# Determinants of Small-Scale Farmer inclusion in Emerging Modern Agrifood Markets: A Study of the Dairy Industry in India

**Vijay Paul Sharma**
**Kalpesh Kumar**
**Raj Vir Singh**

**W.P. No. 2009-02-01**
February 2009



**INDIAN INSTITUTE OF MANAGEMENT**
**AHMEDABAD-380 015**
**INDIA**

# Determinants of Small-Scale Farmer inclusion in Emerging Modern Agrifood Markets: A Study of the Dairy Industry in India[1]

Vijay Paul Sharma[2], Kalpesh Kumar and Raj Vir Singh

**Abstract**

*In response to structural transformations taking place in the Indian dairy sector mainly in processing segment this paper examines determinants of market channel choices of milk producers based on a survey of 390 farm households in 2007. It also attempts to investigate what impacts these market channel choices may have on farmers' income and technology adoption. A two-stage multinomial logit model is employed to investigate determinants and effects of market channel choices of milk producers. While modern marketing channels have emerged in the Indian dairy sector, the traditional sector is still dominant. Farmers sell nearly 85 per cent of milk to traditional channels. The share of the modern organized sector is growing but at a slow pace. The dominance of the traditional channel is an indication of a very competitive and cost-effective traditional market in linking producers and consumers. It is possible that high transaction costs also act as a barrier. However, issues of hygiene and quality of milk being sold through traditional channels require attention. Results indicate that small dairy farmers and the poor are mostly excluded from modern private sector channels. Household's socio-economic variables (farm size, age and education) are important determinants of marketing channel choice in the case of the modern private sector. Large farmers have better opportunity to participate in modern private channels. Market infrastructure such as road, provision of veterinary services, distance from milk collection centre, markets, milk collection centres, price risks, etc. have significant effect on farmers' marketing choices. The second stage results of the Heckman model show that education, membership of producers' association/cooperatives, provision of veterinary services, and farm size have significant impact on cooperative marketing channel farmers' income while in the case of modern private sector, education and price risk have significant impact on income.*

**Keywords:** Agrifood markets, small-scale farmer, cooperatives, multinomial logit model, India

[1] The paper derives from the Regoverning Markets Programme to analyze growing concentration in the processing and retail sectors of national and regional agri-food systems and its impacts and implications for rural livelihoods and communities in middle- and low-income countries. The authors would like to thank the International Institute for Environment and Development (IIED), London for financial support and other institutions/individuals who have helped during the study.

[2] Email: vijays@iimahd.ernet.in

# Determinants of Small-Scale Farmer inclusion in Emerging Modern Agrifood Markets: A Study of the Dairy Industry in India

In 1991, the government of India liberalized its markets leading to fundamental changes in the agri-food sector. The structural adjustment and stabilization programmes substantially reduced controls and state interventions in the agricultural sector and encouraged and facilitated foreign direct investment (FDI). This resulted in new investments in some sectors of the Indian agri-food system, particularly in food processing and retail distribution. Since then, rapid changes have taken place in the structure and governance of agri-food markets, including consolidation, institutional, organizational, and technological transformation, and multinationalization. These changes are occurring very rapidly in many developing countries and are bringing rapid changes in the organizational, institutional and technological practices all the way "upstream".

Some agribusiness and food processing companies, often as part of their own restructuring, have introduced modern procurement systems like contract relationship with farmers to provide basic inputs in return for guaranteed and quality supplies and distribution strategies that have impacted institutional, organizational and technological aspects of the agri-food supply chain. The modern supply chains provide both new opportunities (price and volume stability) and new challenges (quality and food safety standards, continuous supply). Socio-economic factors (income, population, tastes, and preferences) on the demand side and supply side factors such as trade liberalization, privatization, and modernization of agro-processing and retailing sectors are major drivers of changes.

There have been growing concerns on the likely impacts of these changes on smallholder producers in developing countries. Modern retail chains, particular supermarkets, have been emerging in many developing countries since the early 90s (Reardon, et. al., 2005; Balsevich, et. al., 2006). Changes have also occurred in food processing, wholesaling, and procurements (Reardon and Timmer, 2007). Previous studies show that increase in supermarkets could have serious distributional impacts in the downstream of the market chain. Studies in Latin America, Central and Eastern Europe, Mexico, Brazil, and Kenya suggest that mainly large and wealthy farmers benefit from the rise of demand for high-value agriculture and emergence of supermarkets (Reardon and Timmer, 2007; Berdegué, *et. al*., 2005; Schwentesius, *et. al.*, 2002, Dries and Swinnen, 2004, Hu, *et. al*., 2004 ). Because of

the high transaction costs involved with dealing with millions of small farmers and difficulties in ensuring quality and food safety, supermarkets prefer to deal with large and better-off farmers. As a consequence, there could be possible adverse consequences for small, poor farmers (Reardon and Timmer, 2007).

