Case Study of the Viability of Smallholder Dairy Farming in Nharira-Lancashire, Zimbabwe

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ABSTRACT : There is little information on smallholder dairy farming in Zimbabwe. With such inadequate knowledge, no meaningful decisions on how to improve these systems can be made. A study was, therefore, carried out in Nharira communal area and Lancashire small-scale commercial area to provide information on the viability of dairy farms. This paper is based on data obtained through participatory monitoring of 13 smallholder dairy farms in 1996 and 1997. All the four farms in Lancashire were found to be viable in both years. In Nharira, two out of the nine farms in 1996 and three farms in 1997 failed to break even. There were considerable inter-farm differences in the contribution of milk sales towards total income from dairy farming, ranging from 41% to 99% in Nharira and 71% to 81% in Lancashire in 1996. Corresponding estimates in 1997 were 51-95% and 72-78%, respectively. Expenses on cattle feeds contributed 36-84% in 1996 and 37-80% in 1997 towards total variable costs in Nharira. In Lancashire, the respective estimates were 15-33% and 22-36%. Seven out of the nine studied farms in Nharira and three out of four in Lancashire realized higher gross margin (GM) in 1997 than in 1996. All these farming households had conserved considerable amounts of farm-grown feeds. It was concluded that feed costs, number of cows and sizes of land holdings were the main factors determining viability of smallholder dairy farming. The major challenge to smallholder dairy farming in Nharira, in particular, was to develop low-cost feeding strategies. *(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 8 : 1098-1105)*

Key Words : Smallholder Dairy Farming, Participatory Monitoring, Viability, Zimbabwe

INTRODUCTION

Commercial dairy farming was first introduced into smallholder farming areas in Zimbabwe in 1983, mainly as a tool for accelerating rural development. Although ten smallholder dairy schemes have since been established, little ex-post evaluation has been done to assess the performance of the schemes at farm level. The only existing information is limited and mainly in the form of once-off surveys (Matinhira, 1988; Mupunga, 1994; Dube, 1995) and consultancy reports (Hanyani-Mlambo et al., 1998). These reports do not provide satisfactory answers to issues such as the extent to which farmers have integrated dairy farming with other enterprises; how production patterns are changing; viability of dairy farming; and the principal determinants of viability of dairy farming and how they can be addressed. Because there are so many unanswered questions, on-going smallholder dairy development efforts can only be expected to have "hit and miss" effects.

This study was a first attempt in this country to assess the viability (based on gross margin: GM analysis) of dairy farming using farm-level data, obtained through farmer-participatory monitoring. A detailed discussion of how GM analysis was carried out for dairy farms in Nharira-Lancashire and its outputs is presented.

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MATERIALS AND METHODS

Farmer selection

A summary of the approach used to select the studied farms is given in figure 1. Multi-stage stratified and purposive sampling techniques were used to select the farms. Eighty-five farmers in Nharira and Lancashire who were milking and selling milk to the local Milk Collection Centre constituted the recommendation domain. The farmers were first categorized based on whether they belonged to the communal or small-scale commercial farming sector. They were members of specific input-procurement and farmer-training clusters. There were seven such clusters in Nharira and two clusters in Lancashire. Each cluster was requested to identify three of its members who would participate in the studies.

Initial selection of a large number of farms was desirable because it served as insurance against premature termination of the research activities in the event of loss or withdrawal by some farmers. The selection criteria that the research personnel requested the farmers to use were: (a) owning ≥2 lactating or dry cows, or pregnant heifers; (b) genuine interest to collaborate; (c) ≥3 years experience in dairy farming; and (d) having milked and formally marketed milk for ≥10 months in at least one year since assuming membership of the Nharira-Lancashire Dairy Farmers' Association. All the farmers who were registered as members of this association were expected to sell all their milk to a centrally located milk collection center.

