing period is typically less than 4 days.
Rationed grazing	A predetermined amount of forage is allotted to the animal on a daily, weekly, or longer basis.
Strip grazing	A rationed grazing system in which a pasture is grazed in strips to enhance the utilization rate. No further grazing is anticipated. If regrazed, it would be a rotational system.
Flash grazing	Livestock graze a limited amount of high quality forage for a short period, usually once or twice daily, as a supplement to lower quality forage.
First/second grazing	Rotational grazing involving two groups of livestock with different nutritional needs. The group with higher requirements grazes a paddock first to select prime feed. The second group grazes after the first group has been moved to a fresh paddock.

Adapted from Minnesota Department of Agriculture grazing web site (http://www.mda.state.mn.us/animals/grazing.aspx)

Managed grazing systems can maximize forage yields and animal productivity with properly developed rotational grazing systems. Table 2 compares the advantages and disadvantages of continuous grazing, management intensive rotational grazing, and confinement systems.

Table 2. Comparison of three dairy livestock management systems

Dairy management systems	Advantages	Disadvantages
Continuous grazing	• Requires less management • Costs are minimal	• Decreased forage quality and yield • Undesirable plant problem (i.e. weeds) • Lower animal productivity • Uneven distribution of animal manure
Management intensive rotational grazing	• Low input costs • Maximizes forage utilization • More productive livestock • Low labor requirement • Even manure distribution • Controls soil erosion and weeds	• Less control of feed ration • High management requirement • Initial costs are higher for fence and water equipment
Confinement	• Control feed rations • High animal productivity	• High fuel, labor, and time requirement • Store, haul, and apply manure • Greater risk of animal disease • Possible soil erosion

Adapted from Blanchet et al., 2003

Pasture species and grazing management

Pasture is the primary source of forage for grazing and organic dairies, for organic livestock production, regulations require a minimum of 120 days grazing per animal (National Organic Program, 2011). In the northern U.S., this requirement is typically met by a May–September grazing season, and profitability depends on pastures that provide a uniform, season-long supply of high quality forage (Undersander et al., 2004). However, in the northern U.S., seasonal variation in temperature and precipitation creates a challenge, as the predominant forage plants, which include perennial grasses such as Kentucky bluegrass, quackgrass, and smooth bromegrass, and legumes such as white clover, undergo a “summer slump” in production, and do not actively grow in late fall. Extending the grazing season late into fall would reduce the high costs of harvested feed (Ball et al., 2008). To create a more uniform and extended forage supply, Ball et al. (2008) recommended diversifying pasture systems to include warm season species in the summer and annual cool season species in the fall.

Consequently, there is some conjecture regarding the ideal number of species to include in pasture mixtures. Most agronomic guidelines recommend the use of a small number of species in grazed mixtures suitable to specific soil types (Sheaffer et al., 2003; Blanchet et al., 2003). For example, Barnhart et al. (1998) recommends a mixture of alfalfa, smooth bromegrass, orchardgrass and tall fescue for droughty soils, and a mixture of red clover, ladino clover, orchardgrass, and tall fescue for imperfectly drained soils. However, Sanderson et al.

(2005) compared the productivity of white clover-orchardgrass mixtures with mixtures containing six and nine species from three functional groups under grazing. They found no differences in forage yield when rainfall was plentiful, but six- and nine-species mixtures were more productive than a white clover-orchardgrass mixture when rainfall was sparse. This research suggests risk of uneven productivity could be reduced by increasing diversity, but with mixtures that would be appropriate for Minnesota growing conditions.

Another approach to increasing diversity in a farm's forage base is to combine annual and perennial crops in separate fields (Undersander et al., 2004). An example for the northern U.S. would be to use cool season grasses and legumes like Kentucky bluegrass and white clover for forage in spring and early fall, and warm season annuals like teff (Clapham et al., 2011) and sudangrass (McCartney et al., 2009) for forage in summer. To extend the grazing season, small grains and *Brassica* spp. have been proposed for the fall (Jung et al., 1986; Ball et al., 2008, Undersander, 2004). Grazing systems using these different approaches to achieve diversity require biological, environmental and economic analysis.