Very few studies have been done in India on the impact of supermarkets and marketing chains on production and marketing at farm level. Some recent studies have provided anecdotal evidence of smallholder producer participation in modern market channels (Joshi, et. al., 2007, Sharma, 2007; Birthal, et. al., 2007). However, these studies are in scope on geographical coverage, commodities, and market channels. Some household survey based studies in other developing countries provide mixed evidence. Some studies have shown that modernization has benefited largely large farmers and excluded smallholder producers. On the other hand others indicate that modernization indeed can have a positive impact on smallholder producers.

This paper contributes to the literature on farm-level impact of changing market structures in the dairy sector in India. This objective is: what has been response of smallholder producers and processors to changing modern dairy supply chains in India? More specifically:

- What are determinants of smallholder dairy farmer participation in modern supply chains? Key hypotheses to be tested include: small and poor producers are often excluded from modern market channels; market infrastructure, incentives, and risks have significant impact on farmers' marketing decisions and choices; and institutional factors such as farmers' associations facilitate participation in modern marketing chains.
- What is the impact of participation on farmers' income, production, technology choices, etc.? Major hypotheses to be tested include: there are significant impacts of farmers' marketing choices on their income, scale of operation/herd size, and technology adoption.

The results presented in this paper are based primarily on interviews with key personnel in the organized private, public, and cooperative and unorganized milk processing and marketing sector and data from a survey of 390 dairy producers.

The dairy sector in India provides an interesting picture for different reasons. First, India is the largest producer of milk, contributing about 15 per cent of world milk production (MoA, 2006). However, the organized dairy industry accounts for less than 15 per cent of the milk produced and less than 1 per cent in global trade for dairy products. Second, the per capita supply of milk in India is low compared with world average and nutritional requirement, creating opportunity as well as need to strengthen the dairy sector from nutritional point of view. Third, given the low level of processing, several players are making forays into the dairy market. New players include global majors such as Danone, LandoLakes, and Kraft Foods. Among the existing players, besides Nestle, Coca-Cola, Pepsico, Reliance Retail, Bharti, etc. intend to enter into the liquid milk market, while the cooperatives-GCMMF (Amul) and NDDB (Mother Dairy)-are looking at the possibilities of entering global markets to improve profit margins. Furthermore, the combination of lower milk supplies in neighboring markets in South and South East Asia and the Middle-East and the implementation of regional and free trade agreements also provide growth opportunities for the Indian dairy sector.

**Changing Structure of Indian Dairy Sector**

Before 1991, dairy processing was controlled by the government through licensing and was mainly reserved for cooperatives. About 117,575 dairy cooperative village societies, involving about 12.4 million farmer members (out of which 3.2 million are women), had been organized by March 2006 to supply milk to processing firms. Beginning 1991, as part of domestic economic reforms and commitments to WTO, the dairy sector was liberalized in a phased manner. On the supply side, the sector was deregulated and trade was increasingly liberalized. Following decontrol, many private players entered the market and set up milk-processing facilities, mostly in milk surplus areas. Some of the private sector plants also adopted the cooperative model by creating informal contracts with local farmers and providing inputs and services to farmers. However, in 1992 because of pressure from the industry, some restrictions were brought back under the Milk and Milk Products Order (MMPO 1992). Another major development was the removal of restrictions on import and export of dairy products in mid 90s.

