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Factors Influencing the Green House Gas Footprint of US Dairy Farms

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Factors Influencing the Green House Gas Footprint of US Dairy Farms

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INTRODUCTION

In 2008, Dairy Management Inc.(DMI) commissioned and jointly conducted with the University of Arkansas a life cycle assessment (LCA) of the dairy fluid milk supply chain focused on defining greenhouse gas (GHG) emissions. LCA is a tool to evaluate environmental impacts of a product or process throughout its entire life cycle, from crop cultivation, through to food processing, use and disposal of wastes associated with its final end-use. This includes identifying and quantifying energy and materials used and wastes released, calculating their environmental impact, interpreting results, and evaluating improvement opportunities.

The dairy supply chain is broadly divided into 8 stages; each receiving separate analyses that were combined to provide the life cycle footprint. These stages are: feed production; milk production; delivery to processor; processing; packaging; distribution; retail; and consumption/disposal. This poster focuses on the farm level - feed and milk production - stages of the analysis only.

OBJECTIVES

The purpose is three-fold:

- to present information from a nationwide survey of dairy producers regarding current demographics, milk production practices and manure management practices,
- to present estimates of the farm level GHG footprint, and
- to identify important factors that influence the farm-level GHG footprint.

RESEARCH METHODS

A 2008 production year survey comprised of 48 questions in 9 sections solicited information for relevant to the calculation of the farm-level footprint: 1) the dairy facility (location, herd and milk production), 2) farm energy use, 3) animal housing and milking parlor information, 4) feed and grazing practices, 5) crop production, and 6) manure management. Surveys were targeted to 5415 producers in five regions (Fig. 1) and across three herd sizes (less than 100 cows, 100 to 499 cows, 500 or more cows).

These data were with others collected from USDA National Agricultural Statistics Service and Economic Research Service, technical literature and consultation with experts. SimaPro© 7.1 was used as the primary modeling software; the EcoInvent database provided information on the 'upstream' burdens associated with materials. The on-farm footprint was calculated as the sum of the individual footprints associated with enteric methane, fuel use, manure management systems and feed production. The unit of analysis was kilograms of CO_2e associated with the production of one kilogram of fat protein corrected milk (FPCM). Further details regarding the calculation of the footprint are available from the authors.

Regression analysis was conducted to determine the influence of a number of factors on the overall footprint of the farm. The 30+ factors included in this analysis are: region, herd size, pasture use, production enhancements, fuel usage, manure management practices, animal breed, crop production, and efficiency (ratio of feed intake to milk production).

Figure 1. Dairy Production Regions Used for the Study

Table 2: Use of Production Enhancement Practices

Practice	Practices Used in 2008	
	Yes	No
Photoperiod	83	453
Increased milking efficiency for fresh cows	44	492
rBST	125	411
Milk 3 times a day	145	391
Rumensin	236	300
No enhancements	**241**	**295**

Table 3. Top Ten Reported Manure Management Practices

Type of Practice	Type of Manure	Number of Farms Reporting Practice
Solid Storage Stacks††††	Dry	242
Dry Lot	Dry	187
Cattle Deep Bedding, Stored for more than 1 Month†††	Dry	187
Daily Spread†††	Dry	170
Earthen Ponds/Tanks with Natural Crust Cover	Slurry	160
Earthen Ponds/Tanks with Natural Crust Cover†††	Liquid	143
Earthen Ponds/Tanks without Natural Crust Cover†††	Liquid	132
Cattle Deep Bedding, Stored for less than 1 Month†††	Dry	123
Earthen Ponds/Tanks without Natural Crust Cover	Slurry	101
Uncovered Anaerobic Lagoon†	Liquid	99

Top ten practice in: †Regions 3 and 4 only; †† Regions 1 through 4
††† Regions 2 through 5 †††† All regions

Table 1. Survey Respondents by Region and Herd Size

Herd Size	Region					
	One	Two	Three	Four	Five	Total
Small	43	8	109	25	10	195
Medium	37	13	87	26	12	175
Large	25	6	55	38	42	166
Total	**105**	**27**	**251**	**89**	**64**	**536**

Figure 2 : Range of Footprints Calculated for the Farm Survey Respondents
Black Horizontal Line is the Mean; Red Horizontal Line is the Weighted Mean

