Energy Intensity, Carbon Footprint, and Environmental Impact of Pasture-Based Dairy – A partial Life Cycle Assessment of Grazing systems in Wisconsin and Michigan

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Introduction and Overview

Dairy products are a significant component of the global human diet. In developed countries, approximately 14% of dietary energy intake is met by dairy products, while people in developing countries get 4-5% of their dietary energy from dairy products (Gerosa and Skoet 2012).

The production of such a significant source of nutritional energy to humanity suggests significant impacts on social and environmental systems. Major environmental impacts associated with dairy production include GHG emissions, soil erosion, potential water eutrophication[1], and potential soil acidification[2]. According to a life cycle assessment (LCA) of milk production elaborated by the Food and Agriculture Organization (FAO), the global dairy sector contributes 4% (+-26%) to the total global anthropogenic GHG emissions (FAO 2010).

The United States is the world's second largest milk producing country with an annual production level of 88 million tonnes of milk per year, or about 12% of global milk production. Wisconsin, despite having less than 2% of the nation's area and population, produces 13% of all the milk produced in the country, making it the second largest milk producing state. Michigan, Wisconsin's neighboring state and research partner in this study contributed 4% to USA milk in 2011, ranking fourth in USA milk production (USDA-NASS 2012). In 2007, Wisconsin's dairy sector, including on-farm production, sales and processing, accounted for about $26.5 billion (or almost 6%) of the state's total economic output (Deller and Williams 2009).

Milk production of Michigan dairy farms totaled 8,327 million pounds in 2010. Quite remarkably Michigan milk production increased 19% and the state's dairy herd increased from 302,000 to 335,000 cows between 2003 and 2007, contrary to the trend in most states. Over the same time period milk production per cow also increased substantially and Michigan currently ranks 4th in the U.S. and 1st in states east of the Rocky Mountains in milk produced per cow, averaging 22,681 lb/cow in 2007 (USDA Statistics).

The majority (90%) of the milk produced in Wisconsin is sourced from herds managed as "confinement dairy farming" systems (Kriegl, Bauman, and Splett 1999). Confinement dairy farming is characterized by dairy cows fed diets rich in grains, such as corn and soybeans, and confined in stalls or barns with little access to pasture. Confinement dairy farming systems rely on forage and grain produced, mechanically harvested and physically delivered to the cows by the farmer from other farms (Brock and Barham 2009). Thus cows in confinement systems seldom, if ever, obtain feed from grazing.

The remaining 10% of the milk produced in Wisconsin comes from Management Intensive Grazing (MIG), also known as Management Intensive Rotational Grazing (MRIG) systems (Kriegl, Bauman, and Splett 1999). According to the Census of Agriculture, an estimated 3070 Wisconsin dairy farms (22% of all dairy farms) used MIG in 2007. Taylor and Foltz (2006) reported that the percent of Wisconsin farms

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1 Eutrophication: "An increase in the rate of supply of organic matter to an ecosystem" (Nixon 1995); "A process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of organisms; and water quality degradation. The consequences of eutrophication are undesirable if they appreciably degrade ecosystem health and/or the sustainable provision of goods and services" (Ferreira et al. 2011).

2 Acidification is caused by sulphur and nitrogen compounds (e.g.: SO2, NOx). "Actual soil acidification is primarily manifested by leaching of cations from the soil, regulated by the mobility of major anions. Leaching of HCOf and RCOO- occurs naturally whereas leaching of NO~- and SOl- is mainly caused by land use in agricultural soils and by acidic deposition in forest soils" (Vries and Breeuwsma 1987).

using MIG increased from 7.3% to 23.1% from 1993 to 2003. Frank et al. (1995) stated that MIG operations typically result in lower milk production levels than confinement systems; they also typically require lower capital inputs and can decrease economic risk and increase flexibility and profits of the individual dairy farmer (Frank et al. 1995). This could be one factor in the historical increase in MIG operations in Wisconsin as well as a continuation of this trend (Brock and Barham 2009).

The definition of what constitutes a pasture-based dairy is not entirely clear and spans a range of management practices. Farms using MIG management systems are also often associated with other values-based agricultural production systems (e.g. certified organic, Biodynamic, Amish). One-third of the respondents, self-identified as MIG managers in 1999 moved their milking cows to fresh pasture once a day or more often; another third moved cows to fresh pasture every two to six days; and the remaining third moved cows to fresh pasture weekly (Taylor and Foltz 2006). Brock and Barham (2009) defined MIG farms as those that rely substantively on intensive animal grazing rather than solely on forage and grain produced, mechanically harvested and physically delivered by the farmer or from other farms. Oates et al. (2011) further defined MIG management strategy as livestock grazing in relatively small paddocks at high densities but for short durations (Oates et al. 2011). This grazing management strategy is facilitated by the division of pastures into smaller paddocks, and moving cows to a new paddock once a specific residual sward height has been reached.

In September 2010 the Grazing Land Conservation Initiative (GLCI) of the Wisconsin Department of Natural Resources (WI DNR) partnered with the Green Cheese project at the University of Wisconsin (UW) to perform a life cycle assessment (LCA) of pasture-based milk production in Wisconsin. The aim of the LCA was to document some of the environmental consequences of different dairy farming management strategies, and provide guidance on practices to improve the sustainability of milk production systems. Part of the research was done in collaboration with the Michigan State University / Kellogg Biological Station (MSU/KBS).

The objective of this work was to generate models to quantify the energy intensity, carbon footprint, and other environmental impacts for specific grazing practices used in pasture based dairy systems in Wisconsin and Michigan. The comparison of model estimates and field data provides an assessment of the critical input and output variables of contemporary grazing systems and the impacts of new technologies and management strategies. Traditional sustainability indicators such as energy intensity and greenhouse gas (GHG) emissions per kg of Fat and Protein Corrected Milk (FPCM) milk production and land use were quantified. A qualitative analysis of other indicators was also performed to more fully describe the unique attributes of grazing systems.

Life Cycle Assessment (LCA): GHG emissions, Energy intensity and Land Use

We used life cycle assessment (LCA) methods to quantify selected environmental impacts of milk production. LCA is "*the compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle, from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal*" (ISO 2006).

LCA uses a product-oriented approach considering the whole life cycle of a specific product. LCA uses a structured and comprehensive method to evaluate the sustainability of production procedures, quantifying relevant emissions and resources consumed as well as environmental and health impacts that are associated with the entire life cycle of any goods and services (European-Commission 2011). LCA is used as a powerful decision support tool, complementing other methods, to identify and implement effective and efficient methods to make production more sustainable. LCA uses a rigorous scientific approach to quantify the effects of environmental policies and business decisions to achieve more sustainable production and consumer choices.

This study develops a partial LCA of milk production in dairy farms in the states of Wisconsin and Michigan. This is a partial LCA because:

a) It does not assess environmental impacts of milk production in all impact categories, and
b) It does not assess the impacts up to the end of life of the product (consumption and disposal).

Life Cycle Inventory Data

The major components of our system model are:

1. Milk production: including dairy herd structure and animal nutrition;
2. Manure handling and storage: including biogas generation and field application of manure; and
3. Crop production for dairy feeds and ethanol and biodiesel feedstock production.

The life cycle inventory data were obtained from databases accessed through GaBi 5 Professional© (PE 1992-2012), and other research literature where available and by our own calculations and estimates based on data collected from the field when Wisconsin or Midwest-specific LCI data were not available.

Functional unit and System boundaries

The functional unit was 1 kg of Fat and Protein Corrected Milk (FPCM)[3] corrected to 3.3% protein and 4.0% fat, according to the recommendations of the International Dairy Federation (IDF 2010) (IDF 2010)[4], and the Food and Agriculture Organization (FAO 2010)[5].

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[3] Fat and protein corrected milk (FPCM) is "milk corrected for its fat and protein content to a standard of 4.0% fat and 3.3% protein. This is a standard used for comparing milk with different fat and protein contents. It is a means of evaluating milk production of different dairy animals and breeds on a common basis" (FAO 2010).

[4] "FPCM is calculated by multiplying milk production by the ration of its energy content to the energy content of standard milk with 4 percent fat and 3.3 percent true crude protein content" (IDF 2010).

The boundaries of the farm system were milk production "from cradle to farm gate" (**Error! Reference source not found.**). The environmental impacts of producing the inputs for crop production for diary feed, the crop production practices themselves, and processes involved in the operation of the dairy farm were thus included in our analysis. Meat (from culled animals) that was suitable for human consumption was accounted for as a co-product from milk production, and was valued based on the nutritional content (protein and fat) in boneless meat produced compared to the nutritional value of milk produced during the same time period. This approach resulted in: 98.9% of the system inputs and outputs being attributed to milk, and 1% to meat.

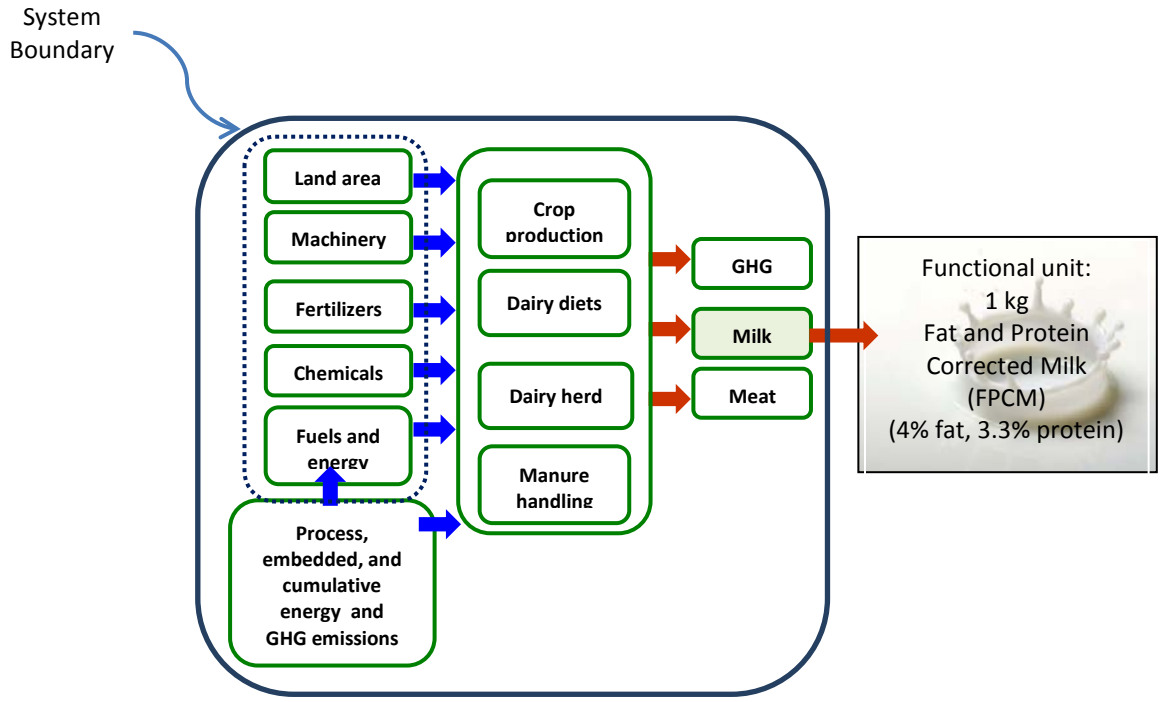

Figure 1. Boundary of milk production system from cradle to farm gate.

Impact Assessment

The impact categories of this assessment were: global warming due to CO_2, CH_4 and N_2O emissions, and resource depletion due to fossil fuels consumption and land use. The characterization factors were: Greenhouse gas emissions [kg CO_2-eq in a 100 years horizon], energy intensity [MJ], and land area [m^2]. The impact categories, inventory indicators, and characterization factors are summarized in Table 1.

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[5] In 2010, both the IDF and the FAO have recommended that the functional unit for LCA of milk production be a unit of milk corrected to 4% fat and 3.3% protein. Up to 2011 the work of Alan Rotz, D.S. Chianese and their other collaborators (e.g. F. Montes, L.M. Risse, J.B. Belflower, T.L. Richard et al.) has been reporting environmental impacts per unit of milk corrected to 3.5% fat and 3.1% protein. The USDA's model IFSM has been updated in September 2012 (Version 3.6) and started using the 4% fat and 3.3% protein.

Table 1. Impact categories, indicators and characterization factors.

Midpoint Impact Categories	Inventory Parameters / Indicators	Characterization Factors (a)	Unit
Depletion of abiotic resources (ADP)	Net Energy intensity		MJ
	Land use		m^2
Global warming potential (GWP)	Carbon dioxide (CO_2)	1	kg CO_2-eq
	Nitrous oxide (N_2O)	298	kg CO_2-eq
	Methane (CH_4)	25	kg CO_2-eq

(a) Characterization factors of GWP for a 100-year time horizon (Forster et al., 2007)

Net energy intensity was defined as the net energy from activities related to milk, calculated as the difference between the energy inputs (required energy) and energy outputs (supplied energy), and discounting the avoided energy use, as shown in the equation below.

$$\text{Net energy intensity (MJ/kg FPCM)} = [(E_I) - (E_O) - (E_A)] \,/\, \text{kg FPCM}$$

Where:
E_I (MJ) = energy inputs to the system, including on-farm and off-farm inputs for crops production
E_O (MJ) = energy generated in form of biogas
E_A (MJ) = avoided energy use due to displacement of natural gas production

Scenario Definition

To simulate certain MIG scenarios, we modeled five grazing operations, three of which were assumed to be located in Wisconsin (based on typical practices determined from published surveys, interviews with farmers and extension agents) and two in Michigan (based on the two production scenarios implemented at the KBS research station). In addition our scenarios were selected to represent a range of grazing intensity as characterized by increasing percentage of annual dry matter intake from pasture. For comparison purposes, we included in this study two scenarios in which the dairy herds were confined all year round. We used the LCA modeling software 'GaBi' to model the energy intensity, land use and GHG emissions[6] for each scenario. Characteristics that were common to all selected scenarios are shown in Table 2.

[6] GHG emissions or Carbon Footprint. "Carbon footprint is the total amount of GHG emissions associated with a product, along its supply-chain, and sometimes includes emissions from consumption, end-of-life recovery and disposal. It is usually expressed in kilograms or tonnes of carbon dioxide equivalent (CO_2-eq.). CO_2-equivalent emission is the amount of CO_2 emissions that would cause the same time-integrated radiative forcing, over a given time horizon, as an emitted amount of a long-lived GHG or a mixture of GHGs. The CO_2-equivalent emission is obtained by multiplying the emission of a GHG by its Global Warming Potential (GWP) for the given time horizon. The CO_2-equivalent emission is a standard and useful metric for comparing emissions of different GHGs, but does not imply the same climate change responses (IPCC 2007)." (FAO 2010)

Table 2. Dairy herd characteristics common to all selected scenarios.

Inputs	Values used in this study
Confined season	October through April
Grazing season	May through September
Milk protein	3.2%
Milk fat	3.7% confined season, 3.8% grazing season
Milk lactose	4.85%
Body weight of non-pregnant adult cow	Varying between 600 and 650 kg
Milk yield	Varying from 25 to 35 kg/cow/day

Differentiation characteristics of each scenario were as follows (Table 3):

A. Low DMI from pasture, High crop/forage yields, High supplemental feed input, Random calving.
B. High DMI from pasture, High crop/forage yields, Low supplemental feed input, Seasonal calving.
C. High DMI from pasture, Medium-Low crop/forage yields, Low supplemental feed input, Seasonal calving.
D. High DMI from pasture, High crop/forage yields, High supplemental feed input, Random calving.
E. High DMI from pasture, High crop/forage yields, Low supplemental feed input, Random calving.
F. None DMI from pasture, High crop/forage yields, High supplemental feed input, Random calving.
G. None DMI from pasture, High crop/forage yields, High supplemental feed input, Random calving.

Scenario A represented a milk production system that utilizes a low percentage of pasture as a source of the dairy herd feed intake. This system has high soil fertility, therefore crops and forage yields are high. The focus was on maximizing the number of animals per area, therefore stocking rate (animal unit per area ratio) was high, supplemental feed input was high, and dry mater intake from pasture was low. Pasture dry matter intake in the cows' diet was a minimum amount to qualify as a MIG dairy system: approximately 10% of DMI during the grazing season provided from pasture, or 5% of total annual DMI along the year provided by grazing).

