*Agricultural Economics Research Review*
Vol. 22 January-June 2009 pp 155-160

*Research Note*

# Evolving Milk Pricing Model for Agribusiness Centres: An Econometric Approach

**V. Saravanakumar[a]* and D.K. Jain[b]**
[a]Directorate of Agricultural and Rural Management, Tamil Nadu Agricultural University
Coimbatore - 641 003, Tamil Nadu
[b]Dairy Economics, Statistics and Management Division, National Dairy Research Institute
Karnal, Haryana - 132 001

**Abstract**

The two-axes pricing policy is followed normally in the dairy business centres of Tamil Nadu. Though it is scientifically rational, it ignores the input prices, technology and government policies. For sustaining the growth momentum and achieving an annual average growth of 7-8 per cent in the next five years and considering that dairying is practised as a component of mixed farming systems, it becomes imperative to take into account the interrelationship among the enterprises and general economic factors while fixing the milk price. In this study, development of a price determination model has been reported. It is based on the cost of production and takes into account price and non-price factors, viz. technology, and projected different price scenarios of milk for the coming years. The study undertaken in the Tamil Nadu state, is based on primary data collected for the year 2002-03 and has used normalized restricted quadratic profit function analysis and price determination models. It has been found that to maintain constant returns to the production cost of milk, the milk price would need an upward adjustment of 9.97 per cent, whereas to provide constant net monetary income, the milk price would need an upward adjustment by 10.30 per cent for buffalo milk. Considering 2002-03 as the base year, the estimated price for milk per litre is expected to be Rs 23.64 at constant monetary income and Rs 23.15 at constant return to production cost in the year 2009-10. The results of the paper are illustrative of the utility approach in generating consistent price sets for milk in response to alternative policy interventions.

## Introduction

Livestock sector plays a critical role in the welfare of India's rural population. It contributes 5.4 per cent to the total GDP and 27 per cent to the GDP from agriculture and allied sectors engaging 30 million small producers, each raising one or two cows and or buffaloes. It is emerging as an important growth-leveraging sector of the Indian economy with annual milk production of 97.1 million tonnes (Mt) in 2005-06 (Economic Survey, 2005-06). It accounts for more than 65 per cent of the total value of livestock output. Though, India is the world's top milk producer, the per capita milk availability remains low at 241 grams per day (Economic Survey, 2005-06), which is lower than the minimum requirement of 250 grams per day as recommended by the Indian Council of Medical Research (ICMR). The demand for milk is estimated to be of 191.3 Mt by 2020 assuming the growth rate of the economy at 5 per cent per annum. The milk supply projections have indicated a deficit of 52.7 Mt by 2020 (Kumar, 1998). The impact of Agreement on Agriculture (AoA) under the globalization process has made the Indian dairy industry to face several challenges, including structural changes in the production and trade patterns.

* Author for correspondence,
Email: sharanu2k @gmail.com

In India, price policy for milk and other livestock products has not yet been adopted by the government and the same is being handled by middlemen, individual traders and vendors. The studies conducted by Ray (1978) and Gandhi (2002) with respect to milk pricing policy have concluded that two-axes pricing policy was more appropriate. However, Patel (1975), Raut and Singh (1979) and Pundir (1996) have concluded that the cost of milk production, seasonal variations and general market trends should be taken into account for pricing of milk. Keeping these views, the present study has developed a price determination model based on cost of production taking into account the price and non-price factors and has projected different price scenarios of milk in future.

## Methodology

### Sampling Framework and Data Collection

The state of Tamil Nadu has been purposively selected. It has emerged as the ninth largest milk-producing state of the country, with annual milk production of 4.75 Mt, accounting for 5.40 per cent of the total milk production of the country and the second largest milk producer in the southern region (CSO, 2004). A multi-stage stratified random sampling technique was adopted to select the sample households. Erode and Trichy districts of the Tamil Nadu state were purposively selected and two blocks were selected randomly from each of these two districts. A complete enumeration of all households in the selected villages was carried out and a sample of 20 households rearing buffaloes from each village was selected randomly and thus in total, a sample of 160 households was selected. The data for the investigation comprised primary data for two seasons, namely flush (August to February) and lean (March to July) for the year 2002-03 collected through a well-structured, pre-tested proforma by personal interview method and the secondary data were obtained from published sources.

