The impacts of the milk pricing policy in Zimbabwe

Gil Rodriguez Jr.
Livestock Economics Division,
ILCA, P.O.Box 5689, Addis Ababa, Ethiopia

Summary

THE MAIN PURPOSE *of this paper is to analyse the effects of government price policies on the production and consumption of milk in Zimbabwe. It begins with an overview of the Dairy Marketing Board (DMB) which is responsible for the collection and distribution of commercial milk products at prices set by the Government. A description of the trends in milk output and the response of commercial milk supply to prices is followed by time-series analysis of monthly milk intake by the DMB. The implications of changes in the milk producer price for the opportunity costs of land and animal draught power in the communal areas are discussed. Finally, the trends in the consumption of dairy products and aggregate demand relationships for whole milk and milk products in Zimbabwe are described.*

Introduction

Dairy products are one of the strategic commodities in the economy of Zimbabwe, since they are not only a major consumer item but also a main source of farm income and employment in various parts of the country. In line with the Government's objective to attain a level of self-sufficiency in dairy products (Ministry of Agriculture, 1985), several public intervention schemes influencing the pattern of consumption and production of dairy products have been adopted.

One of the market interventions is price control at the producer and retail levels. Government participation in the adjustment of the market price of dairy products imposes certain biases on the distribution of economic benefits between the producers and consumers. For example, if the domestic milk producer price is set above the free trade milk price (e.g. the export price of New Zealand), then the Government is implicitly subsidising the domestic producer while explicitly providing signals to the other economic sectors to channel resources to the dairy industry. On the other hand, if the domestic retail price of milk is set below the equivalent free trade price, consumption of milk is being encouraged in excess of the level dictated by the free market. The magnitude of producers' and consumers' response to prices will determine the corresponding cost of the government intervention policy, which can sometimes be high. In order to evaluate the dairy price policy of Zimbabwe, this paper attempts to provide an empirical estimate of the response of both the consumers and producers to milk price adjustments. Furthermore, since the prices of dairy products can affect the value of inputs and outputs, the paper examines the theoretical aspects of dairy input-output adjustments made by subsistence farmers who, because of inadequate marketing structures, are usually unable to reap the full benefits of government price policies for dairy products.

The Dairy Marketing Board: Its role in the price policy

The dairy sector in Zimbabwe is composed of three classes of producers:

- Large-scale commercial dairy producers with an average herd size of 90 purebred animals (mostly Friesians and Jerseys) in prime farming areas with annual rainfall ranging from 750 to 1000 mm.
- Small-scale commercial dairy producers with an average herd size of six animals (which can be purebred, crossbred or indigenous). The marketable surplus of these producers is limited to local retail sales, and they operate in a range of environments (e.g. with annual rainfall ranging from 450 to 1000 mm).
- Communal dairy farmers owning indigenous beef cattle. There are about 700 000 communal farms in Zimbabwe, most of them in areas with average annual rainfall of less than 400 mm.

Prior to 1912, large-scale commercial milk distribution was effected directly from farmers to consumers. An increase in commercial milk production led to the establishment of small creameries between 1912 and 1930. As milk production increased further, the small creameries were unable to distribute the milk efficiently and were in turn replaced by producer cooperatives. These not only distributed milk but also converted it into final dairy products to be sold in the urban centres of Zimbabwe. Further increases in milk production led to the establishment of the Milk Committee in 1949. Its main function was the resale of milk to existing dairies. On 1 October 1952, the Committee was replaced by the Dairy Marketing Board whose main functions are:

- To purchase, collect and receive milk and butterfat from registered producers at prescribed prices.
- To process, manufacture and distribute milk and milk products at prescribed prices.

The determination of milk producer prices is oriented towards the concept of financial viability. In Zimbabwe, a cost-of-production model of commercial farms is used to determine initial producer price levels. These prices are revised by the Cabinet after considering such other factors as the state of the trading account of the DMB, the export prices of milk products and the target levels of milk output.

The setting of milk consumer prices (initiated by the Ministry of Trade and Commerce) seems to be largely dependent on the type of milk products the Government wishes to subsidise. For example, prior to 1975, the Government supported a policy which allowed the DMB to sell some milk products at less than their actual accounting; cost. The deficit was supposedly offset by sales of fresh milk. However, as a result of selling milk products below average costs, the DMB financial deficits have increased (Table 1).