These changes have had major impacts on the structure of milk production and upstream segments of the dairy value chain. The number of private milk processing plants increased

from 250 in 1996 to 403 in 2002 (about 10 per cent increase per year), while that of cooperative milk processing plants increased from 194 to 212 (nearly 1.5 per cent increase per year). In contrast, the number of plants under government milk schemes, government-owned, and mother dairies) declined from 65 in 1996 to 63 in 2002 (Sharma and Singh, 2007, MoA, 2006). The installed capacity in the private sector has increased from 24.4 million litres per day in 1996 to 32.4 million litres per day in 2002 (about 5.4 per cent increase per year). In the cooperative sector, installed capacity increased from 24.2 million litres to 28.3 million litres per day during the same period (2.9 per cent increase per year). However, cooperatives witnessed an increase in average installed capacity per plant from 125 000 litres per day in 1996 to 134 000 litres in 2002. Average installed capacity of government-owned plants and mother dairies increased from 112 000 litres per day to 193 000 litres per day between 1996 and 2002. In private sector plants, a marginal decline in average capacity per plant (from 98 000 litres to 80 000 litres per day) was witnessed. The possible reason for increase in installed capacity in cooperatives and government plants could be their long presence in the sector and strong backward linkages with milk producers to have consistent supplies of raw milk. In case of the private sector, most of these players are new entrants and are not willing to make big investments at first go owing to lack of assured supply of raw milk.

Bowing to pressures from different quarters, the government amended MMPO in March 2002 and removed all restrictions on setting up new milk processing capacity. In addition, it allowed foreign direct investment (FDI) in the dairy sector in the early 2000s. The new policy fully exposed the Indian dairy sector to market forces. The milk processing and marketing sector witnessed significant expansion and new investments in the 2000s. The number of milk processing plants in the private sector increased from 403 in 2002 to 493 in 2006 (5.6 per cent increase per year), while the number of cooperative milk processing plants increased from 212 to 246 (nearly 4 per cent increase per year) during the same period. In contrast the number of plants under the other category (government milk schemes, government owned plants and mother dairies) declined from 63 in 2002 to 50 in 2006. Installed capacity in the private sector increased from 32.4 million litres per day in 2002 to 46.1 million litres per day in 2006 (about 7 per cent increase per year). In the cooperative sector, installed capacity increased from 28.3 million litres to 36.6 million litres per day during the same period (4.8 per cent increase per year). At the national level, the number of

dairy processing plants increased from 678 in 2002 to 789 in 2006 and installed capacity increased from about 73 million litres per day to 98 million litres per day in 2006.

Recently, many national and global players have evinced interest to enter the sector and are expected to make huge investments. Reliance plans to procure milk directly through its collection centre networks mostly in Punjab (high potential state) and is likely to expand operations to Rajasthan and Andhra Pradesh. Existing players such as Amul, Nestle, and Mother Dairy are also planning capacity expansions. However, the question which is bothering policy makers and other stakeholders is: Will the entry of corporates guarantee balance between market forces and societal concerns in rural India? There is also a fear that foreign and domestic retail biggies and modern supply chains will push a large section of farmers, in particular smallholder producers out of the market as they mostly fail to meet the quality threshold requirements. Transaction costs are also high in coordinating supplies from a large number of small producers. Small farms are also constrained financially for making investments in infrastructure and post-harvest activities. Currently the organized sector accounts for about 30 per cent of total milk marketed, making the sector much more attractive to new entrants. With the entry of new players, the share of the organized sector is expected to almost double in the next one and a half decades (Sharma and Singh, 2007). Given this scenario, the timing for entry of retail biggies and other dairy companies and their impact particularly on smallholder producers, who form the backbone of the sector, is worth studying.

It is evident from the results of meso-report (Sharma and Singh, 2007) that restructuring of individual dairy industry segments, mainly in production, procurement and processing, is occurring in simultaneous and interdependent ways, albeit at different rates and in different ways across states. The study identified challenges facing primary producers and their economic organizations in negotiating market access conditioned by liberalization and modernization include technological, organizational and financial demands placed on small-scale farmers. The study pointed out that it is important to analyze changes in procurement patterns for milk as a result of the recent policy changes and also know whether large scale producers have cost advantages and higher efficiency that will lead to the displacement of smallholders under a liberalized market. In order to investigate some of these issues micro-level study was undertaken in four states, namely, Punjab, Haryana, Uttar Pradesh and

Gujarat, which have strong presence of modern (coops and private) as well as traditional sector are major restructuring in agrifood markets is taking place in these states.

**Data Sources and Sampling Procedures**

Using a sample of milk producing households, a market participation model is estimated to explain why some households engage in a particular marketing channel while others do not. We also focus on identifying factors that significantly increase the level of participation in modern supply chains by households.

To study the impact of changing market structure on market channel choice, scales of operations in milk production, livelihoods, and welfare of rural households, one needs a sample containing a sufficient number of households representing various scales of operations, geographical regions, and market channels.