Four clusters of farmers in Nharira submitted three candidate farms each as requested by the research personnel,

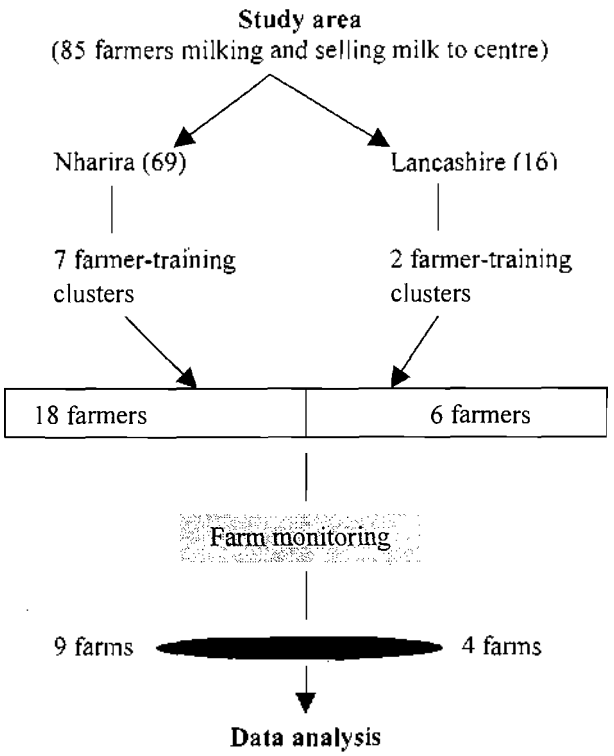

Figure 1. Schematic summary of farmer selection, farm monitoring and data analysis stages

while the remaining three clusters selected two farms each only. The two clusters in Lancashire succeeded in identifying three farms each as requested by the research team. In addition to the researcher-provided selection criteria, the farmers superimposed their own criteria to supplement those recommended by researchers. The supplementary criteria were as follows:

(a) did not participate in past local research and development programmes;
(b) literate full-time resident farm owner, spouse, children or relative;
(c) approachable;
(d) selfless;
(e) having time and patience to participate;
(f) committed to the planned research programme; and
(g) honest.

Data collection and management

Literate members of the selected households gathered and recorded the data. A resident field technician, who visited each farm fortnightly, managed the research programme. On each visit, the technician was expected to (a) check the correctness of data entries, for example, using cash receipts and vouchers as evidence of cash transactions; (b) address any queries that the farmers had; (c) assist the farmers in data recording; and (d) discuss with the farmers how they could use the records in farm planning and development. The principal researcher also visited the study site fortnightly and worked there for an entire working week on each visit. All participating farms were always visited in order to appraise first hand, how the research activities were progressing.

Data management and analysis

The work reported here covered two years, namely 1996 and 1997, and involved 24 farmers. Data from only 13 farms (9 in Nharira and 4 in Lancashire) were complete. The data were entered into the computer, stored and analysed using the Microsoft Excel software package for Windows 95. Gross margin (GM), defined by Johnson (1985) as the difference between gross income and total variable costs (TVC), was calculated for each farm. The analyses acknowledged the fact that dairy farming was inter-linked with other farming sub-systems. A description of the procedures used to estimate TVC and returns from dairy farming is presented below.

Gross income

Gross income was calculated using differences in stock value, which included transfers from dairy farming to the beef enterprise, milk sales and value of cattle manure. The value of milk sold to the Milk Collection Centre was obtained using the prevailing market price. Home-retained milk was assumed to have been sold within the villages. Therefore, income realised from selling milk at village level was estimated using the prevailing village market price of Z$1.30 per litre (1US$ ≈ Z$38).

The number of ox-drawn carts of manure harvested was recorded. Geometric dimensions (lengths, widths and heights) of the carts used on each farm were measured and used to calculate the capacities of the carts. A cardboard box of known volume was then filled with manure from every cart. Assuming that a cardboard box of x m^3 was filled with manure weighing y kg, a cart with a volume of z m^3 would contain z/x * y kg of manure.