Table 1. *Trading account deficits of the DMB by focal years*.

Fiscal years[a]	Deficit[b] ('000 Z$)
1978/79	3 700
1979/80	2 108
1980/81	10 100
1981/82	18 300
1982/83	35 658
1983/84	38 651
1984/85	28 000[c]

[a] Fiscal year is from 1 July to 30 June.
[b] The deficit is estimated as total sales minus the sum of total sales cost, overhead expenses, general management expenses and net operating expenses.
[c] Estimate.
Source: DMB (1984).

The deficits are financed by government loans. Jansen (1982) argued that the DMB trading deficit is a consumer subsidy. She arrived at this conclusion by comparing domestic retail prices with their equivalent border prices and found that the actual retail price of milk in Zimbabwe is only 41% of its border price.

During its initial years of operation, the DMB absorbed the Dairymen's Cooperative Limited (Harare), Gatooma Cooperative Society, Rhodesian Cooperative Creameries and the Bulawayo Creamery. In 1962 and 1963 the DMB also operated dairies in Zambia. A recent addition to the DMB creameries is the Chipinge Milk Plant, formally opened in 1983. A more recent activity of the DMB is to encourage dairying in suitable communal areas through the Small Farm and Peasant Development Programme, the objective of which is to effect a more equitable distribution of agricultural incomes.

The structure of domestic milk output

All milk sold in urban areas is produced by the commercial farms. Milk produced in the communal areas is consumed locally. Given an average yield of 2 litres per cow per day (over a milking period of 4 to 6 months), annual milk production will be close to 15 million litres (DMB, 1984). The aggregate trends in milk output from large-scale commercial dairy producers are given in Table 2.

Table 2. *Milk output*[a] *from large-scale commercial dairy producers, 1965/66 to 1983/84*.

Year	Commercial milk output (million litres)	Number of cows in milk (thousand head)	Milk yield per annum (litres)
1965/66	101.6	41.5	2 448
1.966/67	106.9	40.7	2 627
1967/68	118.5	43.3	2 737
1968/69	127.0	47.0	2 702
1969/70	129.0	47.6	2 710
1970/71	134.6	48.0	2 804
1971/72	141.7	48.4	2 928
1972/73	155.2	50.9	3 049
1973/74	155.3	49.7	3 125
1974/75	142.5	48.3	2 950
1975/76	148.8	49.4	3 012
1976/77	155.9	49.5	3 149
1977/78	151.0	48.1	3 139
1978/79	145.2	43.9	3 308
1979/80	154.9	42.9	3 611
1980/81	149.1	42.5	3 508
1981/82	150.5	40.7	3 698
1982/83	172.5	42.5	4 059
1983/84	181.1	43.8	4 135

[a] On-farm consumption of milk is excluded from milk output.
Source: CSO (1984).

The milk production data in Table 2 imply that the annual growth rate for commercial output was 2.28%, for milk yields 2.49% and for cow numbers –0.20%. These rates were estimated using semi-log (base e) regression relationships; the growth rate for cow numbers was not statistically significant.

As a proportion of the total national dairy herd, the number of cows in milk has changed very little (by about 0.7% per year over the 1959–1984 period). According to CSO (1984) statistics, in 1959 cows in milk represented 36% of the total dairy herd (105 800 head) whereas in 1984 they accounted for 42% of the dairy herd (104 500 head). The number of cows in milk is affected to a certain extent by the efficiency of labour relative to fixed capital inputs. In Zimbabwe there are heavy pressures to increase the minimum wage. If the wage push persists, commercial farmers will shift to more intensive use of capital inputs provided that foreign exchange is available for their importation. The use of more fixed capital will result in a larger inventory of cows in milk. This trend was observed in the country by Higgins (1972) who noted that the number of cows per herd increased as the milking system became more mechanised.

