

Revitalization of the Jamaican Dairy Sector: Evaluation of the Feasibility of Business Models for Intensive Dairy Production

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Overview

The Jamaican Dairy sector has recorded a decline in annual output of milk of approximately 63 percent since trade liberalization in 1992. From a peak of 38.8 million litres in 1992, milk entering the formal trade fell to a 2006 low of 14.5 million litres (Dairy Facts and Figures 2005-2006, JDDDB). The primary factor conditioning this decline was the inability of the local industry to compete with imports of dairy products (principally powdered milk) which enjoyed massive producer and export subsidies at origin (Jennings, 2006a) Without effective countervailing measures to minimize trade distortions in the local market, the local sector was unable to compete with dumped substitutes which reached the market place at retail prices as low as 45 percent below the price of locally produced fresh milk (fluid equivalent basis) even after the local trade had extracted retail margins (over FOB) as high as 118 percent (Jennings, 2005).

For much of the decade ending 2002, the international price of powdered milk remained comparatively stable between US\$1200 – 1600 (FOB) per metric ton (See Jennings, 2006b). Triggered by changing consumption patterns in the emerging economies of China and South Asia, world milk powder prices have increased exponentially since 2002. From an average FOB price ex Europe, of approximately US\$1200 per tonne, European skimmed milk powder currently trades at US\$5200(USDA-AMS May 2007). The escalation in prices between January and May 2007 is highlighted in Figure 1.

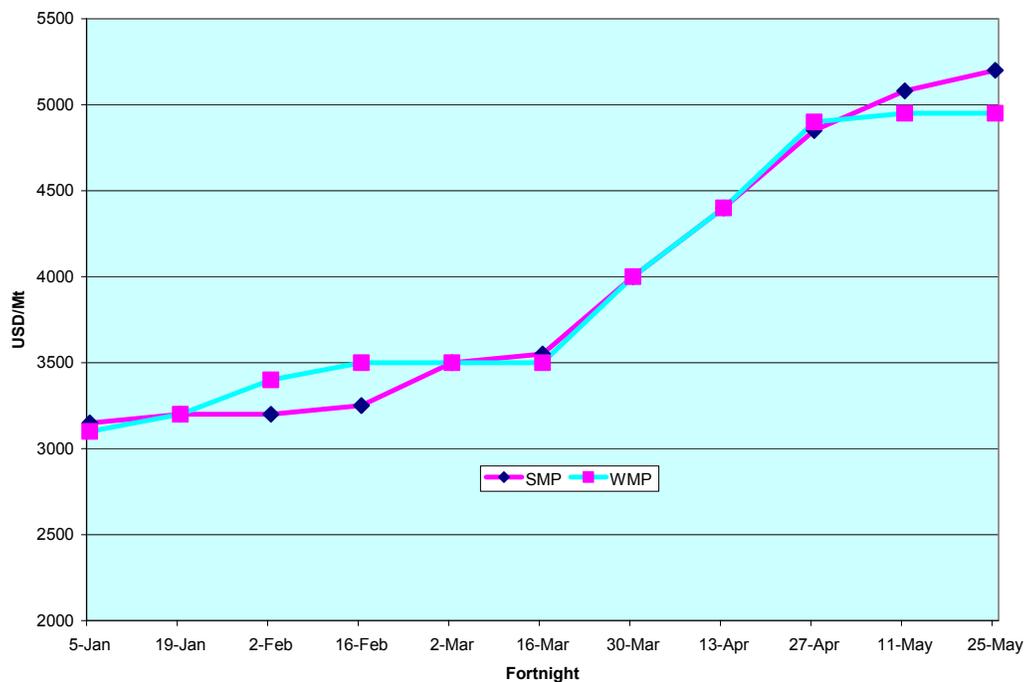
Although the rate of increase since the end of 2006 is expected to slow, as a result of anticipated increases in lower-cost summer milk production within the European Union, the return to prices below US\$3000 per tonne, which prevailed up to last-quarter 2006, can virtually be ruled out due to the following factors:

1. With world fluid milk consumption outstripping growth in production by a factor of 1.7, and the inherent low response rate of milk yield, the demand: supply imbalance with respect to exportable milk solids is likely to continue well into the medium term.
2. The virtual depletion of buffer stocks of milk solids. Given world prices over the past four years, countries such as the United States have had little reason

to purchase intervention stocks, as world prices have remained well above intervention trigger prices.