Samples of manure were obtained from each cart. A compound sample from each farm was then constituted by thoroughly mixing all the samples from that farm. The compound samples from individual farms were subsequently analysed for their nutrient contents using the inductively coupled plasma (ICP) technique (Boss and Fredeen, 1989). The phosphorus content of the manure was subsequently used to calculate the compound D equivalent, taking into account the fact that this basal fertiliser contained 8% N; 14% P_2O_5; 7% K_2O. This information was important for estimating its monetary value (50 kg of compound D cost Z$124.50 in 1996 and Z$148.25 in 1997). Although the farmers kept both beef and dairy cattle, the two types of cattle were usually penned separately. This made it easy to estimate the amount of manure produced by the dairy herd. The cattle manure deposited by the animals

Table 1. Dairy cattle trading account over a two-year period (e.g. farmer 2 in Nharira)

	Jan 1, 1996	Dec 31, 1996	Dec 31, 1997
Bulls			
Opening stock	1	1	2
Minus deaths	0	0	
Minus culls	0	0	
Plus purchases	0	0	
Closing stock	1	2	
Cows			
Opening stock	4	6	6
Minus deaths	0	0	
Minus culls	0	0	
Plus purchases	0	0	
Closing stock	6	6	
Female calves			
Opening stock	4	3	3
Plus births	3	3	
Minus deaths	0	1	
Minus transfers to heifers	4	2	
Closing stock	3	3	
Male calves			
Opening stock	0	1	2
Plus births	1	2	
Minus deaths	0	0	
Minus transfers to bulls	0	1	
Minus transfers to beef herd	0	0	
Closing stock	1	2	
Heifers			
Opening stock	5	7	9
Minus deaths	0	0	
Minus culls	1	0	
Minus sales	0	0	
Plus purchases	0	1	
Minus transfers to cows	2	2	
Closing stock	6	9	

Notes: (a) Change in stock value (appreciation or depreciation) for each class of cattle is calculated as: Σ(BW of closing stock – BW of opening stock) x beef price of Z$10/kg BW. (b) Change in stock value of dairy herd = Σ(appreciation or depreciation of bulls, cows, female calves, male calves, heifers)

in grazing areas was not accounted for, implying that the actual value of manure was under-estimated in this study.

Change in stock value was obtained through conducting a livestock trading account, using the modified Department of Agricultural, Technical and Extension Service (AGRITEX, 1985) approach. Dairy cattle inventories were carried out in the beginning and at the end of each year of study, as shown for farmer 2 in Nharira in table 1. The actual body weight (BW) of individual cattle were obtained using a mobile cattle weighing scale graduated at 5 kg up to 1,000 kg (Kattleway Pvt Ltd, Marondera, Zimbabwe) between 0:600 and 0:800 hours. Calves, defined as those cattle aged less than one year, were weighed using a weighing scale graduated at 0.25 kg intervals. The cattle were weighed before they had access to water and feed. Each class of cattle was valued on the basis of existing market prices per kilogram (kg) of BW for beef cattle, since no reliable local market prices for dairy cattle could be obtained. The price of Z$10 per kg of BW used in year 1 (1996) was maintained in year 2 (1997), irrespective of any change in market price. This analysis also captured the appreciation of calves during the year, due to BW gain. The gain in BW was partly attributed to the milk obtained through direct suckling. None of the farmers bucket-fed their calves.

Castrated male cattle aged more than one year were transferred to the beef herd, from where they were either sold afterwards or used as draught animals. Such cattle were regarded as having been sold at Z$10 per kg BW to the beef herd from the dairy sub-system.

Variable costs

Variable feed costs were calculated using the actual cost of purchased feeds, value of grain fed to the cattle, costs of inputs into fodder production, hay making and silage making as well as harvested crop residues. Crop residues were considered as substitutes for natural pasture hay. The local cost of a 15 kg bale of the hay (Z$6), its nutritive value and the quality of conserved crop residues were known. This information was used to calculate the hay equivalent monetary value for each type of crop residue.