Prices of milk, beef, corn and technology influence milk output. The impacts of such factors were examined in this study using the following equations (fitted for the period 1965 to 1984)[1]:

1 All the basic data inputs used in estimating the regression relationships in this paper were obtained from the Dairy Marketing Board, the Central Statistical Office and the Agricultural Marketing Authority of Zimbabwe.

log Ym = (1)

7.237+0.384 log Pm–0.050 log Pc

(0.150) (0.102)

–0.056 log Ra+0.126 log t

(0.047) (0.018)

R^2 = 0.91 DW = 1.78

log C = –0.721 + 0.1089 log Pb (2)

(0.1327)

+0.2496 log BPm–0.1770 log BPc

(0.1081) (0.0492)

+0.9156 log BC–0.0400 log t

(0.1432) (0.0159)

R^2= 0.95 H = –1.56

where:

Ym = annual milk yield (kg),

C = number of cows in milk (thousand head),

B = lag operator (for example BC means the number of cows during the previous period),

Pm = producers' milk price per kg deflated by the cost of living index (Z$),

Pc = price of corn per kg deflated by the cost of living index (Z$),

Pb = price of beef per kg deflated by the cost of living index (Z$) ,

t = time variable,

Ra = national average annual rainfall (mm),

DW = the Durbin-Watson index, and

H = the h-statistic proposed by Durbin as an alternative test for autocorrelation. The estimated H is equal to the first-order serial correlation parameter multiplied by the constant SQ [n/(1–nv(a))],

where:

SQ = the square root operation,

n = sample size, and

v(a) = the variance of the coefficient of the lagged variable.

All logarithmic transformations are to the base e.

All R^2 have been adjusted for degrees of freedom.

Numbers in parentheses are standard errors of the respective regression coefficients.

The coefficients for log Pm and log BPm in equations 1 and 2 are statistically significant at the 5% level. The short-term milk price elasticity (derived as the sum of the coefficients of log Pm and log BPm) is 0.63, which means that a 10% rise in the milk price will induce an increase of 6.3% in milk output. About 61% of the total change in output arising from a milk price change can be attributed to milk yield response. The technological potential for milk yield increases on commercial farms is yet to be fully exploited. Data obtained through the milk recording scheme of the Department of Research and Specialist Services for 1984 indicated that Friesians can produce 9435 to 13 629 kg of milk per cow per annum compared with 5456 to 7303 kg for the Jersey breed.

The estimate of the milk yield response to milk price changes in Zimbabwe is lower than those obtained for developed countries. In Great Britain, for example, the response was estimated to be 0.50 to 0.54 (Buckwell, 1984). The estimated, long-term milk price elasticity for Zimbabwe is 2.96—derived from equation 2 as (0.2496/ (1–0.9156))—, which is similar to that obtained by Chen et al (1972) for the USA.

It is usually also argued that as the price of beef increases, a corresponding rise in the capital value of cattle occurs. Hence, in the short run, there will be a tendency for the dairy cow herd inventory to increase to take advantage of capital gains arising from an increased beef price. The positive sign of the coefficient of log Pb in equation 2 tends to support such a directional hypothesis.

In both equations 1 and 2, the absolute magnitude of the milk price elasticity is greater than that for the price of corn. Chavas (1982) argued that commodity price elasticities for supply relationships are greater than the corresponding input price elasticities due to the existence of more options for input substitution in the production set. The statistical significance of the corn price (in logs) coefficient is more prominent in equation 2 than in equation 1. This means that through their effects on culling policies, changes in the price of corn will influence the size of the dairy cow herd more than the annual yield per cow. Since adjustments in the dairy cow herd

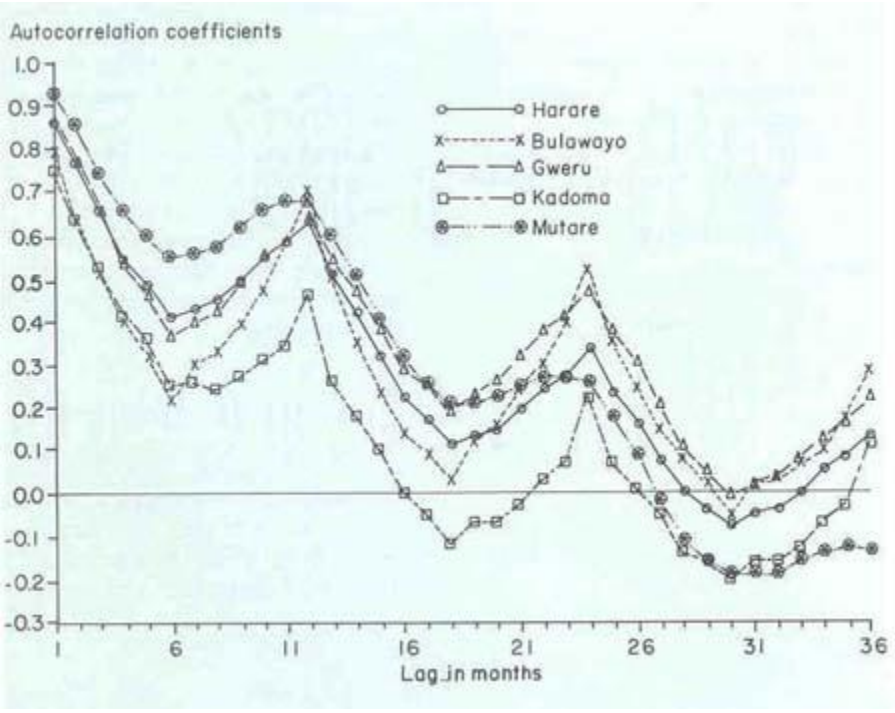
require a longer biological process than changes in annual cow productivity, shifts in corn prices have a longer-lasting impact on milk output.