We selected 390 households in nine districts of four leading milk producing states, namely Gujarat, Haryana, Punjab, and Uttar Pradesh, having well developed infrastructure and a mix of milk marketing channels.

*Sampling Methodology*

The objective of the study is to understand the patterns and determinants of smallholder producers' strategies and responses to restructured dairy market channels and effects of participation in different marketing channels, traditional/informal and organized (cooperatives and private), in different milk producing regions in India. We adopted the stratified random sampling procedure to select the states, districts, talukas and villages. The northern region is the largest milk-producing area in India followed by the western region, both accounting for over two-thirds of total milk production. In terms of number of dairy processing plants also, the north zone has the largest number (356, 73 cooperative and 280 private), followed by the western region with 247 plants (89 cooperative and 119 private) in 2006. Gujarat from the western region and Haryana, Punjab, and Uttar Pradesh from the northern region are the states selected for the study which are well developed and leading milk producing states and represent different forms of the organizational structure. In Gujarat, success in dairy development has largely been achieved through milk cooperatives. This is one of the most successful models of dairy development whereas in Haryana, Punjab and Uttar Pradesh the private sector dominates and presence of cooperatives is limited to a few pockets in the states (Table 1).

Stratified random sampling was used to select districts. Specifically, four districts from Gujarat, two districts from Haryana, one district from Punjab, and two districts from Uttar Pradesh were selected on the basis of milk production potential and presence of various players in the market.

A similar stratified random process was used to select villages. We interviewed all farmers in 49 villages from nine districts in the selected states.

*Sample Size and Composition*

Given the importance accorded to the participation of smallholder milk producers in restructured market channels in the study, we chose a representative sample of households representing various categories of households, types of marketing channels, changing structure of dairy sector, etc. In order to analyze the response of milk producers to modernization of the dairy sector, we focused on three major marketing channels: organized cooperatives, organized private sector, and traditional/unorganized sector. Farmers who live away from village/catchments of organized sector processing plants/collection centres and/or are not members of these organizations are constrained to selling their milk in informal/traditional markets. Farmers who live inside the catchments of organized dairy processing plants have an additional option of selling to the organized sector. For a given village, we have four types of farmers: (i) farmers who have chosen to supply milk to the cooperatives (hence participation in modern channel), (ii) farmers who have chosen to sell milk to the organized private sector (modern channel), (iii) farmers who have chosen to supply milk to traditional channels such as milk vendor, sweet shop, or directly to consumer, contractor, etc. and (iv) farmers who supply milk to multiple channels like milk cooperatives and private cooperatives and traditional, private and traditional, etc.

Finally, based on the above mentioned criteria and discussion with various stakeholders a stratified sample of 390 households consisting of 146 farmers from Gujarat, 85 from Haryana, 90 from Punjab, and 69 from Uttar Pradesh was drawn. After cleaning, 374 observations remained for analysis. Table 2 summarizes the distribution of producers in selected states and market channels. Sample selection was done randomly, except that an effort was made to include statistically significant sub-samples of milk producers representing different marketing channels and sizes for each of the regions.

*Weights for Analysis*

Since we had farm household population data of all districts (assuming that all farm households are milk producers), talukas, and states, and approximate share of different marketing channels in marketed surplus, we could construct farm household-based weights to create point estimates of our variables. In this micro study, analysis of the first set of research questions such as who are supplying milk to modern marketing chains because of the restructuring of the dairy processing and marketing sector and what are major determinants of market channel choice, should use whole sample that includes both traditional and modern market chain households. Therefore we developed weights for the sample to estimate a representative of all farmers who participated in the marketing of milk to different marketing chains in selected areas.

The weight for the $h^{th}$ household with milk production from $k^{th}$ taluka of $j^{th}$ district on $i^{th}$ state $P_{ijkh}$ is defined as:

$$P_{ijkh} = W_i * W_{ij} * W_{ijk} * W_{ijkh} * W_{ijkhl}$$

where,

$W_i$ is the weight for the $i^{th}$ state, its value corresponding to the share of the dairy farmer from the $i^{th}$ state in selected states.

$W_{ij}$ is the weight for the $j^{th}$ district in the $i^{th}$ state, its value corresponding to the share of dairy farmers from the $j^{th}$ district in all farmers in the $i^{th}$ state.

