Pasture-Based and Confinement Dairy Farming in the United States: An Assessment

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Key Words: Dairy farm profitability, dairy farming systems, pasture-based dairy farming.

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Abstract

Dairy farm numbers in the United States have declined 39 percent over the last decade, particularly smaller farms. The predominant production system is Holstein cows housed year round and fed a total mixed ration based on stored forages. However, there is great variation in herd size within and between regions. There is evidence of higher profit margins per cow and per unit of milk sold for pasture-based farms. Most comparative data are from north central and northeastern states but limited data for other humid regions also suggests higher profits for pasture based systems. The data are from smaller farms and in the short run this financial advantage may enhance survival prospects relative to similarly sized confinement farms. However, the total income potential for any small dairy farm seems limited. The data also show wide variation in financial performance among farms of a similar type, both confinement and pasture based. Data on regional competitiveness and economies of size for pasture-based dairies is sparse.

Four types of data are presented and evaluated, but, from the perspective of a farm manager or investor, the data are incomplete. Recommendations for improvements in data collection and reporting include standardisation of methodology, expanding the data collected to include more information on farm resources and management practices, and, where sample size permits, routine statistical analysis.

Introduction

There is a resurgence of interest in pasture-based dairy farming systems in the United States. This can be attributed in part to prevailing trends in the dairy industry. US dairy farm numbers have declined by 39 percent over the past decade (USDA, 1998; 2007b). Farms with 500 or more cows are increasing in number and regional shifts in milk production are occurring, with expansion in the western part of the country and loss of market share in the middle and eastern parts. The latter regions are humid and agronomically suited to pasture-based dairying. Some existing graziers cite lifestyle improvements for pasture based dairying over the confinement system, where the milking herd is housed year-round and fed a total mixed ration. On-farm processing on pasture-based dairy farms may provide profitable niche market opportunities. Well-managed pasture-based farms may create fewer adverse environmental impacts and are more likely to be socially acceptable, thereby reducing external threats to farm viability.

Information on the relative profitability of alternative dairy farming systems is important to beginning dairy farmers, lenders and investors in new dairy farms, and confinement

dairy farmers contemplating a switch to pasture-based systems. Existing graziers and their advisors can benefit from reliable benchmarks to gauge financial performance and make informed business decisions. Financial performance data provide important information to applied researchers investigating ways to make farming systems more profitable.

There are several practical questions to be addressed. Are pasture-based dairy farms more profitable than confinement farms? If so, what herd size is most profitable? What breeds or crosses work best? What level of grain feeding is optimal? Are organic certified dairy farms more profitable than conventional pasture-based dairy farms?

Financial Performance

Four types of information can shed light on dairy farm profitability: Individual case studies, summary data from multiple farms, research on farm systems and components, and simulations. Examples of each are available.

1. Individual Farm Data. Case studies are popular in the farming press, in educational and industry workshops, and the like. Financial data can be helpful in demonstrating the financial feasibility of a farming system or practice (Winsten and Petrucci, 2000), (Davis, et al., 2005). However, decision makers need information about the **relative** profitability of competing systems, from different regions and for various practices. Published data from university-run and similar farm business records programmes show a huge variation in financial performance among farms of a similar type within a limited geographic area. This means judgments about the relative performance of a particular practice or farming system should not be based on financial data from a single farm or even a few farms. This applies to both confinement and pasture-based dairying systems.

Table 1 provides an example of the variation in pasture performance among grazing dairy farms cooperating in the Great Lakes Grazing Network project (Kreigl, 2005). Data are for the group average and the averages for the top and bottom 50%, based on Net Farm Income as the measure of financial performance. Net Farm Income is the return to the family for their unpaid labor, management, equity capital investment, and risk. Costs includes operating or variable costs, interest paid on farm debt, farm property taxes, and the fixed costs associated with capital investments, including depreciation charges. The term “US$ per kg or per cow EQ” (Equivalent) reflect an approach adopted by the University of Wisconsin to standardize costs and returns between farms paid different prices for milk. The difference between the averages for the high and low profit groups is striking and the range within the entire sample would be considerably greater.