Time-series analysis of commercial milk output

The seasonality of commercial milk output in Zimbabwe was analysed using the monthly milk intake data of the DMB for Harare, Bulawayo, Gweru, Kadoma and Mutare (which includes Chipinge) for the period 1975/76 to 1983/84. In 1983/84 these areas accounted for 52%, 12%, 21%, 8% and 7% respectively of the national milk intake of the DMB.

Autocorrelation functions were plotted for the five areas (Figure 1). The autocorrelation coefficient is estimated between monthly milk intake data (say Ot and Ot-k) which are separated by k intervals of time. A common feature manifested in the autocorrelation functions is the presence of spikes at lags 12, 24 and 36, which confirms the presence of an annual seasonal pattern. Another feature is a declining trend in the coefficients after each spike.

Figure 1. *Autocorrelation patterns of milk intake for Harare, Bulawayo, Gweru, Kadoma and Mutare.*



The seasonality of DMB milk deliveries is partly influenced by the seasonal prices applied by the Government during a year and partly by the availability of feed supplies. For example during the fiscal year of 1983/84, the seasonal producer price was highest (at Z$ 0.32/kg milk) in November. The peak period of the annual rainy season is normally from November to January, and since feed production is positively correlated with rainfall levels, feed supplies during that period will be adequate to meet the dairy farmers' demand for feed at favourable prices.

If adequate monthly time-series are available, seasonal causal relationships between prices and monthly milk deliveries can be examined using regression functions. As this was the case, the

DMB monthly milk deliveries for the period 1975/76 to 1983/84 were analysed using the following fitted autoregressive models:

(1–0.9512 B) (1–B(12)) Oh = ah Q = 9.77 (3)

(–1.5300)

(1–0.8911 B) (1–B(12)) Ob = ab Q = 8.14 (4)

(–2.4700)

(1–0.9175 B) (1–B(12)) og = ag Q = 5.64 (5)

(–2.2200)

(1–0.8853 B) (1–B(12)) Ok = ak Q = 11.93 (6)

(–2.5300)

(1–0.9887 B) (1–B(12)) Om= am Q = 6.53 (7)

(–3.4200)

where:

B(12) = the lag operator applicable to a 12-period lag (e.g. the DMB milk intake during the same month, one year previously),

O = monthly milk intake,

a = the error term,

h, b, g, k and m refer to Harare, Bulawayo, Gweru, Kadoma and Mutare, and

Q = the sum of squares of the autocorrelation coefficients multiplied by the number of degrees of freedom.

The numbers in parentheses are the t values of the coefficient. Note that the null hypothesis is that the coefficient equals one. The portmanteau test, which involves estimating Q, indicates that the models adequately fit the data i.e. the estimated Q is less than the critical chi-square value (36.42).

The estimate of total milk delivery provides an implicit index of the pressures on milk producer price adjustments while the regional monthly forecasts indicate the growing demand imposed on the regional DMB distribution facilities. Table 3 gives estimates of monthly milk intakes by the DMB from the five areas in 1985/86. Total milk intake for 1985/86 was estimated to be 191 692 700 litres, an increase of 2% over the 1984/85 intake of 187 987 980 litres. This implies an upward pressure in the real milk producer price of 1.26%.

Table 3. *Estimated monthly milk intakes from the Harare, Bulawayo, Gweru, Kadoma and Mutare areas, July 1985–June 1986*.