Cool season grasses can be maintained for a 150-day grazing season even at a high stocking rate (Hoffman and Chester-Jones, 1996) Cool season legumes give a moderate grazing time with potential for maximum gain/acre (Martin. 1994). The summer months from late June to early August are the ideal period for warm season grasses. The seasonal patterns of forage yields by plant species for the Midwest region from April to December are shown in Figure 1. The management challenges between warm and cool season species across the Upper Midwest are similar although additional warm season grass species are more prevalent in the south eastern states such as tall fescue and bermuda grass.

Figure 1. Seasonal patterns of forage yield by plant species for the Midwest. (Moechnig, 2010)

Each forage species has a distinct seasonal growth pattern. The height at which forage is grazed determines the rate of regrowth. The higher the residual in the pasture, the more rapidly the plant will regrow. Most legumes and grasses should be grazed down to 2 to 4 inch stubble, followed by a 4 week rest period.

Supplementing diets on pasture

Feed costs are a high proportion of the total production costs on dairy farms. With grain prices expected to increase in the future, dairy farms will feel pressure to increase the feeding of high quality but low cost forages. Pastures and perennial forages that can be preserved for winter feeding will be a good source of high quality forage on many farms.

Supplementation of feeds is designed to complement pasture forage at a reasonable cost (Hamilton et al., 2012). Table 3 shows that grasses and legumes benefit from different supplement formulations. Neither grass nor legume pasture will meet the energy requirement of the high producing dairy cow. Levels of Neutral Detergent Fiber (NDF), especially in grasses, will limit the ability of the cow to maximize dry matter intake. High quality legumes or grasses provide adequate levels of protein, although requirements for rumen undregradable protein (RUP) may not be met.

Table 3. Nutrient recommendations for cows in early lactation and nutrient composition of pastures.

Nutrient	Recommendation	Grass	Grass-Legume	Legume
NE_L, Mcal/lb	0.70	0.65-0.70	0.66-0.72	0.68-0.74
Crude protein,% of DM	16.1	27	19	26.5
Bypass protein (RUP)	6.4	4.3-4.6	4.2-5.7	4.6-5.0
NDF, % of DM (min)	25-33	46	45	33
NFC, % of DM	36-44	15-20	15-20	20-25

1989 and 2001 National Research Council Recommendations (NRC, 2001)

There remain unanswered questions on appropriate supplementation for grazing cows. Cows on all forage diets should respond to supplementation with high-energy feeds. Unfortunately grains replace forage in the diet. A typical energy supplement consists of 10 to 16 lb of finely ground shelled corn with salt and minerals. That works out to 1 lb of supplement for every 4 to 5 lb of milk produced each day (Hoffman, 2000). Stored forage or additional grain may be provided to adjust for seasonal changes in pasture performance.

Maximizing dry matter and pasture intake

Why worry about pasture intake? Pasture-based dairy cows will have lower milk production due to reduced dry matter intake and not forage quality (Hoffman, 2000). A producer should be concerned about dry matter intake from pasture because it allows us to determine the appropriate supplementation strategy.

Dry matter intake can be very difficult to measure directly on pasture. There are many plant and animal factors that can influence pasture intake and include plant density, plant maturity, breed of cattle, body weight, and milk production. There are three factors that determine pasture intake; grazing time (the amount of time spent grazing), bite rate (the rate at which pasture is taken into the mouth, and bite size (the amount of pasture eaten with each bite). Simply, pasture intake = grazing time x bite rate x bite size. Dairy producers have very little control over grazing time and bite rate. Bite size and pasture yield are influenced by grazing height and density of the pasture. Grazing time will increase as the density of the pasture decreases; therefore, it is essential for dairy producers to provide cows with at least 8 to 12 inches of pasture height.

To maximize pasture intake, it important to accurately measure or estimate dry matter intake. There are four easy steps for a producer to determine dry matter intake from pasture for heifers and cows. First, the producer should estimate dry matter demand. Dry matter demand is the expected dry matter intake for a particular class of animal and depends on stage of life, production, and body weight. A producer can use expected dry matter intake from Dairy National Research Council (NRC, 2001) tables or use a percentage of body weight to determine dry matter demand. A mature dairy cow will typically consume 2.5-4.5% of her body weight.

