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Is traditional milk marketing and processing viable and efficient? An empirical evidence from Assam, India

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Abstract

Integrated food supply chains serving urban areas are the fastest growing and most visible market phenomenon, yet small scale milk market agents and chains supplying fresh milk and traditionally processed dairy products still play a very large role in most of the developing countries. This study estimates the costs and returns of milk marketing and processing, identifies the drivers for participation in high value milk processing and value addition and estimates the cost efficiency and its determinants in the traditional milk sector in Assam. The study observed that raw milk trading and processing offers good opportunities for income generation to small scale milk traders and processors. The raw milk marketing and trading is reasonably efficient and has the potential for continued dominance in spite of emerging integrated food supply chains.

Keywords: milk marketing, processing, cost efficiency, determinants
JEL: Q12, Q13

1. Introduction

Integrated food supply chains serving urban areas are the fastest growing and most visible market phenomenon, yet small scale milk market agents and chains supplying fresh milk and traditionally processed dairy products still play a very large role in most of the developing countries. They often provide the main outlet for small holder dairy producers, and the main source of fresh milk for resource poor consumers. They played an important role in being the primary mechanism for linking growing demand among consumers with increased production from producers. These market chains are increasingly being challenged by public demands for higher standards and safety, and facing stiff competition from the large scale regulated players. However, these traditional small scale markets still account for over 80% of marketed milk in many countries in South Asia, Sub-Saharan Africa and in Latin America (OMORE et al., 2004). In India, too, some 80% of milk marketed still passes through these traditional

milk marketing channels in spite of the high profile given to co-operative dairy development throughout the Operation Flood programs. However, the dominance of traditional channels varies across states and in some of the underdeveloped states traditional channels are the only milk marketing outlets available for smallholder dairy producers. This basic structure in milk marketing in India is not expected to change significantly in the near future. But, the dynamics, efficiency and functioning of the traditional milk market are not well understood and generally evade the attention of policy planners. Because of their exclusion from policy and lack of attention, factual information on its functioning is limited. An understanding of the efficiency and its driver would be useful to evolve policies, development strategies and business development services for the efficient value chain in milk marketing. This study was undertaken to deliberate on some of these issues in Assam, where traditional milk market agents control more than 90% of the milk marketing opportunities. Specific objectives of the study are to (i) understand the economics of traditional milk marketing and processing, (ii) identify the drivers for participation in high value milk processing and value addition, and (iii) estimate the cost efficiencies and their determinants in raw milk trading and processing.

2. Dairy production and milk marketing systems in Assam

Dairying is an important component of mixed farming systems in Assam. About 82% of rural households in Assam keep cattle or buffalo. The predominance is for cattle, with only 5% of the households keeping buffalo. However, milk productivity is very low in the state. The average milk yield of indigenous cattle, crossbred cattle and buffalo is far below the national average. In Assam, dairying is characterized mostly by rural smallholders' production using indigenous cattle and buffalo, with pockets of specialized dairy production using improved dairy cattle in the peri-urban areas and in certain rural zones having better market access.

While the increasing farm-level production and productivity will require more improved animals, improved fodder/feed technology, and access to livestock services, smallholders' access to reliable markets to absorb more milk at remunerative prices may remain a critical constraint. Organized marketing of milk in Assam remains insignificant, despite efforts in the past to develop and promote collective market mechanisms. Formal pasteurized milk and dairy product channels, both cooperative and private, account for only about 3% of the total locally-produced marketed milk. The traditional market, either for fresh liquid milk or importantly, for traditional products such as sweets, thus accounts for about 97% of the market opportunities for farmers. For smallholder producers in areas with poor market access-there are likely to be no alternative market options, besides the traditional market. Developments in the

traditional market will be extremely important for the Assam dairy sub-sector, and a set of interventions that could facilitate improvements in that market could complement the ongoing efforts to develop cooperative organized milk markets.