Scenarios B and C focused on maximizing dry matter intake from pasture (40% of DMI in grazing season provided by pasture, or 25% of total annual DMI along the year provided by grazing), which was achieved due to strategic seasonal calving. Calving was concentrated in the spring, so that during winter there were no lactating cows to be milked or fed. As dry cows have lower dry matter intake requirements than lactating cows, seasonal calving systems require lower supplemental feed input in the winter than systems in which calving occurs randomly throughout the entire year. The difference between Scenario B and C was the level of productivity of the land: Scenario B was simulated in high productive land, whereas Scenario C was in 20% lower productive land, achieving 80% of Scenario B crop and forage yields.

Scenarios D and E simulated the systems currently in operation at the W.K. Kellogg Biological Station (KBS) of Michigan State University (MSU), in Hickory Corners, MI. These systems have been designed and managed to achieve the same level of forage utilization per hectare and the same milk production per Automatic Milking System (AMS) unit, resulting in different milk yields per cow. Both have high crops and forage yields, but Scenario D has high stocking rate and high supplemental feed input, whereas Scenario E has low stocking rate and low supplemental feed input. The percentage of DMI from pasture during the grazing season was 25% for Scenario D and 33% for Scenario E (or 12% and 16% of the annual DMI, respectively).

In scenarios F and G, the herds were confined all year round, with no access to pasture. Both confinement farms had uncovered lagoons for manure storage. The difference between them was that Scenario G had an anaerobic digester as a manure treatment, whereas Scenario F did not. Where the anaerobic digester was used, it was assumed that the biogas was utilized to generate electricity. It was also assumed that biogas displaced natural gas because of its similarity to biogas, and because it can be used for either heat or (electric) power generation. GHG credits for avoided natural gas production and combustion were calculated as the GHGs that would be emitted by the production and combustion of the amount of natural gas with the same energy content (MJ) as the biogas.

In all seven scenarios, manure from the confined season was stored in uncovered lagoons, and spread on crops and forage fields once in the Spring and once in the Fall.

Table 3. Individual key characteristics of selected dairy systems.

Characteristics	A	B	C	D	E	F	G
Crops and forage yields	High	High	Medium -Low	High	High	High	High
Calving period	Random	Seasonal	Seasonal	Random	Random	Random	Random
Stocking rate (milking cow/ha)	High	Low	Low	High	Low	-	-
Annual DMI from pasture	Low (5%)	Very High (30%)	Very High (30%)	High (12%)	High (16%)	None	None
Feed supplementation in grazing season (concentrate/forage ratio)	High	Low	Low	High	Low	High	High
Percentage of DMI in grazing season from pasture	9.2%	40%	40%	25%	33%	0	0
Milk yield (kg/cow/year)	10,200	7,500	7,500	9,750	9,000	10,500	10,500
Manure storage in grazing season	-	-	-	-	-	Uncovered lagoon	Uncovered lagoon
Manure treatment	-	-	-	-	-	-	Anaerobic digester

Seasonal dairy diet compositions for each of the scenarios are listed in Table 4,

Table 5, and Table 6.

Table 4. Dairy diet composition for lactating cows during the confined season (October through April) for scenarios with calving randomly distributed year round: Scenarios A, D, E, F and G.

Ingredients	A	B	C	D	E	F	G
Intensively managed pasture	-	-	-	-	-	-	-
Harvested legume silage (immature)	5.0	-	-	5.0	5.0	5.0	5.0
Harvested corn silage	8.0	-	-	8.0	8.0	8.0	8.0
Corn grain	6.6	-	-	6.6	6.6	6.6	6.6
Soybean meal (sbm)	2.6	-	-	2.6	2.6	2.6	2.6
Total Dry Matter Intake (kg/day)	**22.2**	-	-	**22.2**	**22.2**	**22.2**	**22.2**
DM Concentrate : DM Forage ratio	**0.71**	-	-	**0.71**	**0.71**	**0.71**	**0.71**
Milk yield (kg milk/cow/day)	**35**	-	-	**35**	**35**	**35**	**35**

Table 5. Dairy diet composition for lactating cows during the grazing season (May through September) for each scenario.

Ingredients	A	B	C	D	E	F	G
Intensively managed pasture	2.0	8.0	8.0	5.0	6.5	-	-
Harvested legume silage (mature)	5.0	4.0	4.0	3.5	4.5	-	-
Harvested corn silage	5.0	4.0	4.0	3.5	4.5	8.0	8.0
Corn grain	7.5	4.0	4.0	7.3	4.0	6.6	6.6
Soybean meal (sbm)	2.2	-	-	0.7	-	2.6	2.6
Total Dry Matter Intake (kg/day)	21.7	20	20	20	19.5	22.2	22.2
DM Concentrate : DM Forage ratio	**0.81**	**0.25**	**0.25**	**0.67**	**0.25**	**0.71**	**0.71**
Milk yield (kg milk/cow/day)	**33**	**25**	**25**	**30**	**25**	**35**	**35**

Table 6. Dry matter intake from pasture in relationship to total DMI year round.

Dry Matter Intake (kg DMI/cow/day)	A	B	C	D	E	F	G
Total DMI from pasture	2.0	8.0	8.0	5.0	6.5	-	-
Total DMI in grazing season	21.7	20	20	20	19.5	22.2	22.2
Total DMI in confined season	22.2	6.8	6.8	22.2	22.2	22.2	22.2
Sum of DMI in grazing and confined seasons	43.9	26.8	26.8	42.2	41.7	44.4	44.4
% Pasture / Grazing DMI	9%	40%	40%	25%	33%	0	0
% Pasture / Annual DMI (grazing+confined)	5%	30%	30%	12%	16%	0	0

Results and Discussion: Greenhouse gas emissions

The lowest GHG emissions among all scenarios resulted from Scenario G (0.43 kg CO_2-eq/kg FPCM), which represented a confined herd with an anaerobic digester (Figure 2). That scenario generated gas that could either provide electricity to the farm itself or to the grid, therefore not emitting the GHG that would otherwise be emitted had the farm used electricity that had been generated with the consumption of fossil fuels. The highest GHG emissions resulted from Scenario F (0.77 kg CO_2-eq/kg FPCM), which represented a confined herd without an anaerobic digester.

The MIG systems had similar or lower GHG emissions than the confinement system without digester. Among the MIG scenarios, those that used the least amount of pasture (D and E) resulted in GHG emissions comparable to the confinement scenario. Scenario D, which had higher level of feed supplementation in the grazing season compared to Scenario E, resulted in 0.72 kg CO_2-eq/kg FPCM, whereas Scenario E resulted in 0.75 kg CO_2-eq/kg FPCM.

The lowest MIG GHG emissions resulted from the two scenarios that had the maximum DMI from pasture and used seasonal calving (Scenarios B and C).

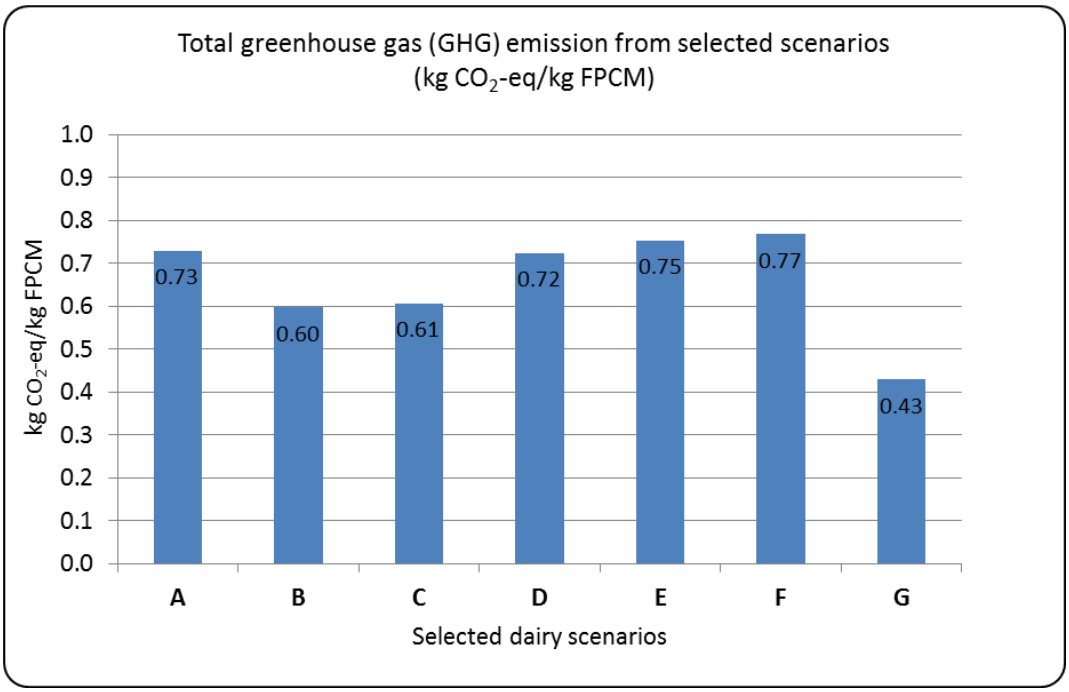


Figure 2. Total greenhouse gas (GHG) emission from selected scenarios.

Within each scenario, the farm sector that contributed the most to GHG emission was the dairy herd itself, via methane emission due to enteric fermentation (Table 7).

Table 7. Greenhouse gas (GHG) emission per sector for selected scenarios.

Greenhouse gas (GHG) emission per sector (kg CO_2-eq/kg FPCM)	A	B	C	D	E	F	G
Dairy herd	0.43	0.37	0.37	0.42	0.44	0.39	0.39
Manure	0.15	0.12	0.12	0.15	0.15	0.18	0.13
On-farm energy use	0.05	0.04	0.04	0.05	0.05	0.06	0.06
Crops and Feeds on-farm	0.06	0.03	0.04	0.07	0.07	0.10	0.10
Crops and Feeds off-farm	0.04	0.03	0.04	0.04	0.04	0.04	0.04
Subtotal Greenhouse gas (GHG) emission (kg CO2-eq/kg FPCM)	0.73	0.60	0.61	0.72	0.75	0.77	0.72
Avoided due to displacement of natural gas (kg CO2-eq/kg FPCM)	-	-	-	-	-	-	(0.29)
TOTAL GHG emission (kg CO2-eq/kg FPCM)	**0.73**	**0.60**	**0.61**	**0.72**	**0.75**	**0.77**	**0.43**

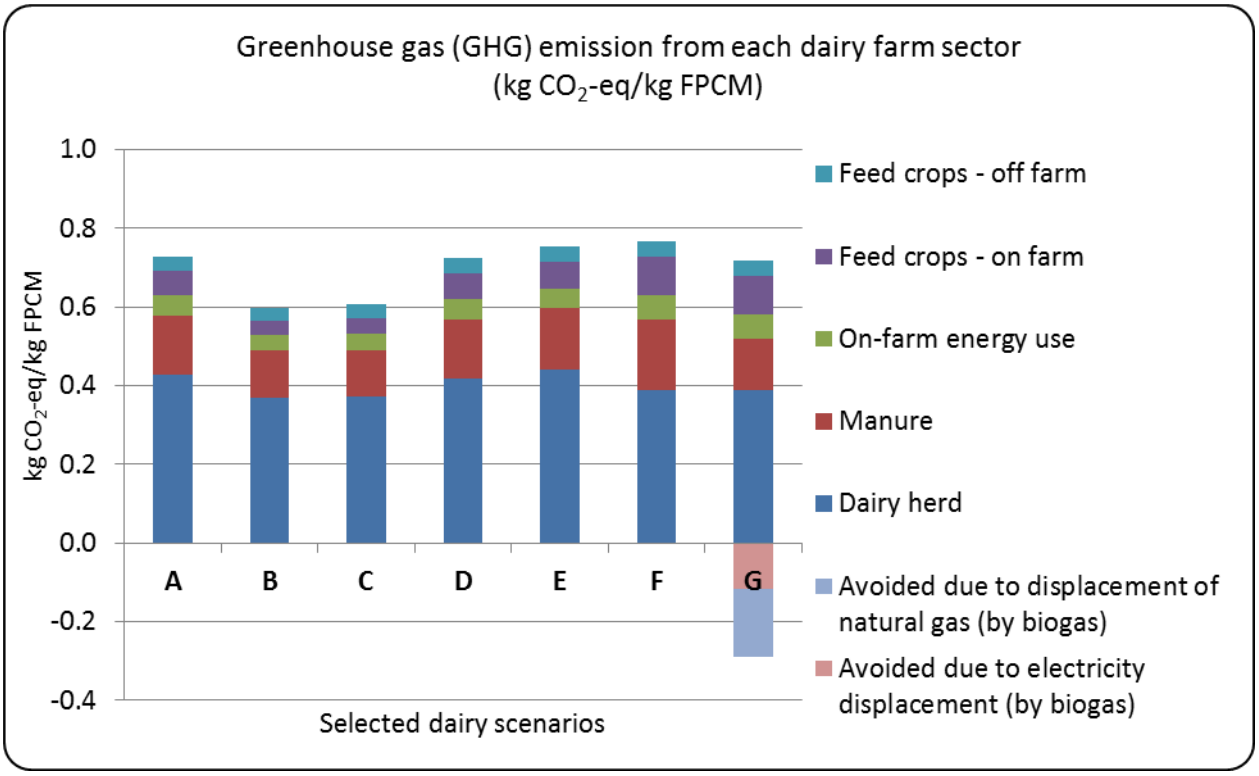


Figure 3. Greenhouse gas (GHG) emission from each dairy farm sector.

In a case study examining dairy farms in the state of Georgia, the carbon footprint of the simulated MIG system was approximately 4% larger than that of the confinement system (Belflower et al. 2012). The differences between the two were largely attributed to the varying management practices and farm characteristics (Belflower et al. 2012). For example, the pasture based system produced lower milk production rates and thus, required additional maintenance of animals for the same amount of milk produced. However, when considering the potential for soil carbon sequestration, the MIG carbon footprint dropped to 12% less than that of the confinement system (Belflower et al. 2012).

In addition to the production of livestock feed, the feeding of forage and concentrate to dairy cows can affect methane emissions. The enteric methane emissions from livestock are strongly influenced by the type and amount of grass forage in their diets. Because they are dependent upon the dry matter intake (DMI) level and quantity of fermentable carbohydrates and non-carbohydrates in the diet, the management of grassland in these systems can strongly influence the amount of methane and nitrogen emissions (Bannink et al. 2010). In exploring different nutritional strategies and their impacts on these emissions, this study found a tradeoff between nitrogen emissions through fecal material and urine and methane emissions through enteric fermentation. The simulations estimated lower methane emissions under higher nitrogen fertilization rates and early cuts of forage, in contrast to the higher methane emissions released under lower fertilization rates and late forage cuts (Bannink et al. 2010). This poses a challenge when optimizing management decisions for different environmental goals, as this study shows that measures taken to decrease nitrogen pollution may result in increased methane emissions (Bannink et al. 2010).

Confinement systems are considered high input-high output operations. Higher inputs such as feed crop production costs, synthetic fertilizers, chemical inputs such as herbicides, and pesticides are associated with higher environmental impacts such as N_2O and CO_2 emissions (Cabrera, Kirksey, and Mathis 2007). The greatest reduction in environmental burdens in dairy operations can come from controlling or reducing the amount of on-farm fertilizer use in forage production. This can be done by incorporating more nitrogen fixing legumes into crop rotations, or incorporating more pasture based feed. In addition, energy efficiency measures taken on farm can decrease GHG emmisions of a dairy operation. These could include the implementation of renewable energy technologies that use biomass, solar, wind, or manure wastes for on-farm electricity production (Arsenault, Tyedmers, and Fredeen 2009)

Results and Discussion: Energy intensity and Land use

The energy intensity of the MIG systems were all less than the confinement system w/o digester, however, the addition of a digester turned the confinement system from the highest net energy user to substantial net energy producer. The trend of energy use was correlated with GHG emissions with the lowest net energy resulting from the highest DMI from pasture.

The land used for milk production was generally lower for the pasture systems than the confinement systems with the exception of scenario C, as this scenario assumed a lower level of crop yield, representative of farms operating on less productive land. This higher level of land use must be put into context with the additional environmental benefits of maintaining pasture cover on lands that may have more highly erodible soils (see following sections).