The dry matter demand formula can be written as dry matter demand (lb) = body weight x (DMI % body weight/100 lb). Second, determine the dry matter intake from feed sources other than pasture. A feed sheet from a nutrition consultant should show the amount of dry matter for each feed being fed per day. Third, determine the dry matter intake from pasture by subtracting the dry matter intake from other feed sources from the dry matter demand. Lastly, calculate the percent dry matter intake from pasture by dividing the estimated dry matter intake from pasture by dry matter demand. A producer may re-calculate the dry matter intake each time a ration changes and then average the values across the grazing season (Rinehardt and Baier, 2011). For organic dairy producers, it is essential that the dry matter intake from pasture average at least 30% across the grazing season. Below is an example calculation from the National Organic Program (Rinehardt and Baier, 2011).

Example: A lactating dairy cows with an average body weight of 1200 lb. will consume approximately 3% of her body weight in dry matter intake.

1) Dry matter demand (lb) = 1,200 x (3/100) = 36 lb.
2) The cow is fed 5 lb, as fed of hay (90% dry matter) and 11 lb as-fed of grain (89% dry matter).
    a. Dry matter intake from hay = 5*(90/100) = 4.5
    b. Dry matter intake from grain = 11*(89/100) = 9.79.
    c. Total pounds of dry matter intake from other feed sources = 4.5 + 9.79 = 14.29
3) Dry matter intake from pasture = 36 lb – 14.29 lb = 21.71 lb.
4) Percent dry matter intake from pasture = (21.71/36) * 100 = 60.31%

Figure 2 documents the ration changes and dry matter intake from pasture for the University of Minnesota’s West Central Research and Outreach Center organic dairy during 2011.

GRAZING SEASON RATION RECORD
(Electronic Version)

Use this worksheet to document Dry Matter Intake (DMI) from pasture for specific groups of ruminants during the grazing season. Complete a new worksheet (Ration 1, Ration 2, Ration 3 etc.) each time the supplemented feed ration changes significantly for each group. The % DMI total from each ration worksheet will automatically be entered onto the Results Sheet to calculate average DMI from pasture for the overall grazing season. Use a separate set of worksheets for each specific type of ruminant livestock.

Operation Name:	WCROC	Type of Ruminant Livestock:
Date Ration Began:	8/18/2011	Dairy Cows
Date Ration Ended:	9/2/2011	
# of Grazing Days:	15	
* Dry Matter Demand (DMD) in Lbs:	44.52	

* When calculating Dry Matter Demand (DMD) for the type of organic ruminant livestock, please refer either to the Reference Charts (on the last worksheet) or use your own DMD estimate (please provide proof of this estimate).

Feed Type (do not list pasture)	Avg. # fed/hd/day		** Dry Matter %		DMI fed in Lbs
Example: Dry Hay	*Example: 25*	X	*Example: 85*	%	= 21.25
Organic Corn Silage	22.05	X	32.2	%	= 7.1001
Organic Haylage	12.84	X	41.2	%	= 5.29008
Organic Dry Hay	0	X	0	%	= 0
Organic Grain	10.62	X	87.6	%	= 9.30312
Organic Corn/Wheat Mix	3.17	X	88	%	= 2.7896
		X		%	= 0
		X		%	= 0
		X		%	= 0
			Total DMI fed from non-pasture:		24.4829

44.52	–	24.4829	=	20.0371	÷	44.52	=	0.4501	X 100
DMD		Total Dry Matter Fed		DMI from Pasture		DMD		DMI from Pasture	

= **45.01 %**
TOTAL % DMI FROM PASTURE (for this period)

** When estimating Dry Matter % of supplemented feed types, please refer to the Reference Charts provided on the last worksheet. If you test feed and have % Dry Matter from testing, use your own numbers in this calculation.