The value of maize grain, in Z$, fed to dairy cattle in each year was obtained using the formula: value of maize grain=kg grain fed×Z$1.20, the prevailing Grain Marketing Board (GMB) price per kg of grain. This meant that the opportunity cost of feeding the grain to dairy cattle was to sell it to the GMB at the prevailing price of Z$1,200 per tonne.

Although the farmers used their own draught animal power (DAP) in dairy farming activities, it was assumed that this DAP had been hired locally. The costs of hiring DAP were, therefore, obtained through calculating the product of the number of hours worked in a year and village rates of hiring (e.g. ranging from Z$100 to Z$140 per hectare for plowing). Expenses on full-time and casual hired labour were calculated on the basis of actual payments made.

The actual value of purchased drugs or medicines and charges for veterinary services rendered were summed up to give the total veterinary expenses.

The volumes of milk produced, marketed and consumed at home were all recorded. Variable costs incurred through

transporting milk to the Milk Collection Centre were calculated using the prevailing car hire rate for the area of Z$0.20 per litre of milk. This was done because there were no known charges for transporting milk using a bicycle or delivering milk to the Centre on foot.

Lastly, the actual value or amount paid when purchasing cattle was treated as a fixed cost. It was assumed that the cattle were bought using loans from financial institutions, which the farmers would repay at fixed rates of payments over a given number of years. This assumption was maintained even when the farmers used their own cash resources to purchase the cattle. Donated animals were assumed to have been purchased or bought-in. The Agricultural Finance Corporation rate of interest remained steady at 33 % per annum during the two years of study.

Literate family representatives recorded labour use data daily using a recording sheet. The recording sheet was designed such that it would reveal the task carried out, type of labour used (whether men, women, children, hired and community or exchange) and the time in hours spent carrying out the task. Family labor time was obtained by summing up the times worked by men, women and children. Children were defined as those family members aged less than 12 years. They were classified by adults as helpers who were too young to perform duties as efficiently as older family members. It was assumed that family labour would be paid using the local rates of hiring casual labor, which averaged about Z$14 per 8 h working day. When estimating labour use, no quality differences between labour inputs of men, women and children were taken into account. No quantitative evidence was available on how efficient each of these people performed each of the dairy farming activities.

RESULTS AND DISCUSSION

As shown in tables 2 and 3, a number of economic performance indicators were calculated in order to establish the viability of dairy farming. These included the absolute farm GM, GM per variable costs, GM per feed costs, GM per milked cow, GM per family labour hour, the proportion of feed costs in relation to total variable costs and the contribution of milk sales towards gross income. Other indicators of efficiency of dairy farming used included milk production per cow per milking day, GM per litre of milk produced, variable costs per litre of milk produced and feed costs per litre of milk produced. Before discussing these indicators, results of family labour input will be presented first.

Family labour input

In 1996, the total labor input into dairy farming was about 06:20 to 20:12 hours per farm in Nharira and 16:86 to 21:24 hours per farm in Lancashire (table 4). It is also shown in table 4 that the estimates for the year 1997 were 04:06 to 22:61 hours per farm in Nharira and 08:55 to 25:96 hours in Lancashire. Family labor contributed 13-100 % of the total labour input into dairy farming in Nharira in 1996 compared with 18-76% in Lancashire. These results compare with 11-100% and 24-74% in Nharira and Lancashire, respectively, in 1997. In both years, three out of the nine farms in Nharira and one out of the four farms in Lancashire relied, mainly, on family labor to carry out dairy farming activities (table 4). Hanyani-Mlambo et al. (1998) reported that one of the characteristics of smallholder dairy farms in Zimbabwe was their heavy reliance on family labor, a fact that contrasts the findings of this study. This observation highlighted the fact that family members on the farms in Nharira-Lancashire were engaged in alternative economic activities. Alam, Yasmin, Sayeed and Rahman (1995) observed that rich farmers owning mini dairy farms in Bangladesh relied more on paid hired labour than family labour. Assuming that these authors' observation would always hold, it may be inferred that the results obtained in this study highlighted the high social status of the dairy farmers in Nharira and Lancashire. It is also possible that the farmers were busy elsewhere, for example doing off-farm jobs.