Another example comes from the approximately 200 Cornell University Dairy Farm Business Management program cooperators (Table II), (Knoblauch et al., 2004; 2005). These are mostly confinement operations. Note that the farms are grouped

independently for each item (row) and show a wide range in the measures of financial performance between the first and tenth deciles. Rate of return on assets (investment) is net farm income less a charge for unpaid family labor divided by farm investment. Assets are valued at estimated fair market value. Labor and management income is an alternative measure of performance derived by deducting an imputed charge for equity capital from net farm income.

Table I. Selected Performance Measures for Grazing Dairy Farms Cooperating in the Great Lakes Grazing Network Project, 2004

Item	Top 50%	Bottom 50%	Average
Number of Farms	50	50	101
Average no. of Cows in Herd	89	99	93
Milk Sold, kg per cow per year	6,799	7,381	7,108
Cost of Production, US$ per kg EQ	$0.240	$0.305	$0.274
Net Farm Income from Operations, US$ per cow EQ	$1,062	$478	$758

Table II. Financial Performance Measures for Selected New York Dairy Farms, 2004

Item[a]	Top 10%	Bottom 10%	Average
Total Cost, US$/cwt	$0.302	$0.545	$0.347
Net Farm Income, US$ per cow	$1,306	- $70	$601
Return on Assets	23%	-5%	11.3%
Labor & Management Income per Operator, US$	$357,551	- $63,025	$78,061

[a] Data on the items in each row are grouped independently

2. Farm Summary Data. Data of the type presented in Tables I and II are more reliable indicators of relative performance than case studies but in most cases cooperating farms are self-selected and, therefore, are not a random sample. As such, they may not be representative of a particular farming system. Also, historic data inevitably lags behind innovation, for example, new farming systems such as certified organic production. It takes time to recruit adequate numbers of similar producers into a program and measure their performance.

Several studies used group data to compare pasture-based and confinement systems. One study summarized 22 reports from the Northeast and Upper Midwest regions of the

US (Ford and Musser, 1998). Pasture based systems had an advantage in annual net farm income per cow over confinement systems of US$49 to US$294. Hamilton (2002) reported similar results.

A multi-year study of Wisconsin dairy farms showed an advantage in net income per kg for pasture-based dairy farms compared to both small and large confinement dairy farms (Kriegl and Frank, 2005). Table III shows financial data for grazing and confinement farms processed at the University of Maryland (Johnson, et al., 2005). These are five-year averages, for 2000-04, and demonstrate a consistent financial advantage to pasture based dairying. Average revenue per cow was lower for the grazing dairy farms but the reduction in cost was even greater, leaving high operating margins per cow and per kg of milk.

Table III. Income and Expense, Selected Maryland Dairy Farms, Averages for 2000-04

Item	Grazed	Confinement
Revenue per Cow, US$	$2,481	$3,281
Production Expense, US$ per cow[a]	$1,547	$2,744
Operating Margin, US$ per cow[a]	$934	$537
Revenue, US$ per kg.	$0.391	$0.370
Production Expense, US$ per kg.[a]	$0.244	$0.279
Operating Margin, US$ per kg.[a]	$0.148	$0.091

[a] *Interest, personal taxes, and depreciation are not included and the operating margin corresponds to earnings before interest, taxes, depreciation and amortization (EBITDA)*

Data for similarly sized grazing and confinement dairy farms in New York are summarized in Table IV (Knoblauch et al., 2004; 2005). The pasture-based farms grazed at least three months of the year, changed paddocks at least once every three days, obtained at least 30 percent of forage needs from pasture, and were not certified organic producers. The confinement herds showed higher levels of milk production but the pasture-based farms demonstrated superior financial performance. However, labor and management income per operator was small for all groups and compares unfavorably with earnings from full time employment in non-farm occupations, estimated at US$39,354 for 2004 (US Department of Labor, 2005).

The variation in financial performance between the two years reflects the considerable volatility of US milk prices. Therefore, it is important to compare financial performance within a particular year not across years.