GRAZING SEASON RESULTS SHEET
(Electronic Version)

Listed below is a summary of the specific rations provided, along with the calculated average DMI % from pasture overall for the entire grazing season. Please keep in mind that National Organic Standard 205.240 states that producers must provide an average minimum of 30% for each group of ruminants.

Operation Name:	WCROC	Type of Ruminant Livestock:
Total # Days in Grazing Season:	138	Dairy Cows
Dry Matter Demand (DMD):	44.52	

Specific Grazing Dates:		# of Days		Daily DMI % from Ration record			DMI from Pasture during period
From: / *To:*	*Example: 4/25/2010* / *6/30/2010*	*66*	X	*50*	%	=	*33*
From: / To:	5/11/2011 / 5/16/2011	5	X	29.25	%	=	1.4625
From: / To:	5/17/2011 / 5/23/2011	6	X	38.15	%	=	2.289
From: / To:	5/24/2011 / 5/30/2011	6	X	38.15	%	=	2.289
From: / To:	6/1/2011 / 7/5/2011	34	X	38.23	%	=	12.9982
From: / To:	7/6/2011 / 8/8/2011	33	X	37.49	%	=	12.3717
From: / To:	8/9/2011 / 8/17/2011	8	X	42.5	%	=	3.4
From: / To:	8/18/2011 / 9/2/2011	15	X	45.01	%	=	6.7515
From: / To:	9/2/2011 / 10/3/2011	31	X	45.01	%	=	13.9531
	Total Days :	138		DMI Pasture Total:			55.515
Weighted Average % DMI from Pasture During the Grazing Season						=	**40.23 %**

To calculate the weighted average (season average), multiply each number of grazing days by the corresponding daily DMI% from each Ration Record worksheet (see example provided above). Add these numbers up (in the far right column) to get the DMI pasture total, then divide by the total number of days in the grazing season and multiply by 100.

Figure 2. Example of dry matter intake calculations from pasture for the University of Minnesota-WCROC organic grazing dairy.

Grazing plans

Dairy producers need to make a grazing plan for the grazing season and this is where the concept of the "grazing wedge" comes in. The grazing wedge (Figure 3) depicts a 30 paddock management intensive rotational grazing system. This is about the right number of paddocks for providing fresh pasture each day and allowing plenty of time for healthy plant regrowth before grazing again. The columns, depicting daily rotation through paddocks, show that on any given day the paddocks will have different amounts of forage. The paddocks with the smallest supply, on the far right, were grazed as short as they should be yesterday. It is important to always leave a certain amount of forage so the plant will regrow as quickly as possible. In this example of clover/bluegrass, note that 1000 lb per acre is left as permanent base growth. On the left columns, the paddocks that had the longest rest period grew more than needed in 30 days. Therefore, the first 5 paddocks can be hayed to feed next winter, or later in the summer when forage supply is low. Thus, tomorrow we want to graze paddock 6, moving along to 7, 8, etc. as they advance to the best stage for grazing. We want to continue to graze in the space between the "too mature" line and the "permanent base growth" line. That space between these two lines is called "The "G*razing Wedge.*"