Gross margin as a measure of viability

Although dairy farming on farms 1, 3 and 7 in 1996 and farms 1 and 3 in 1997 failed to break even, it was viable on the other farms (tables 2 and 3). In 1996, the gross margins varied from -Z$ 2,370 to Z$ 3,872 in Nharira and Z$ 7,815 to Z$ 13,490 in Lancashire. The results for 1997 were -Z$ 3,550 to Z$ 13,130 and Z$ 8,823 to Z$ 16,575 in Nharira and Lancashire, respectively. When these results were converted to returns per family labour input, the GM for the year 1996 translated to -Z$13.54 to Z$ 15.08 per farm in Nharira compared with Z$ 8.74 to Z$ 33.51 in Lancashire. In 1997, the estimates were -Z$8.69 to Z$ 36.73 in Nharira and Z$ 8.65 to Z$ 43.06 in Lancashire.

The concept of returns to family labour input in dairy farming was relevant because of the need for justifying employment of non-migrant family labour in the dairy enterprise. In Lancashire, all the dairy farming households had much higher returns to their labour in both years of study when compared with the local casual hired labour rate of payment of Z$1.75 per hour. The full-time hired labor wage rate was lower than Z$1.25 per hour. Only three out of the nine farming households in Nharira and five in 1997 realised higher returns to their labour than the casual hired labour wage rate.

The evidence presented in the preceding paragraphs suggests that in both 1996 and 1997, dairy farms in Lancashire performed better than in Nharira. However, based on estimates of milk production per cow per milking

Table 2. Gross margin analysis of dairy farms in year 1, 1996

	Nharira Farms									Lancashire Farms			
	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of cows	5	6	2	5	3	2	5	2	3	21	15	11	11
Cumulative milking days	887	1,255	495	699	1,010	455	1,034	366.	732.	3,306	1,984	1,951	2,013
Gross income													
Difference in stock value	-605	515	2,085	710	-190	915	405	190	565	3,160	2,660	1,785	740
Valueof manure	645	1,772	873	2,202	1,222	941	1,017	898	1,069	1,478	2,770	1,588	2,510
Milk sales													
Centre	2,656	11,464	3,041	9,545	7,117	705	4,117	655	3,237	11,842	12,816	12,437	12,6215
Local	324	500	375	594	630	608	430	1,025	586	518	576	865	1,263
Variable Costs													
Milk transport	275	1,153	295	898	725	79	407	29	323	1,098	1,241	1,235	1,264
Veterinary expenses	120	603	406	986	435	143	625	326	181	25	193	318	630
Hired labour expenses	2,100	2,764	1,850	1,904	2,930	60	3,283	240	1,643	1,600	2,252	2,084	4,302
Feed costs (Minus labour expenses)													
Bought-in	1,938	3,346	2,765	4,867	3,550	706	1,794	199	1,335	541	1,011	1,247	2,359
Grain	211	794	209	1,013	267	146	344	100	367	0	0	0	257
Maize stover	480	671	525	1,040	359	1,180	522	601	802	0	492	0	456
Legume crop residues	35	65	0	33	5	48	5	7	12	0	0	0	14
Silage	0	110	86	124	0	72	0	78	94	0	146	0	0
Hay	0	142	105	144	26	46	76	64	54	0	0.	0	0
Draught animal power use	231	731	219	319	163	131	581	175	131	244	119	75.	31
Farm Gross Margin, (GM) Z$	-2,370	3,872	-86	1,723	319	558	-1,668	949	515	13,490	13,375	11,716	7,815
GM/Variable costs	-0.44	0.37	-0.01	0.15	0.04	0.21	-0.22	0 52	0.10	3.85	2.45	2.36	0.84
GM/Feed costs	-0.89	0.76	-0.02	0.24	0.08	0.25	-0.61	0.90	0.19	24.94	8.11	9.40	2.53
GM/Cow, Z$/Cow	-474	645.33	-43	344.60	106.33	279	-333.60	474.50	171.67	642.38	891.67	1,065.09	710.45
GM/Family Labour Input, Z$/h	-13.54	15.08	-0.51	2.94	0.31	0.90	-4.66	1.25	3.29	33.51	8.74	16.08	20 65
Feed/Variable costs (as %)	49.42	49.41	57.12	63.74	49.73	84.18	35.89	57.67	53.91	15.42	30.23	25.15	33.14
Milk Sales /Gross Income (as %)	98.68	83.95	53.59	77.69	88.24	41.43	76.18	60.69	70.06	72.71	71.12	79.77	81.03