$W_{ijk}$ is the weight for the $k^{th}$ taluka of the $j^{th}$ district in the $i^{th}$ state, its value corresponding to the share of dairy farmers from the $k^{th}$ taluka in all dairy farmers in the $j^{th}$ district of the $i^{th}$ state.

$W_{ijkh}$ is the weight for the $h^{th}$ farmer of the $k^{th}$ taluka, $j^{th}$ district in the $i^{th}$ state, its value corresponding to the share of dairy farmers supplying milk to a particular channel from the $k^{th}$ taluka in all dairy farmers in the $j^{th}$ district of the $i^{th}$ state.

$W_{ijkhl}$ is the reciprocal of sample household numbers in the $k^{th}$ taluka in the $j^{th}$ district of the $i^{th}$ state.

The sum of $P_{ijkh}$ over i, j, k and h equals one.

*Survey Timings and Problems Encountered*

The household survey was carried out during March-June 2007. Data were collected using a pretested structured questionnaire (see Annex). Information collected in the survey included data on household demographics, land ownership, cropping pattern, agricultural production, livestock ownership, asset ownership, milk production and marketing, employment, feed and fodder use, animal health and breeding services, credit, etc.

Relevant secondary information related to the study area was also collected from published and unpublished sources to supplement the primary data collected from selected households.

We encountered several problems during the survey common to many fieldwork surveys. The most serious was to meet the household head, who was always pre-occupied with his work. In the dairy sector, there are seasonal variations in milk production and feeding patterns, which have not been captured in this study owing to one-time survey of the selected households. However, we have tried to collect data for the pre-liberalization and post-liberalization periods (major amendments to MMPO in 2002) as well as for seasonal variability based on the recall method. There are wide regional, cultural, social and lingual variations in India, which might have had some affect on the quality of information.

**Milk Production and Marketing**

We first present important characteristics of the milk producers selling to three different market channels. Table 3 shows characteristics of farm households in selected states; Table 4 compares modern-channel farmers and traditional channel farmers with respect to a set of key characteristics; and Table 5 shows size, production and market infrastructure related differences between modern and traditional-channel farmer types.

*Channel Participation and Household Socio-economic Characteristics*

Tables 3 and 4 indicate that average family size of the surveyed households was about 6 members and did not vary significantly across states and market channels. There is significant difference in the age of head of household between modern and traditional-channel farmers. The average age is higher (48.8 years) in the case of traditional channel farmers compared to farmers supplying milk to modern channels (45.9 years), which indicates the preference young farmers have for modern channels. Education level (number

of schooling years) as well as highest education of any household member was higher in the case of modern channel farmers. Education plays an important role in adoption of new innovations/ technologies and young farmers are expected to be early adopters. Almost all the households in the sample were male-headed. The average family size was significantly higher (6.2) in traditional channel households than modern channel households (5.8).

The selected households had fairly long experience in dairy farming and farmers had over 20 years of experience in milk production. Traditional channel farmers had more experience in dairy farming compared to modern farmers and the difference was statistically significant. Major source of income was agriculture in most cases and milk production was a secondary source of income. This shows that majority of the farmers have been integrating their crop and milk production activities in rural areas.

*Milk Production, Marketed Surplus, and Producer Prices*

Table 5 provides a summary of breed composition, milk production, marketed surplus, and producer prices between two farmer types. Herd size of dairy producers is not significantly different whether they sell to modern channels or the traditional market. Indirectly this suggests that herd size is not an entry requirement. However, when we compare herd size between modern private and cooperatives/traditional channel farmers, there is significant difference, which suggests that herd size may be an entry barrier to the modern private sector channel but not for cooperatives. Furthermore, herd composition by species/breed also differs significantly between modern and traditional channel farmers. While about 75 per cent of traditional channel farmers' herds consist of buffaloes, those of modern channel farmers is about 52 per cent. The share of crossbred cows is higher (31.2 per cent) in the case of modern market channel farmers than traditional channel farmers (20.8 per cent). The difference in species composition is largely the outcome of pricing mechanism because the traditional channel pays higher prices for butter-fat while in the organized sector pricing is based on butter-fat and solid-not-fat (SNF) content of milk. Organized private dairy channel farmers have significantly higher number of crossbred cows than traditional and cooperative dairy farmers. Modern market channels promote high-yielding cow farms to reduce seasonal variations in milk production whereas buffalo milk production has greater seasonality.