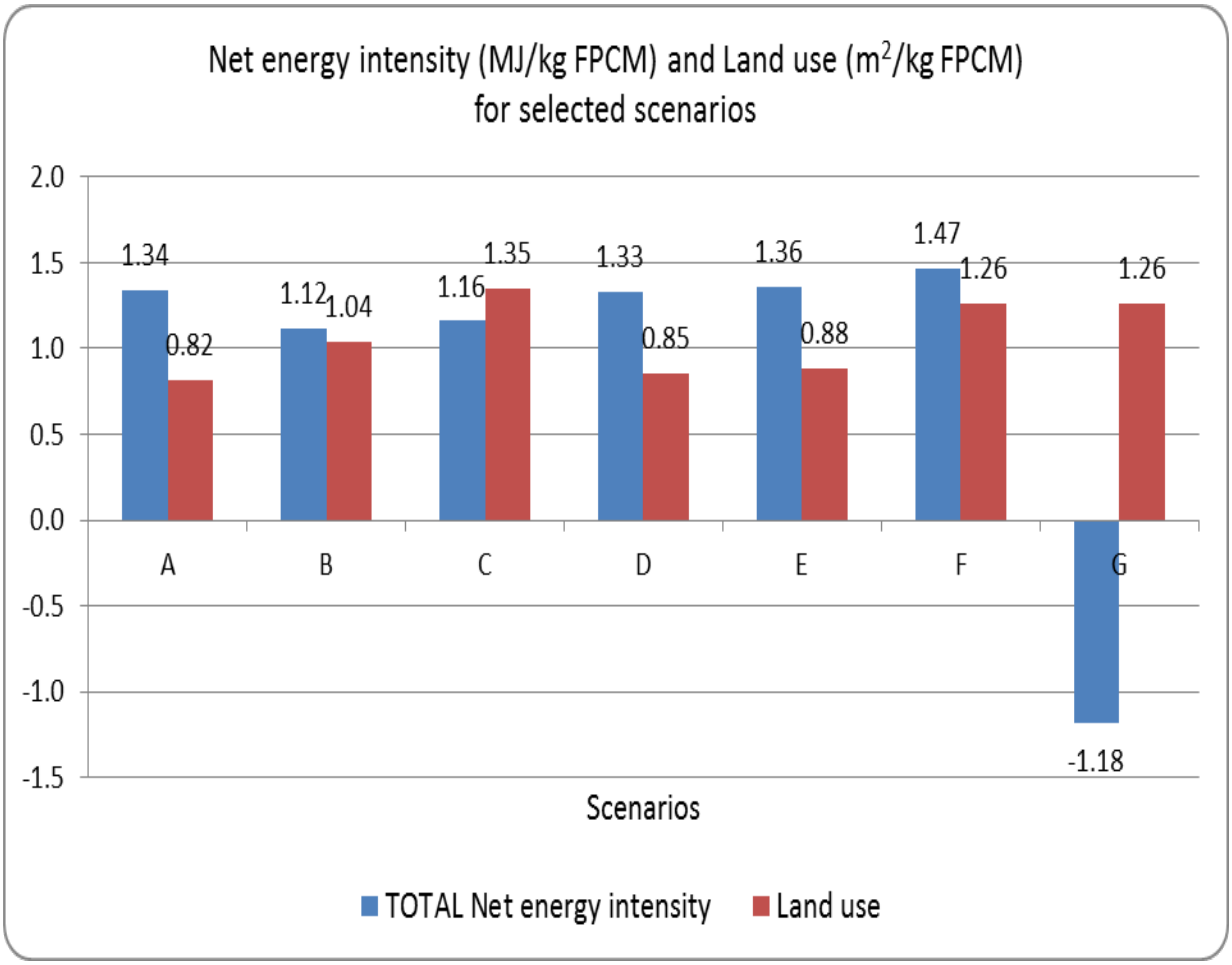


Figure 4. Net energy intensity (MJ/kg FPCM) and Land use (m^2/kg FPCM).

The largest energy user in all scenarios was the energy used to produce the inputs for crop production (fertilizers, fuels, etc), followed by the energy used on the farm for crop production processes (mainly fuels). The reduction in total energy used in MIG scenarios was accounted for primarily by the reduction in the energy used on-farm for crop production. The energy used for manure handling and the processes to maintain the dairy herd and harvest milk were minor contributors in all scenarios.

Table 8. Net energy intensity and Land use for selected scenarios.

Energy use (MJ/kg FPCM)	A	B	C	D	E	F	G
Dairy herd	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Manure handling	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Feed crops - on farm	0.55	0.38	0.36	0.51	0.52	0.67	0.67
Feed crops - off farm	0.72	0.68	0.73	0.75	0.77	0.72	0.72
Energy intensity (MJ/kg FPCM)	1.34	1.12	1.16	1.33	1.36	1.47	1.47
Energy from biogas	-	-	-	-	-	-	-2.39
Avoided due to displacement of natural gas and electricity	-	-	-	-	-	-	-0.26
TOTAL Net Energy intensity (MJ/kg FPCM)	**1.34**	**1.12**	**1.16**	**1.33**	**1.36**	**1.47**	**-1.18**
Land use (m^2/kg FPCM)	**0.82**	**1.04**	**1.35**	**0.85**	**0.88**	**1.26**	**1.26**

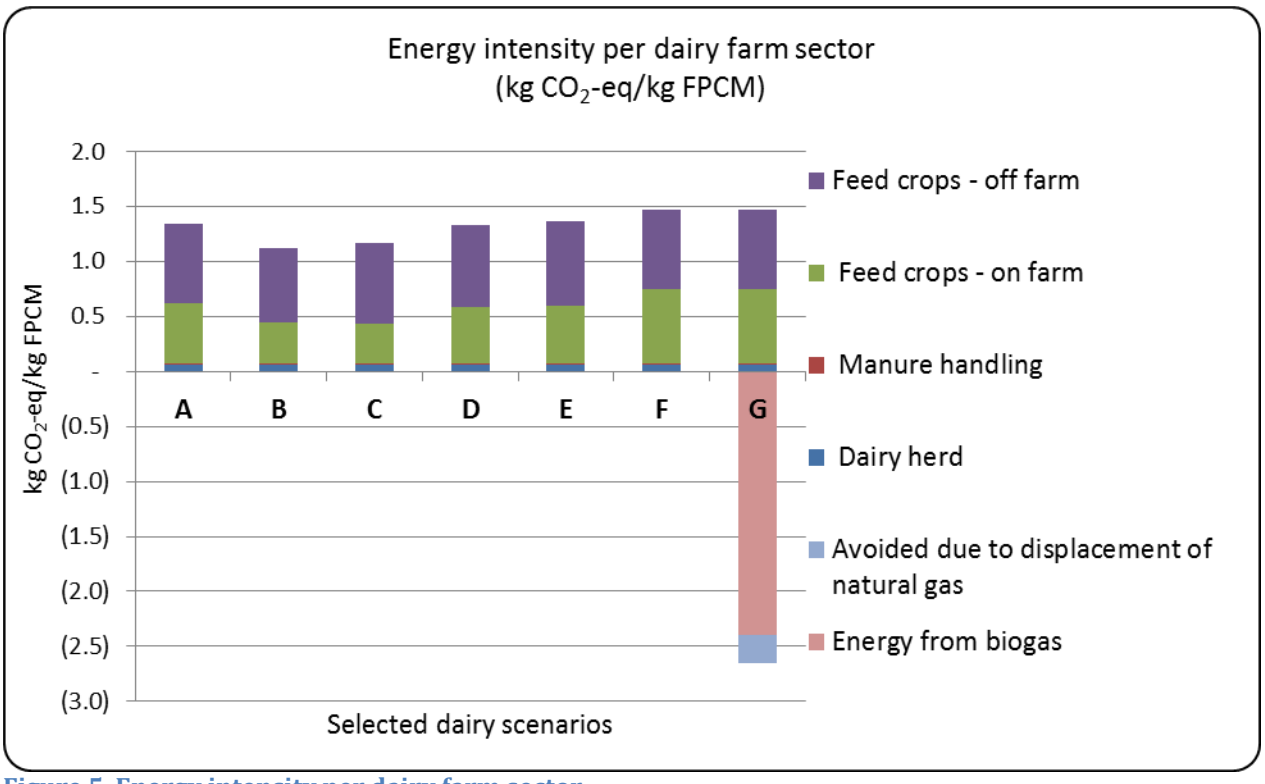


Figure 5. Energy intensity per dairy farm sector.

Other Environmental Impacts

Decisions regarding which type of dairy production system to adopt depend on many factors, including family tradition, lifestyle choices, profitability, land resources, and other social and environmental issues.

A farm must be profitable in order to survive, and profit maximization is a common goal of business management. Several studies have indicated that the type of management system is not the major indicator of profitability. The profitability of both confinement and MIG systems depends on the scale of operations, types of technology adoption, herd health management and general management skill (Brock and Barham 2009; Kriegl and McNair 2005). A study on the financial performance of dairy farms in Wisconsin reported that the simple average Net Farm Income From Operations (NFIFO) from 1995 through 2002 for MIG, traditional (small) confinement, and large modern confinement farms was USD 3.96, 2.39 and 1.50 cents per hundredweight milk equivalent (CWTEQ[7]), respectively. In 2002 the NFIFO for MIG farms ranged from USD 2.05 to 4.22 per CWT EQ, while the range for farms using confinement management systems ranged from USD -0.04 to 2.29 per CWTEQ (Kriegl and Frank 2004). Well managed MIG farms can clearly be economically competitive with other farm types.

Environmental impacts of milk production vary from region to region and according to farming practices and farm characteristics (Belflower et al. 2012). Impacts of dairy operations include soil erosion, nitrogen volatilization from manure, nutrient runoff, and nitrate leaching into the groundwater (Rotz et al. 2009), and can be direct or indirect. Direct impacts include those that occur as a result of the processes in dairy farm operations (Powers and McSorley 2000). Indirect effects are those associated with the processes of producing and transporting the livestock feed and forage from one farm to the dairy operation (Powers and McSorley 2000). The range of environmental impacts depends on land characteristics on which the dairy farm operates (e.g. soil type and slope), the management decisions made by the farmer, and the overall goals of the dairy operation. The best management practices are also not absolute, but rather depend upon the land characteristics, current management practices, and operation goals.

Studies carried out across varying land resources (e.g. soil type and slope) and management practices highlight the dynamic nature of these systems, and how strongly management practices are influenced by the land on which they are conducted. The environmental impacts of these systems are significant, but are often difficult to compare across farms because of their great variability across land types (e.g. soil, slope) and management practices. Below is an overall review of the general environmental impacts of both confined and pasture based dairy farms.

A significant environmental impact of dairy operations comes from an overall nutrient (N, P, K) imbalance (de Boer 2003), where there is a surplus in one component of the system (e.g. livestock

[7] CWTEQ is calculated as total revenues divided by the average milk revenues per CWT (100 lbs. or 45.2 kg) of milk produced.

containment operation) and a deficit in another (e.g. soils in cropping systems that produce livestock feed and forage). These imbalances present problems such as reduced local water quality, nutrient runoff, nitrate leaching, nitrogen emissions, or nitrogen deficit in cropping fields. They can result from manure storage and handling, and biomass extraction from the local system and transport elsewhere to where the livestock are located (de Boer 2003).

Other environmental impacts of both confinement and MIG dairy operations include soil erosion, greenhouse gas emissions, and resource consumption (de Boer 2003). Comparisons between grazing and confined dairies have been evaluated to examine their carbon footprint, extent of nitrate leaching, and ammonia volatilization. Because of the complex and dynamic nature of dairy farming operations, field empirical studies of the environmental impacts are often logistically infeasible. The application of LCA models is highly effective in estimating GHG emissions and other environmental factors over a range of farming operations, locations, local soil and climate conditions, management practices, and scales (Rotz et al. 2009).

The largest contributor to environmental impacts in dairy operations was reported by Belflower et al. 2012, to be the production and transport of livestock feed. The cropping systems that grow the livestock feed are highly influential to the overall environmental impacts of the system. When compared to conventional confinement dairy operations, rotational grazing operations can deliver positive environmental benefits including improved soil and water quality, wildlife habitat improvement, and improvement of livestock health (Thomassen and de Boer 2005). The substitution of pasture vegetation that is harvested by the livestock for mechanically harvested feed can also significantly reduce the production costs (Kriegl and McNair 2005).

In a study comparing modern dairy operations, (Capper, Cady, and Bauman 2009) found that 90% of global warming, eutrophication, and acidification potential occur during the on-farm production phase of the dairy operation. Annually tilled row crop systems that rely heavily on chemical inputs such as synthetic fertilizers or pesticides contribute to the upstream environmental costs (Arsenault, Tyedmers, and Fredeen 2009). The impacts of growing crops in such conditions include loss of soil and nutrients to runoff and erosion, eutrophication of local water bodies (Arsenault, Tyedmers, and Fredeen 2009), and are exacerbated by production of these crops on soils that are highly erodible or on land that is steeply sloped. The distance between the croplands and the livestock operation is also a determinant in the amount of emissions released and the consumption of fossil fuels in the transportation of the feed to the livestock operation (Arsenault, Tyedmers, and Fredeen 2009).

Nutrient Imbalance Impacts

The manure management costs of confinement dairy operations are much higher than in pasture based dairy systems, as they require significant overhead for manure storage, transport, and application (Arsenault, Tyedmers, and Fredeen 2009). In a MIG system the manure is delivered directly to the field during grazing, where it decomposes and becomes available for plant uptake. However, management is still required for wastewater or organic bedding material that is applied from milking parlors or other housing areas of the operation (Moynihan 2007).

The Georgia study found that the soil type was a strong contributor to the extent of the nitrogen dynamics. The combination of high nitrogen concentrations from urine and fecal deposits on the small pasture area with local coarse soil texture drove higher nitrate N leaching (151 kg ha^{-1}) on the simulated MIG dairy operation when compared to the confinement dairy operation (7.0 kg ha^{-1}) (Belflower et al. 2012). When comparing rates of soluble phosphorus and erosion at MIG and confined dairy operations, rates of both were much higher at the confined operation due to the high clay content of the soil. In addition, the land surrounding the confinement operation was tilled each year for annual row crop production (Belflower et al. 2012), which contributed to overall erosion and P runoff.

The contribution of farm operation characteristics was illustrated by the reported higher rates of ammonia volatilization from the confinement dairy operation (88.5 kg cow^{-1}) than the MIG (26.4 kg cow^{-1}) operation. This was attributed to the storage of manure within the housing facility, on barn floors, and application of manure on the land (Belflower et al. 2012). The sandier soils of the simulated MIG operation generated less erosion and less nutirent runoff, but generated greater nitrate leaching rates than the confined dairy operation situated on clay soils (Belflower et al. 2012).

Confinement dairy operations require importing all livestock feed and concentrates into the system, which creates a higher input system overall. Inputs involved with feed crop production include synthetic fertilizers, herbicides and pesticides, and are associated with higher environmental impacts (Cabrera, Kirksey, and Mathis 2007). A grazing system includes the return of nutrients (N,P,K) to the system for plant uptake, rather than transport out of the system, which reduces the nutrient deficit of the system (Cabrera, Kirksey, and Mathis 2007), and puts the dairy production system back into balance. Nitrogen is deposited to the land by urine and fecal matter, and when there is insufficient plant cover for N uptake, much of that N is leached into the groundwater as nitrate (Rotz et al. 2009).

Soil and Water Quality Impacts

Farm management decisions have a strong influence on both ground and surface water bodies. The use of chemical fertilizers, agricultural chemicals, and livestock manure has resulted in ground and surface water contamination (DiGiacomo et al. 2001). The potential impacts of these dairy operations on soil and water quality are mainly attributed to the production of feed that is required for livestock in a confined operation system (Arriaga et al. 2009). Annual row crops grown on marginal land (i.e. land with steep slopes and/or having highly erodible soils) are a substantial contributor to soil erosion, surface water pollution, and reduced soil productivity. Eutrophication coupled with reduced dissolved oxygen levels in surface water bodies has resulted in large scale fish kills, while elevated levels of nitrate have also been recorded in domestic wells (DiGiacomo et al. 2001).

Conversion of cultivated land to perennial pasture forages can increase soil aggregate stability, water infiltration rates, water holding capacity, and soil organic matter, all of which facilitate overall soil productivity (Belflower et al. 2012). The decrease in soil disturbance frequency from tillage facilitates reduced soil loss through erosion or soil carbon loss via oxidation. Perennial forage grasses grown for grazing can help to maintain a consistent vegetative cover and provide feed for livestock in dairy operations, decreasing the reliance on high input and high impact cropping systems for feed (Moynihan 2007).