day on each farm, a contrasting picture emerged (table 4). The daily milking averages per cow for all the farms in Nharira (0.37-1.78 litres in 1996 and 0.38-3.18 litres in 1997) were invariably greater than for the farms in Lancashire (0.08-0.33 litres and 0.12-0.24 litres in 1996 and 1997, respectively). From these observations, it can be concluded that the relatively larger volumes of milk produced by the farmers in Lancashire when compared with their colleagues in Nharira were simply due to the fact that each farmer in the former area milked a considerably greater number of cows. Probably, the better performance per cow in Nharira originated from the more distinct efforts that the farmers took to improve the feeding management of their cows. This assertion is supported by the consistently higher feed costs in relation to TVC in Nharira than in Lancashire (table 4).

Principal determinants of gross margin

Profitability of dairy farming is principally affected by the price of milk, quality of the milk, reliability of markets, price of feed and production efficiency. Production efficiency is in turn determined by the managerial skills and level of discipline of the farmer, milk yield and calving intervals of cows in the dairy herd, among other factors. In

Table 3. Gross margin analysis of dairy farms in year 1, 1997

	Nharira Farms									Lancashire Farms			
	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of cows	5	7	5	7	6	2	4	2	3	19	13	12	12
Cumulative milking days	438	1,449	1,176	1,234	1,443	590	1,310	147	666	1,917	2,362	2,930	2,108
Gross income													
Difference in stock value	-733	2,810	550	1,250	215	1,085	705	590	365	3,575	2,200	2,165	1,585
Valueof manure	881	2,369	1,316	2,560	1,824	1,391	1,377	982	1,612	979	2,884	1,925	2,697
Milk sales													
Centre	2,191	18,912	6,110	21,195	11.169	2,697	8,743	1,250	5,259	11,240	16,555	13.579	11.599
Local	883	557	485	760	1,221	620	415	365	681	542	906	1,323	1,042
Variable Costs													
Milk transport	160	1,512	613	1,727	880	224	712	91	411	784	1,364	1,095	943
Veterinary expenses	69	821	1,670	967	327	325	543	59	424	223	206	452	610
Hired labour expenses	3,975	3,370	3,350	2,760	2,970	121	3,040	80	2,655	2,280	2,615	2,040	4,630
Feed costs (Minus labour expenses)													
Bought-in	1,419	2,626	2,459	6,357	2,715	1,252	2,090	586	1,855	386	916	1,118	725
Grain	198	956	518	1,272	251	174	356	116	416	0	0	0	297
Maize stover	697	1,339	1,141	1,643	606.	1,710	732	909	1,118	806	827	901	716
Legume crop residues	44	100	46	81	12	92	8	17	32	0	11	25	23
Silage	80	165	126	183	0	87	105	110	133	0	0	143	0
Hay	61	254	187	261	83	146	166	153	131	0	0	0	0
Draught animal power use	69	375	106	125	175	206	275	81	81	50	31	288	156
Farm Gross Margin,(GM) Z$	-3,550	13,130	-1,755	10,389	6,410	1,456	3,213	985	651	11,807	16,575	12,930	8,823
GM/Variable costs	-0.52	1.14	-0.17	0.68	0.80	0.34	0.40	0.45	0.09	2.61	2.78	2.13	1.09
GM/Feed costs	-1.42	2.41	-0.39	1.06	1.75	0.42	0.93	0.52	0.18	9.91	9.45	5.91	5.01
GM/Cow, Z$/Cow	-710	1,875.71	-351	1,484.14	1,068.33	728	803.25	492.50	217	621.42	1,275	1,077.50	735.25
GM/Family Labour Input, Z$/h	-8.69	36.73	-7.10	10.60	26.02	1.21	24.60	2.52	1.67	28.04	8.65	43.30	11.76
Feed/Variable costs (as %)	36.90	47.23	43.82	63.72	45.373	79.80	43.07	85.88	50.72	26.32	29.38	36.08	21.74
Milk Sales /Gross income (as %)	95.41	78.99	77.95	85.21	85.87	57.26	81.48	50.67	75.03	72.12	77.45	78.46	74.70