3. Data and methodology

3.1 Data

Detailed data were collected from representative random samples of traditional milk market agents in Assam. The survey of milk market agents was conducted in 9 districts of Assam: Barpeta, Kamrup, Sonitpur, Nagaon, Morigaon, Jorhat, Tinsukia, Cachar and North Cachar Hills. Eight of these are the target districts of the Assam Agricultural Competitiveness Project (AACP), of which dairy development is a component. The North Cachar Hills district was added in order to include a milk marketing system that faces difficult access issues of hilly terrains. The study on milk agents was conducted at the selected urban/peri-urban centers and rural areas in the chosen nine districts. The agents as defined in this project included the un-organized milk vendors, wholesale milk collectors, and small processors (e.g., sweets makers, chhana makers, dahi/curd makers, ghee makers). The overall sample size (590 respondents) was determined based on discussions with the dairy development department of the Government of Assam and AACP on an adequate sample size to provide a representative view of the dairy market in the state of Assam. The sample was allocated proportionately on the basis of population in a district. In each district, two administrative blocks, one with a population less than 10,000 and the other with a population more than 10,000, were randomly selected. Within each block, the main urban centre was identified and two villages from each block were also randomly selected. In urban and peri-urban centers, the main markets, e.g. collection points, distribution points and selling points were identified and market agents were randomly selected. In villages, it was assumed that market agents would be easily identifiable, hence complete enumeration was done. Altogether 590 informal milk market agents were surveyed from these districts. Respondents were randomly selected from sites purposively selected within each district. Out of 590 informal milk market agents, 355 are raw milk traders and 222 are milk processors. The remaining 13 traders were engaged in both raw milk trading as well as in milk processing. All respondents were surveyed through a direct questionnaire method using a structured questionnaire.

3.2 Methodology

A partial budgeting method was used to estimate the costs and returns in traditional milk marketing and processing. The logit model was applied to understand the factors

which induce milk traders to participate in the value-added activities of milk processing. A stochastic frontier cost function was employed to assess the efficiency levels of traditional milk trading and processing and to identify the factors to further increase the efficiency of milk trading and processing. The influence of socio-economic and trader characteristics was also examined on the cost efficiency.

3.2.1 Logit model

A logit model was estimated to identify the factors that influenced milk traders' decision to participate in the value-added activities of milk processing. The dependent variable was binary, taking a value of 1 for the milk processor, 0 otherwise, using the expression:

(1) $$C_i = \delta_1 + \delta_2 Z_i + \mu_i$$

Where, C_i is a dummy variable taking the value of 1 if the milk trader processes milk, 0 otherwise. Z_i is a vector of independent variables, and includes factors like schooling, age, labour availability, ownership of assets, experience in milk marketing, etc.; δ_1 and δ_2 are the estimated parameters, while μ_i is the error-term.

3.2.2 Cost efficiency

The cost efficiency in traditional dairy marketing and processing was empirically investigated by estimating a stochastic cost function. In order to analyze the cost efficiency of traditional milk traders and processors, the stochastic cost frontier was specified as follows:

(2) $$C_i = \beta_0 + \beta_1 LN(Y_t) + \beta_2 LN(C_t) + \beta_3 LN(C_m) + \beta_4 LN(C_l) + \beta_5 LN(C_f) + \beta_6 LN(K_i) + \xi$$

where, C_i=Total cost incurred by raw milk trader/milk processor; Y_i=Total milk handled, litres/day; C_i=Cost of transport (per litre); C_m=Cost of additional material (per litre); C_l=Cost of labour (per litre); C_f=Cost of fuel and electricity (per litre); K_i=Capital investment (per litre), while ξ=Error-term.
In order to identify the determinants of cost efficiency, the equation (3) is estimated.

(3) $$C_e = \alpha_0 + \alpha_1(X_1) + \alpha_2(X_2) + \alpha_3(X_3) + \alpha_4(X_4) + \alpha_5(X_5) + \alpha_6(X_6) + \alpha_7(X_7) + \alpha_8(X_8) + \alpha_9(X_9) + e_i$$

Where, C_e=Cost efficiency of raw milk trader/milk processor; X_1=Age in years; X_2=Years of schooling; X_3=Experience, number of years; X_4=Participation of family member in the business; X_5=Source of finance; X_6=Location of business (rural/urban);

X_7=Ownership pattern of business; X_8=Mode of business acquisition; and X_9=Occupation other than trading/processing.