3. The elimination of export rebates on milk powder by the European Union in 2006, long a source of contention within the WTO. Based upon published UK average cost of production (Greig, 2006), it was calculated that at average 2005 European prices, export rebates might have represented a subsidy of 28 percent to European exporters (Jennings, 2007).
4. The escalating price of feed grains, pulled by a 93 percent increase in US corn prices since first quarter 2006 (USDA- AMS, *Market News* April, 25), will continue to drive production costs upward, given the US policy commitment to greater reliance on bio-fuels.

Fig. 1 European Milk Powder High FOB January to May 2007



Implications of a Volatile International Market for Local Milk Production

Currently whole-milk powder (WMP) retails at prices as high as J\$55 per 80g sachet, within the local trade. Along with skimmed milk powder (SMP) in sachets (which has enjoyed a duty waiver originating with a waiver of the JCTC applied price-equating levy in 1987), supplies of milk powder in the retail outlets since March, have been extremely erratic and marked by regular price increases. Having started the year at approximately \$35 (WMP) and \$27 (SMP) per sachet. Prevailing retail prices and the erratic supplies, suggest that the trade is fast depleting last-quarter 2006 stocks or

alternatively are taking significantly reduced margins on current imports. Given historical margins, imports at current FOB prices for SMP at US\$5200, would be expected to retail at approximately \$62 per 80g sachet. On the basis of fluid equivalency, this equates to approximately \$70.50 per litre and compares to current retail prices of \$90-93 per litre of fresh milk.

The serial increases in farm gate prices over the past two years, which have seen prices paid to farmers move from a 2005 average of \$22.63 to a current high of \$30.50 per litre, clearly speak to a growing demand for fresh milk as the price of milk powder substitutes approach the consumer indifference threshold. During 2006, processors absorbed much of the increase; retail prices moving by only 8.4 percent compared to 2005. **However, the obviously high price elasticity of demand for fresh milk, cautions that the current margin between farm gate and retail, of approximately 205 per cent, might adversely affect any sustained growth in consumer demand.**

The relative sensitivity of the Jamaican consumer to changes in the price of fresh milk and its direct dairy substitutes, as derived from decomposition of data from the annual Survey of Living Conditions (STATIN 1994-2005), is apparent from the summary provided in Table 1.

Table 1. Changes in Real *per capita* Expenditure (J\$) within Wealth Groups on Selected Dairy Products (1994-2005)

Product	1994			2003			2005		
	Poorest 40%	Wealthiest Quintile	All	Poorest 40%	Wealthiest Quintile	All	Poorest 40%	Wealthiest Quintile	All
Liquid Milk	115	512	257	35	345	131	57	298	133
Condensed/ Evaporated	202	928	445	207	652	366	212	664	332
Powdered Milk ¹ .	190	320	260	230	433	309	320	725	485
Total Dairy Products	725	2878	1477	664	2489	1356	716	2405	1215
Retail Price Fresh Milk (J\$/L) ² .	30.40			59.15			69.85		
Fluid Equivalent Consumption Litres/yr	22.8	90.6	46.5	21.5	80.4	43.9	26.9	90.2	45.6

1. 2003 & 2005 Expenditure adjusted for introduction of category 'Fluid drinks' 60% of which is assumed to derive from powdered milk.
2. Source: STATIN, *Consumer Price Indices*

The table indicates the substantial reallocation of expenditure from liquid milk, particularly to milk powder and its derivatives, between 1994 and 2006, as consumers responded to relative changes in price. The STATIN Annual Reviews of Consumer Price Indices indicate that price increases in dairy

products and in particular fresh milk, have, in the main, exceeded the average increases in annual CPI. The data indicate a marked income elasticity of demand for fresh milk; the poorest quintile reducing *per capita* expenditure on fresh milk by 50 per cent, compared with 42 percent by the wealthiest quintile. **It is instructive that the increase in expenditure on milk powder by the wealthiest quintile, outstripped that by the poorest 40 percent of the population by a factor of 1.86 between 1994 and 2005; on a product which enjoys a tariff regime, targeted, *a priori*, at benefiting the poor.** The data also indicate an encouraging 25 per cent increase in *per capita* fluid equivalent consumption between 2003 and 2005, among the poorest 40 percent, in spite of only a marginal reduction in annualized rate of inflation (14.1 cf. 12.9%) and is consistent with the aforementioned restraint on increases by processors during this period; retail price of fresh milk increasing from \$59.16 to \$69.85 per litre, an annualized increase of 6 percent.