both farming areas, milk sales contributed considerably (41-99% in Nharira and 71-81% in Lancashire) towards dairy income in 1996. The trend was almost similar in 1997, when the respective contributions in the two farming areas were 51-95% and 72-78%.

An examination of the results displayed in table 4 revealed that all the farms in Nharira consistently incurred more variable costs per litre of milk produced when compared with the farms in Lancashire. It is also shown in Table 2 that the contribution of feed costs towards TVC, particularly in Nharira, was considerable. The feed-related expenses accounted for 36-84% of TVC in Nharira and only 15-33% in Lancashire in 1996. The results for the year 1997 were 37-80% and 22-36%, respectively. These estimates were appreciably lower than the ≥70% quoted by Dube (1995) for large-scale commercial (LSC) dairy farms. This problem, coupled with poor producer prices was blamed for the lower viability of LSC dairy farming in the country (Dube, 1995).

In this study, the GM per TVC was estimated to be –Z$0.44 to Z$0.52 and Z$0.84 to Z$3.85 in Nharira and Lancashire, respectively, in 1996. Estimates obtained in 1997 were –Z$0.52 to Z$1.14 in Nharira and Z$1.09 to Z$ 2.78 in Lancashire. Dube (1995) noted that LSC farmers in

Table 4. Efficiency indicators in dairy farming in Hgarira-Lancashire, 1996 and 1997