Table IV. Competitiveness of Pasture-based and Confinement Dairy Farms, Selected New York Farms, 2003 and 2004

Item	2003		2004	
	Grazed	Conf.	Grazed	Conf.
Number of farms	27	76	30	84
Average no. of cows	98	99	104	103
Milk Sold, kg per cow per year	7,133	8,953	7,775	8,708
Net Farm Income, US$ per Cow	$449	$193	$652	$571
Rate of Return on Assets, %	4.7%	0.2%	8.1%	5.7%
Labour & Management Income per Operator per Cow, US$	$99	-$151	$215	$103
Labour & Management Income per Operator, US$	$9,744	-$14,952	$22,397	$9,555

Table V shows the performance of a high profit group of farms for both farm types (Knoblauch et al., 2004; 2005). In 2003, a year of low milk prices, the grazing farms had an advantage over confinement farms in three of the four financial performance measures but differences were much smaller than those in Table IV. In 2004, a year with higher milk prices, the financial performance of both farm types was similar.

Table V. Competitiveness of High Profit Pasture-based and Confinement Dairies, Selected New York Farms, 2003 and 2004

Item	2003		2004	
	Grazed	Confined	Grazed	Confined
Number of farms	10	16	10	11
Average no. of Cows	66	57	110	114
Milk sold, kg per cow per year	8,493	8,830	7,794	9,721
Net Farm Income, US$ per Cow	$759	$795	$957	$1,152
Rate of Return on Assets, %	5.3%	2.3%	13.2%	13.4%
Labour & Management Income per Operator per Cow, US$	$252	$229	$520	$503
Labour & Management Income per Operator	$16,702	$13,040	$57,202	$57,373

The data in Tables IV and V remove the effects of herd size but whole farm performance is an important aspect of competitiveness. The number of cows that a grazing farm can support is limited by the availability of pasture and the distance milking cows can walk. The physical layout of a farm may be an additional constraint. Herd size may be less constrained under a confinement operation because forage crops can be transported to the dairy facility more easily and over greater distances or purchased. Therefore, opportunities to obtain economies of scale may be greater under the confinement system.

The predominant breed of cow in the United States is the Holstein and the most common management system is confinement housing and feeding. However, dairy genetics developed for these conditions may not be appropriate for pasture based systems, particularly for seasonal calving where reproductive performance is critical.

Production data suggest superior performance from Jersey and cross-bred cows over Holstein in health, reproductive performance and longevity, but there are limited data on the profitability of alternative breeds and crosses. Table VI shows data from the Great Lakes Grazing Network project (Kreigl, 2005). Net Farm Income was higher for Holsteins, both per unit of milk and per cow. A study in Vermont compared Jersey and Holstein in similarly sized grazing herds and found that Holsteins outperformed Jerseys on a per cow basis (Winsten, 1998). However, there was little information about the grazing systems employed and the results could have been confounded by differences in the systems. Also, a farm may be able to support more smaller cows like Jerseys, in which case a financial disadvantage per head may be partly or completely offset by greater stock numbers.

The low cost of production under the New Zealand pasture based seasonal production system has created interest in the US. In a seasonal dairy operation, the milking herd is completely dry for a few weeks each year, there is a 12-month calving interval, and calving is timed to match the milking cows' nutritional needs with pasture growth or to mitigate climate variables. Proponents suggest advantages in matching the nutritional needs of the lactating cow with the pattern of pasture growth and the ability to focus management time and effort to specific tasks such as calving and calf raising. They cite the advantage of a "vacation" from milking when the herd is dry. Others note that a concentrated calving and calf raising period creates a high peak workload, and increased investment and inefficiencies in the use of specialized capital such as milking parlors and calf raising facilities. As with breed differences, comparative data on the profitability of seasonal and non-seasonal herds are relatively scarce. Table VII presents data from the Great Lakes Grazing Network project (Kreigl, 2005). There is a notable difference in milk production per cow but virtually the same net farm income per cow. Seasonal herds had a lower operating cost per unit of milk but the lower production per cow offset this advantage.