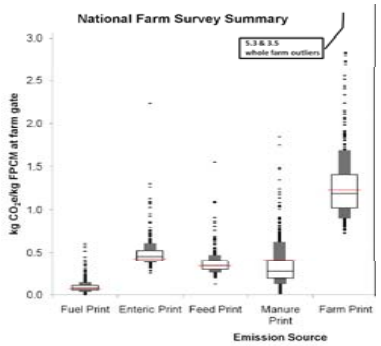

Table 4. Factors that Influence the Overall Footprint of the Farm

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	95% Confidence Limits	
Intercept	0.20	0.053	3.71	0.0002	0.09	0.30
Inefficiency	1.21	0.055	21.95	<.0001	1.10	1.32
Deep Cattle Bedding >1 Month (0.1% to 33.33%)	0.09	0.026	3.48	0.0005	0.04	0.14
Deep Cattle Bedding >1 Month (33.34% to 66.67%)	0.35	0.052	6.86	<.0001	0.25	0.46
Deep Cattle Bedding >1 Month (66.67% to 100%)	0.97	0.081	11.90	<.0001	0.81	1.13
Uncovered Anaerobic Lagoon (0.1 to 33.33%)	0.09	0.037	2.37	0.018	0.01	0.16
Uncovered Anaerobic Lagoon (33.334 to 66.66%)	0.21	0.057	3.68	0.0003	0.10	0.32
Uncovered Anaerobic Lagoon (66.67% to 100%)	0.47	0.061	7.61	<.0001	0.35	0.59
Percent Pasture Time	0.004	0.0005	6.81	<.0001	0.003	0.005
Region 1	-0.16	0.040	-4.08	<.0001	-0.24	-0.09
Region 2	0.07	0.060	1.22	0.22	-0.04	0.19
Region 3	-0.11	0.036	-3.06	0.0023	-0.18	-0.04
Region 4	0.00	0.042	0.09	0.93	-0.08	0.09

RESULTS

Of those surveyed 536 (roughly 10%) responded. Responses were fairly evenly distributed across the three size categories. However, significant differences ($p < 0.0001$) across regions did exist. Region 3 represented nearly half (47%) of all respondents. Larger farms made up a larger percentage of overall farms in Region 4 than in other regions.

For 75% of the farms, mature cows did not receive the majority of forage intake from pasture at any time that year. Region 4 had the smallest percentage (15%) of farms using some pasture; Region 2 had the largest percentage (67%) of farms using some pasture. Data suggest the larger the herd size, the less likely that cows are placed on pasture on the farm.

Nearly 45% of all farms used no type of production enhancement practice in 2008 (Table 2). Rumensin was the most popular practice adopted; it was used by 44% of respondents on at least some of their herd for at least some part of the year. Other more commonly reported practices were three times a day milking (27%) and rBST (23%).

Producers provided information related to both the type of manure managed (dry, liquid and/or slurry) and type of practices (18 different practices) used. Of the 54 practices (18 practices for 3 types of manure), the 10 most commonly reported practices are shown in Table 3. Comparing regionally, 6 practices ranked in the top 10 in all regions.

Carbon Footprint Analysis

Figure 2 presents the range of values for the on-farm, fuel, enteric methane, feed, manure and total farm prints associated with the farms represented by the survey data. The open box represents the 25th to 75th percentile for each category; the gray boxes represent the 10th and 90th percentile; and the redline represents the weighted mean value. Enteric methane and manure management practices were generally the largest contributors to the farm-level footprint. Most farm footprints ranged from 0.70kg to 2.0 kg CO2e per kg FPCM.

Five variables explained nearly 67% percent of the variation in the farm print (Table 6): inefficiency, managing volatile solids (VS) from manure with deep cattle bedding, pasture feed fraction, managing VS with an uncovered lagoon and region. Increases in inefficiency (that is the more kg of feed it takes to produce one kg of milk), pasture feed fraction (percent of annual feed that comes from pasture), and use of cattle deep bedding and/or a lagoon each can increase the footprint. The regional impact suggests that farms in Regions 2 and 4 are likely to have higher prints than those in Regions 1 and 3. But the influence of region is much smaller than the potential influence of most of the other variables.

CONCLUSIONS

Through this study we have amassed the most recent and comprehensive data set for dairy facilities across the US. These data have offered a snapshot of dairy production practices across five regions and three herd sizes in the US for 2008. The LCA indicates that overall footprint of the farm is comprised of the footprints associated with feed production, enteric methane, fuel use and manure management practices. Statistical analysis suggests there are opportunities to influence the farm footprints through changes in some manure management practices and efficiencies in milk production.

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