The above two-stage method, consisting of maximum likelihood (ML) estimation of a stochastic cost frontier followed by ordinary least square (OLS) estimation of an equation relating to predicted cost inefficiency to the potential determinants of cost inefficiency has lately been criticized. Hence, twin steps are alternatively combined into a single step according to the model by BATTESE and COELLI (1995). However, trends emerging from both the procedures remain the same and two-stage method is still widely used (HAZARIKA and ALWANG, 2003).

4. Results and discussion

4.1 Profile of market agents

The profile of selected milk market agents is given in table 1. The average age of milk market agents was 38 years with little variation across different types of milk market agents. These agents had on average 8 years of schooling. Raw milk traders had on average 7 years of schooling, while raw milk traders & processors and milk processors had higher levels of education, each having 11 years of schooling. This suggests that education could be a form of barrier to entry into value-added dairy activities. Milk trading is the domain of men in Assam, as in 590 milk market agents, only 2 were women. This suggests that customary roles preclude women in the state from active participation in the dairying industry.

Table 1. Demographic characteristics and scale of business in Assam

Type of business	Age (years)	Education (years)	Average milk handled/day (litres)	Other family laborers (No.)	
				Full time	Part time
Raw milk trade	37.5	6.6	74.9	0.10	0.36
Raw milk trade and processing	39.5	10.5	86.8	1.00	0.31
Milk products processing	39.5	10.7	51.6	0.26	0.57
All	38.3	8.2	66.4	0.18	0.44

Source: Milk Market Agents Survey, Assam Dairy Development Project (2006)

On average, a traditional market trader (raw milk traders and traditional milk processors) handles 66 litres of milk per day. Raw milk traders handle about 75 litres of milk per day. Traditional milk processors handle about 52 litres of milk per day and

the average milk handling by milk market agents engaged in both raw milk selling and processing is slightly more at 87 litres per day. The traditional milk trading in the state is dominated by small traders, as a significant proportion of them handles a very small amount of milk. 33% of the respondents handle only 8-30 litres milk per day; 39% handle 31-60 litres milk per day and the remaining 22% handle more than 60 litres milk per day. Traditional milk market agents apparently operate individually, although with help from hired labourers. The involvement of family members in milk trading is not very high. Apart from the milk trader himself, on average only 0.2 man days per milk trader from the family is engaged in the business on full-time basis, while 0.44 man days of family members per day per market agent help in milk trading on part-time basis.

4.2 Costs and returns in milk marketing and processing

In this analysis, costs and returns have been considered separately for raw milk traders and milk processors. Only variable cost was considered for estimating the returns. Thus, the net return was calculated by deducting the variable cost from the gross return, and thus represents a return to labour and investment by the trader. The variable cost mainly consisted of transaction costs in purchasing and selling of milk. In particular, the expenditure on transport in procurement and sale of milk, expenditures on materials like preservatives, water, electricity, taxes and rents, etc. were considered.

It has been found that raw milk traders incurred approximately Rs. 0.64/litre as variable cost and this adds about 4% to the expenditure incurred on procurement of milk (table 2). On average, the milk traders in the study area earn a profit of Rs. 259/day, which is considerably higher than the prevailing wage rate and comparable with alternative employment opportunities available in the state. Further, getting work on the existing wage rate elsewhere is always uncertain. The margins in fresh or raw milk trading depend on several factors like distance, level of infrastructure, urbanization, availability of milk with respect to demand, purchasing power, tastes and preferences, etc. As these parameters change across different locations, the net return received by milk market agents also will change.

Milk is processed into different intermediate and end products. While calculating the gross income the total value of different processed products was taken into account. On the cost side, apart from the cost of milk, expenditures on labour, material, fuel, electricity, etc. have been taken into consideration. Milk processing offers the potential for value-addition and income generation for the milk processors. On average, traditional milk processing earns a margin of about Rs. 15 per litre in Assam. The value-addition margins have been reported to be from Rs. 1.38 to Rs 10.50 per litre of milk bought in Orissa, depending on the marketing channels and level of processing

(SAHA et al., 2004). These value-added products are generally sold in unbranded form in the market by these traditional milk market agents, and are accepted on processors' credibility and reputation in the market. The costs and returns, as depicted in table 2 suggest that milk processing offers good opportunities for enhancement of income and employment generation.