Month	Harare	Bulawayo	Milk intake ('000 litres) Gweru	Kadoma	Mutare
July	8 111.19	1 693.90	3 027.56	1 151.04	1 175.38
August	8 311.45	1 753.17	3 091.52	1 159.25	1 212.23
Sept	8 171.77	1 711.74	3 096.25	1 144.86	1 221.34
Oct	8 626.46	1 819.16	3 333.58	1 184.15	1 371.58
Nov	8 663.32	1 821.58	3 427.27	1 137.02	1 362.93
Dec	9 585.58	2 006.68	3 812.02	1 273.26	1 438.50
Jan	9 530.61	1 870.31	3 866.95	1 396.67	1 384.85
Feb	8 141.33	1 621.76	3 232.86	1 165.64	1 124.72
March	8 652.71	1 682.58	3 371.32	1 237.12	1 153.24
April	8 243.32	1 568.70	3 126.79	1 172.27	1 089.14
May	8 305.97	1 625.89	3 208.63	1 155.10	1 128.62
June	7 965.48	1 556.79	2 991.42	1 125.69	1 100.82
Total	102 309.19	20 732.26	39 586.17	14 301.67	14 763.41

The communal sector and milk price changes

Information on dairying in communal areas is scarce. A recent case study undertaken by the Dairy Marketing Board (1984) at Chikwaka provides some insights into the nature of milk production in such areas. In 1984, the average milk production on the 310 communal farms surveyed was 2 kg/cow/day over lactations of 4 to 6 months, compared with 13.36 kg/cow/day on commercial farms. The DMB estimates that production of 3 to 4 kg milk/cow/day can be achieved through improved nutrition.

Milk price policies affect communal farmers differently than the commercial farmers. On communal farms, livestock play a multi-purpose role, providing draught power and manure in addition to such commodities as beef and milk. As a result, a change in the price of milk will have repercussions on the costs of other farm activities.

Consider the case where a cow is used to plough land and is also a source of milk to the farm household. The increase in the milk price can lower the cost of the animal's draught power services and can increase land costs. The larger return from dairy activities, arising from a higher milk price, will induce an expansion of the cow herd (since milk yield per cow is low). Concomitant with such a change is an increase in the supply of male calves which may not be fit for beef production. However, as there is a constant demand for draught power, the male calves can be used as a labour input to crops at a lower cost. The lower animal labour cost can induce more extensive cropping. With low crop yields, crop output can only be increased by increasing the acreage planted. The increased demand for land (given a fixed supply) will increase the opportunity cost of land. As a consequence, persons enjoying favourable land-use rights will reap economic rents.

Milk consumption

A substantial portion of milk products is consumed in the form of whole milk. For example, of the 181 million litres of milk utilised by the DMB in 1983/84, 59% was sold as whole milk. Over the period 1966/ 67 to 1983/84, DMB sales of whole milk increased from 7.35 to 13.27 kg per caput, showing an annual growth of 3.3%. Data from the DMB indicate that a major portion of this growth was accounted for by increased consumption in high-density urban areas, where the DMB whole milk sales increased from 0.1 million kg in 1954 to 17.7 million kg in 1975. Prior to the 1964/1968 period, whole milk consumption in these areas was suppressed due to the absence of a milk delivery system.

An aggregate demand relationship for whole milk was estimated using CSO (1984) data for the 1965–1983 period in the following equation:

log Dt = 4.209 – 0.658 log Pmr (9)

(0.127)

+ 0.124 log t + 0.086 log Ppr

(0.19) (0.101)

R2 = 0.94DW = 1.83

where:

Dt = per caput consumption of whole milk (kg),

Pmr = retail price of whole milk deflated by the cost of living index (Z$/kg), and

Ppr = retail price of powder milk deflated by the cost of living index (Z$/kg).

All the coefficients have the correct signs. Except for the coefficient of log Ppr, the rest are statistically significant.

The consumer whole milk demand relationship highlights the pressure exerted by the Government on the price of fresh milk. For example, a 10% decline in the real price of fresh milk will induce a 6.58% increase in per caput consumption of whole milk. In the absence of sufficient growth in domestic milk production to satisfy the increased demand for whole milk, shortfalls have to be met by importing dairy products. The total value of dairy imports to Zimbabwe rose from Z$ 145 000 in 1978 to Z$ 2 648 000 in 1983, the majority of the imports being in the form of skimmed milk.

