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## Smallholder Dairy Farmers' Access to Modern Milk Marketing Chains in India<sup>§</sup>

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### Abstract

The smallholder dairy farmers' access to modern milk marketing chain has been assessed in India by collecting data at the farm level in two states, viz. Bihar and Punjab. These states are among the largest milk producing states of the country but depict stark variations in terms of milk productivity and per capita milk availability. Another significant feature is the emergences of modern milk marketing chains in both the states. The study has shown that in spite of the growing presence of modern milk supply chains, the traditional milk supply chain is still dominant in the Indian milk market. Its presence is even more pronounced in less-developed states like Bihar. However, the traditional milk supply chain is being replaced, *albeit* slowly, with the commercialization of dairying. The structure of the milk marketing in Punjab has depicted this conclusion. The study has concluded that the modern milk supply chain seems to have an inclusive structure and the resource-poor dairy farmers are not excluded from the modern milk supply chain. The study has argued that the traceability and food safety issues will further strengthen the modern milk supply chain. The scalability of the modern milk supply chain will depend on the development of milk collection and transportation facilities and incentive pricing for a quality produce.

**Key words :** Milk marketing chain, Smallholders, Dairy farmers, Modern milk marketing chain, Bihar, Punjab

**JEL Classification :** Q12, Q13

### Introduction

One of the most significant changes in India's agricultural economy over the past three and a half decades has been the rising contribution of livestock sector in the agricultural gross domestic product (AgGDP). Between 1970 and 2008, the share of livestock in AgGDP has risen from 17 per cent to 29 per cent. Dairying accounts for more than two-thirds of the livestock output and is largely responsible for

the rising importance of the livestock sector in the country. India has emerged as the world's largest milk producer and milk production continues to grow at a fairly high rate. Despite trebling of milk production between 1970 and 2008, the dominance of traditional marketing channels has not been affected.

About 80 per cent of the milk marketed still passes through the traditional channels handling raw milk and conventional processed products (Staal *et al.*, 2006; Kumar and Staal, 2010). The much hyped cooperative dairy development has also failed to affect the dominance of the traditional milk marketing channels. Liberalization of the dairy sector since 1991 has permitted formal, private processors to compete increasingly with both traditional market and cooperative processed milk market. Consequently,

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several private milk processing firms have emerged in the Indian milk market. Further, since late-1990s the importance of supermarkets and retail chains has swelled in the Indian food market which includes milk also in its ambit.

The growing middle class with increasing income and expanding urbanization are likely to boost the demand for more formally processed milk products, which the traditional markets generally do not cater for. This will fuel the growth of a modern, formal and organized milk market. These emerging trends, while indicative of catering to the expanding consumer base with growing wealth, have generated concerns on both the supply as well as the demand side. Internationally, one of the most controversial issues is that the rise of modern marketing chains (especially under private ownership) could have negative effects on income equality. Several studies have opined that the poor will suffer from this process (Elizabeth *et al.*, 2000). In India, this is an ongoing debate and the concern has dampened the prospects of modern supply chains in some states. However, recent research has brought in another side of the argument by suggesting that the emergence of modern food supply chains has improved linkages between the buyers and poor farmers in developing countries, which has turned out to be beneficial for the smallholders (Dries *et al.*, 2004; Minten *et al.*, 2006; Maertens and Swinnen, 2006; BIRTHAL *et al.*, 2007). It is important to mention here that the majority of milk producers are smallholders and contribute more than 70 per cent to the total milk production in India.

Will an increased role of modern private formal dairies put pressure for a change in the structure of production, in favour of large milk producers, who may be able to supply higher quantities and better quality of milk at lower collection cost? Will the smallholder dairy farmers be deprived of reaping the benefits of emerging market opportunities? Or, are they inter-linked with the emerging market opportunities and maximizing their welfare? This study has addressed the structure of production and marketing of milk, and links between smallholder dairy farmers and alternative milk marketing channels. The status of food safety practices and traceability issues in the alternative market channels have also been indicated. The extent of participation of smallholder dairy farmers in modern milk marketing channels and its determinants have been examined by

using data collected in two states of India, viz. Bihar and Punjab.