Research in Minnesota from 1998-2000 monitored soil and water quality data across three farm types in the Sand Creek Watershed; a grazing dairy farm, an organic grazing dairy farm, and a rotational grazing beef cattle farm. The grazing dairy farm grew grass, legume, and hay production for over ten years and was on moderately sloping (average 2%) land. During a significant rain event in June 1998, this site experienced sediment loss of 0.8 pounds $acre^{-1}$, with similarly low values of N and P loss. During the same rain event, an annual tilled corn and soybean rotation farm on similar soils nearby lost 5 - 10 tons $acre^{-1}$ of sediment (DiGiacomo et al. 2001). The organic dairy grazing farm was situated on different soils and steeper slopes (up to 18%) and consisted of a mixture of pasture, forages, and crops. Contour strips were used on steeper portions of the site and were in an oats, alfalfa, and corn rotation. During the same 1998 rain event, this farm lost 52.8 pounds of soil per acre (DiGiacomo et al. 2001). At all three farm sites, the grazed land was shown to reduce nutrient and chemical runoff, and dramatically reduce soil erosion.

The management of grazing vegetation is an important driver of local water quality. Well managed pastures can act as large buffers to local riparian water bodies (Lyons et al. 2000). However, when pastures are over-grazed or over-stocked, concentrated areas of ground can be churned up by hoof action. As a result, greater sediment loss can occur during a runoff event. In the same study, the grazing beef cattle farm in a different watershed lost an average of 6.5 pounds per acre during two significant (but separate from above) rain events (DiGiacomo et al. 2001).

The implementation of a grazing system can produce a more dense vegetative cover, and in turn reduce potential soil loss by erosion. An intact vegetative cover holds soil in place during large storm events and facilitates greater water infiltration. The benefits of such a practice include reduced loss of soil and nutrient runoff, and a reduction in the local nutrient deficit. Such an effect can deliver net environmental benefits such as improved soil and water quality, in addition to long-term farm profitability (Rayburn 1993).

Wildlife Habitat, Rural Aesthetics, and Animal Herd Health

Anecdotal and observational evidence in the literature and across popular farm media describe a link between environmentally positive practices such as rotational grazing, and an improvement in herd health and environmental quality (Arsenault, Tyedmers, and Fredeen 2009). The increased use of high quality pasture can result in improvements in animal health and on-farm wildlife habitat.

Studies have been conducted to explore the valuation of livestock production systems beyond the provision of dairy products. Additional benefits to a pasture based dairy operation include the aesthetics of open pastoral lands with grazing livestock (Moynihan 2007). These pastures can also provide wildlife habitat, particularly for meadow birds. Research has also shown that fish populations are more prolific in areas close to land in rotational grazing than those close to conventional cropland (Hendershot 2004).

A study conducted in the Netherlands (Boogaard, Oosting, and Bock 2008) identified nine themes of value beyond food production in dairy operations, particularly emphasizing landscape, nature, and culture. Study participants expressed value for such things as “respecting animals’ naturalness”,

"maintaining landscape and nature", and that the image of cows grazing in an open field is valued as part of the Dutch national identity (Boogaard, Oosting, and Bock 2008).

Anecdotal information in the popular farm media suggests a link between rotational grazing and an improvement in herd health when compared to traditional confinement feeding production systems. Graziers report that their livestock are less stressed in a pasture environment, which reduces their vulnerability to disease and infection (Moynihan 2007). There are also many reports of fewer leg and hoof problems among grazing livestock, as the hooves wear normally on the sod, and there is less exposure to manure buildup. In addition, grazing livestock receive more exercise than their confined counterparts, which improves the animals' overall health (Moynihan 2007).

Best Management Practices

Because of the great diversity in farming operations, local climate and soil conditions, there is no single overarching best management practice for dairy operators. A study on simulated dariy operations in Nova Scotia found that given a climate that provides sufficient precipitation during spring, summer, and early fall, pasture systems can produce at least 9,000 kg milk per cow per year with fewer inputs. This is within a system with management aims of producing high quality vegetative livestock feed (Arsenault, Tyedmers, and Fredeen 2009).

Much of the information around dairy operation systems remains anecdotal and the variability in these systems is great. Variability is attributed to management practices and farm location, and certain environmental impacts are sensitive to one, the other, or both. For example, Jackson et al (2007) found that soil inorganic nitrogen was more variable across location than across management practices, when considering MIG or a continuous grazing system. They also found that N_2O fluxes are more sensitive to management, while CH_4 fluxes are more sensitive to location.

Management interventions to reduce environmental impact can include changes in livestock diets, manure management methods, and pasture management. The use of synthetic nitrogen fertilizers to grow livestock feed is usually displaced by the growth of leguminous forage on the landscape in MIG systems. The reduction in the use of synthetic fertilizer reduces emissions of GHG during fertilizer production (Jackson, Bell, and Gratton 2007). However these GHG reductions may be offset by other GHG emissions resulting from other MIG practices.

There is a high level of uncertainty in estimating the environmental impacts of complex agricultural production systems in different contexts. This complicates the decision process of farmers, society and policy makers in determining specific management practices that are more environmentally friendly and sustainable than others. Life Cycle Assessment (LCA) provides a systematic method to assess the environmental impacts of complex systems and has been applied to MIG systems in this study.

Farmers' Perspectives

There are numerous drivers to farmers' decision making processes that are rooted in their social and historical context. We have identified these drivers through the use of surveys and focus groups.

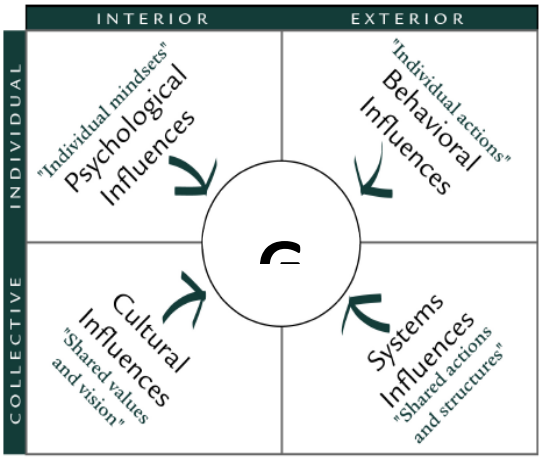
Focus groups are "groups of people who possess certain characteristics and provide qualitative data in a focused discussion to help understand the topic of interest. The purpose of focus groups is to listen and gather information; to better understand how people feel or think about an issue, product, or service. The intent of the focus group is to promote self-disclosure among participants so that they express what they really think and feel. Participants are selected for their characteristics in common that relate to the topic of the focus group. The researcher creates a permissive environment in the focus group that encourages participants to share perceptions and points of view, without pressuring participants to vote or reach consensus. The group discussion is conducted several times with similar types of participants so the researcher can identify trends and patterns. The researcher compares and contrasts data collected from at least three focus groups. Careful and systematic analysis of the discussions provides clues and insights as to how a product, service, or opportunity is perceived" (Krueger and Casey 2009).

To gather information on the perspectives of graziers on the challenges and benefits of pasture-based milk production, two focus groups were conducted in Michigan and one in Wisconsin. Farmers were asked to discuss their motivations for grazing, views on grazing practices, sense of community and their perceptions of how others perceive grazing:

> *What does the grazing mindset look like? How do farmers that practice management intensive rotational grazing perceive their own operations? What motivates farmers to adopt pasture-based (rather than confined) milk production? What are the different ways of conceiving of nature in the dairy sector? What are the different communication systems in the dairy sector? What and how do farmers (get to) know about the environmental consequences of their practices?*

Integral Theory framework

We use the framework of Integral Theory as guide to develop the structure of our interviews and focus groups as well as to categorize the responses. Integral Theory divides any event into four interactive quadrants: individual interiors, individual exteriors, collective interiors and collective exteriors. Interior aspects are clearly drivers in external actions and shape our interaction with our environment. Likewise, the external world clearly influences our interior development. Integral Theory is an attempt to bring all of these aspects into the analysis of any event or system.



Integral methodological pluralism attempts to include aspects of subjectivity (what is my experience of the world) and inter-subjectivity (what is our shared understanding or meaning of the world) — in addition to objective scientific, technological, and economic perspectives and resources—to the seeking of human self-actualization and global sustainability (Esbjörn-Hargens and Zimmerman 2009). Esbjörn-Hargens and Zimmerman, (2009) state that: One of the biggest breakthroughs for dealing with environmental problems would be to acknowledge that individual and collective interiors exist, that they develop, that there are multiple ways of conceiving of nature, and that a successful ecology must learn to communicate in accordance with such an understanding.

The integral framework recognizes and draws on first-person (my view of my interior), second-person (my view of another's interior) and third-person (my view of individual and collective exteriors) perspectives. According to Esbjörn-Hagens and Zimmerman (2009), this is an integral "multiperspectival" approach to characterize and solve environmental problems. It requires that the interior and exterior of individual and collective realities be represented: the personal ("I"), behavioral ("it"), cultural ("we") and social or systems ("its").

- Subjective realities (I) are most accurately known through felt-experience (e.g., direct perception, introspection, phenomenological investigation, meditation);
- Inter-subjective realities (we) are most accurately known through mutual resonance (e.g., dialogue, shared depth, participant-observer techniques, interpretation);
- Objective (It) realities are most accurately known through measurement (e.g., laboratory observation, field research, chemical testing, statistical analysis);
- Inter-objective realities (its) are most accurately known through functional-fit (e.g., part-whole relationships, observation of systemic dynamics, instrumental function, energy flows, feedback loops)." Adapted from (Esbjörn-Hargens 2005).

According to Luhmann, the environment can make itself noticed only by means of communicative irritations or disturbances, and then these have to react to themselves. Only a communicated environmental disturbance can matter to society. Communication is necessary to coordinate actions to restore equilibrium. Social systems include communication, which generates behavior. How does this communication coordinate actions to sustain the system's equilibrium? For Luhmann, there is a gap between ecological consciousness and effective social communication, which has a significant resonance threshold. Ecological social communication is about whether current dealings with the natural environment will undermine the social structure that depends on it. Such a communication of possible disaster may or may not resonate with the frequencies that define social subsystems. So far it has been an inevitable aspect of society that the next step in autopoiesis is more important than concern for the long term futures (Adapted from Esbjörn-Hargens and Zimmerman 2009).

Farmers' responses to questions about their motivations for grazing, their views on grazing practices, sense of community and their perceptions of how others perceive grazing were categorized within the four quadrants of the Integral Theory framework: individual interior (personal or I), individual exterior (behaviors or it),, collective interior (cultural or we) and collective exterior (social systems and behaviors or its).

Individual Interior – The personal ("I")

In the case of the Wisconsin and Michigan graziers, the individual interior represents their personal valuation or reasoning for choosing pasture-based dairy farming. Many of the farmers spoke of ideals of environmental stewardship, a gained sense of connection to nature and a desire to minimize their ecological impact as motivations.

> *"I feel like I'm being good environmentally to the soil—building the soil versus taking it, mining it."*
>
> *"You feel like you're more part of, more in communion with the cows…in connection with your environment, with nature, the seasons and their cycles."*
>
> *"I feel good about how I am farming, I feel like I am adding something good to the world."*

There was much discussion of the difference between controlling nature and working with nature and how the environment dictated their decision-making and management style.

> *"The confinement people like to do things with what they have to make it work for them. We look at what we have and work with it."*
>
> *"We are trying to work with nature and make things fit rather than taking the system that is being imposed on us and trying to fit [it] into the farm."*

Personality, attitude and a strong sense of independence and entrepreneurship also played key roles in their decision to graze. Some farmers experienced conventional dairy farming and transitioned, while others grazed from the start. Both groups expressed a willingness to take a risk of doing something they had little or no practice with. The desire for community and support networks was also expressed. The importance of trust and willingness to share were said to be vital in creating farmer-to-farmer connections and improving the grazing community as a whole.

> *"[Grazing takes] a certain kind of person, someone who likes to be challenged, someone who likes to think outside the box, someone who enjoys that sort of thing."*
>
> *"There is also a certain aspect of what we do and what we enjoy about it is control, the ability to control more of our own decisions and choices, to have control over the business."*
>
> *"People who graze in my experience have a different attitude about sharing information about their operation. I remember one of our early grazing conferences had a panel of people talking about their financial performance; they were willing to talk about the mistakes they made as well as the things they did right. I really see potential to create a community in which you can share things and really learn from each other a lot more than I might experience from traditional extension programming and kind of the more mainstream farmers who are less inclined to have that sharing go on."*

Other reasons these farmers chose grazing rather than confinement were family tradition, a sense of personal fulfillment, or simply for the financial incentives.

> *"We have always grazed; my father did and now I do."*
>
> *"They always said farming was a way of life, but farming is a business too. So to some people it's more of a business, to [us] it's more a way of life."*

"We are interested in grazing as a way to survive the difficult economy, to reduce our costs associated with growing feed. Corn, gas, fertilizer—it's all so expensive."

Individual Exterior – The Behavioral ("it")

The individual exterior explores how the farmers viewed grazing, their farms and management practices. It is an approach based on representing the objectivity of the farmers' environment, what is 'visible' to them. In general, farmers were more likely to compare grazing and their farm to other systems rather than describing their immediate, physical environment. Common responses included comparing production levels, inputs and profit margins to confined systems.

"Pasture-based dairy farms have lower inputs, higher margins, and a more stable milk income."

"Graziers use fewer chemicals, less herbicides on our lands. We have less erosion"

"Pasture-based dairy farms require less investment, involve less disease, less manure removal and management issues, and are less harmful to the land than confinement dairy farms."

"We feed grass and maybe supplement with something else, but for them [confined operations] it's the opposite…they use the grass as a supplement. They get the cows out and get the benefits of cow health, cows getting exercise, the savings of feed costs."

Farmers also compared their grazing techniques and styles to other grazing farmers. This range or spectrum of grazing methods was positively received and illustrated in the individual interior as the independent lifestyle that was a reason to choose grazing.

"Each farm is very unique in the way that it gets grazed. It's very unique to each individual."

"It's such a variance in systems, and grazing heights, and how fast you go around the grazing cycles, and there is no cut and dry 'this is the way you do it, and this is the correct way.' "

"We're still trying to graze the same piece of land… but he's completely different, and both would work."

Other aspects of grazing perceived by the farmers were the decreased risk of injury and lessened infrastructure costs due to the minimized use of heavy machinery in MIG systems.

"I really appreciate the safety of farming like this because we have so much less equipment."

"[Safety] was one of the reasons I made the switch, because I didn't like the idea of our kids being around a lot of machinery."

"Driving a tractor every day just presents more dangers, more opportunities [for accidents]."

"I don't want the financial burden of a machine."

Collective Interior – The Cultural ("we")

The shared, cultural "we" of the collective interior serves to define the grazing community by its members. In their responses, farmers displayed mixed feelings about their sense of and connection to community. Experiences varied depending on the farmer's location and connection to other farmers.

"I like the community… I like us. It's not very often you can get this many people together that have the same idea and can get along."

"I suppose there is a lot of grazing people but I don't know if there is much of community about it."

"I don't feel connected to grazing as a community."

"Our area has a lot of graziers and there is some community; we bounce off ideas with each other."

"I think the dairy grazing community is more challenging because those farms are even more scattered around the state."

Some of the farmers considered the grazing community to be setting an example for the dairy industry as a way to create business that benefits more people.

"I see [the grazing community] as an example of what things should be more like, and the only way you get any change in the world is by setting an example. I think if there were more small farms doing what we're doing, it could be good for the county, good for the state, and all the way up through. If you can establish that and maintain it, it can be a better world for us."

"I think most of us here have a role of educating people about what we do and why we do it."

"We can do something different and we can succeed. We create business…because in my mind if we have 20 of our farms in five square miles, everybody would be better off than having one big one right up on the hill. It just creates more business, having more little entities."

Other farmers who expressed feelings of disconnect from a community spoke of the need for leadership in the grazing movement and a united effort to bring stability to the dairy industry.

"Somewhere the industry needs a designated leadership. We have farmers all over the state. It is possible they can do it themselves but I also have a huge investment in all of this infrastructure. We need to ask of our government that our tax dollars are spent to put something together that has some stability. We need to bring back stability to this industry."

Collective Exterior – The Social/Systems ("its")

The collective exterior examines the ecological, economic, political and social systems affecting the farmers and grazing community through a third-person perspective. The farmers were asked to discuss their perceptions of how others perceive MIG dairy. The farmers imagined there to be both positive and negative opinions of the environmental and economic impacts of grazing.

"As a whole I think we are perceived as being more environmentally friendly. We use less fossil fuels."