### Existing Milk Pricing System

In India, the price of milk is determined in cooperatives by two methods (Ray, 1978 and Gandhi, 2002), viz., (i) bulk line costing method, which is that level of cost which covers / reflects the bulk line (i.e., $85^{th}$ percentile) of milk production, and (ii) two-axes pricing policy (considering both fat and SNF); fat is estimated by Gerber method (BIS, 1981), the SNF is estimated by using lactometer reading and modified Richmond's formula. But, there is no uniform pattern followed throughout the country to give weightage to SNF-fat value or bulk line costing method, while fixing the price of milk. Generally, the dairy plants fix their own SNF-fat weightage rates to attract higher milk procurement. These pricing policies completely ignore the factor allocation, yield levels and income, which are very much affected by the movements of relative prices. In such situations, it is important to take into account the interrelationships of milk on both the factor and product market sides for determining the price of milk.

### Price Determination Model for Milk

The price of milk ought to be at a levelwhich covers production cost and leaves sufficient margins to milk producers. The methodology developed by Kumar(1984) has been used in this study. The analysis required the cost and returns structure of milk computed based on the survey data and has been given in Appendix Table 1. In addition to these parameters, there was also need of elasticity parameters of milk supply and input demand for milk production with respect to milk price and variable and fixed input prices. These production elasticities were derived by using the normalized restricted quadratic profit equations. The estimated elaticities have been given in Appendix Table 2. Using the models developed by Kumar (1984), the growth equations for cost of milk production and net income from milk production were derived and used for fixing the milk price under few scenarios.

## Results and Discussion

The price determination model based on cost of production was developed for milk and the results have been presented in the following sections.

### Cost of Production Model

Growth model used for cost of milk production with respect to realized changes in price and non-price factors was:

$$\dot{C} = 0.09\,\dot{p}_1 + 0.19\,\dot{p}_2 + 0.14\,\dot{p}_3 + 0.02\,\dot{p}_4 - 0.01\,\dot{Z}_1 - 0.03\,\dot{Z}_2 \quad \ldots(1)$$

where, $\dot{p}_1$, $\dot{p}_2$, $\dot{p}_3$ and $\dot{p}_4$ represent the growth in prices of green fodder, dry fodder, concentrate and wage rate, respectively; $\dot{Z}_1$ and $\dot{Z}_2$ represent growth in veterinary and miscellaneous cost, and fixed cost, respectively.

It was observed from model (1) that the elasticities of growth of cost of production with respect to prices of variable inputs were positive and less than one. The elasticities of fixed inputs $Z_1$ and $Z_2$ were negative and inelastic for buffalo milk production during the study year. It implied that increase in both fixed resources like veterinary and miscellaneous cost and interest and depreciation on fixed assets would improve the productivity of milk and reduce the cost of milk production. The prices of dry fodder and concentrate had a major impact in raising the cost of milk production for buffalo milk which implied that one per cent increase in these prices would increase the cost of milk production by 0.19 per cent and 0.14 per cent, respectively.

**Net Income Model**

The growth model used for the net income from milk with respect to observed changes in price and non-price factors during the study year was:

$$\dot{I} = 4.55\,\dot{P} - 0.45\,\dot{p}_1 - 0.95\,\dot{p}_2 - 0.63\,\dot{p}_3 - 0.14\,\dot{p}_4 - 0.67\,\dot{Z}_1 - 2.72\,\dot{Z}_2 \quad \ldots(2)$$

The signs of net income elasticities with respect to the prices of green fodder, dry fodder, concentrate and wage rate were observed to be negative, which was anticipated with the theoretical framework. It was found that the elasticity estimates were less than unity in both the models. With respect to milk price ($\dot{P}$), the net income elasticity showed more responsiveness, i.e. one per cent increase in milk price would raise the income by 4.55 per cent for buffalo milk production.

Under the assumption that there were no changes in the fixed factors, viz. veterinary and miscellaneous cost ($\dot{Z}_1$) and interest and depreciation on fixed inputs ($\dot{Z}_2$) and that factor price inflation in prices of green fodder, dry fodder, concentrate and wage rate will continue to rise in future at the rate of 10 per cent, the growth equations for cost of production and net income for buffalo milk may be reduced to equation (3):

$$\dot{\underset{\sim}{C}} = 0.0997, \quad \dot{I} = 5.62\,\dot{P} - 0.5676 \quad \ldots(3)$$

where $\dot{\underset{\sim}{C}}$ is the average cost of milk production per litre and I is the average net income.