## Data and Methodology

### Data

This study is based on the primary data collected in the year 2007 at the farm level in two states, Bihar and Punjab. These states capture the geographic and institutional diversity of milk production and milk marketing. Bihar and Punjab are among the India's largest milk producing states, and account for 8.9 per cent and 5.5 per cent of the national milk production, respectively. However, stark variations exist between the two states in terms of milk productivity and per capita milk availability. Punjab exhibits the highest level of per capita milk availability (962 g) and milk productivity (7.9 kg/day/milking animal), while per capita milk availability (only 170 g) and milk productivity (3.7 kg/day/milking animal) in Bihar is one of the lowest in India (DAHD, GoI, 2008). Modern milk marketing chains have emerged significantly in both the states. However, the traditional market which dominates the Indian dairy, continues to play important roles in both the states.

At the farm level, the traditional market is represented by the private milk traders or vendors who buy milk directly from producers and supply it also directly to the urban consumers, or to informal institutional buyers such as restaurants, tea stalls, etc. or wholesalers and other retailers. They often operate on a small scale, handling 50 to 100 litres of milk per day. Dairy cooperatives and private formal processors, in contrast, collect milk at the established collection points in villages, and unlike private traders, milk price paid to farmers is generally scaled according to milk quality measured by the amount of fat and solid not fat (SNF). Recently, they have started offering some premium price for lower microbial counts also. In the analysis which follows, formal private processing firms and cooperatives were combined into one category of modern milk marketing channel. This was done primarily because they follow similar collection and payment practices and also because private processors accounted for only 3-4 per cent of milk marketed in the study area.

One district from each of the states was selected purposively. The districts selected were Patna in Bihar

and Rupnagar in Punjab. Three administrative blocks were randomly selected from each selected district. From each selected block three villages were selected randomly. From each block, 75 dairy households were identified for the survey. At the village level, the number of sample households was decided in proportion to the village population. Sample households were post stratified into different categories<sup>1</sup>, viz. landless, marginal, small, medium and large households. Thus, 225 households were selected from each state, making the total sample size of 450 households and data were gathered from these 450 dairy farming households. The data gathered covered a wide range of information on household, farm and milk marketing practices.

## Methodology

Descriptive statistics were worked out to understand the structure of milk production and milk marketing, trading behaviour of dairy farmers, status of adoption of food safety practices by farmers, etc. A logit model was estimated to identify the factors that influence dairy farmers' decision to participate in the modern milk marketing channels. Since dependent variable was a binary variable (farmers selling milk to modern supply chain = 1, otherwise = 0), and independent variables were a mix of qualitative and quantitative variables, the multivariate logistic regression given in Equation (1) was used:

$$Y = \ln[p/(1-p)] = \beta_0 + \sum \beta_i X_i \quad \dots(1)$$

where,  $p$  represented the probability that the farmers were selling milk to the modern milk supply chain and  $\hat{\beta}_s$  were the regression coefficients estimated by the maximum likelihood method. The explanatory variables used in the model included gender, age, education, milk production, milk price, milk testing, road connectivity, distance from city, and presence of milk collection centre in the village.

The interpretation of coefficients is less straightforward in the logit than the OLS model. Usually, a positive coefficient for an independent variable increases the probability of a household being upwardly mobile. However, the marginal effects of the explanatory variables on the probabilities are not equal to the coefficients. Further calculations were required

to estimate the marginal effects of each explanatory variable. The marginal effect of a variable was computed by using Equation (2):

$$\delta p(y) / \delta X_i = \beta X_i * \exp[Z] / [1+\exp(z)]^2 \quad \dots(2)$$

where,  $Z$  was the sum of coefficients multiplied by the means of respective variables plus the constant term.

## Structure of Milk Production and Marketing

Unlike the large scale commercial milk enterprises that characterize many countries, milk production in India is dominated by smallholder producers with a few buffaloes or cattle, in systems closely integrated into agricultural production through use of crop residues such as straw of rice and wheat. The marginal and small landholders account for about 69 per cent of the total milk production (Birthal, 2008). The structure of milk production exhibits an explicit dissimilarity in Bihar and Punjab. Similar to the structure of milk production at the national level, milk production in Bihar is overwhelmingly dominated by small landholders. Landless, marginal and small landholders accounted for 64 per cent of the total milk production and 69 per cent of the marketed milk in Bihar. In Punjab, the share of landless, marginal and small landholders taken together was only 39 per cent, indicating increasing commercialization of dairying in this state; their share in marketed milk was about 33 per cent. Based on the herd size also, a similar pattern was discernible. In Bihar, 78 per cent of milk production and 67 per cent of marketed milk are contributed by the households having one or two milch animals; while in Punjab more than 75 per cent of milk production and marketed milk are contributed by the households keeping 3 or more milch animals. This is expected as majority of the surveyed households (90%) keep one or two milch animals in Bihar and only about 3 per cent of the households were observed to keep more than three animals. But in Punjab, one-fourth of the households keep more than 3 milch animals.