"Cows live longer. It is better for the cow than feeding grain. Corn is a new feed for cattle; it's not good for them. It increases quality of life and consumers like the idea."

"Some people think that it's a waste of time and effort; the land could be used for better things; you could grow things on that!"

"[The cows] are burning off calories when you let them walk around."

"They think we just let it go and don't do anything, that it is unmanaged."

"It's perceived as low-tech."

"Farmers think you are a nut because you could have had about five times more money per acre. That's what they think, but they don't take feed into account."

"There is a perception that bigger and more is better. If you graze you can't brag about how many cows you have, and people won't take you very seriously. With a small number of cows they will call you a hobby farmer, not a serious dairy farmer. It's a whole differnt mentality."

Some farmers talked about the general public's confusion over defining 'pastured' and grazing systems.

"When I talk about 'pasture-based' with the general public they ask, 'What does that mean?' I tell them, 'Well that means our cows can go out and graze.' Then they say, 'Don't they [dairy fams] all?' So I'll point out that we are 100% pastured-based. And they say, 'Well, what is the big deal? All milk is 100% pasture?' They confuse pasture with pasteurized."

There was unanimous agreement among the farmers that support from their state land-grant universities and Extension services was lacking for grazing research and development.

"We do get environmental information from Extension, but we get the impression anyhow that the effort being put out at the university is rather small."

"We need more of a scientific base for grazing. We need to be able to show that it is better for certain reasons. We also need to know what to plant for forage."

"Has [the university] studied the health benefits of pasture milk? We need this information and more research."

"It's a problem of lack of exposure; we need more pasture walks and farm visits. Extension has more validity; they should be exposing farmers to it."

"We have lost grazing Extension educators who led pasture walks, and that has caused some of these pasture walk groups to fall apart in the last couple of years. I think those communities have disintegrated in many cases."

"No offense against Extension but we may need to start looking at [other governmental agencies] because they are emerging, but we need people with livestock expertise. I don't think they have that many livestock experts. But we may need to rely on other governmental agencies or maybe we need to create some new partnerships we haven't necessarily done before."

Farmers also felt that federal cost-share and conservation-incentive programs did not provide enough economic incentive to encourage participation for graziers.

"It's just awful. They will pay you if you want to graze but you have to make certain improvements, and you have to pay for them, and the amount they are going to pay you is just [not enough]… there were hundreds of improvements."

"Land improvements would have been really expensive. Fencing is a big one. I think the most you could get was like $30/acre/year."

"Access to programs and aid for fencing and cost-sharing are expensive."

When asked why there are no grazing milk cooperatives in their state, Michigan farmers indicated that the lack of marketing and product differentiation between grass-fed milk and conventional or organic were to blame. With no price or marketing distinction, little consumer demand is created. The complex logistics of operating a co-op with small-scale production and high transportation costs were also discussed.

"I think it's almost like milk is milk whether it's coming from a grazing co-op or from a [conventional] co-op. It is the worst marketing ever."

"The way our system is structured you have these co-ops that consolidate milk. They are the ones that are responsible for hauling it from the farm to the processing plant. But they are scaled to the point that the way they pay for their milk is to have volume premiums so the more you shed...they are not excited about dealing with smaller scale farms."

"Production for grazing is lower but more profitable because there is less expense - but still lower production … a lot of co-ops I have talked want our production at a certain [level] or they aren't going to bother to go out and get your milk."

"They want you to sell a certain amount; they want us to have so much milk out there or they aren't wasting their time with you."

"The grazing community is so scattered around this state; it is an expense to gather that milk in a co-op situation. They would rather just pack a semi up and fill it up."

"Why do they want to go to 10 different dairy farms milking 100 cows each when they could go to one dairy farm to milk 1,000 cows."

The four perspectives of the integral model are considered irreducible, meaning excluding any one of them can lead to a partial or incomplete understanding of a problem and its solution. Using such a comprehensive approach to analyze the graziers' mindset and external environment created a framework with which to organize these complex issues. Strategies for developing a more environmentally, politically, socially and economically sustainable system need to address the role of the dairy industry at large, the grazing community and the individual farmer.

Summary and Conclusions

The GHG emissions for MIG systems decreased as the percentage of annual DMI from pasture increased. Herds obtaining 30% of their annual DMI from pasture (very high for Wisconsin conditions) with a seasonal calving had about 20% less GHG emissions per Kg of milk produced than those that used less pasture (5-16% annual DMI), annual calving and higher levels of supplemental feed to increase milk production. MIG systems had similar or reduced GHG than confinement management systems but the addition of an anaerobic digester to a confinement system produced lower GHG emissions than and of the MIG systems. The major source of GHG emissions for all systems was enteric methane emissions from cows. Our model predicted small changes in enteric methane emissions accounted for by changes in the diet, however, these predictions are subject to much uncertainty. Research is being conducted to improve the prediction of the effect of diet on enteric methane emissions and the results of this research will improve these estimates in the future. It is unlikely, however, that there are substantial gains to be made in enteric methane emissions from modifying the dairy diet.

The net energy intensity of milk production followed a similar trend as GHG emissions with the high pasture DMI scenarios having about 16% lower than the higher input MIG systems. The MIG systems all had lower energy inputs than the confinement system but the addition of an anaerobic digester on the confinement system resulted in this scenario being a net energy producer. The vast majority of the energy inputs for all systems were accounted for by crop production with energy used to produce crop inputs (primarily nitrogen fertilizer) being somewhat larger than the energy used on the farm for tillage, planting and harvesting crops. The main reduction in energy use was accounted for by a reduction in the on-farm energy used for crop production as the percentage of annual DMI increased.

The land used to produce one kg of milk was generally lower for the MIG systems than for the confinement systems; however, the MIG scenario assuming moderate to low productivity land had the highest land use footprint. This result shows the importance of location in the analysis of any agricultural production system. Land that is less productive is often more environmentally sensitive and the corresponding environmental benefits of MIG on these land (continuous crop cover versus annual harvest and tillage) is much more pronounced than on less sensitive lands.

The environmental impacts of GHG emissions, energy intensity and land area uses are the most common in LCA analysis. There are a number of other environmental impacts that are typically not addressed by LCA because they are much more difficult to assess and/or not suited to LCA analysis. These include the very important impacts of:

- Soil erosion
- Nutrient runoff and leaching,
- Soil carbon, organic matter and general soil health
- Animal welfare
- Biodiversity: both on the micro scale (soil fauna) and macro scale (insects, birds, vertebrates)

In addition to the impacts on these physical assets of the ecosystem, farms and farming systems are part of the social ecosystem. It is clear from our investigation into personal, cultural and societal aspects that there are a number of positive benefits to individuals and communities that graziers attribute to the practice of MIG. We look forward to further work by other physical and social scientists to expand our perspectives to better understand the broader ecological implications of MIG as well as other agricultural production systems.

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Appendix A. LCA Assumptions

Table 9. Temperature in WI. Average range in years 1959 through 2009 (°C).

Season	Min average (°C)	Max average (°C)
Grazing (May – September)	6.05 - 7.61	19.33
Confined (October – April)	-8.28	6.05 - 7.61

Table 10. Crops and forage yields for selected scenarios.

Crops and Forages	High yields (kg DM/ha)	Medium-Low yields (kg DM/ha)
Intensively managed pasture	9,000	7,200
Harvested legume silage	7,865	6,292
Harvested corn silage	19,338	15,470
Cotton (whole plant)	793	n/a
Corn grain	7,591	6,072
Soybean	2,386	1,909

Appendix B. Transcript of Focus Group discussions

Th: What sort of things would encourage more farms to practice pasture based dairy? (examples: Milk price support, Less regulation, More regulation, Animal welfare regulation, More subsidies, Less subsidies). What do you think in your context, your situation, your state would encourage more farms…

Farmer Bt: to start grazing? my answers, one it would be a higher milk price

Th: specific for grass fed?

Farmer Bt: Yes. If I could tell my neighbor that if they shift to pasture land they will get 26 dollars a 100 weight to the grazing season, they would certainly think about it

Farmer B: like organic products people were not even considering 15-20 years ago. It was not a very common place thing and now you cannot walk into a store without seeing a shelf dedicated strictly to organic products. And I think the biggest reason for that is because the idea of we are getting paid a certain amount from our dairy and our hero is our neighbor who is organic and he is making money hand over fist. What are we doing, why are we doing this? That's such a big motivator when it comes to that, so…

Th: how do you create that market, the structure? A label, who would label it, who would certify?

Farmer J: it doesn't revolve around the farm, but I think there should be more educating the public on what good food is.

Farmer T: No, I don't think you need to educate. I think the people that are really impressed with it are the people that are really into quality food. The people that are most interested in our project is people that are in the food industry like Shafts and what not. So, you want a certain group of people that want something that tastes better. And we're motivated for grass-based is not so much the health side, but the taste side.

Farmer C: I think around Madison more people are interested in that health aspect of it; is it healthier than the other products to eat?

Farmer H: most people consider our product to be organic, even though this, we haven't labeled it.

Farmer ?: they're confused

Farmer H: They automatically make that association. We're grass fed, "Oh, you guys are organic." Well, no. Farmer T.: [Grass-based milk] tastes better[8].

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[8] The "better taste" of grass fed milk has not yet been validated by the study that has been conducted since 2008 using the milk from these farms [the farms that belong to the participants of this focus group] to *"explore the physical, chemical and culinary differences between dairy products from the milk of pastured cows versus those made with milk from conventionally fed*

Farmer B.: In a way it's easier to stay with what makes sense to you instead of trying to make a change.

Farmer T.: Or to struggling… do you take the risk of doing something you don't know nothing about? Why gamble?

Farmer Tr.: The stress level is so much less grazing than conventional (…) my husband (…) had a little more free time (…) a little more social, instead of being isolated. [Grazing system means more] family time. And you feel good about how you're farming, you feel like you're adding something good to the world (…), it makes you feel good.

Farmer Tr.: [Grazing would be appealing to] A certain kind of person, someone who likes to be challenged, someone who likes to think outside the box, someone who enjoys that sort of thing.

Farmer Tr.: [Grazing] is fun!!

Farmer T.: [Grazing] is fun. (…) I think it's a more enjoyable way of farm, it just is.

Farmer Bt.: I hate [machinery]. I sowed grain for a day and a half and I was tired of it, more than happy to park the tractor and leave it there. I'm done. And ho, I am not missing planting corn this year.

Farmer T.: not me, it's just that the cows are on pasture and… and there is just they [the cows] enjoy it [the pasture], you enjoy it, it's like things should be so as to say

Farmer D.: we catch ourselves after milking in the evenings, … we go out, and it's getting dusk out and just listen to them eating, and that sound is like the best in the world

Farmer Tr.: it's soulful, it's so… soulful

Farmer T.: yeah, the sound, the smell, the cows on the pasture smell, there is something really nice and earthy and good about it.

Farmer Tr.: and the birds, and the breeze, and the

Farmer Bt.: there's nothing like that experience of being out in the pasture when those cows are starting to graze a fresh paddock

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cows". So far, *"grass-based dairy products have a yellower color, a softer, creamier texture, and a flavor that has been described as 'complex'"*. UW scientist Scott Rankin said that when asked how much they liked the products, people generally *"liked the conventional milk more. One-hundred people said they preferred the milk from conventionally fed cows, while 50 said they preferred the milk from the grazed cows. On a scale of 1 to 10, the conventional milk outscored the "grass-fed" milk 6.3 to 5.8. (…) The milk from grazed cows had a "very distinct, unique flavor,"* Rankin added. But he hinted that perhaps more people would like it as they become "educated" about it. The 2011 annual report of the study says *"the chemistry data is not as clear-cut as we had expected. Fatty acid profiles are not significantly different among the samples and no single constituent seems to stand out as being responsible for the flavor, color and texture differences we're observing. (…) Our observations continue to support the notion that the unique characteristics of grass-based products are probably suited to some products and not others" (Paine 2011)*.

Farmer Tr.: yeah, and that first day you put them out in the spring, they go, they're like 'Yyeeaah!' and they kick up their legs

Farmer Bt.: and our eyes just are open just as big.

Farmer T.: somebody wants to come and you feel like you're more part of, more in communion with the cows otherwise if you were in a confinement you feel like they are in prison or so as to say.

Farmer D.: instead of calling grass farmers grass farmer, call them more like a natural farmer

Farmer T.: humane?

Farmer Bt.: your personality

Farmer T.: it would be your connection with your environment

Farmer Tr.: with nature…

Farmer Tr.: natural farming, natural

Farmer Bt.: Holistic management?

Farmer J. : Yeah, because a lot of these CSAs that are running these gardens, their catch word is that holistic life style, like gardening as kind of natural

Farmer Tr.: your personality, your spiritual

Farmer Bt.: We are all business

Farmer J.: well the big dairies are more profit oriented, would you agree with that?

Farmer Bt.: we're all profit oriented

Farmer T.: the other thing would be driving me: the money, the profit, connecting with nature, involves everything, the beauty … the personal

Farmer Bt.: yeah, for each person it's very personal and could be different. Individually personal

Farmer Bt.: Fulfillment. Personal fulfillment

Farmer J. : Maybe it is more of an environmental thing, though, why we choose to farm the way we do, because Farmer D. and I's farm, environmentally it dictates what we do versus what the gentlemen over here with better ground or better set up paths

Farmer D.: The farm very much dictates our management practices

Farmer Tr.: something like controlling nature or (versus) working *with* nature. That is a little different too, because the confinement people like to do things with what they have to make it work *for* them. And we look at what we have and work *with* it. [Note: This resonates with what Lyon et al. (2011) found

in their interviews with eight graziers in Wisconsin, especially this quote: “But that’s fighting the weather rather than using what you have and working with it. (…) It’s a much more integrated system. It’s working *with* the cows, capitalizing on what the cows can do. And then working *with* the piece of property that you have, and capitalizing on it. And *with* your family, and your goals”, in “Farming without a recipe: Wisconsin graziers and new directions for agricultural science” (Lyon et al. 2011).

Farmer D.: yeah, we definitely work more *with* our farm than…

Farmer T.: maybe it’s how we want to make the picture of our farm look in the world … or in our mind, just like that guy buying the new tractor: to him that’s very important; it may not even be profitable, it may just be the way he wants things to be perceived.

Farmer Bt.: I like the word spirit, I think personal,

Farmer H.: spirit… that’s for me too…

Farmer Tr.?: Natural truth?

Farmer Tr.: socialization,

Farmer Tr.: group contact or group bonding

Th : like you are trying to deal with the farm as it is? and find the way to …

Farmer T.: … find its sweet spot, to make …. Things click

Farmer Tr.: can we just use ‘be’? We just want to <u>be</u> rather than do.

Farmer Bt.: being part of what you’re doing

Farmer Tr.: being with everything, to be.

Farmer Bt.?: We talked about earlier too, is the fact that we are trying to work <u>with</u> nature and make things fit or optimize rather than taking the system that is being imposed on us almost and trying to fit that into the system, into the farm.

Farmer T.: We are trying to almost be more indigenous and they are trying to be more… colonial

Farmer Bt.: it’s a number of reasons, because it’s fun, it challenges us personally and professionally

Farmer Bt.: Because I like to being independent, I like the lifestyle, I like being outside

Farmer D.: I think it’s a connection to nature

Farmer D.: we don’t know any better. We grew up dairy farming. I missed the animals and I missed the nature

Farmer J. : But why have we chosen the grazing and why have we chosen the way we are grazing, our personal ways that we graze? What triggered in our heads, in our minds?

Farmer Tr.: You weren't happy with the other way

Farmer D.: You hated that custom bill and having all that heavy machinery command and having to bow down to them and their schedule - that drove you absolutely nuts

Farmer Tr.: so maybe it is an ability to change, where some of those big guys are not very happy but they're not going to change because they are not willing to,

Farmer Bt.: There is also a certain aspect of what we do and what we enjoy about it is control, the ability to control more of our own

Farmer T.: [control] not nature, but our business and lives

Farmer Bt.: decisions and choices, control over the business

Farmer T.: more independence, I wouldn't define is as control

Farmer Tr.: I didn't grow up on a farm, and I would say I have *learned* to love the farm

Farmer D.: Well, I hated the farm, but it was my choice to come back to the/a farm, I missed the animals…

Farmer J. : so your connection is the animals, you have to be involved with that part of the..