Table VI. Dairy Farm Performance by Breed, Great Lakes Grazing Network Project, Averages for 2001-4

Item	Holstein	Non-Holstein
Milk Sold, kg per cow per year	7,801	6,198
Milk Price, net, US$ per kg.	$0.346	$0.348
Production Cost, US$ per kg EQ	$0.244	$0.253
Net Farm Income from Operations, US$ per Cow EQ	$647	$469

Table VII. Seasonal and Year-round Calving Herds, Great Lakes Grazing Network Project, 2000-4

Item	Seasonal	Non-Seasonal
Milk Sold, kg per cow per year	5,282	7,483
Milk Price, net, US$ per kg.	$0.343	$0.331
Operating cost, US$ per kg EQ	$0.236	$0.247
Net Farm Income from Operations, US$ per cow EQ	$520	$523

Studies on economies of scale in milk production do not identify grazing systems separately, for example (Knoblauch, et al., 2005), (USDA, 2007b).

USDA (2007b) uses survey data for estimates of costs and returns per unit of milk sold for selected regions of the US but does not distinguish between different farming systems.

3. *Research.* Most financial data for pasture-based dairy farms comes from Northern US dairy states where cool season perennial grasses are the predominant pasture types. There are pasture-based dairy farms in other regions but climate, pasture types and milk prices are different and financial data are lacking. In these circumstances, it is necessary to use other sources of data, including research results, to assess competitiveness.

Summer and winter annual pastures are the basis for pasture-based farms in the Mississippi Delta region of the US. A multiple year study in Mississippi compared milking cows on pasture with and a no-till maize silage-based feeding system (Murphey, et al., 1997). The silage fed herd produced more milk but had higher feed costs. Income over feed cost was similar for both groups.

A North Carolina University study split the university dairy herd into four treatment groups. There were two feeding treatments, grazing and a total mixed ration fed in a confinement facility. There were two seasonal calving groups within each feeding treatment, fall and spring, and each treatment group had both Holstein and Jersey cows. This study covered seven lactations and the results showed that grazing cows of either breed produced less milk and had lower feed costs. However, income over feed cost was not significantly different for season of calving or feeding system. Holsteins had higher income over feed costs per cow than Jerseys. Reproductive efficiency and herd health favored Jerseys over Holsteins and grazing cows over cows in confinement. Non-feed costs were not measured but were considered likely to be substantially lower for grazing herds (White, 2002).

4. *Simulation.* Simulating financial performance can be valuable both when direct measurement is not possible and in investigating multiple alternatives. One simulation used the North Carolina research project data to evaluate the effects of different stocking rates and three supplementary feeding systems on profitability (King, 1997). The three feeding systems were pasture only, pasture and a pelleted concentrate fed in the milking parlor, a system which limits concentrate intake, and pasture with a mixture of corn and whole cotton seed (WCS) fed under a fenceline feeding system, which allows high levels of concentrate feeding. Gross margin per hectare was the measure of financial performance and representative regional milk and input prices were used in the model.

High levels of supplementary grain feeding under a fence line feeding system combined with a high stocking rate produced the highest gross margin per hectare (Figure 1). This system yielded gross margins approximately double the levels under restricted feeding of concentrates in a parlor feeding system and almost triple those in a pasture-only system. There were high levels of pasture intake under each feeding system (Figure 2).

However, because this was a simulation, findings should be tested in the field along with an assessment of the environmental effects of high stocking rates. A further research project evaluated two stocking rates and feeding strategies, purebred and crossbred cows, seasonal calving, and environmental impacts. Income over feed costs was used to measure financial performance. The results of the field trial supported King's simulation results (Table VIII). Cows stocked at high rates suffered a small reduction in performance per cow but there was a large increase in income over feed costs per hectare (Benson et al., 2006).