The rearing of cattle and buffalo is not always necessarily a market-oriented activity, given the strong household demand for consumption of milk and milk products. As shown in Figures 1 and 2, it is estimated that 49.3 per cent of milk is marketed and 50.7 per cent is retained for domestic consumption in Bihar, while in Punjab, two-thirds of the milk produced is marketed and one-third is retained for home consumption. The

<sup>1</sup> Landless (without any land); marginal ( $\leq 1$  ha); small ( $> 1 \leq 2$  ha); medium ( $> 2 \leq 4$  ha); large ( $> 4$  ha)

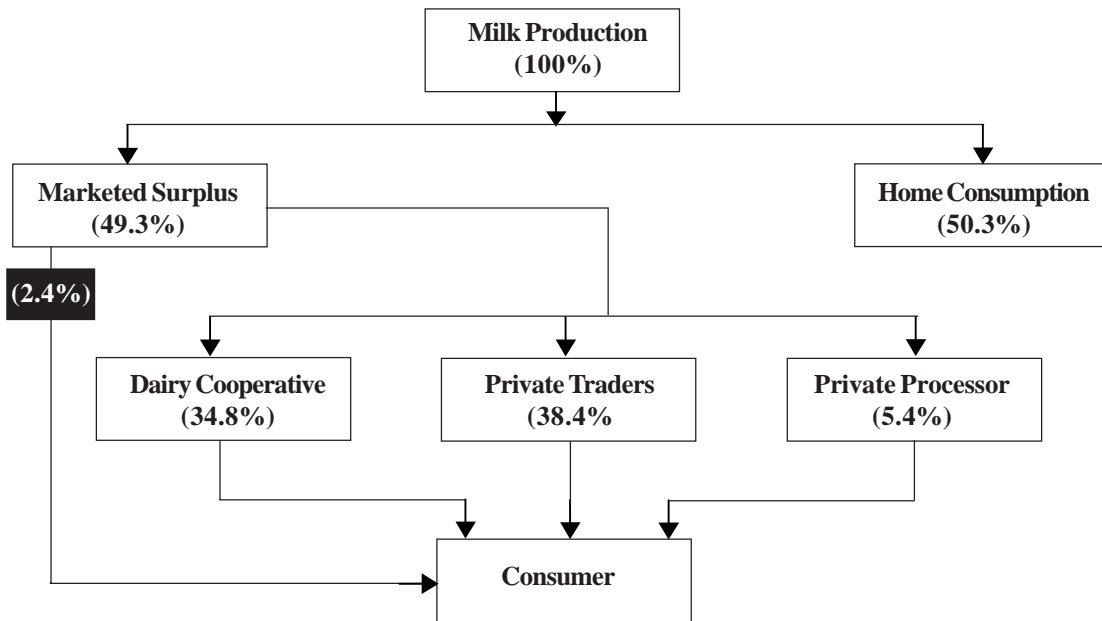


Figure 1. Milk flows in Bihar

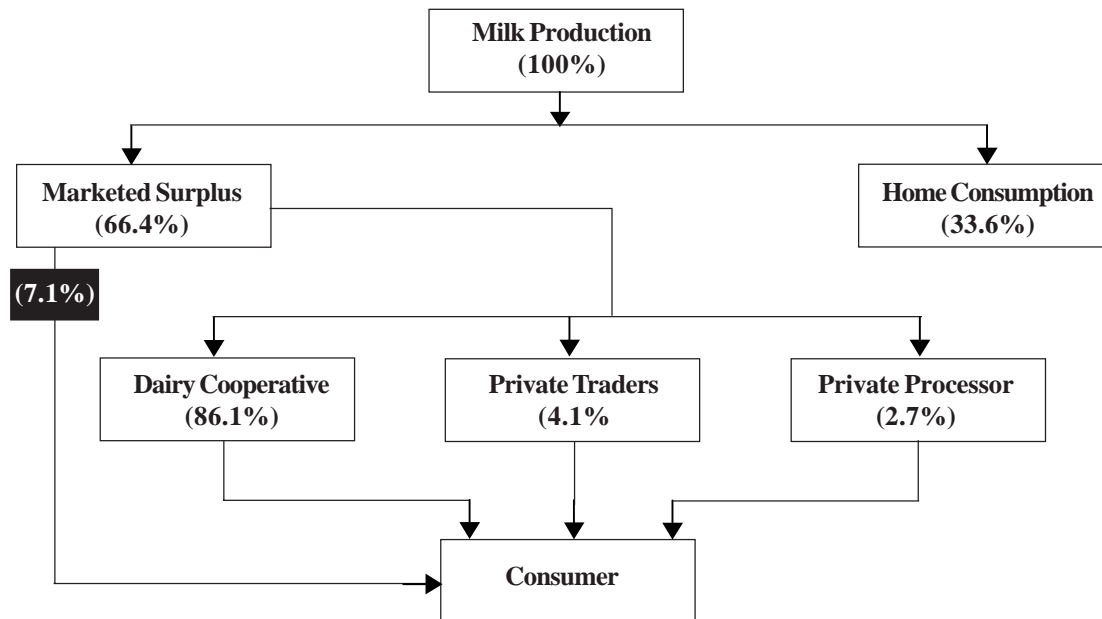


Figure 2. Milk flows in Punjab

dairy cooperative societies take the largest segment of marketed milk in Punjab (86.1%), while very small volumes of milk, 4.1 per cent and 2.7 per cent, go to the private traders and the formal private processors, respectively. Unlike in Punjab, private informal traders turned out to be the biggest buyer of marketed milk (36.6%) in Bihar, closely followed by dairy cooperative societies (34.8%). Formal private processors account

for 5.4 per cent of marketed milk in Bihar. Direct sale to consumers was a significant component of milk marketing channels in both the states. About 21 per cent and 7 per cent of marketed milk was being sold directly to consumers in Bihar and Punjab, respectively. Thus, survey of the marketing behaviour of milk producers shows that the modern milk marketing chains have penetrated significantly in both the states, though it has to go a long way in Bihar.

**Table 1. Share of different categories of households in milk production in Bihar and Punjab**

Household group	Bihar				Punjab			