Farmer T.: connection to the season, nature, and cycles, and …

Farmer Tr.: appreciating that

Farmer T.: yeah, and just kind of being a part of something

Farmer D.: being excited about the first green grass

Farmer T.: more of an indigenous than colonial

Farmer Tr.: it's kind of synergistic then too

Farmer J.: That part of becoming, learning to deal with nature, you learn that it rains that cycles of rain come and go, so that was hard for me to get used to that fact, that you have to work around that somewhat and let things happen certain ways when it doesn't rain.

Farmer J. : it [grazing hay fields] has just become part of us

Farmer D.: it has become part of our grazing rotation; and our mindset is to graze those hay fields.

Farmer J. : So certain things have become important now that weren't important five years ago, versus five years ago something was important that isn't important now.

Farmer J. : I've met a different group of people who are way outside the box than people I've met in the past, so then I meet these people and I talk with them and I started to think they are doing something to try to improve the system and the world, or whatever you want to call it, and then I am kind of looking at what I am doing and I'd like to try to do the same thing, and I guess I'm trying to incorporate some of their beliefs because I've got to the point where I believe in some of that too in my life, so I'm trying to... And I don't want my kid growing up and seeing corn and soybean fields all across the country side either.

Farmer T.: I've always have an interest in trying to minimize your impact on the environment, but it gets to be a strange paradox, because 'am I doing better, if I don't spray that ???, is it better is it worse?' You're always playing with that. I think what I've been doing, because it has been done in the past, has a tracked record. So therefore you can say you know what is going to be, so I'm somewhat sticking with that, I could get rid of the problem and buy my corn and not raise it, but then: is that better?

Farmer T.: ... I dwell with the idea of going all grass, no grain, but then I'm going to get less milk; is that better?

Farmer T.: so I know what I am doing should meet the minimum requirements for soil conservation. Is there a better model out there? Maybe; I don't know.

Farmer J. : [You're kind of an] oxymoron doing the work. Because they're going to the city to work. [laughs]

Farmer T.: There is a conservationist called A.L. and he made the statement that man will never live in harmony with nature, that's impossible, you just have to minimize your impact. So that's what you're trying to do, I think grazing helps a lot that way, but… you're always wondering about what you're doing, and how it's affecting things, and sometimes you affect things you didn't begin to think you would affect, negatively or positively. And it's always changing; it's not cut and dry.

Farmer J. : …. So this all happened when I started grazing, that's when my mindset kind of changed four or five years ago. My sister and her husband were trying to do a non-profit want to grow food into food pantries. That got me thinking, well, maybe I should be changing what I am doing here on the farm and maybe I can help the world? So after I switched to grazing then all these questions started coming up around.

Farmer B.: Well, I just feel that having grass all over the farm, and just test(?) of minimize the amount of soil runoff and the fact that we are not disturbing the soil, keeping cover on it. I feel like I'm being good environmentally to the soil and building the soil versus taking it, mining a lot from it.

Farmer Tr.: but you see that in the plant life in it, I mean the animal life, worms, and… We have a neighbor who has a falcon and he asks if he can come and work our land because his bird enjoys that land where he can't do that other places. So he lets the bird go, and the bird goes and gets a rabbit, and brings it back, or goes and gets something else, and he just loves our fields for that.

Farmer J. : well, the diversity I think in the grass allows the feed that the bird eats to be out there, because you have the bugs that feed a mouse and the mouse feeds another bird and so on, and so on, forth so

Farmer B.: I think of the birds probably more because you hear the birds

Farmer T.: you can see the birds, you see them

Farmer T.: …. going to see that even in my area where I till, you would think it's just highly distracted form … I got my own corn growing there, but while I'm not there … I was doing my new seeding I just planted, there was nine crawlers going through that already. (…) And you would just think that it is completely destroyed but it doesn't, and the other thing just to watch is the permanent pasture where you don't use any defensives there is huge ant mounds there. You know that if this wasn't tilled or clipped or anything there wouldn't be some pretty significant ant mounts all over, and they say that the number of pounds of ants in the soil is truly amazing.

Farmer B.: I do think about the birds but I don't think about them as environmentally, I just think it is a good habitat for them and they kind of like it, and I enjoy hearing them, but when I think about the environment and what I'm doing that is healthy for the environment, those aren't the first things for me it's always I am building organic matter, I feel like I'm not disrupting the soil that much, I'm … not intrusive to it.

Farmer T.: I want to take in the whole, the barn swallows, the beehives, the bumble bees, all that, it's all a part of that, so you are always conscious of that. It isn't just the big things, or the colorful(?) things you try to look at, everything out there is a part of that.

Farmer J. : I still think there is two different types of graziers, though.

Farmer D.: I think there is more of a conventional farming grazier and more of a natural farming grazier.

Farmer J. : Right. Because D. and R. are driven by sheer of success, I think. Wouldn't you say?

Farmer T.: They always said farming was a way of life, but farming is a business too. So to some people it's more of a business, to some people it's more a way of life

Farmer D.: I think you [Farmer J.] struggle with that.

Farmer J. : I still struggle with that, yes.

Farmer T.: yeah I do too.

Farmer J. [to Farmer T.]: Do you struggle with that so much too then? With profit versus …

Farmer D.: happiness

Farmer B.: I think what they get out of grazing isn't the same as what we get out of it.

Farmer T.: no. Somehow they are driven or they *have* to do it, it becomes so much more important; and we all do it to a degree and it varies (??) between farms and farmers, but they are the one in the extreme and you [Farmer J.] or Farmer B. is on the other hand

Farmer D.: but I see the big graziers being more of the driven for success and money than small graziers

Farmer B.: they also feed their cows differently because the focus is on stored feed with supplementing grass

Farmer T.: it's more profit what drives it

Farmer B.: so yeah, I think that [having profit as a priority or not] is a big difference between our farms and the graziers themselves.

Farmer B.: not only it would have to be economically inviting to them, but they would have to say 'ok I can switch to that kind of farming and enjoy it or make a living'

Farmer T.: well, if profit was there I think they would. If they could see it.

Farmer B.: That's why I think we would have to get close to that organic price really to attract people [farmers].

Farmer J. : What was the driving force besides, I heard rumors that they switched from grazing to confinement because of the cold war stare, is there any truth to that or not?

Farmer T.: no .. I think the main reason was the way they used to graze was not managed grazing, so they put the cows out the 10th of May, they grazed all the mature cows that milked good after two weeks, and then if they hayed and had a lot of alfalfa, or bloat, they turned the cows in a whole field, wouldn't subdivide at all… and the milk was good for 2 days, and then they partially teed it out, and they took them to a new field, and then they had watch out for bloat, because the cows are hungry, and they're going in and eating the choice stuff, and then they don't have that and they don't have alfalfa then everything is drying out, so it's just gets dry and hot, and when they went to stored feed it gave them sort of consistency, it gave them a sense of … of the community of building something big and impressive for the neighbors, which was a factor too

Farmer T.: yeah, it looked like you're successful. I remember my father going up north "look like it's a good farm country, there is a lot of silos here"

Farmer T.: [Pasture-based dairy farms have] lower inputs, higher margins, more stable milk income.

Farmer T.: We can't be too much under [the organic price?], but they [the public] would accept grazing better than the organic, but maybe they would rebel(?). They [confinement farms] would be more scared of transitioning to our grazing program than transitioning to organic

Farmer B.: Because they can get the organic premium all year round

Farmer T.: yeah, and the organic you can still do a certain amount of confinement feeds and they are comfortable with that

Farmer B.: so we are almost more restricted than organic in certain ways

Farmer J.: in feeding.

Farmer C.: I think another reason that people don't want to switch [from confinement to grazing] is because they're older farmers and they don't like to switch, they are going to retire before they switch.

Farmer T.: Their [confinement farms] view of it [that graziers use less chemicals, less herbicides and less erosion] is that [their confined] herd productivity will more than make up for the extra cost.

Farmer T. : It's such a variance in systems, and grazing heights, and how fast you go around the grazing cycles, and there is no cut and dry 'this is the way you do it, and this is the correct way'.

Farmer D. : Each farm is very unique in the way that it gets grazed, and the way people do graze it's very unique to each individual. Me and him [Farmer J.] can go out and say 'ok we're going to fence off this' or I go 'no, I want it this way'; he wants it in another way, but we're still trying to graze the same piece of land… but he's completely different, and both would work. But it's two people on the same land, two completely different ways of how they want to graze this one land, this one piece.

Farmer Tr. : I really appreciate the safety of farming like this because we have so much less equipment… And milk in that parlor so then when the kids get down there they will not get squashed, they might get pooped on, but not hurt.

Farmer Bt.: [safety] was one of the reasons I made the switch, because I didn't like the idea of our kids being around a lot of machinery for like filling silo, and all that bale and feed bunks and [Farmer Tr.: bull], any of that stuff, driving a tractor every day, it just presents more dangers, more opportunities.

Farmer Bt.: I don't want the financial burden that a machine would cost.

Farmer B.: we feed grass and maybe supplement with something else, but for them it's the opposite, where they use the grass as a supplement.

Farmer T.: they are grazing because it works good with the supplementation

Farmer B.: yeah, because they get the cows out and the benefits they're getting, the cow health, cows getting exercise, the savings of feed costs

Farmer T.: because there wasn't enough profit

Th : so they were reducing the amount of grazing to increase the amount of profit?

Farmer T.: yes. Because they were not happy with the profit they were making; that was the driving force behind it

Farmer B.: By doing that I think they struggle more with their grazing, because their cows aren't that good at it, because those cows become used to being fed and so they don't bother to clean up the grass

Farmer D.: I think the cows do learn, it's definitely a learned thing, even our cows the first week of being back out on grass, they're like … what was I supposed to do this again?

Farmer D.: The crossbreeds no; the Holsteins most definitely.

Farmer T.: another reason we don't allow silage in the summer (…) we've heard of somebody starting a bag or a silo they had to keep it going.

Farmer B.: the other reason is if they are going to feed any amount of silage at all, they'd have to feed.

Farmer T.: a very small amount just to make the 60%. If you're feeding just 10 pounds of grain of dry matter grain, you're turned, you're down to 75%.

Farmer B.: oh that [a lot of silos with stored feed] is probably the same thing that keeps them from going to grazing, because they've got this investment.

Farmer B.: if you're only going to feed a small amount of corn silage, you're going to feed them 10 pounds, you get to have a thousand cows just to keep up with the silage in the silo or the bag, because you have taken enough off of that surface.

Farmer J. ?: my point was now he gradually quit grazing or limited his grazing because he had to feed stored feed. But I suppose it was more profit driven then. 'Why they switch from grazing to more of the confinement?' was my original question.

Farmer T.: I think that if they had good managed intensified grazing I think it would have took off, because it was some attempt of grass farms and ?? grazing, but the equipment they had wasn't as good.

Farmer B.: in terms of electric fencing.

Farmer J. : He has seven kids to keep track of the cows, they run around keeping the cows.

Farmer T.: (…) this stigma out there that [grazing] is like a crock pot way to farm [meaning it's not acceptable, or different, crazy].

Farmer T.: I think it's just community, it does so much better.

Farmer T.: I would see it more as serving the example of what things should be more like, and the only way you get any change in the world is setting an example. And I think if there were more small farms doing what we're doing, it could be good for the state, it could be good for the county and all way up through, and if you can establish that and maintain it, it can be a better world for us to say for it?

Farmer Bt.: I guess if I add anything to the community, I'm hoping it's said it's an example of… that we <u>can</u> do something different and we can succeed and we create a business, a small business, because in my mind if we have 20 of these [grazing/small] farms in five square miles, everybody would be better off

than having one big one right upon the hill, because it just creates more business, having more little entities.

Farmer D.: I like the communi… I like *us*. There's not very often you can get this many people together that have the same idea and can get along.

Farmer Tr.: and this case share ideas. And they're not competitive, they're all trying to help and support each other.

Farmer T.: As a whole I think we are perceived as being more environmentally friendly.

Farmer Tr.: Well, we use less fossil fuels.

Farmer T.: But we are producing less milk for every volume of gasoline we're using.

Farmer Tr.: But we're not planting any crops, so…

Farmer T.: Yeah, then we'd have to figure that in the whole year what feed you buy and the energy it takes to raise that also.

Farmer Bt.: We [graziers] use less chemicals, less herbicides on our lands, we have less erosion.

Farmer T.: The average consumer I think will view grazing as more environmentally friendly.

Farmer Bt.: I could see though where we would want to even [get] certified but we do get an outsider organization just to certify us just so we could put a stamp on our label, that might appeal to consumers.

Farmer T.: We do get something [on environmental information] from extension (…). But we get the impression anyhow that the effort being put out at the University is rather small.

Farmer J.: I was just wondering if the community has some part of that about what the farmer can do, does that make any sense or not, the community kind of dictates what these confinements look like, right?

Farmer T.: no, business determines what confinement looks like

Farmer Tr.: Farmer T. he is talking about like the community says 'we don't want that farm here, or a 100 cows, a certain number of cows'

Farmer J. : right. They basically tell, they ask for certain cow number, but if you educated the community, couldn't the community start asking for or saying "we want this type of farming", meaning grazing or a certain type of farming? Why does it always have to come back to farmers to change when there is so few of us?

Farmer T.: but that goes on the big version as far as what you can label in this country, what the community legally do, and they're going to challenge it, and they have the money

Farmer T.: yeah, that's where it has to come, consumers have to

Farmer Bt.: consumers do it with their dollars

Farmer Bt.: the other thing about what we do is, if we have all these graziers go away to the big guys, the possibility of having that unique cheese like “U. L” is going to be gone.

Farmer Tr.: I think most of us here we do have a role of educating people though also about what we do and why we do it.

Farmer J.?: the NRCS office had a blurb in the newspaper that they will pay you for if you have pasture ground if you have timber ground, you get the payment for so many acres of pasture, so many acres of timber ground that you have. (…) I think it was to allow people to come and walk in the woods and what and have green space I think…

Farmer J. : Pay you for keeping pasture or keeping timber,

Farmer B.: the program I was talking about I think they created that so that the graziers would have some government income tax from corn farmers. But I looked that up once and I just thought ‘wow I’m not going to spend all this money so I can’

Farmer Tr.: you have to prove all these things, though, and monitor it

Farmer B.: it’s really, it’s just awful. They will pay you if you want to graze but you have to make certain improvements, and you have to pay for them, and the amount they are going to pay you is just… There was hundreds of improvements.

Farmer T.: Fencing is a big one… and you have to do it according to their rules, right?

Farmer B.: correct. And I think the most you could get was like 30 dollars/acre/year

Farmer B.: land improvements would have been really expensive

Farmer T.: … or water quality they’ve really been just hard on

Farmer J. : get on speed to have someone to put in a barn yard for you, it was cheaper for a person to put in the barn yard in yourself versus having the county come out and then to have you follow all the specs to put in a barn yard … and all that sort of stuff, so that was dollars that... It’s just regulations, government, waste(?).

Farmer Tr.: have you ever seen “all about grazing, by R.S.”? He … gets over the tipping point where more people will use MIG(?) then more people will jump on.

Farmer T.: for 20 years

Farmer Tr.: he doesn’t get, he says what’s enough.

Farmer T.: But I think the real problem in the state now is not is getting either farm started small dairy farmers started or training people hands on in dairy farming

Farmer B.: … with us, no matter how much corn they put in and how much they get paid for their milk

Farmer J. : yes, right, right. At the end of the month you have to have a paycheck

Farmer B.: It's like a, like their factory

Farmer J. : the more you burn…

Farmer B.: it's all changing. Lots of positives

When asked about their perceptions about grazing or confined systems, farmers answered they think pasture-based dairy farms require cheaper investment, result in less disease, less odor, less manure removal and management issues, and are less harmful to the land than confinement dairy farms. Among the reasons by which some of them chose grazing rather than confinement were: family tradition ["We have always grazed; my father did and now I do."] and financial incentive ["There was a push in the 80s and my husband's father decided to try it. It wasn't his type of thing to do, but they were giving free fencing and help so he thought he would try it. We are so glad he did. We really love it. Now we are 20 days away from going organic with Organic Valley. We are really struggling this year with the drought though and want to learn what types of forages to plant for drought tolerance."].

Referring to why they think others find grazing a good idea, they mentioned cow's higher longevity than when fed corn ["Cows live longer. It is better for the cow than feeding grain. Corn is a new feed for cattle; it's not good for them"], visual and odor aesthetics ["It is nicer to look at and doesn't smell bad (or as bad)", and the appeal of a higher quality of life [for the cows] to the consumers ["It increases quality of life and consumers like the idea"], and lower inputs[?] ["Lower feed bills" and "We are interested in grazing as a way to survive the difficult economy - to reduce our costs associated with growing feed - corn, gas, fertilizer it is all so expensive"].