Table 2. Cost and return of raw milk trading, processing and value addition

Sr. No.	Particulars	Average costs and returns of raw milk trading (Rs./day)	Costs and returns to milk processing and value addition
1	Milk handled per day (litres)	78	51
2	Total value of milk purchased (Rs.)	1 123.9	786.6
3	Total value of consumed and leftover milk	5.3	9.3
4	Cost of transport in marketing (Rs.)	17.9	1
5	Additional material cost in milk handling and processing	1.2	244.4
6	Labour Expenditure	13.9	107.4
7	Electricity and water expenditure (Rs.)	1.6	50.2
8	Rents/Maintenance of trading practices (Rs.)	15.5	39.7
9	Total variable costs (Rs.)	50	452
10	Gross expenditure (Rs./day)	1 173.9	1 229.3
11	Gross income (Rs./day)	1 427.7	1 980.3
12	Net Income (11-10+3) (Rs./day)	259	760.3
13	Total variable costs per unit milk (Rs./litre)	0.64	8.9
14	Net income (Rs./litre)	3.3	14.8

Source: Milk Market Agents Survey, Assam Dairy Development Project (2006)

4.3 Determinants of traders' participation in milk processing

It has been clearly established that the returns to labour are substantially higher in milk processing than in raw milk trading. These are quite large to attract traders to this value adding activities and there are no legal barriers to enter into the venture of milk processing. However, it is the traders' specific socio-economic characteristics that influence their decision to participate/start in milk processing activities. A clear understanding of these factors would help in facilitating the entry of milk market agents in these value-adding activities. It would also help in up scaling of the traditional milk processing activities. We have used a logit model to identify those characteristics that influence milk market agents' participation in the milk processing.

It was hypothesized that availability of family labour, higher education and age of the trader has a positive effect on the decision to participate in milk processing. It was expected that a trader with larger surplus labour is more likely to join milk processing because of the labour-intensive nature of the processing activities. On asset specificity, it was considered that the greater the asset specificity, the higher would be the probability of participation in milk processing due to the higher requirement of capital. Further, on the basis of experience in milk processing, it was hypothesized that the more experienced milk traders would participate more eagerly in the milk processing. Similarly, a person with higher education level was expected to have a better access to information and more clarity about emerging marketing opportunities in the milk processed products. The results of the logit analysis of the decision of milk market agents whether or not to process milk are reported in table 3.

Table 3. Factors influencing traders' decision to participate in milk processing

Explanatory variables	Coefficient	Standard error
Age of the trader (years)	0.0412363*	0.01252
Education (years of schooling)	0.2687377*	0.03593
Initial capital (Rs)	0.000022*	
Experience in milk trading (years)	0.0095647	0.0168815
Occupation Only milk trading=1, other=0	0.5782702**	0.2487593
Participation of family members in the business If yes=1, otherwise=0	0.958306*	0.2328346
Urban=1, otherwise=0	1.014793*	0.377418
Mode of business acquisition Self started =1, otherwise=0	-0.2959049	0.3023443
Ownership of business Sole=1, otherwise=0	-0.5352585	0.7431401
Source of financing Formal credit=1, otherwise=0	-0.482951	0.4468203
Constant	-5.995213	1.070513
Chi-squared	250.31	
Log-likelihood	261.70	
Number of observations	584	
R^2	0.3235	

*, ** indicate significance at 1% and 5%, respectively.