The foregoing speaks clearly to the critical importance of cost control at all segments of the local dairy chain, in order to capitalize on the clear opportunities for expanding market share provided by the escalation in world prices of powdered milk. **Given the aggressive marketing campaign associated with non-dairy substitutes, and a largely unchallenged, negative campaign against dairy products, it cannot be assumed that consumers will revert *en masse*, to locally produced milk at any price.**

Out of recognition of the potential threats to, and the clear weaknesses and fragility of the local Dairy Sector, the Jamaica Dairy Development Board and the Beef and Dairy Producers' Association of Jamaica have collaborated in undertaking an evaluation of varying enterprise models for dairy production. This initiative was undertaken in order to create an information base, not only for potential new investments, but also as guides to incumbent producers as to the levels of intensiveness and the performance coefficients required to achieve sustained international competitiveness in the local production of milk.

While improved efficiencies at primary production level is clearly the starting point to overall improved industry performance, there is also the need to address constraints such as industry structure, capacity utilization and general efficiencies at processing plants, product diversification and pricing structure. Several of these issues have been elaborated by Jennings (2005, 2006a and 2007) and Duffus and Jennings (2005). It is critical to industry amelioration, that these be addressed *pari passu* with improvements in on-farm efficiencies.

Brief Review of Efficiency Levels on Jamaican Dairy Farms

The annual Surveys of Cost of Production conducted by the Jamaica Dairy Development Board since 2000 (Ffrench *et al.*, 2001 – 2006), and more detailed analysis of efficiencies on dairy farms (Miller *et al.*, 2001 & 2006), have highlighted the low comparative efficiency of milk production in Jamaica and indeed, the slippages which have occurred since 2001 as producers react to spiraling input costs. Jennings (2006a) assessed overall productivity on Jamaican farms at 4032 litres per hectare; 58% of the levels reported for New Zealand and the UK and 40 per cent of the productivity achieved in the Netherlands. It is salutary, however, that the highest producing Jamaican dairy farm, has achieved productivity levels, under grazing, in excess of 15,000 litres per hectare (Jennings and Clayton, 1995); among the highest achieved, commercially within the Caribbean Region; clearly signaling a local competence to effectively compete internationally.

The critical area of weakness in local dairy farming is the patent underutilization of pastures notwithstanding the reduced inputs of fertilizer in the face of rising costs. Table 2, adapted from Ffrench *et al.*, (2006), typifies the prevailing low levels of pasture utilization and the correlated low levels of productivity as derived from farms sampled during the 2005 cost of production survey.

Table 2. Comparison of Stocking Rates and Per Hectare Output within Farm Size

Size Group	Ave Stocking Rate (cows/ha)	Milk Yield Per Hectare (litres/yr.)
Small Non-Irrigated	1.04	1394
Medium Non-Irrigated	1.94	3589
Medium Irrigated	4.70	12384
Large Non-Irrigated	1.63	3328
Large Irrigated	2.83	7794
Overall Average	2.43	5698

Source: Ffrench *et al.* (2006)

Contrasted with the low achieved levels of stocking, Jennings (1988), based upon the results of research conducted locally as well as in Puerto Rico, postulated that improved tropical pastures, under grazing, were capable of supporting productivity levels approaching 17,000 litres of milk per hectare, in conjunction with strategic supplementation with concentrate feeds to maximize carrying capacity (the *Pasture Extender* concept). Table 3 provides a model which relates fertilizer nitrogen and concentrate feed use to carrying capacity and projected levels of productivity under intensive grazing management. The high productivity levels recorded and sustained at Serge Island (Jennings and Clayton *op cit.*), and their continued cost leadership, as well as the reported (supplemented) yield of 27,250 litres per hectare in

Puerto Rico (Yazman *et al*, 1979) attests to the robustness of these projections.