Some of the non-graziers' perceptions of pasture-based dairy and reasons for not choosing grazing were: low efficiency ["It's a waste of time and effort; the land could be used for better things; you could grow things on that!". "You are burning off calories when you let them walk around"]; lack of management and low-tech ["They think we just let it go and don't do anything, that it is unmanaged and it ain't doing nothing" and "It's perceived as low-tech"]; and irrationality ["Farmers think you are a nut, because you could have had about five times more money per acre (that's what they think, but they don't take feed into account). There is a perception that bigger and more is better. They think graziers are liberal hippies; it's a mentality"]. The most influential motives in preventing others from grazing were: past economic situations ["At some point confinement presented an advantage, perhaps grain was cheaper then" and "Access to programs and aid for fencing and cost-sharing; it is expensive"], challenging transition ["The transition to grazing can be rough; you can really take a hit"], environmental challenges ["like this drought"]; land issues ["The landscape may not be ideal for pasture" and "It can be hard to find land; land area is small sometimes; for Jersey cows you can get more cows per acre, but 3-4 animals per acre is standard"]; tradition or fear of change ["Old farmers don't want to change; it's their character"; "It's just something new; new is scary"; fear of trying something new"]; and pride ["Not wanting to go against the majority. If you do grazing you can't brag about how many cows you have and

people won't take you very seriously. With a small number of cows they will call you a hobby farmer, not a serious dairy farmer. It's a whole new mentality"].

As to market penetration, farmers pointed the importance of premiums in price ["Right now for marketing there is no premium for us; why would others do it if there is no premium?"] and of attractive information for advertising ["Has MSU studied the health benefits of pasture milk? We need this information and more research"]. Farmers also seem to expect that more incoming graziers and/or MSU could help make pasture-labeled milk in Michigan be viable ["Maybe there are not enough farmers who do grazing" and "It's because MSU hasn't been pushing it"].

"Some people think it is an admirable thing; because you are doing it and it is reduced yields".

The need of more understanding about grazing was expressed… ["There is a knowledge gap about forage. You have to know about protein ratios. Actually a lot goes into forage management"], which they think could help to create more positive opinions about grazing; "We need more of a scientific base for grazing; we need to be able to show that it is better for certain reasons. We also need to know what to plant for forage"; and "It's a problem of lack of exposure; we need more pasture walks and farm visits. MSU Extension has more validity; they should be exposing farmers to it"]. Although pasture walks would be beneficial, they are becoming less frequent ["my role is putting together an electronic newsletter trying to connect the graziers in the state of Michigan to inform people about upcoming educational events and pasture walks but still there aren't that many pasture walks anymore"], probably due to a lesser focus from extension? ["we have lost grazing extension educators who led pasture walks, and that has caused some of these pasture walk groups to fall apart so in the last couple of years I think those communities have disintegrated in many cases"]. In addition, the extent to which pasture walks are practicable/doable(?) for graziers is often limited in terms of timing ["it seemed like the pasture walks were always at like 6pm, when we are milking the cows"; "It is always a challenge in the dairy industry"; "the livestock producer who works in town and then has time at night, but you are milking"; and "it just seemed like that is what was happening with us"].

Extension was perceived to have a less important role in creating a sense of community than other organizations ["no offense against extension but we may need to start looking at MAEAP because they are emerging but we need people with livestock expertise and I don't think we have that many livestock expertise but we may need to rely on other governmental agencies and (unclear 15:18) you know like they may have them in other states it is just an idea and maybe we need to create some new partnerships we haven't necessarily done before"].

Farmers seemed to have mixed feelings about their sense of community ["I suppose there is a lot of grazing people but I don't know if there is much of community about it"; "I don't know I don't think I feel connected"; "I don't feel connected to grazing as a community"; and "our area has a lot of graziers and there is some community there; we bounce off ideas with each other"]. Apparently, the sense of community depends on (or varies according to?) culture and religion ["the Amish are connected with their communities"], location ["I think the dairy grazing community is more challenging because those farms are even more scattered around the state"], type of activity ["There seems to be more community

when you have to go buy the hay then you are attracting with other farmers getting the hay", "It seems more community when you have to go buy the hay because then you are talking to the person when you buy the hay and attracting people when you get the grain"].

The importance of trust and sharing for having a community was related to personality styles. ["People who do grazing in my experience have a different attitude about sharing information about their operation. I remember one of out early grazing conferences had a panel of people talking about their financial performance and got up and were willing to talk about the mistakes they made as well as the things they did right so I really see potential to create a community in which you can share things and really learn from each other a lot more than I might experience from traditional extension programming and kind of the more mainstream farmers are less inclined to have that sharing go on" and "In Northern Indiana I have noticed several of these where it's common for famers to get together and go over financial and all that kind of stuff and are bound by confidentiality but it is not extension that is there commonality it's NRCS, it is either the local conservation district or their state grazier"].

The discussion included aspects of the relationship between graziers and confinement farmers ["We are always talking [with our neighbors that are confinement] but, other than that, not really"]. One of the participants said he thinks confinement farmers talk about them? as "those organic people growing all those weeds and seeds are blowing on our land"] ["I am around the confined producers because they have become more of target (unclear 11:17) rights and things like that. They are a lot more protective of their operations and it is the smaller graziers on the pasture walks and they kind of know you are there and you are at their invitation and extensions are working on these kinds of things but I have noticed a huge disparity or change in that mental attitude with visitors but it is the bio-security part it is the security of their operation. When I was in Indiana in a dairy meeting, they were open to everyone being there but when you sit there and hear about people I have found slits and these are deliberate slits in my screens and as far as they know someone went and destroyed some of their building (…) so there is a difference and some of it is I think we need to work together as agriculture it doesn't matter what your background is but we need to make sure that these people over there and those people over there and have somebody in the middle and there were multiple incidents that came up and that was just one of the (unclear 12: 54)"] ["our government is even pushing that [bio-security] as a general rule"].

F: It is the PMO in Michigan laws they increase the PMO is a fundamental and they added onto fuel inspections that is probably as simple as I can make it.

F: It is all interpretation.

F: Well it's an interpretation depending on the state you are in and this why I always like to tell people just keep your money everybody because it is the letter of the law not the intent...

F: Go to the source go to your milk inspector for your region that is going to be the bottom line because everyone else is going t have some interpretation of it but it is going to be that inspector with the Michigan Department of Agriculture.

F: I have not yet had an inspector come out to our farm we don't sell that much milk we just kind of give it the cows.

F: Well yea that is right and they like doing consulting vs. enforcement.

F: it might be open to interpretation so you have to be stricter on the letter of the law or something.

B: Why do you think there haven't been any grazing co-ops in Michigan?

F: I think it's almost like milk is milk whether it's coming from a grazing co-op or from a co-op...

F: That is the worst marketing ever it drives me up the wall because originally it started out in California where the regular guys are saying well the organic milk is not different than the regular milk where in certain instances if you are going confinement to confinement you might be able to you know real high intensity confinement organic to high intensity confinement conventional you may be able to test the milk and may not have been a whole lot of difference, but the facts are that labs have been showing today that milk is nutritionally different based on where you produce it and what that cow is being fed; I mean we have proven that even as low as 6 pounds of grain a day can change the Omega 3 to Omega 6 ratio in milk. We ship to (..) a 100% grass fed organic people but they have tested all of the famers that are producing for them and every one of us were coming in better than 2 to 1. The one came back at 6 to 1, Omega 6's to Omega 3's and just by that they knew they were feeding corn.

Farmers seemed to think that the fact that grazing practices are not standardized might be an obstacle to the strengthening of the grazing community ["It is hard to agree on your production method a little bit because they say I can feed 8 pounds of corn and get 20% increase of milk production and still feed it as grass fed and then you might have some people who don't want go that way and want to be 100% grass fed so sometimes it is difficult to work with people who have similar but not necessarily the same production methods and it leads your marketing"].

They also seemed to find themselves in prejudice by producing in low scale in comparison with confinement systems ["Production for grazing is lower but more profits because there is less expense - but still lower production … a lot of co-ops I have talked want our production at a certain height or they aren't going to bother to go out and get your milk" "They want you to sell a certain amount; they want us to have so much milk out there or they aren't wasting their time with you"]. Distance/logistics ["You generally have to pay to transport milk" "The grazing community is so scattered around this state and it is an expense to gather that milk in a co-op situation"].

Some farmers commented about public perception of pasture-based dairy ["I have done talks with the general public when I talk about (…) pasture based, they ask 'what does that mean' 'Well that means the cow can go out and graze' 'Don't they all?'. So that would be a real challenge I think in marketing that the point of it is we are 100% pasture and they say 'well what is the big deal all milk is 100% pasture?' They confuse pasture with pasteurized"].

One of the topics was the value of local products ["What Mike talks about is he doesn't even always mention that his cattle are out on the pasture it is kind of the whole story of the farmstead and he is the

farmer and the cheese maker." "Absolutely that is the local thing it is a whole system." So it is part of the story but not necessarily the whole story and that is like [a dairy plant] up here they are buying organic but doing well because they are local, people can go up there and meet and know them." "The local concept has been so powerful I didn't think it would last 5 years and it just continues to grow and I think it has overpowered organic labeling or anything else really. It is that connection." "Our neighbors have a confinement herd and an organic herd and what has made them so popular is people can come out to the food-day kind of agro-tourism, it is people coming out and actually being able to see the cows."].

F: "When you get into a big co-op you lose control of your product" "It sounds like your more libertarian if you are a grazier maybe"

B: So then what are the other options for graziers to sell their products and what might be better?

F: A real challenge we have here is the fact that some of the rules written in the co-ops that wont take the milk now for instance MMPA you cant start a small market so you want some of your cheese made you cant do that they want 100%. The only way you can do that is to agree to let you buy it back from them. We are taking operation that is way bigger what a normal small local cheese plant would normally have and you have to start small when you are marketing.

F: That is where the partnership idea that idea of the value chain where you are actually in partnership with your processor and are willing to help you and you help them which is key.

F: It is not a bad option buying the milk back from like MMPA and get they are still in on it but it does let you build your market to the point where you can say ok I am done.

B: So buying back from MMPA is one option Laura is saying working with an existing processor, is that an option for people here in Michigan?

F: Most of the processing plants I think are hooked up with the co-ops and they take their members milk and that is where it goes and if you are in a co-op like MMPA you may contract with let's say with Kalamazoo but if you want to split...your trucker is switching where their routes are and they want you to go to (unclear 26:51) or to a different processing plant I mean that is a heck of a change and it is the same.

F: Well if co-ops made a rule like you don't have to have so much milk if you could bring milk in yourself. There is a special license you have to get to ship milk but if you brought in the milk yourself then we wont have to require some special license. You get the special license and bring in milk yourself we may let you get away with this amount of milk rather than this amount of milk and that would require a lot of people getting special licenses but still maybe it would help.

F: I am wondering in Michigan there are several producers of co-ops than consolidate and then it is sold to processors is that how it works?

F: especially one or two so if your count DFA and NFO it is the same and then you have Michigan Milk.

F: Not truly a co-op.

F: Exactly and I assume a nice co-op talking on your level is a nice small group of farmers that get together. This co-op we are talking about, Michigan Milk, is just a huge monstrosity of Indiana...so it's not … it's a big business.

F: So what would happen if you... I guess I am imagining if you bring in some of these processors that might be interested in a product line that is grass fed or special cheeses and sat them down at grazing farms what do you think would happen then?

F: Who is that going to be that is what I am wondering.

F: Well a lot of people are worried about losing MMPA as a market because it might be the only market so if you start causing the waves or thinking ok we are going to see if someone wants to go together and do this. They look at you differently if you think about doing it on your own but if you're talking taking a group of people with you might be hung out to dry.

F: Does it bring you solitude?

F: Well they can at some point or be less lenient if you had an issue or something like that.

F: Then you get into some legal issues I mean it is hard to regulate something like that because how can you prove they are really being harder on you because you suggested a bunch of people go out on their own so a lawsuit probably wouldn't get you anywhere.

F: In central Ohio we have a lot more cheese producers because they created a neat market that in Holmes county I had 4 different people who produced their own cheese and things like that so we were shipping to traders point if we needed to or wanted to I couldn't actually do some on my own shipping to some of these other plants we aren't bound by contract, we never really did it. The only thing I ever didn't ship to Traders Point is what we used for our own stuff for our own sales, food, milk, yogurt, and cheese we did but there was a way you could do that. Four farmers could get together and ship a load a week to one of these places and it is not quite that way here we just don't have infrastructure.

F: We are spread out too far.

F: That goes back to what I was talking about. At one point you have 25-50 small dairy farms in a county I mean you may only have a handful and some are giant CFO's and some of them are Amish and you aren't going to get those 2 different communities to mix that well.

F: It's almost if you could convince more people to become graziers then you could maybe form a co-op having convinced enough of them.

F: in Missouri they really have less dairy infrastructure than almost any other state I can think of but they actually talk about...I don't know if the state Department of AG was involved but the extension was heavily involved with kind of re-creating a dairy industry in the their state because they wanted to supply their own milk supply for the population so they got some kind of grant and took a bunch of dairy

farmers over to New Zealand. They intentionally sent out to establish a grass based dairy industry and they actually have not only gotten a bunch of Missouri farmers to start grazing but brought from New Zealander's over to establish their own farms there.

F: If you already have a lot of our land owned in our area that doesn't want to sell then you are bringing a whole bunch of people in then you really cant bring people in.

F: Luckily Missouri did that about 5 years ago when they had the land available down there and grazing they have a great environment for grazing down there.

F: Yea it is a better environment for grazing.

F: I don't know I think the Kiwi's found it pretty challenging.

F: That is because they were trying to bring New Zealand...

F: Hot dry summer that is that.

F: Yea they don't like the heat that is their one challenge.

B: So in a vision of what a grazing market would look like here in Michigan in an ideal situation what would you guys like to see? Would you like to see new grazing co-ops starting, grazing lines with existing co-ops, a lot of farmstead processors, what would be a vision for success?

F: I think the first thing you need is some kind of communication and have it hanker somewhere in our government whether it is extension, NRCS, or MAEAP and re-establishing of that used to be extension but has been obliterated basically you know we had a lot of talent then people left. Every county agent used to be an expert and in Michigan I think we used to have when we split up the teams we used to have about a dozen and the last I knew we are down to a handful. In my area I don't even know who the heck is in there other than hearing somebody say they might fill the position because they are getting so desperate.

F: Well you said something about more communication maybe a Grazing.com might help or something or Michigan grazing on [a social network] maybe.

F: And one thing I don't know where it would stand but I think they would be supportive but I don't think they have a specific person but it is the I call them the MOTT group they formed a regional food system thing but it is open supposedly not just to Michigan but potentially worldwide. One place they are already going on with what I see is the livestock and dairy industry, would we be better off encouraging that and help bridge the gap you know pooling some of the resources?

F: Yea they do have a livestock group within that and we are starting to develop some ideas and are working on some stuff to develop...I think the first focus would be within the dairy and (unclear 35:27)

F: Somewhere the industry needs a designated leader or leadership and they kind of come together and no offense to a bunch of farmers kinds of running all over the state it is possible they can do it

themselves but I also have a huge investment in all this infrastructure and we need to ask of our government and our tax dollars being spent is that we should put something together somewhere and have some stability. We need to bring back stability to this industry.

F: "They [the AG development or industry development of the state Department of AG] haven't been active like in Wisconsin. We have been cutting this budget for 7-8 years and we hope we found when it is going to come back but they try to offer educational systems for innovation and development but no dollar inputs, we used to 10 years ago but not today."

F: "Whenever you look into a grant you need $10,000 to hire someone to put together a grant; if I had $10,000 I wouldn't go for the grant because $10,000 is about what I need."

F: That is like some places where we still have local conservation districts I mean a lot of counties don't even have those anymore because there is no funding and they couldn't be self sufficient in their fund raising but some of them do have access potentially to the full time grant writers and maybe they are tied into something that is off and some ways maybe there would be so there is more reason to tap into that. For example, in Indiana where they have a collection of (unclear 38:37) of conservation district well they have connections and created connections for grant writing.

Talking about resource conservation and development conserves

F: So that's not really a government agency that is kind of a non-profit.

F: In Michigan in conservation district it is actually MDA.

F: It's actually USDA.

F: That's NRCS but she is talking...

F: Resource conservation and government councils are totally different things.