For ten per cent increase in the level of price factors used in milk production for buffalo milk, the cost would increase by 9.97 per cent. Thus, if the objective of the policymakers is to maintain constant returns to the production cost of milk production, the price of milk needs to be adjusted upwards at a rate equal to the magnitude of cost-push inflation. For maintaining constant monetary net income ($\dot{I}$ = 0) to the milk producers, the adjustment in milk price for buffalo would be $\dot{P}$ = 0.1010 during a year.

The cost of production of milk and prices of milk at constant monetary net income (dI = 0) and at constant return to production cost were estimated based on the model developed in the study. Considering 2002-03 as the base year, the cost of milk production, and prices of milk at constant monetary net income (I = 0) as well as at constant returns to production cost were estimated for buffalo milk production by the year 2010 (Table 1).

A perusal of Table 1 revealed that the estimated overall cost of production per litre of buffalo milk would be Rs.19.66 during the year 2009-10. And, the estimated price for buffalo milk is expected to be Rs.23.64 and Rs.23.15, respectively, at constant monetary income ($\dot{I}$ = 0) and constant return to production cost during the year 2009-10 based on the price determination model with the assumption of 10 per cent increase in the prices the variable inputs every year.

The technological change allows the productivity growth to compensate for cost-push inflation, while maintaining product price and rate of profit to be constant. However, productivity change itself is conditioned by the rate of profit on investment in dairying. Hence, there is a need to set the limits of milk price at the existing cost-push inflation. Net income from milk for buffalo during the year will face a negative growth, if the milk price is adjusted below the level at which net income

**Table 1. Estimated production cost and price of milk, based on the cost and price model for buffalo farms**

(Rs/litre)

| Year | Cost of milk production | Milk Price | |
|---|---|---|---|
| | | At constant monetary net income ($\dot{I} = 0$) | At constant return to production cost |
| 2002-03* | 10.11 | 11.90 | 11.90 |
| 2003-04 | 11.12 | 13.13 | 13.09 |
| 2004-05 | 12.23 | 14.48 | 14.39 |
| 2005-06 | 13.45 | 15.97 | 15.83 |
| 2006-07 | 14.79 | 17.61 | 17.40 |
| 2007-08 | 16.26 | 19.43 | 19.14 |
| 2008-09 | 17.88 | 21.43 | 21.05 |
| 2009-10 | 19.66 | 23.64 | 23.15 |

*Source:* Based on survey

elasticity with respect to milk price is negative. This would act as a disincentive to the milk producers in the context of adoption of improved technology. On the other hand, the price adjustment above the limit, where net income elasticity is positive and elastic, will leave the milk producers with high profit rates. So, the milk price should be adjusted within that range where net income elasticity floats between zero and one; it may provide fair income to milk producers, so as to induce them towards the adoption of improved milk production technology. Further, keeping in view, the competition among the farm enterprises, constraints in rapid adoption of new technology, general economic condition and scenario of the international market, the prices are required to be adjusted. The changes in net income and elasticity of net income for corresponding changes in milk prices for buffaloes were calculated during the study year and have been presented in Table 2.

It is evident from Table 2 that the growth in milk price will compensate for the cost-push inflation if it lies between 10.10 per cent and 12.29 per cent during a year. The adjustment of milk price below 10.10 per cent per annum will generate a negative growth in net income and may not provide enough incentive to the milk producers for the adoption of improved technology. Price adjustment above 12.29 per cent will give high rate of profit to the milk producers which may led to specialization of dairy farms. The results obtained in the present study were in conformity with the findings of Pundir (1996) who obtained similar results for buffalo milk production in Himachal Pradesh.

**Table 2. Changes in net income elasticity and net income due to change in corresponding price of milk of buffalo farms**

| Changes in net income elasticity ($E_I^P$) | Change in net income ($\dot{I}$) | Changes in milk price ($\dot{P}$) |
|---|---|---|
| - $\alpha$ to 0 | -0.46 to 0.00 | 0.00 to 0.1010 |
| 0 to 1 | 0.00 to 0.1010 | 0.1010 to 0.1229 |
| > 1 | > 0.1229 | > 0.1229 |

## Conclusions and Policy Implications

The pricing model for milk based on cost of production has revealed that the prices of green fodder, dry fodder and concentrate play a significant role in raising the cost of milk production and the fixed factors influence negatively to reduce the cost. The growth of net income of milk with respect to milk price is also influenced positively. The study has indicated that the price of inputs and fixed factors influence the cost of milk production significantly. The study has concluded that the price of feeds is an important factor in determining the cost of milk production, therefore, to have a rational price policy of milk, the price and non-price factors like technology should be considered for taking up appropriate decisions. The price model based on cost of production developed in the study can be used to project the future price of milk by taking into account the cost of inputs, technology and general economic conditions. The calculated parameters of the model are to be treated with caution in as much as they are based on the reference year for the milk. The results of the study are illustrative of the utility approach in generating consistent price sets for milk in response to alternative policy interventions.