Source: Milk Market Agents Survey, Assam Dairy Development Project (2006)

By and large, the age, education, capital, availability of family labour, occupation and location of the business activities have been found to influence the traders' decision to participate in the milk processing activities. Other variables included in the model were non-significant. Age and education of the trader influence positively the traders' decision to go for milk processing. It is apparent that a higher level of education facilitates traders' entry into high-value milk processing activities. The availability of and access to higher capital also inspire the traders to enter into this high-value activity. The traders who solely depend on milk marketing are likely to go for milk processing to augment their household income. The participation of family labour in milk and milk products marketing reduces the uncertainty of availability of labour and thus induces the traders to enter the high income generating milk processing activity. The traders located in urban areas have higher prospect for participation in the milk processing and value addition activities. Urban location helps the traders in assured supply of raw materials and provides better marketing opportunities for the processed milk products.

4.4 Estimating cost efficiency in informal/traditional milk trading and processing

The stochastic cost frontier estimation shows the effect of different parameters on the total cost of milk traders. Estimates of cost frontier coefficients are shown in table 4.

Table 4. Maximum likelihood estimates of the parameters milk marketing and processing cost function

Variable	Raw milk marketing		Milk processing	
	Coefficient	Standard error	Coefficient	Standard error
Total milk handled in litres/day (Yi)	1.060929*	0.0254113	1.010366*	0.022317
Cost of transport (Ct)	-0.0075375	0.0175109	-0.0140268	0.0411246
Cost of additional material (Cm)	-0.0225066	0.0242338	0.1290552*	0.0088681
Cost of labour (Cl)	0.0267329	0.0293267	0.1706426*	0.0268664
Cost of fuel, electricity (Cf)	0.0156072*	0.0055536	0.0602842*	0.0157458
Capital (Ki)	0.0119452*	0.0062791	-0.0016547*	0.0082651
_Constant	2.332793	0.6777144	2.696456*	0.118099
σ^2	0.0122783	0.0009972	0.0180768*	0.0045364
Γ	0.0016302	0.8381189	0.9620501*	0.0451384
Log-likelihood	246.02194		169.16723	
No. of observations	315		219	

* Significant at 1% probability level.

Source: Milk Market Agents Survey, Assam Dairy Development Project (2006)

The sum of input coefficients indicates that the sample milk market agents operate at decreasing returns to scale. The results show that coefficients with respect to quantity of milk handled, costs on transportation, inputs, labour and initial capital stock are all positive, conforming to the basic properties of the cost function that satisfy the cost minimization assumption. However, in the case of raw milk trading, coefficients of costs incurred on labour, electricity & rent and initial capital are significant at 1% level of probability, while coefficient of transport cost is significant at 8%. The coefficient of cost on additional material is not significant, may be because of limited use of additional material in raw milk trading. In the case of milk processing, the coefficients of costs of additional material, labour, rent & electricity are positive and significant. The coefficients of transportation cost and initial capital investment do not have the expected signs, but they are not significant. Output elasticity is positive in both cases, which implies that an increase in volume of milk handled would necessitate an increase in the total cost of milk market agents.

Cost efficiency estimates in the case of raw milk trading ranged from 1.02 to 1.45 with an average efficiency of 1.07. This indicates that raw milk traders operate at 7% higher cost than the best practice. This also implies that on average 7% of the costs incurred can be avoided without any decrease in total quantity of milk traded. In the case of milk processors, also the cost efficiency estimates ranged from 1.03 to 1.36, with an average efficiency of 1.08. It seems that the informal marketing of milk and milk products is reasonably efficient and this could be one of the reasons for predominance of informal milk trading in the state. Moreover, on average 61% of raw milk traders and 57% of milk processors were below the mean efficiency level, implying that more than half of the milk market agents were more cost efficient than the average milk market agents in the sample (table 5).

Table 5. Average cost efficiency estimates and the distribution above and below the mean efficiency estimate

	Raw milk trader	Traditional milk processor
Efficiency estimate		
Mean	1.07	1.08
Range	1.02 - 1.45	1.03 - 1.36
Distribution of efficiency estimate (number of respondents)		
Below mean	193 (61%)	124 (57%)
Above mean	122 (39%)	95 (43%)

Source: Milk Market Agents Survey, Assam Dairy Development Project (2006)

4.5 Determinants of efficiency

The variables that were hypothesized to affect the cost efficiency of milk market agents included age, education, experience, participation of other family members in the business, sources of financing, business acquisition mode, business location, ownership pattern, etc. Results of estimation of the determinants of cost inefficiency in raw milk trading and milk processing are shown in table 6.