Average milk production in the modern private channel is highest (49.4 litres/day), followed by the traditional channel (46.5 litres/day) and cooperative (29.8 litres/day). Average marketed surplus is also higher in the case of modern private channel farmers. Nearly 80 per cent of milk produced in modern and traditional channel farms is marketed and the rest is retained by households for self-consumption.

Land holding size of producers selling to the modern channel is larger than traditional channel farmers.

Distance to milk collection centre is found to be significantly different between the two farmer types (modern and traditional). Average distance to milk collection centre is more (2.8 km) for traditional channel, followed by cooperatives (1.4 km) and modern private channel (1 km). Distance to main market is more (6.2 km) for traditional channel farmers than modern market channel farmers.

Because of lack of time series data on producer prices for analyzing price variation over time, average milk prices received by producers from alternative marketing channels have been used in the analysis.

Highest price (Rs. 14.11/litre for cow milk and Rs. 16.28/litre for buffalo milk) is received by producers who sold milk through the traditional channel, followed by modern private (Rs. 13.78/litre for cow milk and Rs. 15.85/litre for buffalo milk) and cooperatives (Rs. 12.80/litre for cow milk and Rs. 14.16 litre for buffalo milk). The price offered by cooperatives becomes a benchmark for traditional and as organized private sector players. Price offered by modern channels varies according to butter-fat and solid-not-fat content of milk delivered by the producer. The average price for buffalo milk is higher than cow milk in both channels. Prices are different in lean (April-June) and flush seasons (October-December). Prices are higher in the lean season because of relatively low milk supply. However, these fluctuations are less in case of modern channels. Moreover, the price paid by cooperatives does not include the bonus (price difference) which member producers receive at the end of the year. The magnitude of bonus depends on the operating expenses of the cooperative and normally covers utilities, lease and loan payments, salary to milk collection centre staff, etc. There is no significant difference in butter fat and SNF content of milk procured by traditional and modern market channels.

*Milk Marketing Channels*

In India, all forms of marketing channels exist in the dairy sector. These include modern/organized (cooperatives and private dairy plants) and traditional/unorganized sectors comprising marketing of liquid milk and traditional products such as locally manufactured *ghee* (butter oil), *paneer* (cottage cheese), and indigenous products like sweets. In 2004-5 out about 40 million tonnes of milk (48 per cent of total production) was retained in the villages itself and 44 million tonnes were (52 per cent) sold in urban areas. Out of 44 million tonnes of marketed surplus, the share of the organized sector (cooperatives and private sector) is small (30 per cent). A large portion (about 70 per cent) of milk continues to be marketed through traditional channel(s).

Depending on the involvement of market intermediaries in marketing of milk from producer to consumer, major marketing channels in the study area are shown in Figure 1. The predominant traditional marketing channel is from producer to milk vendor/trader to consumer. However, some farmers also sell milk directly to consumers in the village itself or nearby villages. Milk marketing cooperatives, is another marketing outlet available to member-producers. Cooperatives are owned by members - milk producers, who participate in the cooperatives with the principle of "one member, one vote", independent of the level of their investment, ownership of shares, and volume of milk supplied. Cooperatives transfer their entire income to farmers, after taking out operating expenses. Farmers are given a minimum procurement price for milk on a butter fat and solid-not fat (SNF) basis. In the case of traditional channels, milk vendors pay for milk mostly on a butter fat basis (in many cases a flat rate irrespective of fat content) with little or no consideration for the nonfat solids content. The organized private sector also procures milk directly from farmers. The share of the private organized sector is small but is increasing owing to the liberalization of the dairy sector.

However, downstream restructuring has not penetrated into farm procurement. Farmers' milk marketing channels in the study area are still dominated by the unorganized sector. Nearly two-thirds of milk is marketed through traditional supply channels, while modern channels, which include cooperatives and private companies, account for about 36 per cent (Figure 3). The share of the cooperative sector has increased marginally from 22.2 per cent to 22.6 per cent between 2002 and 2006, while the share of the organized private sector has

increased marginally from 14.4 per cent to 14.7 per cent. As the traditional sector handles the largest share of unprocessed milk marketed in India, the entities that process and sell fluid milk to consumers in each region/state varies. For example, most of the milk produced in the northern region flows from dairy farms to traditional channels, while in the western region dairy cooperatives procure and process most of the milk and distribute to consumers through retail outlets. The share of cooperatives in the selected states varies from less than 5 per cent in Haryana and Uttar Pradesh to as high as 72 per cent in Gujarat; the share of the traditional sector varies from nearly 10 per cent in Gujarat to over 90 per cent in Uttar Pradesh and that of the organized private sector is highest in Punjab and lowest in Gujarat. The results of the micro household study on milk marketing channels support the findings of the meso-level analysis (Sharma and Singh, 2007).