## References

BIS (1981) *ISI Handbook of Food Analysis. Part XI. Dairy Products.* Bureau of Indian Standards, New Delhi. pp. 21-44.

CSO (2004) *National Accounts Statistics*, Central Statistical Organisation, Ministry of Statistics & Programme Implementation, New Delhi.

*Economic Survey* (2005-06) Economics Division, Ministry of Finance, Government of India, New Delhi.

Evenson, R.E. and Binswanger, H.P. (1980) *Estimating Labour Demand Function for Indian Agriculture*. Centre Discussion Paper No. 356. Economic Growth Centre, Yale University, New Haven, Connecticut, USA.

Gandhi, P.M.K.C. (2002) Pricing policy and cost of production of milk in Coimbatore dairy cooperatives. *M.Sc. Thesis*, National Dairy Research Institute, Karnal, Haryana.

Greene, W.H. (1997) *Econometric Analysis*. Prentice Hall, New Jersey, USA.

Kumar, P. (1984) Price policy model of sugarcane and its products. *Indian Journal of Agricultural Economics*, **39**(4): 595-612.

Kumar, P. and Mruthyunjaya (1989) *Methodology for Simultaneous Determination of Factor Product Prices :* Project report. Division of Agricultural Economics, Indian Agricultural Research Institute, New Delhi.

Kumar, P. (1998) *Food Demand and Supply Projections for India*. Agricultural Economics Policy Paper 98-01. Indian Agricultural Research Institute, New Delhi.

Patel, R.K. (1975) Sound basis of pricing milk. *Indian Dairyman*, **36**(1):1-7.

Pundir, R.S. (1996) Cost and price determination models for milk. *Ph.D. Thesis*, National Dairy Research Institute, Karnal.

Raut, K.C. and Singh, S. (1979) A system of continuous milk costing by balancing interest of both producers and consumers. *Indian Dairyman*, **31**(9):635-639.

Ray, A.K.C. (1978) Pricing of milk. *Indian Dairyman*, **30**(12): 809-813.

Zellner, A. (1962) An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of American Statisticians Association*, **57**(298): 348-375.

**Appendix Table 1**

**Cost and returns structure of buffalo milk production**

| Sl No. | Particulars | Description | Rs/day/milch animal |
|---|---|---|---|
| 1. | Green fodder cost | $X_1p_1$ | 5.31 |
| 2. | Dry fodder cost | $X_2p_2$ | 5.64 |
| 3. | Concentrate cost | $X_3p_3$ | 11.63 |
| 4. | Total labour cost | $X_4p_4$ | 4.84 |
| 5. | Veterinary and miscellaneous cost | $Z_1$ | 1.09 |
| 6. | Total fixed cost | $Z_2$ | 4.71 |
| 7. | Gross cost | Cost C | 33.21 |
| 8. | Milk production (litres/day) | Q | 3.17 |
| 9. | Cost of milk production (Rs/L) | C | 10.11 |
| 10. | Net income | I | 4.31 |

**Appendix Table 2**

**Factor demand and output supply elasticity estimates (aggregated) of buffalo milk production**

| Demand function | Price of green fodder ($q_1$) | Price of dry fodder ($q_2$) | Price of concentrate ($q_3$) | Wage rate ($q_4$) | Veterinary and miscellaneous cost ($Z_1$) | Interest and depreciation on fixed cost ($Z_2$) | Price of milk ($P_Y$) |
|---|---|---|---|---|---|---|---|
| Green fodder ($X_1^*$) | -0.1685 | 0.0144 | -0.1510 | -0.0561 | 0.0094 | 0.1274 | 0.4671 |
| Dry fodder ($X_2^*$) | 0.0135 | -0.0643 | 0.0057 | 0.0014 | 0.0018 | 0.0946 | 0.1388 |
| Concentrate ($X_3^*$) | -0.1456 | 0.0032 | -0.6125 | 0.0117 | 0.0055 | 0.0004 | 0.7315 |
| Human labour ($X_4^*$) | -0.0510 | 0.0007 | 0.0197 | -0.2378 | 0.2118 | 0.1151 | 0.4018 |
| Milk supply ($Y^*$) | -0.0073 | -0.0028 | -0.0415 | -0.0740 | 0.0225 | 0.0718 | 0.1163 |