Table 6. Parameter estimates of determinants of cost inefficiency

Variables	Raw milk trading		Milk processing	
	Coefficient	Standard error	Coefficient	Standard error
Age of the trader (years)	-0.00154**	0.00062	-0.00100	0.00080
Education (years of schooling)	-0.00254	0.00269	-0.00585**	0.00271
Experience in milk trading (years)	-0.00062	0.00138	0.00033	0.00149
Participation of family members in the business If yes=1, otherwise=0	-0.01084**	0.00529	-0.00599	0.00499
Initial capital to setup the business	0.00000	0.00000	0.00000	0.00000
Source of financing Formal credit=1, otherwise=0	0.01544	0.01294	0.01170	0.01331
Urban=1, otherwise=0	0.01068	0.00661	-0.04166***	0.01028
Ownership of business Sole=1, otherwise=0	0.00783	0.03291	-0.01821*	0.01050
Mode of business acquisition				
Self-started =1, otherwise=0	-0.05445	0.04193	-0.00240	0.00657
Inherited =1, otherwise=0	-0.07679*	0.04246	(dropped)	
Purchased =1, otherwise=0	(dropped)		-0.02943*	0.01573
Occupation Only milk trading with dairy farming=1, otherwise=0	0.01584	0.01533	-0.02553	0.03986
Interaction of variables				
Age and education	0.00008	0.00007	0.00012*	0.00006
Age and experience	0.00003	0.00003	-0.00001	0.00003
Initial capital and formal credit access	0.00000	0.00000	0.00000	0.00000
Milk-handled	0.00016***	0.00002	0.00003	0.00006
Constant	1.14860***	0.05944	1.18972***	0.03798
R^2	0.3260		0.1345	
Adjusted R^2	0.2922		0.0705	
F-test	9.64		2.10	
No. of observation	315		219	

* denotes significance at 1% level.

Source: Milk Market Agents Survey, Assam Dairy Development Project (2006)

In case of raw milk trading, only age, participation of family members and quantity of milk handled affect the cost efficiency significantly. Other variables included in the model were not found to have significant influence. Age and participation of family members affects the efficiency positively, while the quantity of milk handled seems to have an inverse relationship with cost efficiency, indicating the small holder's competitiveness in raw milk marketing. But, in case of informal milk processing, education turned out to be one of the important parameters for determining the efficiency in milk processing. The higher the level of education of the milk market agents, the higher is the efficiency in milk processing. The location of business also affects the cost efficiency; business carried out in an urban area has a positive and significant affect on cost efficiency. Further, the mode of business acquisition and the pattern of ownership also have significant influence on cost efficiency in milk processing. Single ownership and business acquired through purchase were likely to be more efficient. In milk processing the scale of business does not seem to have significant effect on cost efficiency, indicating cost efficiency to be neutral to scale.

5. Conclusions and policy implications

The study suggests that raw milk trading and processing offers good opportunities for milk market agents, the majority of whom are operating at small scale. This informal trading and processing is an economically viable proposition. The study further demonstrates that milk processing and value addition offers comparatively more lucrative options for milk market agents. However, the unavailability of assured labor, lack of education and of capital constrain the traders for taking up the milk processing and value addition activities. The cost frontier estimates indicate that milk traders in Assam are reasonably cost efficient. But about 39% of the raw milk traders and 43% of the milk processors are less cost efficient than the average trader in the sample. The presence of economies of scale in raw milk was not supported by empirical evidence from the study. Rather, smaller raw milk traders were observed to be efficient. The empirical evidence on economies of scale in milk processing also remains inconclusive. Therefore, in view of the continued dominance of traditional milk marketing and processing it would be prudent to address these markets in a constructive manner. The increased attention to quality by the growing middle class may work against these markets which are otherwise competitive and efficient. The quality gap can be bridged to a large extent by introducing training and certification programs for small scale milk and dairy product processors, which in turn would be helpful in maintaining the efficiency and competitiveness of these .milk market agents.

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