It should also be noted that the studies from which the model was developed, were conducted prior to the introduction to the Caribbean Region, of the *Cynodons*, typically much higher-yielding than Pangola and the other recumbent grasses then evaluated. With respect to grasses such as African Star and the Tifton hybrids, therefore, the model might understate potential herbage yield, carrying capacity and output of milk per hectare, for any given level of fertilizer N.

Table 3. Interaction of Fertilizer N and Concentrate Supplementation on the Productivity of Grazing Management Systems for Milk

N Level (kg/ha/yr)	Est. Herbage Dry Matter Yield (kg/ha/yr)	Carrying Capacity (cows/ha)	Milk Yield (L/ha/yr)	
			Zero Supplement	Supplement @0.4 DMI)
0	10000	2.0	4925	7100
56	11800	2.3	5850	8450
112	13450	2.7	6780	9780
170	15140	3.0	7400	10100
225	16800	3.5	8620	12450
336	20200	3.9	9850	14200
450	23550	4.7	11700	16900

Source: Jennings (1988)

The carrying capacities projected by the model, assume optimal soil moisture availability. Under rain-fed management, and in the absence of fodder conservation, it is essential to determine critical carrying capacity, on the basis of herbage availability during the typical dry seasons. Studies conducted at WINDALCO'S Manchester Pastures Dairy (Miller *et al.*, 2003) indicated that critical carrying capacity is likely to be limited to approximately 3.3 cows per hectare. Given that in rain-fed systems of management, applications of fertilizer are likely to be limited to a maximum of three dressings per year and a maximum of 225 kg N per hectare, the model projects productivity levels, under these conditions, of up to 12,450 litres per year, with strategic supplementation.

A more detailed analysis of the WINDALCO study, and an earlier replicate at Serge Island (Miller *et al.*, 2005), indicated annual herbage yields of between 19 and 21 tons per hectare from African Star grass and 24 to 28 t/ha from Tifton 87; the latter exceeding those projected by the model presented in Table 3. Reinforcing the productive capacity of Jamaican pastures, the nutrient profiles of the pastures, at both sites, were indicative of the

nutritional potential of improved pastures, under local commercial conditions, to sustain much higher levels of yield than are currently being realized. The data in Table 4; adapted from Miller *et al.*, 2005; attest to the high nutritive value attainable under improved grazing management.

These authors concluded that at the Metabolizable energy contents of the pastures recorded in the two studies, well managed, unsupplemented pastures are capable of supplying approximately 2.2 times the energy requirements for maintenance, of cows of the body size of the Jamaica Hope; adequate to sustain lactation yields above 2500 litres per cow.

Table 4. Chemical Composition of Jamaican Pastures under Commercial Conditions

	Serge Island Farms				WINDALCO	
	African Star		Tifton 85		African Star	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Crude Protein (g/kg)	14.5	13.5	13.3	13.6	17.1	17.0
In Vitro Digestibility (g /kg OM)	571	596	584	576	533	602
Metabolizable Energy (MJ/kg DM)	8.57	8.94	8.76	8.64	8.00	9.02

Source: Miller *et al* (2005)

Proposed Enterprise Models for Enhancing the International Competitiveness of Milk Production in Jamaica

The evidence from the 'pristine' conditions of Research Stations, as well as from on-farm evaluations, confirms Jamaica's potential to attain cost-competitiveness at farm level, in the production of milk. This information was therefore integrated into the development and financial analysis of seven dairy enterprise models. The essential characteristics of these enterprise models are summarized in Table 5.