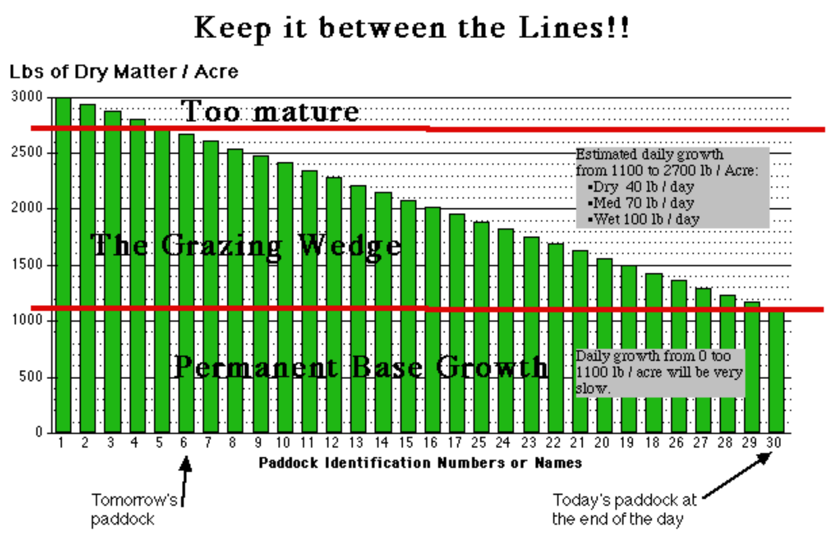

Figure 3. The grazing wedge

The rates of growth will not always be equal. We know that variations in rainfall, sunlight, temperature, fertility, forage species and other factors leave us with uneven growth. If there has been a period of excellent growing conditions the pasture wedge will have a hump. When that happens there will be a time two or three weeks beforehand when we know there will be some extra hay to make. There are also times, for example a couple of weeks without rain, when we know there will be a depression in the wedge, the wedge will be concave. But, we won't be caught unaware of this situation because we've been watching the wedge. A few extra lbs of corn silage or hay will meet the cow's nutritional needs and slow down the daily paddock rotation. Moving at a slower rate and providing extra supplemental feed gives the pasture extra time to grow to the proper yield. Experience has shown that speeding up the rotation or dipping into the permanent base reduces the likelihood of maintaining healthy growth later in the season.

In most years you can have green grass late in the fall if you use a planning tool like the grazing wedge to keep your forages healthy through the summer.

Pasture Calendar

A planning calendar is especially useful with a grazing system as needs and opportunities change month by month. It is never too early to plan ahead. The pasture calendar below is adapted from Johnson (2009).

January – February: This is a good time to study new developments in forage varieties. If animals are being wintered on pasture, land fertilizer can be provided by moving feeding sites to encourage uniform distribution of manure. It's not too late to review the situation of the pastures following the past grazing season.

March: If seed isn't ordered for frost seeding, planned renovation or new pasture development, it should be done before supplies are reduced. Frost seeding needs to be completed before the pastures are muddy to achieve best soil seed contact. Check fences and water lines for damage and begin repairs. Waste feed and manure accumulation can be distributed. If there is a lot of mud after a winter of heavy snowfall, a sacrifice area to hold cattle may need to be installed.

April: Some grazing is usually possible by mid- to late-April, but the grazing plan should provide for very rapid moves, completing a cycle in two weeks or less. If your pastures lack legumes, a spring application of nitrogen may be needed to jump start the grasses. Schedule replacement of broken posts and other equipment.

May: Pastures change from very slow growth to maximum growth during June. Monitor all pastures weekly to determine appropriate supplementation early in the month and to identify areas of the pasture that may need to be harvested for hay later in the month. Decisions made in May determine the sequencing of grazing moves to have a continuous supply of high quality forage through the summer. During May the rotation cycle should be extended to 21+ days. Most renovation seeding will be done in early May. Key points in pasture development include choice of adapted varieties and species that will save you money by persisting for several years, adding legumes to provide nitrogen, and considering both quality and yield potential.

June: Continue to schedule a weekly walk over all the pastures as the rotation cycle extends to 28 to 31 days and surplus forage is harvested. Watch for new problem areas and maintain a "grazing wedge" to stabilize supply, as discussed earlier in this paper. If growth becomes uneven or plants develop seed heads, clipping or following the cows closely with heifers will help keep the appropriate pasture sequence.

July: By mid-summer, given appropriate moisture and fertility, the length of a rotation should have stabilized to about 28 days. Watch for signs of nitrogen deficiency and supplement with an appropriate fertilizer material to maintain pasture production. Plan for changes in soil moisture, rate of regrowth, animal needs and weed pressure. If you want to extend the grazing season, a stockpile should be started before the end of July.

August: If pasture growth is declining, the length of the grazing cycle will need to be increased to 35 days in order to avoid overgrazing and loss of pasture productivity. This may be a time to utilize annuals to fill the gap in pasture growth. If you want a spring calving herd, you'll need to be very aggressive in completing breeding by August 15.