In the traditional sector, milk vendors/traders handle the largest volume, implying that small milk traders are more effective in procuring and marketing milk from smallholder dairy producers. However, despite health risks associated with consumption of unhygienic unprocessed milk and dairy products marketed through traditional channels, the traditional sector is still predominant. The number of intermediaries has a bearing on both producer and consumer milk prices. It is expected that shorter the channel more likely consumer prices will be lower and the producer will get a higher return. However, milk producers may not necessarily benefit from a short marketing chain, modern channels may be paying the farmer almost the same price as traditional channels. However, farmers sometimes prefer selling milk to milk vendors because factors such as prompt payments (sometimes in advance) and inaccessibility to formal market outlets such as producer cooperatives or organized private milk processing units. The biggest disadvantage of traditional channels/milk vendors is lack of quality control and frequent adulteration of milk with water and other chemicals.

There is growing consumer awareness of food safety and quality issues. Demand for milk and dairy products is increasing in the country due to rising per capita income, changing dietary patterns and lifestyle, and demographic changes. This explains why, following the liberalization of the dairy industry, the share of modern channels (cooperatives and private) has been on the increase.

*Channel Participation and Growth for Smallholder Producers*

In order to analyze the effects of participation in modern dairy channels on the growth of smallholder farmers, we analyzed changes in herd size and breed upgradation over the period 2002-06. As indicated earlier, this is the period during which all restrictions on entry of the private sector in milk processing including milkshed area concept were abolished. We include two size dimensions - number of dairy animals and milk output volume - and one upgrading dimension - share of improved breeds and milk yield.

Table 6 provides the statistics of growth indicators and upgradation over the period 2002-2006. In both channels there is a shift towards larger herds with a higher percentage of more productive crossbred cows. The average herd size is highest (11.2 animals) in modern private channel farms, followed by traditional channel farms (7.2 animals) and cooperatives (6.4 animals). The share of improved crossbred cows has increased in all channel farms but increase is highest in the case of cooperative channel farmers. Average productivity per animal has increased by about 5 per cent in all three types of farms, while in the case of buffaloes yield increase is higher in modern private and traditional channel farms. Increase in productivity is higher in the case of cows compared to buffaloes. This implies that farmers have started replacing low-producing traditional breeds with high-yielding crossbred animals because of availability of the breeding services.

Milk output volume has increased in all farm types; it increased more in traditional channel farms, followed by organized private channel farms and cooperatives. Although average marketed surplus has increased for all farmer types, it increased more for dairy farmers in the cooperative channel, followed by traditional and modern private channels.

Cow milk price has increased by 28.7 per cent in the case of traditional channel farmers while buffalo milk price has increased by about 12 per cent. There has been a moderate increase in milk prices but is higher in the case of the private sector than cooperatives.

**Factors affecting Market Channel Choice**

Milk producers use different market channels for their output. They sell to traditional channels such as milk vendors/traders, sweetshops, directly to consumers, village dairy cooperative society milk collection centres, and milk collection centres of organized private sector dairy plants. The largest share of milk is sold to traditional channels comprising mainly milk vendors, while sale to modern chains (cooperatives and private) is low but

increasing. Farmers may use more than one market outlet but in different degrees and perhaps for different purposes.

Market access is not uniform across different categories of households because of different transaction costs (distance to roads, markets, towns, transport facilities, etc.) to market participation, risks associated with prices and contract arrangements, human capital (age, education, gender, extension, training), physical capital (number of dairy animals, farm size, farm assets), and financial capital (income from crop and off-farm income). Geographical markets may likewise be differently integrated into the local/national/global economy because of spatial difference in costs of commerce, in the degree of competition among market channels or both. In general the farmer first decides to participate in the market when it is profitable to do so, and then decides on how much to sell and to which channel. The above factors affect profitability by affecting marketing costs.