Table 5. Basic Features of Selected Dairy Enterprise Models

Enterprise Type	Management System	Stocking Rate (AU/ha)	Farm Size (ha)	Replacement Rearing		Irrigation	
				Yes	No	Yes	No
Traditional 1200-Cow Dairy	Full Grazing +Purchased Concentrate	5.0	361	+		+	
Specialized 1200-Cow Dairy	Partial Zero Grazing - TMR	6.25	192		+	+	
Specialized 440-Cow Dairy	Partial Zero Grazing - TMR	6.25	70		+		+
Traditional 250-Cow Dairy	Full Grazing +Purchased Concentrate	5.0	75	+		+	
Specialized 60-Cow Dairy	Partial Zero Grazing – Purchased TMR	6.0	10		+	+	
Specialized Heifer Rearing Farm	Full grazing+ Concentrate to 9 mths	6.0	60	590 Pregnant Heifers/yr		+	
Fodder Production farm	Haylage Production	n/a	80	9450 bales(200kg)/yr		+	

Specialized milking farms will outsource the rearing of replacements, thus fully allocating their resources to the revenue earning cow. On the 1200- and 440-cow specialized units, the Total Mixed Ration system of feeding will be applied in conjunction with night grazing. Rotational systems of grazing will be applied on all farms with the aid of electric fencing and fertilizer N applied to optimize carrying capacity. Annual herbage yield is projected at 20 – 25 ton Dry Matter per hectare. An underlying assumption is that at any level of fertilizer N application carrying capacity is increased 25 percent through adoption of a partial zero grazing management system. On farms carrying replacements, a heifer, at median weight of approximately 140 kg, is assumed to represent approximately 0.6 animal units.

The other key technical production coefficients assumed for each of the milk production models are summarized in Table 6.

Table 6. Technical Coefficients for Milk Production Units

Coefficient	Specialized 1200-cow	Traditional 1200-cow	Specialized 440-cow	Traditional 250-cow	Specialized 60-cow
% Cows-in-milk	85	85	85	85	85
Daily Milk Yield (Litres/cow in herd)	12.0	11.0	12.0	11.0	12.0
Lactation Length (days)	300	300	300	300	300
Annual Milk Production (Million Litres)	4.47	3.91	1.64	0.853	0.224
Yield per hectare	23,270	8,650	23,400	11,380	22,340
Age at 1 st calving (mths)	27 - 30	27 - 30	27 - 30	27 - 30	27 - 30
Replacement Rate	20	20	20	20	20
Calf Mortality (%)	5	5	5	5	5
Fertilizer N rate (kg/ha/yr)	400	400	400	400	400
Calving Interval (mths)	12.0	12.0	12.0	12.0	12.0

With respect to **Specialized Heifer Rearing** the key technical assumptions are:

- ❖ Cow calves purchased at day 3 (minimum weight 22.7kg)
- ❖ Target weight gain 0.45-0.5 kg per day
- ❖ Early weaning at 6 weeks
- ❖ Calves bucket-fed with milk replacer
- ❖ Introduced to purchased hay and concentrate at 7 days
- ❖ Turn-out to full grazing on irrigated pastures at 90 days
- ❖ Grazing interval 14-21 days depending on season
- ❖ Fertilizer N rate – 400k
- ❖ Supplementary feeding to 9 months of age
- ❖ Strategic supplementation with hay/molasses during dry season
- ❖ Target breeding weight 236 kg (520 lb)
- ❖ Age at first service 18-21 months
- ❖ Service by Artificial insemination
- ❖ Pregnant heifers sold at 3 months in-calf following veterinary confirmation

On the **Fodder Production Unit** the key technical assumptions are:

- Minimum of 5 harvests per year from irrigated pastures
- Haylage in 200kg transportable round bales will be the primary product
- African Star and Tifton 85 – the principal grasses
- Harvesting at maximum of 6 weeks to optimize yield and nutritive value
- Haylage minimum quality: 40% DM; 8% CP; 52% IVOMD; 7.8 MJ ME
- Target yield 9450 round bales haylage per year
- Fertilizer N application rate

Financial Evaluation of Dairy Enterprise Models

Table 7 summarizes the projected financial performance of each model; assessed at peak production. The investment analysis for each model is extended over a 14-year project life at an interest rate of 8 percent.

The data in Table 7 highlight the critical importance of scale, in achieving reduced unit cost of production and satisfactory returns on investment. It also highlights the advantage of specialized milking in optimizing financial performance. Given the non-scalar relationship between investment in equipment and farm size, scale and specialization; the latter which also contributes directly to scale expansion; represent key options for improving local competitiveness. The 440-1200 cow herds demonstrate the highest level of robustness, showing least change in Internal rates of return with either a 10% increase in operating expenses (IRR1) or a 10% reduction in farm gate price (IRR 2).