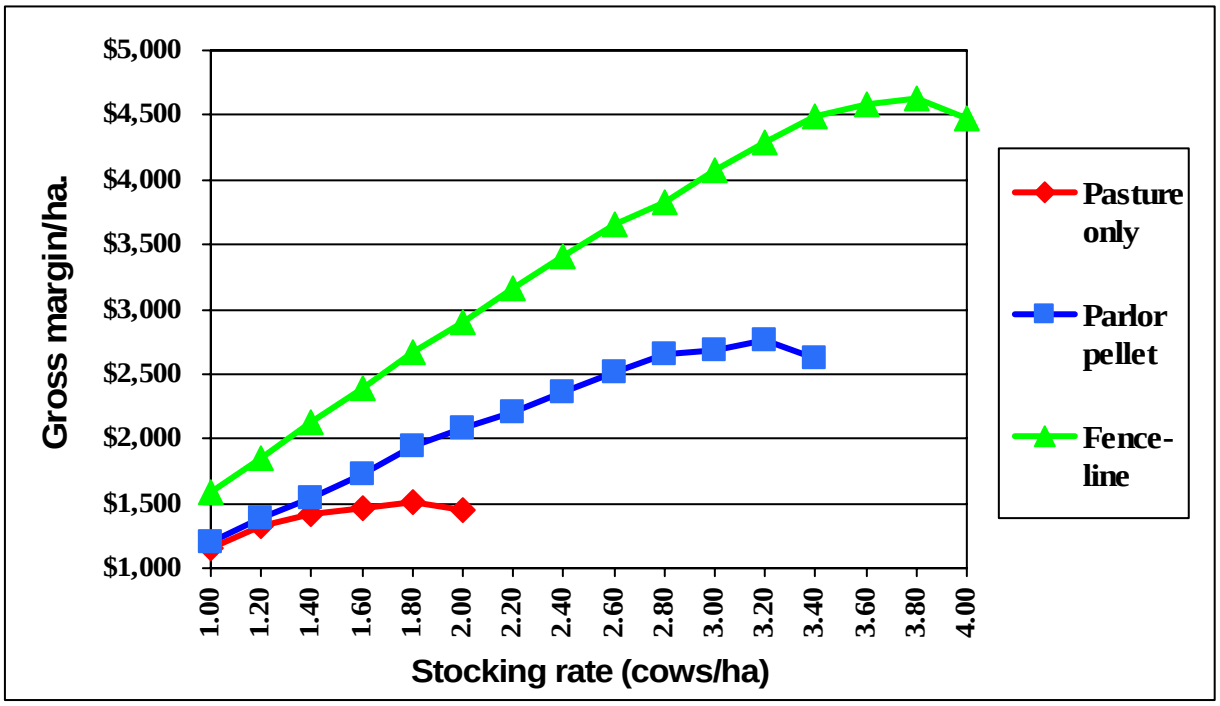

Figure 1. Gross margin per hectare under three feeding systems at different stocking rates.