	Nharira Farms									Lancashire Farms			
	1	2	3	4	5	6	7	8	9	10	11	12	13
Farming experience, Years	5	9	5	6	8	5	9	4	9	5	8	5	9
Arable land owned/held, ha	3.7	3.2	2.7	2.5	2.3	2.3	2	1.9	1.8	11.1	10.7	10.1	7.8
In 1996													
Number of cows milked	5	6	2	5	3	2	5	2	3	21	15	11	11
Total milk produced, liters/household	1,627	6,149	1,765	4,949	4,111	864	2,368	932	2,066	5,887	6,650	6,839	7,239
Total labour input, hours	872	2,012	1,031	1,460	1,813	620	1,422	785	938	1,686	2,018	2,010	2,124
Family labour: Total labour*100	20	13	16	40	58	100	25	96	17	24	76	36	18
Milk production, liters/cow/milking day	0.37	0.82	1.78	1.42	1.36	0.95	0.46	1.27	0.94	0.08	0.22	0.32	0.33
Gross Margin per liter of milk, Z$/l	-1.46	0.63	-0.05	0.35	0.08	0.65	-0.70	1.02	0.25	2.29	2.01	1.71	1.08
Variable Costs per liter of milk, Z$/liter	3.31	1.69	3.66	2.29	2.06	3.02	3.23	1.95	2.39	0.60	0.82	0.73	1.29
Feed costs per liter of milk, Z$/liter	1.64	0.83	2.09	1.46	1.02	2.54	1.16	1.13	1.29	0.09	0.25	0.18	0.43
In 1997													
Number of cows milked	5	7	5	7	6	2	4	2	3	19	13	12	12
Total milk produced, liters/household	1,481	7,988	3,436	9,219	5,341	1,596	3,381	937	2,578	4,337	7,519	6,494	5,516
Total labour input, hours	985	2,261	1,680	1,533	2,011	1,201	1,179	406	1,149	1,780	2,596	855	2,226
Family labour: Total labour*100	42	16	15	64	12	100	11	96	34	24	74	35	34
Milk production, liters/cow/milking day	0.68	0.79	0.58	1.07	0.62	1.35	0.65	3.19	1.29	0.12	0.24	0.18	0.22
Gross Margin per liter of milk, Z$/l	-2.40	1.64	-0.51	1.13	1.20	0.91	0.95	1.05	0.25	2.72	2.20	1.99	1.60
Variable Costs per liter of milk, Z$/liter	4.57	1.44	2.97	1.67	1.50	2.72	2.37	2.35	2.82	1.04	0.79	0.93	1.47
Feed costs per liter of milk, Z$/liter	1.69	0.68	1.30	1.06	0.69	2.17	1.02	2.02	1.43	0.27	0.23	0.34	0.32

Zimbabwe got an average of Z$1.10 for every Z$ committed to variable expenses. In both years, the TVC per liter of milk produced in Nharira were generally greater (Table 4) than Z$1.20 (for Rusitu resettlement area), an estimate that was greater than what was obtained in Lancashire. The data on feed expenses quoted above did not include labor-related costs. Presumably, the lower feed-related costs in Lancashire were due to a better feed base, in the form of larger (23-43 ha) and privately-owned grazing lands. In contrast, the farmers in Nharira depended on communal grazing areas, which were overgrazed, as a major source of feed for their cattle. It can be assumed that communal grazing areas contributed very little towards total feed intake of cattle, which forced the farmers in Nharira to seek substantial amounts of supplementary feed for their cattle from elsewhere.

The evidence presented above demonstrates that any interventions that could potentially reduce the feed budgets of farmers would also significantly improve the viability of dairy farming in Nharira-Lancashire. Similar recommendations were made in Malawi (Agyemang and Nkhonjera, 1986) and Uganda (Okwenye, 1994). One way of reducing expenses on feeds was to grow and formulate their own feed. Such a strategy would go a long way towards reducing the farmers' reliance on expensive bought-in feeds. The farmers in Nharira-Lancashire also grew fodder crops that they conserved in the form of hay and silage. Shortage of land was a major impediment to fodder production in Nharira because of competition with field crops. Those farmers who manage to grow the fodder crops would still have to find ways of processing or conserving the forages, for example in the form of silage, because appropriate machinery were not readily available.

The farmers, particularly in Nharira, were using farm-grown maize grain, maize stover and pulse crop residues. Apart from all these feed development strategies, they harvested natural pasture hay using both family and hired casual labor. Seven out of the nine farms in Nharira and

three out of the four in Lancashire realized higher GM in 1997 than in 1996. All the farming households who realised improved GM had conserved considerably greater amounts of farm-grown feeds.

CONCLUSIONS

Although substantial inter-farm differences were observed, smallholder dairy farming in Nharira-Lancashire was found to be viable. The number of cows and size of grazing land owned by the farmers apparently determined gross farm performance. Development of low-cost feeding strategies based on farm-produced feeds would improve the profitability of the smallholder dairy farms. Although the results were obtained through studying a small number of farms, they still provided a clear insight into the viability of dairy farming. Given the declining formal employment opportunities in Zimbabwe, there could be scope for the farmers to employ their school-leaver children as paid labour.

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