	Sample size (No.)	Milk production (litres/day)	Share in milk production (%)	Share in marketed milk (%)	Sample size (No.)	Milk production (litres/day)	Share in milk production (%)	Share in marketed milk (%)
<b>Land-size</b>								
Landless	47	2.1	14.5	13.8	30	4.0	4.5	2.7
Marginal	89	2.4	31.1	35.8	86	6.1	19.7	18.9
Small	34	3.9	18.1	19.8	35	12.0	15.6	15.9
Medium	25	4.9	16.6	13.9	39	19.4	28.0	31.0
Large	20	7.3	19.7	16.7	34	25.6	32.3	31.5
All	215	3.3	100.0	100.0	224	12.0	100.0	100.0
<b>Herd-size</b>								
One animal	151	2.3	46.6	35.3	84	3.6	11.1	7.6
Two animals	43	5.4	31.8	32.5	53	7.0	13.7	11.2
Three animals	14	5.1	9.7	13.2	29	14.2	15.3	14.1
More than three animals	7	12.6	11.9	19.0	58	27.8	59.8	67.2
All	215	3.4	100.0	100.0	224	12.0	100.0	100.0

Source: Field survey (2007)

**Table 2. Choice of marketing channels by milk producers in Bihar and Punjab**

Size group	Share of farmers selling milk to marketing channels (%)			
	Bihar		Punjab	
	Traditional	Modern	Traditional	Modern
<b>Land-size</b>				
Landless	93.8	6.3	14.3	85.7
Marginal	77.4	22.6	7.8	92.2
Small	61.5	38.5	13.6	86.4
Medium	60.0	40.0	3.1	96.9
Large	20.0	80.0	10.7	89.3
All	72.0	28.0	8.8	91.2
<b>Herd-size</b>				
One animal	73.8	26.2	2.7	97.3
Two animals	63.2	36.8	12.1	87.9
Three animals	77.8	22.2	4.0	96.0
More than three animals	80.0	20.0	13.5	86.5
All	72.0	28.0	8.8	91.2

### Participation of Smallholders in Modern Milk Supply Chain

In this section we have examined the extent of participation of different categories of dairy farmers who sell their milk through traditional and modern supply chains (Table 2). In the first set of rows of Table 2, we

can look at the ownership and size of landholding (comparing how landless, marginal, small, medium and large farms market their milk). In the second set of rows, we can look at the number of their milch animals comparing on the basis of scale of production, how the milk is marketed.