F: That is supposed to be formed under Michigan law within Michigan Department of Agriculture but because funding has been so tight they have evaporated out of a lot of counties. My county folded up and ran away and they did some emergency stuff and came back and all are part time and wonder when they are going to be (unclear 39:34)

F: And their mandate isn't economic development at all it is conservation.

F: But what the conservation districts are doing ones that are surviving are getting into the GAP certification education in training they are writing grants and they have to be self sufficient because there are no state dollars coming to them.

B: Who is Michigan who is doing economic development? What are existing resources that we could mobilize?

F: Well that is why I suggested the state Department of AG and then there is usually a Department of Commerce.

F: Economic development cooperation.

F: these are agencies within the state that are right now focused on job creation primarily.

F: I always distrust the government with everything other than our military defense.

Typically EDC want to see 10 or more jobs created before they will come in and assist on a project so for our small scale agricultural operations that is tough to create 10 new jobs.

F: We just aren't even on their radar screening.

F: Yeah there are grant dollars from the conservation districts through the MAEAP program and EQUIP dollars it wont be for your barn per se but it can be for a grazing operation, watering systems, and for manure storage.

F: if you have an environmental issue you have to come up with some of it but they have assistance where usually they will pay around 75% of the cost and they have people that will come out and help you apply for that so you don't have to come up with a grant write up per se.

F: Why do you think a processing plant doesn't open up for these specialty milks here in Michigan? What is preventing them?

F: Liability.

B: Isn't MMPA? I mean what are the barriers?

F: I think Michiganders are just less interested in milk I don't know.

F: The way our system is structured you have these co-ops that consolidate milk so they are the ones that are responsible for hauling it from the farm to the processing plant.

F: Well they coordinate it so you still pay for it I mean...

F: They contract with a hauler the co-op doesn't own the hauler or the trucks that they contract and then they sell it but there is one major co-op and the other ones are not number owned and you have the same ones in Wisconsin: Deans and DFA.

F: So it seems that one thing that would be valuable would be to survey the milk consolidators, co-ops, and the processors and find out what their views are about specialty products or milk.

F: Well we don't have a processor so they are the ones that are theoretically buying this specialty milk so we don't know whether they are instead.

F: I think it would take someone who would be interested in investing a lot of money into selling this special brand of grass fed...

F: Michigan Milk has 2 big plants that they own (unclear 43:48). They are all scaled for large production. One is powder food and milk.

F: But they are scaled to the point the way they pay for their milk so they still have volume premiums so the more you shed...they are not excited about dealing with smaller scale farms and the smaller you are the less excited they are about dealing with you.

?: Yea when we started this project here at KBS we were talking about this (unclear 44:45) and robots so that they can help conserve small and mid size dairies and we had a lot of pushback from MMPA and others saying why do you want to do that?

F: They would rather just pack a semi up and fill it up.

?: Why do they want to go to 10 different dairy farms milking 100 cows each when they could go to one dairy farm to milk 1,000 cows.

F: Well that is what I was saying earlier about production talking about dispersed over but it is a result of a low production market. When you have a little production market you are going to have mini farms dispersed over a large area rather than a few farms in a small area. That means more gas and maybe it needs to be talked about...you talked about the nutritional value of grass fed maybe we need to market the idea that this is different.

F: It has to start with the consumer you have to have somebody willing to pay.

F: Exactly and it may have to be charged more for this and convince them this is better.

F: What inevitably happens is we can build up a really good market and if you have a lot of profit potential because you have a better product or something like that the big guys will come later. They will come in and say well maybe we want a piece of that and will come in and try to do a little bit of that and they may or may not be flexible enough to handle a smaller market like that with a premium profit and that is an advantage you have by being a smaller cooperative.

B: So it is sounding like in Michigan we might need a different solution than what they have found to be successful in Missouri or Wisconsin because there has been resistance from the big co-ops so maybe making a new co-op would be...

F: Well the thing is they are maybe talking about 4,000 dairy farms maybe we are talking about 1,000 divided among so it is just the numbers you have a lot more smaller farms...

F: Yea but a lot is small dairy plants.

F: Yea because those guys all want to stay in business too.

F: And Minnesota mirrors that you have a completely different set up and the number of farms and dairy is the largest economic rank in the state of Michigan even with all the fruit and other things.

F: But we have changed we have to reinvent something and that is where you were talking about some kind of leadership.

F: Well also I think if maybe we can bring in the big guys from these other state where Wisconsin is already set up if they are willing to ship our milk out of Michigan into Wisconsin and sell enough of it there I am not sure if they are willing to travel all the way into Michigan to get their milk or not.

F: Then you lose the locality of it and the marketing aspect of it.

F: That is where the sustainability part and I mean a lot of our organic shippers already ship to New York.

F: We don't have organic processing in the state of Michigan.

F: We need some sort of cooperation of business...

F: We do but it is small.

F: We need somebody to come into the state and invest in a plant.

F: Well there are small bottlers of grass based milk and organic milk and I think the focus in the survey should be if those small bottlers talk to them if they are interested in cooperating together and maybe growing their scale because some of them over the last 10 years have build their own basically grass roots form the ground up and now are getting to the point where they may be looking for more product.

F: The crazy thing about Mooville is they are getting just as much money for their yogurt per pint as I was getting and I was 100% organic grass fed that is all marketing so what does that tell you? It tells you there is room in this market here that is all local their whole thing is that they are local that is it so there is room for local, grass fed, and organic you know there is room there. Right now it is tough and it is just the local confinement guy.

B: Is there anything that other grazier could learn from the organic sector in Michigan growing some? What might their organic focus as far as marketing have to teach to the rest of the dairies?

F: Well what is the difference between pasture and organic? Isn't that what pasture is, organic?

F: So the NOP requires you to have a 30% dry matter intake form grazing during the grazing season which is like 120 days so you are talking your overall grazing intake dry matter ends up be 10% or less.

F: And organic is adding animal welfare into...the NOP is addressing some of that and certain providers are getting involved in that as well.

F: And likewise grazing kind of is [adding animal welfare] too, you know what I mean, so there is this overall thought you have to look at it from the consumer point of view is like oh your cows are out on grass so they will equate that to those cows are "happy" but you have to look at from their point of view. The California cow commercials always show the cows out on grass but if you go to California you realize…

F: You guys will love this, for the first 2 years I shipped to Horizon, guess where my milk went? Right on the conventional truck with everyone's too. They just didn't want to ship it and in '07 they were so concerned about getting every organic farmer so when Organic Valley had a meeting at one of the farms

in the morning and in the afternoon there were 3 of us that had 150 cows that is who Horizon wanted to talk to. Horizon came in and talked to jus the 3 of us and they ended up signing up all of us because it was a huge financial difference between them but even after all of that only one of the 3 farms were ever shipped to an organic market because they were just trying to sell it and then they just throw us on a regular truck and it went to Tamarack or into Kroger milk or whatever. Your neighbors don't look of you fondly when you are going on the same truck they are and you are getting $32 off waiting for your milk then 16.

B: Even the organic producers in Michigan don't have a local processing and local market.

F: I always wondered with the milk processing plant could you use the same plant wash all the machines out and then go with organic.

F: They do an organic day then non-organic.

F: Or you run your organic first and follow up with your other stuff you work with clean and special inspection or whatever they are called and then shift to the other.

F: They have different tanks to store the milk in and then they run all that organic milk first because then they don't have to wash it out.

F: Well that is why I was suggesting doing a survey of the existing plants to see what their interest is I don't know if they are primarily fluid milk bottlers or do specialty crop.

F: There was so much milk this last Spring they just weren't open to it because they don't want to ship to New York...trying to let the local to let them in once a week or...

B: So Seth you are saying Organic Valley try to work with local processors?

F: Yea and they just weren't open.

F: That is why they worked out a deal with Smith's in Orville to do that so they paid for Smith's to put in Organic tank silos and the way Smiths does it everyday they just run the organic milk isn't because you don't have to wash after that to do the conventional milk and then they do all the CRP.

F: The same thing could be done to segregate grass milk except you wouldn't have all the requirements.

F: Right except you wouldn't have a lot of those, exactly.

F: Another component is realizing a lot of our milk processing plants with what I understand are owned by the co-op or there is a huge share. It is the member farmers that ship their milk you are not just dealing with that you are talking about you know all the members that own that co-op.

F: It might be easier to work with a commercial processing company rather than a co-op.

F: Yea and another thing is just the geographic stuff but a lot of these dairy processing plants have those gallon jugs and would be the same container as in the store you might buy your milk. Well they are

going through the same processing plant they are doing juice and all these other different blend and things so they're diversifying...Dairy plain as I understand today is only a fraction off their actual output.

F: That would actually help the organic co-op a lot because we talked earlier about how organic is spread out and this way you could just put a special organic label on the container that milk is going to and all go to the same place.

F: “That facility still has to be certified.” “That is the problem.” “And can be quite a challenge.”

F: It is a lot easier to certify a processing plant then it is like a farm it is much easier and I have talked to certifiers about it and stuff and there is more paperwork and more record keeping but it is almost a slam dunk is they are willing to go through the extra steps and it is not that hard.

F: I don’t know how this could be duplicated but we have one processor in Wisconsin that has really focused on fostering the next generation of cheese makers and he now has 2 plants and he has set them up with smaller scales so that people can actually come in and lease time in his facility and he also does custom processing for people who want their milk made into a special product. What this does which is really helpful is it solves the problem of having to start really small and not having a place to go with the rest of your milk because he takes the rest of your milk. You can work out the bugs on the recipes and then several of the people who work with him have gone on one they built and then they can afford their own plant.

F: An incubator or what they have done the kitchens for that but with state that have been more flexible and Michigan has come along is the cottage laws that are hardly perishable products that meets the dairy...

F: Kind of a community kitchen kind of idea.

F: Well something like this works well because it is one facility and you have somebody in charge of making sure it meets all the regulations and then different people can come in and use the facility.

F: I am not sure spearheaded it but about 5-10 years ago the organic people for the meat and slaughter...there were no small slaughter houses left anymore and they got together with what I am hearing here and it went through similar processing and now they have more local small slaughter places they can go. Is there something maybe we can learn from them?

B: “Do you feel that to access the consumer market it would be an advantage to be all grass no grain or to be more flexible in terms in what we define as grass fed?”

F: “I don’t know”.

F: I think if you are grass fed you are grass fed, no grain.

F: From my own experience what you have seen out in Ohio the guys are not 100% they are started to use words like “grass grazed” and but they are trying to stay with the local thing so it’s like trying to be on the edge.

F: It might be better to put down the words 100% grass fed so it shows the animals diet is grass fed meaning we didn't feed any grain instead of well we gave it 10% grain.

F: There are educated consumers looking for something specific will find you it is the peripheral that aren't necessary looking for something specific they might want local and say hey I heard grass fed is good or me so they read something that says "grass grazed" they can imagine what that means I have no idea and that might be fine for them. If you do go with something like 100% grass fed my suggestion is it is premium product and you are going to lower production and you are going to have to be paid for that.

F: I think you could with Grade A's and Grade B of whatever just put % of diet is grass fed and give an estimate.

F: To keep into that kind of marketing would require a whole government regulatory agency.

F: One of them is that in the focus groups and consumer surveys part of our research...the phrase that showed up the most is pasture grazed, grass fed didn't sound good to them which is kind of if you are positioning a product.

F: But you cant say 100% pasture grazed.

There was some discussion about the differences between grass fed milk and 'grain fed milk' ["Mike [the guy that sells the $25 pound cheese] feeds grain because he thinks it contributes to the unique flavor of his product, so by limiting yourself to 100% grass fed you may be limiting the quality of the product you end up with or changing the quality." "Characteristics is a better word" "absolutely, so it is what you want to produce"].

F: So one of the things we are trying to do is observing...one of the farms that contributed milk to our Rorschach feeds some grain and we are seeing these unique qualities to the milk so 'where is the cut off?' is the question. In the end a buyer will buy 100% grass fed because it is healthy for them once but if it doesn't taste good they aren't going to buy it again.

F: "you have to be a good cheese maker."

F: "You need to know what creates the quality in the product and not necessarily get hung up on some standard of grazing which doesn't matter to the consumer in the end besides the really health conscious ones."

Appendix C. Discussions with Project Advisors

This is a follow up on a conversation Joe Tomandl, Dick Cates, Tom Kriegl, Ruth McNair, and Steve Ventura had over emails in March 2012[9]. They discussed about how much milk could potentially be produced from grazing dairy cows in Wisconsin pastures, and to what extent this would match the supply needed by the dairy processors in the state: "If all milk in Wisconsin were to be produced from grazing dairy cows, what would be the consequences to the dairy industry in the state?"

The capacity of Wisconsin to support more grazing farms in terms of:

1. Land area
2. Number of livestock to put on that land
3. Supporting infrastructure (suitable land, milking Machinery, buildings, roads, etc...)
4. Support for graziers (information from Extension, communication streams Among graziers, access to economic support resources, etc...).
5) balancing the environmental inputs and outputs with the inputs and outputs of the milking system.

Tie this discussion of what the level of the grazing dialogue is about with the results of our analysis (modeling and focus group)

Steve Ventura said:

"An approximation based on WASS data about WI farmland from 2011 and some assessment of marginal land we did a few years ago:

- 15.2 million acres of land in farms
- 7.6 million "harvested acres" (row crops plus cut hay and alfalfa; about 2.7 million is hay/alfalfa)
- remainder is about 7.6 million acres of pasture, woodlot, and rough land.

From our remote sensing estimates of open land (includes non-farmland):

- 3.5 million acres of suitable open land (about 0.7 million is currently in CRP)
- 1.5 million acres of marginal open land suitable for pasture
- 0.6 million acres of marginal land too steep/droughty/rocky

So we have 2.7 million of current hay/alfalfa, and 3.5+1.5 million acres of potential pastureland (2.7+3.5+1.5=7.7 million acres of grass and alfalfa). "

[9] This conversation was kindly shared by Richard Cates, via email (Personal Communication).

How many cows can be supported on 7.7 million acres of grass and alfalfa? How much milk would they produce?

Ruth McNair said: "Assuming each cow in managed intensive rotational grazing (MIG) produces 15,430 pounds of milk on average[10], and that a grazier needs 4 acres per cow if they are pretty dependent on grazing, we would need 1,691,510 cows (instead of 1.27 million dairy cows there were in Wisconsin in 2011 (USDA-NASS 2012), and 6.8 million acres of pasture to match production of 26.1 billion pounds of milk produced by the state in 2011 (USDA-NASS 2012). While this amount of land is less than what Steve Ventura mentioned as possibly being available, there may be many of the marginal acres that are too marginal to include, and we don't know how many acres are accessible to a milking facility."

What would happen with the acres of pasture devoted to other livestock now?

Tom Kriegl said: "Assuming managed intensive rotational grazing farms produce 70% as many pounds of milk as confinement farms (Kriegl and Frank 2004), it would take 1.43 grazing cows to replace each confinement cow to maintain the state's total milk output. That means an addition of ## cows to the 1.27 million dairy cows there were in Wisconsin in 2011 (USDA-NASS 2012), making a new total of ## dairy cows - all in MIG. How much feed is necessary to feed ## dairy cows in MIG? How much land is necessary to produce that amount of feed? Can enough feed be produced on the same number of acres currently being used to feed the state's dairy herd? I think that total milk production in Wisconsin could be maintained if all dairy herds in Wisconsin practiced management intensive rotational grazing. It would likely take more cows and maybe more farms and maybe more acres growing feed for the cows and it would take a paradigm shift for many in the Wisconsin dairy industry. It probably has to be fairly complicated if it will change the mindset of those who say that if everyone went to grazing, total state milk production would decline and we wouldn't be able to maintain our dairy processing infrastructure. In the 1990's it became the conventional wisdom that the large confinement model was the system of the future in the dairy industry and that other models had little, if any future. Tied in with this perception was that production per cow and total production not only needed to increase, but increase faster than it increased for our competitors. The statement that dairy farms have to become large confinement units to survive seems to have become part of the belief system in the U.S. dairy industry. Part of that is built on the belief that growth is good and each year has to be bigger and better than the one before. Another part of this belief is built on the idea that we have to maximize returns to labor and capital (which tends to ignore environmental impacts). In Wisconsin and in the U.S. our perception is that we have to maximize output per cow and output per unit of labor. When we were answering economic questions, ideally we are trying to optimize input/output relationships. In most circumstances, one where if you inputs is more constraining than the other potential inputs. Usually the most constraining input is the one for which we try to maximize the return to. Our mindset in the U.S. is that labor is a limited input."

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[10] For reference: (Paine and Gildersleeve 2011)