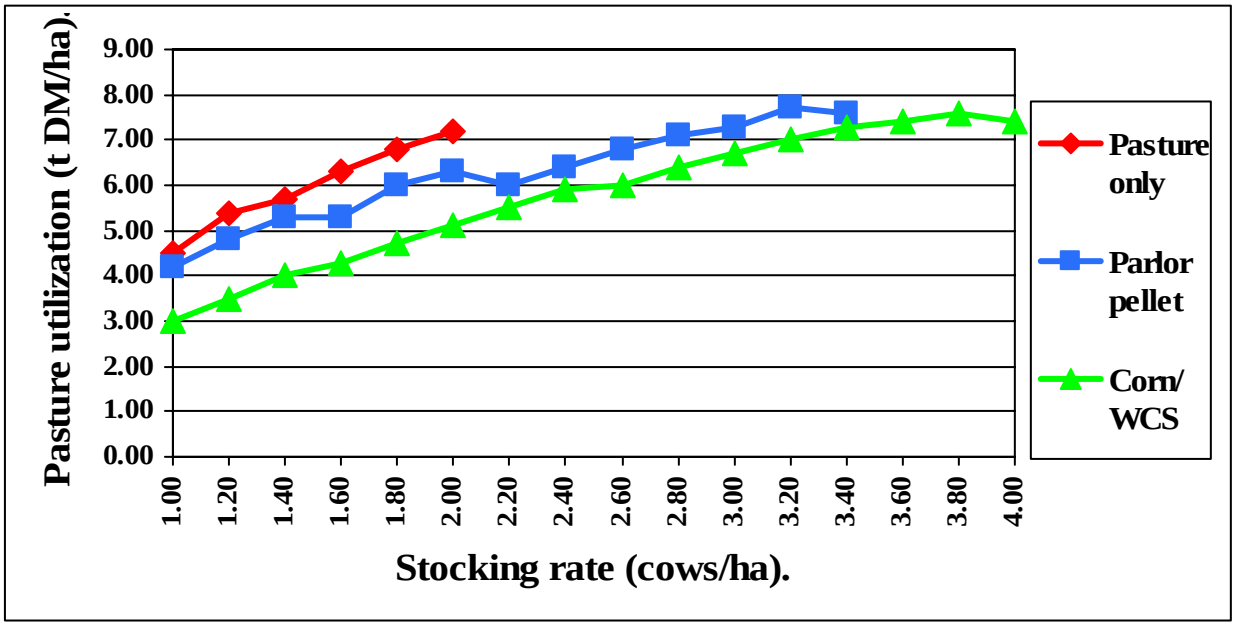

Figure 2. Pasture utilization per hectare under three feeding systems at different stocking rates.

Table VIII. Income over Feed Costs for Cows Stocked at Two Different Rates

Item	Low Stocking Rate 2004-5	High Stocking Rate 2004-5	Low Stocking Rate 2005-6	High Stocking Rate 2005-6
Stocking Rate, cows per ha	2.3	3.5	2.0	3.0
Milk Sales, US$ per Cow per Day	$6.90	$6.84	$5.76	$6.17
Feed cost, US$ per Cow per day	$1.80	$2.11	$1.64	$1.96
Income over Feed Cost, US$ per Cow per Day	$5.10	$4.74	$4.12	$4.22
Income over Feed Cost, US$ per ha per Day	$11.71	$16.60	$8.25	$12.60

Organic Production. Organic milk production is a specialized type of pasture-based dairy farming. Certification under the National Organic Program administered by the US Department of Agriculture requires that cows have unrestricted access to pasture. Currently demand for organic dairy products is small but growing rapidly and production is lagging because of transition rules. However, at some point, a balance between production and sales will be achieved and cost of production data may provide some insights into competitiveness and the longer-term prospects for organic farms.

A one-year study in New England by McCrory (2001) showed net farm income per cow was $278 greater for organic farms than conventional farms. Organic farms had fewer cows, so total net farm income was only slightly higher. However, there is a significant transition cost in changing to certified organic status, including lost income and added expense. Transition costs were discussed but not included in the expenses reported for the organic farms, and the data were not adequate to evaluate the likely effect on performance. Transition costs should be treated as an investment, amortized over the planning horizon and reported as an annual cost.

A study in California included amortized transition costs and found that conventional dairy farms had superior financial performance in spite of a substantial price premium from organic milk (Butler, 2002). Net farm income per kg of milk was seven cents higher for the conventional farms and net farm income per cow per month was US$9 greater.

A more recent comparison of organic and conventional farms in Maine and Vermont concluded that organic farms were relatively unprofitable as measured by returns to labour and management or the rate of return on assets (Dalton, et al., 2005). However, conventional milk prices were relatively high in 2004, which may have given an

advantage to these farms that would not occur normally. Prices for organic milk are more stable than those for conventional milk, which vary monthly based on national supply and demand conditions.

The US Department of Agriculture (2007b) reported the costs and returns per unit of milk sold for organic dairy farms in their most recent Agricultural Resource Management Survey. Data for 2005 for five northern states permit comparison of organic farm performance with that of all dairy farms in those states. Organic farms in four of the five states had an advantage over conventional farms in terms of the value of production over operating costs except labour. However, the organic farms had fewer cows and much lower milk yields per cow and generated smaller net returns per farm. When hired labor, farm overhead, capital recovery, and opportunity costs of family labor and land were considered, the net returns per unit of milk sold were unfavorable for the organic farms for four of the five states and similar to conventional farms in the fifth. Grouping these data by herd size showed little evidence of economies of scale in operating (variable) cost per unit of milk sold, but pronounced effects when all economic costs were considered.