New dairy farms with milking herds below 440 cows, even at the comparatively high levels of intensiveness at which these models were evaluated, are likely to be regarded by lenders, as too risky, at current interest rates (app. 8% *p.a.*). The sensitivity analysis suggests that such farms are unlikely to absorb either a 10-percent increase in operating costs, or a reduction in the farm gate price of milk of a similar magnitude.

Table 7 Financial Performance of Enterprise Units (\$M except otherwise stated)

Model	Sp. 1200 Cow	Tr. 1200 Cow	Sp. 440 Cow	Tr. 250 Cow	Sp. 60 Cow	Heifer Unit	Fodder Unit
Cap. Invest	149.1	144.1	84.6	48.8	16.6	26.4	24.2
Invest/ha	0.776	0.399	1.21	0.651	1.663	0.447	0.303
Peak Year	6	5	6	5	5	4	3
Op. Exp	93.66	79.89	43.24	21.22	6.9	21.4	11.6
Gross Rev.	147	128.3	51.0	28.1	6.95	35.3	18.9
Unit Cost (\$)	20.96/L	20.55	26.43	24.9	30.89	36.41K	6.1K/t
Loss Period	Yr 1	Yr. 1	Yr 1-5	Yr. 1& 3	Yr. 1- 8	Yr. 1	Yr 1
Net income	46.1	40.2	5.73	5.60	(0.718)	11.84	5.92
Return/ha	0.240	0.111	0.082	0.075	(0.072)	0.201	0.074
NPV	414.54	212.9	62.9	14.74	1.085	60.38	31.2
IRR (%)	30	20	16	11	9	23	22
IRR1 (%)	25	18	12	7	4	22	17
IRR2 (%)	27	17	12	8	5	17	16

IRR1 – Adjusted for 10% increase in operational costs

IRR2 – Adjusted for 10% reduction in farm-gate price

Of interest, are the relatively high internal rates of return to specialized heifer rearing and fodder production. This is correlated with the comparatively low level of investment per hectare and the much higher gross margins from specialized heifer rearing (64%) and fodder production (64%), compared to 36 % on the lowest-cost milking farm.

The advantage of specialized dairy farming lies in the opportunity to maximally allocate farm resources to the productive cow, as against enterprises in which the non-revenue-producing, pre-parturient heifer, ties up as much as one-third of available land resources. By adopting a specialized heifer rearing model, replacements, which on traditional farms are often relegated to the poorer pastures, are afforded access to improved nutrition on high quality pastures, which would otherwise have been allocated to the milking herd.

Summary and Conclusion

The study assessed the likely financial performance of seven potential models for new investments in dairy farming, employing intensive management systems, at scales or levels of specialization which seek to enhance the viability of such enterprises. The models for milk production enterprises, assumed stocking rates of 5 animal units per hectare under grazing, supplemented at the rate of one (1) ton proprietary concentrate per cow per year. Herd sizes varied from 60 to 1200 Jamaica Hope cows. An additional option, the integration of the Total Mixed Ration (TMR) feeding system with night-only grazing, and cows stocked at 6.25 per hectare; was also evaluated annual consumption of TMR was projected at approximately 2.8 tons dry matter per cow. The feasibility of enterprises adopting specialized rearing of replacement heifers and fodder farming was also examined.

The analysis highlighted the critical importance of economies of scale to the viability of *de novo* dairy enterprises, and the advantage of specialization over traditional, composite dairy farming. The high cost of dairy farm equipment and the non-linear relationship to farm size, make it imperative that new enterprises seek to apply available production technology for highly intensive dairy farming. They also suggest that greater intensification of existing enterprises might provide a less risky option for immediately responding to the opportunities created by the current surge in the international price of powdered milk.

Even at the comparatively high rates of stocking at which the models were evaluated, it appears that new dairy farms below 440 cows are likely to be considered risky for financing, at current rates of interest. This suggests that to promote small farmer dairy development, there is need to examine the viability of communal systems, such as joint-stock ownership, which confer economies of scale.

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