According to our data, there is no evidence that small milk producing households are relegated to the traditional supply chains or excluded from modern supply chains. And this holds true for both the states. The households in Bihar having herd-size of 1, 2, 3 and more than 3 are respectively, selling 26.2 per cent, 36.8 per cent, 22.2 per cent and 20.0 per cent of their milk to modern supply chains. In Punjab, milk supplied to modern supply chains by the corresponding herd-sizes was 97.3 per cent, 87.9 per cent, 96.0 per cent and 86.5 per cent, respectively. In other words, there is no discernible relationship between herd-size and the choice of milk marketing channel.

The same appears to be true on examining the relationship between size of farm and the choice of marketing channel of milk producing households (Table 2). In case of Bihar, a linear relationship between land size and access to modern marketing supply chain is somewhat visible. But in Punjab, the relationship between farm size and choice of marketing channel did not follow a clear trend. For instance, 92.2 per cent of marginal milk producing households sell milk to modern marketing channel, while 89.3 per cent of the large farmers access modern marketing channel to sell their milk. In fact, according to descriptive statistics based on our data, landless and small landholder dairy farmers are not being relegated to traditional marketing channels. Similarly, although the activity of modern

marketing supply chains is limited in Bihar, small and poor households are not being excluded.

Largely the same story was true when we examined the proportion of milk sold by different categories of farmers to alternative milk marketing channels (Table 3). Although there is a slight linear trend in Bihar that shows landless dairy farm households are more likely to sell through traditional milk supply chain than landholder dairy farmers. The same trend does not hold true in Punjab. There is no evidence that landless or small landholder dairy farmers are getting less access to modern chains.

Hence, from the above descriptive analysis several points are clear and provide evidence that can help clarify one of the debates about the effect of emerging market integration models and changes in the downstream segment of the marketing chain. First, the structure of milk production and marketing exhibits a significant regional variation. The dominance of landless, marginal and small holders in milk production is weak in Punjab as compared to Bihar. Second, the modern milk supply chain is quite important in an agriculturally-developed state like Punjab, while the traditional milk marketing supply chain continues to play a dominant role in Bihar, which is yet to catch up to the same extent of agricultural and dairy development as witnessed in Punjab. Finally, and most importantly, when we look at who is selling to different chains, there are no

**Table 3. Proportion of milk sold by farmers to different marketing channels in Bihar and Punjab**

Size group	Share of milk purchased by marketing channels (%)			
	Bihar		Punjab	
	Traditional	Modern	Traditional	Modern
	<b>Land-size</b>			
Landless	98.0	2.0	14.3	85.7
Marginal	62.3	37.7	9.9	90.1
Small	63.9	36.1	39.3	60.7
Medium	73.3	26.7	2.2	97.8
Large	6.6	93.4	6.4	93.6
All	59.8	40.2	11.2	88.8
	<b>Herd-size</b>			
One animal	63.4	36.6	4.8	95.2
Two animals	58.5	41.5	7.0	93.0
Three animals	70.8	29.2	3.2	96.8
More than three animals	47.8	52.2	14.3	85.7
All	59.8	40.2	11.2	88.8

**Table 4. Services provided by marketing channels in Bihar and Punjab**

Particulars	Bihar		Punjab	
	Traditional	Modern	Traditional	Modern
Milk price (₹/litre)	11.7	11.3	15.1	14.8
<b>Services provided (% farmers)</b>				
Credit	16.7	33.4	7.7	6.7
Breeding services	0.0	17.7	0.0	64.1
Veterinary services	0.0	15.6	0.0	72.8
Feed	0.0	31.0	0.0	25.6
Extension	0.0	2.6	0.0	21.9
Training	0.0	0.9	0.0	4.0

distinguishable differences in terms of land-size or herd-size. In other words, according to our descriptive statistics, landless, small farmers face few if any barriers in accessing India's emerging modern milk markets.