Methodological and Data Issues

The lack of consistency is evident from the data presented. There is no national program of farm financial record keeping or analysis in the US. The definitions and methodology used by different individuals and organizations which collect, summarize and report financial data are not standardized.[1] Many, if not most, economic studies lack detailed data on farm resources and production practices, which is an obstacle to identifying the profitability of a specific component or practice. Most studies do not report the land area used for grazing by pasture-based dairy farms and land-based performance measures.

These data limitations affect any assessment of relative farm financial performance of pasture based dairy farms. In addition, these farms are not homogeneous. Climate, including rainfall and seasonal temperature ranges, and soil types vary widely. The land area, pasture types and yield, and the contribution of pasture to the cow's total diet all vary. Pasture use in US dairies spans a continuum from 0%, in the case of cows fed a total mixed ration (TMR) in a confinement system, to 100% on farms that have adopted a New Zealand-style system. Grazing management varies from set stocking to intensively managed, rotational grazing where milking animals are moved to new pastures as often as twice daily. Pasture-based dairy farms include seasonal milk production and organic production, which, if not documented, can complicate data interpretation.

[1] The Farm Financial Standards Council (1997) developed and published guidelines for the preparation of farm financial performance measures and many organizations have adopted these as a goal. A task force created by the American Agricultural Economics Association (2000) developed guidelines for the estimation of farm commodity costs and returns. However, for historical and other reasons, some differences in methodology, terminology and definitions remain.

None of the studies reviewed for this paper have been subjected to statistical analysis to identify those factors that affect financial performance and their relative importance. However, as a corollary, this is only possible if there are adequate numbers of cooperating farmers. Experience suggests that this will be a challenge, in part because US income tax regulations permit farmers to file taxes on a cash basis, with all the attendant problems cash based accounting causes for complete and accurate financial analysis. A further challenge is obtaining the resources needed to conduct these studies.

Summary and Conclusions

Dairy farm financial performance measures show that pasture-based farms were somewhat more profitable than confinement farms, on average, when compared on a per cow or a per kg of milk sold basis. However, for most studies, the average rate of return on assets was below prevailing market rates of interest for agricultural borrowers (Federal Reserve System. Quarterly) and average returns to labor and management were below the prevailing wage rates in non-farm employment (U.S. Department of Labor). Based on these measures, profitability was low for both types of dairy farms. However, some farms of both types were highly profitable by these same measures. Most of the data on grazing farms were for small herds and, given the trends in the US dairy industry, the longer-term viability of a small farm of either type is questionable. Data on the relative performance of larger herds of both types was sparse.

Within pasture-based dairy farms, there is limited information on the relative profitability of specific breeds and seasonal compared to year-round calving. Information on the financial performance of farms employing such practices as rotational grazing and cross breeding also are scarce. Results for organic farms suggest challenges that are similar to those faced by other types of dairy farms.

The studies reported here are considered representative and show variation in methodology, differences and gaps in the measures reported, and incomplete geographic coverage. More comprehensive and consistent information is needed about pasture based dairying systems, including resources, production and financial data. The US dairy industry would benefit if government agencies, agricultural economists and others involved in collecting, analyzing and reporting data standardized their methodology and expanded their data collection and analysis to include wider geographic coverage and more information on farm resources and production practices employed on farms. A comprehensive system would include various financial performance measures for the whole farm, per cow, per unit of milk sold, and, for grazing farms, per unit of land area. However, given resource constraints and the divergent goals and responsibilities of the various individuals and organizations currently or likely to be involved in these activities, progress toward this goal is likely to be slow at best.

The profitability of any farm type or farming practice likely depends on many factors. For the foreseeable future, given the limited information available, US farmers interested in converting to pasture-based dairying and others considering commencing in dairying are advised to carefully examine their family goals, evaluate their farm resources and financial status, develop a detailed farm plan based on the best available information, and evaluate the expected profitability, cash flow and risk consequences of this plan. Given the observed variation in dairy farm financial performance and the trends in the US dairy industry, all dairy farmers are likely to benefit from adopting proven business management practices.

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