September: Monitor weeds, especially thistles, to determine a course of action. If you've managed rotations and been pleased with adequate moisture, the grass should be thick with few serious weeds. Plan for the emergence the pocket gopher and find an ambitious trapper for the fall season. Length of rotation may need to be extended to 42 days or even longer.

October – December: Prepare for winter and spring by maintaining fences, lanes and watering systems. Inventory quality and quantity of stored forage to sell excess or purchase shortages. If feeding on pasture, make a plan that includes feeding areas that are moved where fertility of manure is best utilized.

Who should be grazing dairy cattle?

Pasture-based dairying is not for all dairy producers. Figure 4 (NRCS, 2007) provides a diagram of a thought process for determining when grazing is an appropriate system for a dairy producer.

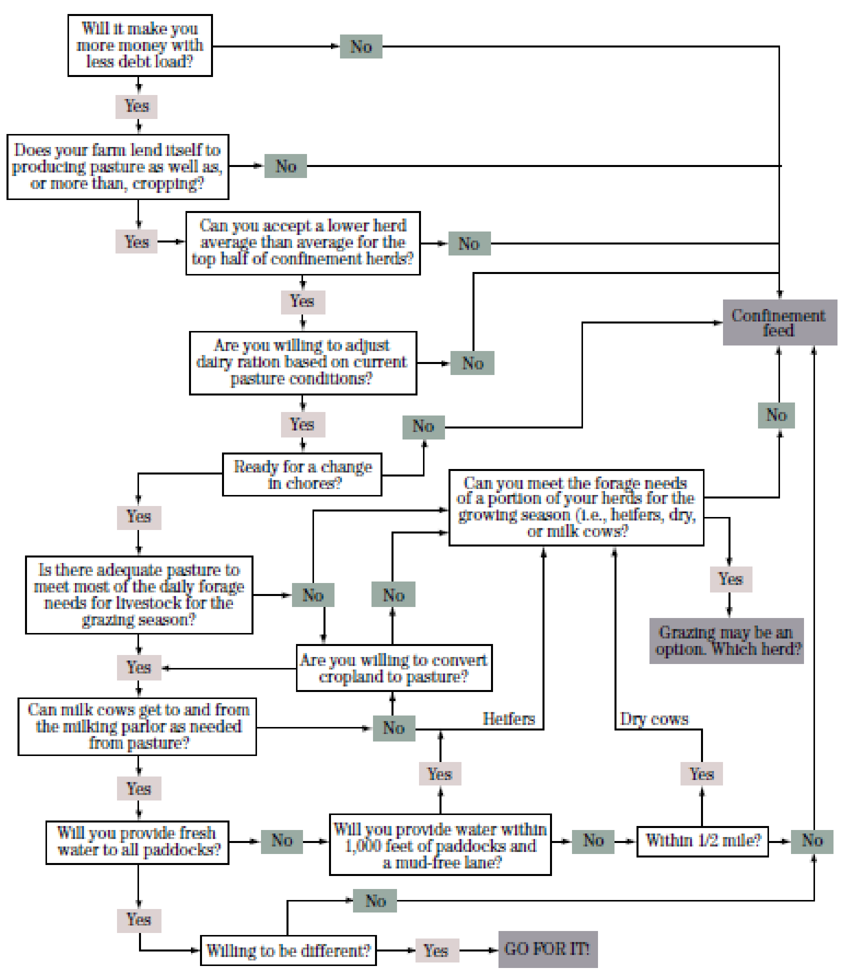

Figure 4. Diagram to determine if pasture dairying is appropriate for a producer.

Conclusions

Pasture can be a cost effective source of feed and housing for dairy animals. The pastures should utilize productive and high quality legumes and grazes organized in paddocks that are intensively grazed with rest periods of three to four weeks before being grazed again. Animals should be monitored regularly to determine the need for supplementation and general health.

Maximizing dry matter intake from pasture can be a difficult task. Develop a pasture checklist to determine whether intake is being limited by pasture or animal factors. From there, a management plan can be developed to improve the grazing outcome. Grazing may not be the simple best way to dairy for all producers. However, when you have forage shortages, determine what kind of pasture management system that a producer could develop that would best suit their needs and goals.

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