### Prices and Services Offered by Alternative Milk Supply Chains

The milk price received by dairy farmers did not exhibit variation with the choice of milk marketing outlets (Table 4). Contrary to general perception, farmers selling milk to the traditional milk supply chain received a slightly higher price. This seemed to be counter intuitive. Therefore, we examined the price received by farmers at a more disaggregate level, which revealed that farmers fetched a relatively higher price by selling milk directly to consumers than to any other milk marketing outlet (Figure 3). Price<sup>2</sup> offered by milk vendors (₹ 11.30/litre) and dairy cooperatives (₹ 11.20/litre) in Bihar was almost same, while the private formal dairy processors offered a little higher price (₹ 12.10/litre). However, in Punjab, the price offered by the milk vendors (₹ 11.90/litre) was considerably lower compared to the price offered by the dairy cooperatives (₹ 14.90/litre) and formal private dairy processors (₹ 14.80/litre). This explains partly the continued dominance of the traditional milk supply chain in Bihar and its diminishing role in Punjab.

It is clear from the above discussion that there are no distinguishable differences in prices offered by alternative marketing chains, except when farmers sell milk directly to the consumers. However, direct sale to consumers is limited. Segregation between the main

milk producing centres and milk consumption hub (which is the urban area), changing tastes and preferences of the consumers, perishability of the produce and growing concerns about food safety are some of the important reasons which limit farmers' opportunities for direct sale to consumers. Besides, services provided by the alternative milk supply chains may influence the farmers' choice of milk marketing channels. Credit is provided by both the supply chains but the farmers' access to credit through the modern supply chain is considerably higher in Bihar (Table 4). In Punjab, only 7-8 per cent of the farmers are taking credit through their milk market outlets.

In terms of other services, modern supply chain is definitely better placed and the extent of service provided by them particularly in Punjab in breeding (64.1%) and veterinary services (72.8%) was high. In Bihar, the marketing of milk and service providers seem to be working independently and the modern milk supply chains are not providing many services, except credit. Training, an activity crucial to improve the human resource capacity and for maintaining food safety of milk, did not get proper attention from the modern supply chain. This is a disappointing fact.

### Issues of Traceability and Food Safety

While there seem to be no direct measures of safety status of milk marketed in India, we were able to observe the nature of transactions between the buyers and sellers. During our survey, we specifically asked the farmers several questions that we used as a basis of our analysis concerning the ability of India's domestic milk marketing channels to guarantee a safe and hygienic product. Based on these assumptions and using our data, we found that there is a big challenge