Aggregate demand relationships were also estimated for other major dairy products such as lacto (acidulated milk). Although the resulting fits were quite poor and the standard errors of the regression coefficients were large, the own-price elasticity for lacto (–0.595) was consistent with previous estimates (e.g. –0.65 obtained by Ruigu (1979) using the data of the Kenya Creameries Cooperative for the 1962–1975 period). The elasticity parameter indicates that a 10% drop in the real price of lacto will increase per caput consumption by 5.95% .

Lacto products are usually consumed more in the high-density urban areas. For example, DMB records showed that sales of lacto to such areas increased from 1.13 million gallons in 1966 to 2.2 million gallons in 1969. Hence, if the Government wishes to increase lacto consumption to improve the nutritional status of low-income urban families, then the subsidy of the lacto retail price must be increased.

The absolute magnitude of the milk demand price elasticity plays a role in determining the 'appropriate' prices for milk products, since the trading deficit of the DMB is considered as one of the crucial variables in the milk pricing process. If the Government maximises social welfare (defined as a function where milk prices and consumers' income are independent variables) subject to a zero profit condition for DMB, then the price deviation of, say, consumer whole milk from the marginal cost of producing it should be set equal to (Varian, 1984):

$k/Ei = (Pm – MCm)/Pm$ (10)

where:

Pm = unit price of whole milk,

MCm = marginal cost of producing whole milk,

Ei = own-price elasticity for whole milk, and

K = a constant whose value depends on the shadow price corresponding to the zero profit constraint and the marginal utility of income.

If the premium attached by the DMB in meeting a zero profit goal is equal to the utility value attached by domestic milk consumers to their incomes, then, based on the elasticity parameter of equation 9, the whole milk price can be increased by 203% without affecting the consumers' welfare. It is recognised that such a large price adjustment cannot be undertaken abruptly. It should be a goal intended to be accomplished gradually in order to improve the efficiency of the DMB.

Conclusions

The major findings of the analysis of the effects of the milk price policy in Zimbabwe are:

- The short-term response of commercial milk output to producer price increases will be mainly in the form of yield increases. It is estimated that a 10% rise in the milk producer price will result in a 6.3% increase in milk output.
- The Government's policy of depressing consumer prices for milk is not consistent with the objective of achieving self-sufficiency in dairy products. The low consumer price for milk has encouraged its consumption. Whole milk demand estimates in this paper indicate that a 10% reduction in the retail price of whole milk would increase per caput consumption by 6.58% . The rapid rise in milk consumption has increased the trading deficits of the DMB and has resulted in importations of dairy products.
- The retail price of fresh milk can be increased by as much as 203% without substantially affecting public welfare.

- A change in milk price can affect the opportunity costs of such major inputs as land and animal draught power in the communal areas.

Acknowledgements

Comments on an earlier draft were given by S. Sandford, Addis Anteneh, V. von Massow, S. Debrah, J. McIntire, P. Borland, E. Cross, K. Katsande, T. Richardson, T. Metz, and J. Durkin.

References

Buckwell A. 1984. Herd structure and milk supply response*. J. Agric. Econ*. 3 (35): 341–354.

Chavas P J. 1982. On the use of price ratio in aggregate supply response: Some evidence from the poultry industry. *Can. J. Agric. Econ*. 2 (35): 345–385.

Chen D, Courtney R and Schmitz A. 1972. A polynomial lag formulation of milk production response. *Am*. *J. Agric. Econ*. 1(54): 77–83.

CSO (Central Statistical Office). 1984. *Quarterly digest of statistics, Dec. 1984*. CSO, Zimbabwe.

DMB (Dairy Marketing Board). 1984. *Milk collection in Chikwaka.* DMB, Zimbabwe.

Higgins C W. 1972. Milking efficiency. *Newsletter 4.* Department of Research and Specialist Services, Ministry of Agriculture, Zimbabwe.

Jansen D J. 1982. Agricultural prices and subsidies in Zimbabwe: Benefits, costs and trade-offs. Unpublished paper.

Ministry of Agriculture. 1985. The development of the dairy sector. Ministry of Agriculture, Zimbabwe.

Ruigu G. 1979. An analysis of the Kenya milk subsystem. Unpublished PhD. thesis, Michigan State University.

Varian H. 1984. *Microeconomic analysis.* Second Edition. Norton W.W. Co., New York, USA.