<sup>2</sup>Price refers to the year 2007

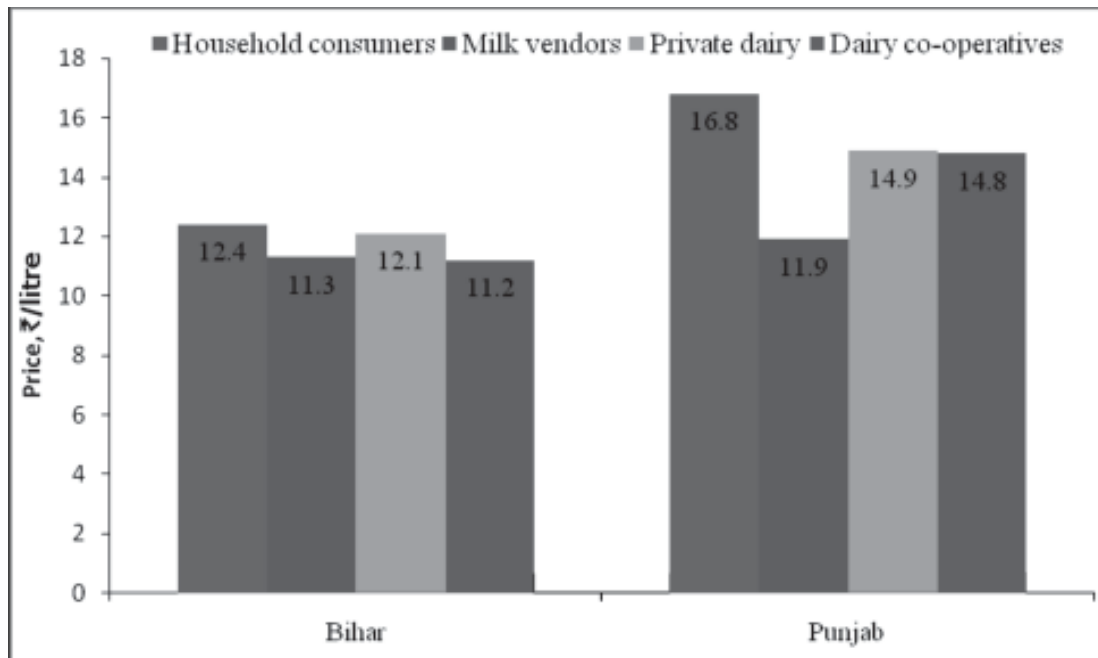


Figure 3. Average price received for milk by sample producers from different type of buyers during 2007, ₹/kg

Table 5. Contracting arrangements in milk producing villages of Bihar and Punjab

(Percentage)

Type of contract	Bihar		Punjab	
	Traditional	Modern	Traditional	Modern
Quality contract	38.9	61.9	23.1	27.6
Quantity contract	0.0	9.5	7.7	71.6
Payment contract	9.3	9.5	0.0	0.0
Delivery time contract	0.0	4.8	7.7	0.7
None	51.9	14.3	61.5	0.0

before India's dairy economy to ensure delivery of a safe product. One basis for the statement came from our data related to contracts between sellers and buyers. There was no activity based on written contracts (Table 5). However, 39 per cent of the farmers linked to the traditional milk chain and 62 per cent linked to the modern milk supply chain in Bihar had oral contract regarding the quality of the milk delivered by them. But, in Punjab, only 23 per cent of the farmers linked to the traditional chain and 28 per cent linked to the modern chain had oral contracts about the quality of milk sold by them. Besides, modern supply chains encourage the farmers for quality assurance by paying a premium price for desired microbial count. In Punjab, it has been reported by the personnel of dairy cooperatives that the microbiological quality of milk has

improved significantly in recent times with the introduction of premium prices linked with microbial counts and installation of bulk coolers at the grassroots level.

Although, there was lack of adequate emphasis on the quality and safety of milk explicitly through contracts, the adoption of food safety practices (examined at farm level), was encouraging (Table 6). An overwhelming proportion of farmers in both the states, irrespective of their choice of milk marketing channels, followed the basic hygienic practices required for safe milk production. These practices help to a great extent in maintaining the quality and safety of milk at the farm level. There are evidences that the bacteriological quality of raw milk in India is comparable with that in the leading milk exporting countries

**Table 6. Adoption of food safety measures (hygienic practices) at farm in Bihar and Punjab**

(in per cent)

Hygienic practice	Bihar		Punjab	
	Traditional	Modern	Traditional	Modern
Washing of buffalo/cattle	94.4	100.0	100.0	100.0
Cleaning/draining of animal shed	100.0	100.0	100.0	100.0
Cleaning of feed pot	98.1	100.0	100.0	99.3
Cleaning of milking area	61.1	71.4	69.2	44.0
Cleaning of hands before and after milking	96.3	100.0	100.0	100.0
Drying of hands before and after milking	42.6	52.4	69.2	75.4
Cleaning/drying of udders and teats before and after milking	74.1	81.0	100.0	100.0
Cleaning and drying of utensils before and after milking	100.0	100.0	100.0	100.0
Cleaning/draining of milk storage area	59.3	76.2	69.2	86.6
Hygienic disposal of dung	33.3	52.4	53.8	74.6

(MOFPI, 2005). This is partly explained by the adoption of good animal husbandry practices by the dairy farmers in India. In fact, deterioration in quality of milk takes place during transportation of milk from farm to milk processing plants or other end-users. Several initiatives have been taken by the government and significant investments have been made to ensure quality and safety of milk. The support for installation of bulk milk coolers, automatic milk collection centres, bucket milking machines, supply of hygiene kits, training of personnel involved in milk collection and handling are being vigorously pursued to ensure safety of milk and milk products.

### Determinants of Household Milk Marketing Choices

The results of the logit model, presented in Table 7, reveal that education, milk price, milk test and presence of cooperative milk collection centres in the villages have a significant positive influence on farmers' decision to integrate with modern formal milk marketing supply chain. However, its marginal effect on the choice of milk marketing channel is negligible. The presence of milk collection centres of the modern milk supply chain, a proxy for saving in transaction cost, has a significant positive influence on the farmers' decision to participate in the modern milk supply chain. The marginal effect of milk collection centres established by either cooperatives/formal private processing farm is high (14%).

The price offered by the channels also induces the farmers to sell milk to a modern milk supply chain. The

marginal effect of price in the selection of modern milk supply chain is only 3 per cent. The adoption of milk testing done by the modern milk supply chain positively and significantly affects the farmers' choice of milk marketing outlet. The interpretation here is that milk testing adopted by the modern milk supply chain promotes differential pricing of milk and gives incentives to the farmers based on the quality of the produce. Enterprising commercial farmers are particularly motivated to sell to a modern marketing supply chain and can harness the opportunities of getting higher prices. The emphasis on quality has the highest propensity to induce farmers to sell milk to a modern milk supply chain. The marginal effect of unit increase in milk testing is 69 per cent.

The household size implying greater labour availability for the farming households has a negative influence (though not significant) on the farmers' decision for integration with the formal markets. This suggests that if labour is abundant, farmers would explore different market opportunities and would not like to tie-up with one marketing channel. With greater labour availability, they can endure the pressure of search, bargaining and delivery costs for sales to the traditional milk supply chain and maximize their price. Similarly, households producing higher quantity of milk are more likely to sell through the modern milk supply chain, which reflect their better ability to integrate with the modern supply chain. This indicates that farmers producing higher volume of milk seek out channels that more easily accept larger, and possibly more variable quantities of milk. However, again the effect of scale

**Table 7. Factors determining farmer's decision to sell milk to modern dairy**

Explanatory variable	Coefficient	Standard error	Marginal effects (dy/dx)	Standard error
Age (years)	-0.012	0.027	-0.0010	0.0023
Sex (Male=1, otherwise=0)	-0.203	1.607	-0.0156	0.1146
Education (years)	0.110*	0.064	0.0091	0.0073
Household size (No.)	-0.005	0.088	-0.0004	0.0073
Land size (ha)	0.053	0.136	0.0044	0.0113
Milk production (litre/day)	0.007	0.024	0.0006	0.0020
Milk price (₹/litre)	0.323**	0.136	0.0268	0.0115
Milk test (Yes=1, otherwise=0)	4.888**	0.708	0.6919	0.0792
Road connectivity (Yes=1, otherwise=0)	-1.466	1.043	-0.0749	0.0398
Dairy cooperative/private milk collection centre (Yes=1, otherwise=0)	1.274*	0.740	0.1429	0.1079
City distance (km)	-0.126	0.088	-0.0105	0.0072
Constant	-4.437	2.939		
Number of observations	222			
log likelihood	-41.043			
LR chi <sup>2</sup> (1,2)	189.81			
Pseudo R <sup>2</sup>	0.698			

Note: \*and \*\* denote significance at 10 per cent and 1 per cent levels, respectively.

of production is not significant on the choice of milk marketing outlets, indicating the propensity of modern milk supply chain to include even the small-scale producers.

Education positively and significantly affects the choice of milk marketing channels. Higher education generates more awareness about the market opportunities and reflects better ability of the farmers to integrate with the modern milk supply chain. Age and sex of the household-head are not significantly associated with the choice of milk marketing channels. It should be noted that 98 per cent of the households were headed by a male, and therefore, there was very little spread on this variable.

### Conclusions and Policy Implications

The study has shown that in spite of growing presence of modern milk supply chains in the Indian milk market, the traditional milk supply chain is still dominant. Its dominance is even more pronounced in less-developed states like Bihar. However, it is apparent that the traditional chain is being replaced, *albeit* slowly, with the commercialization of dairying. The structure of milk marketing in Punjab is a clear pointer to this conclusion.

Upstream segments of the milk marketing chain in India have evolved significantly, yet there is no clear and conclusive evidence that this is directly moving down to the farm gate. However, the modern milk supply chain appears to be inclusive and the resource-poor dairy farmers (landless, small, marginal) are not excluded from the modern milk supply chain. The traceability and food safety issues may further consolidate the position of modern milk supply chains and the existence of the traditional chain would be increasingly challenged. Further expansion of the modern milk supply chains by and large is dependent on the development of milk collection infrastructural facilities at the doorstep, incentive pricing and rewards for quality produce.

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