*Transaction Costs*

In general, we expect that farmers with lower transaction costs are more likely to participate in modern channels and sell higher quantities. Thus we expect farmers having easy access to milk collection centres, living near roads, markets, towns, and having better transportation facilities to participate in modern markets. Smallholder producers face high transaction costs, and this reduces the opportunity of participation in modern markets. Given the transaction costs encountered when using the input and output markets, a solution for the individual farmers would be to cooperate with other farmers for various farm activities. Indeed the advantage of organizing farmers into groups is widely acknowledged in the literature. The advantages comprise the reduction of transaction costs in accessing input and output markets and strengthening of the negotiation power of the farmers.

*Human Capital*

We expect age to be negatively associated with modern market participation, as older households tend to have more subsistence production activities and are risk averse. Education and extension are expected to have a positive impact on market participation since both enhance the skills and ability to meet food safety and quality requirements of modern channels and better utilize market information, which may reduce marketing costs and make it more profitable to participate in modern market channels.

*Physical Capital*

We hypothesize that larger the farm, greater the probability that the grower will opt for the modern channel. Physical assets such as land, herd size, and farm assets may have an indirect positive impact by enabling farmers to overcome credit constraints, where land can be used as collateral for getting institutional credit for adopting improved technologies that increase productivity and profitability.

*Financial Capital*

Financial capital is expected to have mixed impacts. For example credit for dairy activities is expected to have positive impact, while that given for crop farming and other activities may raise the opportunity cost of dairy production, hence reducing participation in modern markets. Other assets that we hypothesize to be important in participating in modern market channels include sources of off-farm income to serve as risk management mechanism to balance the initial risk of selling to a traditional channel and providing finance for working and investment capital.

**Econometric Model and Estimation**

It is known that farmers' decision of supplying one market or another is categorized as a function of a set of incentives and capacity variables that allow the fulfillment of technological requirements. In this section we discuss the econometric model used to test the hypotheses of exclusion and/or inclusion of dairy farmers from market restructurings and impact of farmers marketing choices on income, employment, and technology.

Given that we have formulated channel selection as a three-alternative choice (cooperatives, private, and traditional), we have applied the multi-nomial logit model to estimating marketing channel choice problems with mixed continuous and discrete dependent variables. The model uses a two-step procedure with channel choice first and then model the correlate behaviour with endogenous stratification of the sample into the channel strata, controlling for the conditional probability of inclusion in a given channel. According to rational choice theory, we assume individuals rank mutually exclusive alternative marketing channels in order of utility and will choose the channel with maximum expected utility given their socio-economic and demographic characteristics and relevant resource constraints.

The producer's market channel choice can be conceptualized using a random utility model (RUM). RUM is particularly appropriate for modeling discrete choice decisions such as between market channels. It is an indirect utility function where an individual with specific characteristics associates an average utility level with each alternative market channel in a choice set. In our sample, a member of a cooperative dairy society did not sell to other channels, a member of a private dairy company did not sell to cooperatives or traditional channels and a producer for the traditional channel did not sell to cooperatives or private dairy plants. A few producers in our sample who sold milk to multiple channels were dropped from the analysis. Producers are mapped into three mutually exclusive channels: cooperatives, private dairy plants, and traditional channel.

*Random Utility Model*

Let decision-maker I choose from a set of mutually exclusive alternatives, j = 1, 2, …., J. The decision-maker obtains a certain level of utility $U_{ij}$ from each alternative. The discrete choice model is based on the principle of that the decision-maker chooses the outcome that maximizes the utility. The producer makes a marginal benefit-marginal cost calculation based on the utility achieved by selling to a market channel or to another. We do not observe his/her utility, but observe some attributes of the alternatives as faced by the decision-maker. Hence, the utility is decomposed into deterministic ($V_{ij}$) and random ($\varepsilon_{ij}$) part:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad \forall_{ij} \in N \qquad (1)$$

Since $\varepsilon_{ij}$ is not observed, the decision-maker's choice can not be predicted exactly. Instead, the probability of any particular outcome is derived. We can not observe directly the utilities (or the difference between benefit and cost) but the choice made by the producer reveals which one provides the greater utility (Greene, 2000).

A producer selects market channel j=1 if

$$U_{ik} > U_{ij} \forall_j \neq k \qquad (2)$$

where $U_{ik}$ denotes a random utility associated with the market channel j=k, and $V_{ij}$ is an index function denoting the producer' average utility associated with this alternative. The second term $\varepsilon_{ij}$ denotes a random error which is specific to a producer's utility preference (McFadden, 1976).

Now, in our implementation model, market channel choice is modeled as:

$$M_{ij} = \beta_j X_{ij} + \varepsilon_{ij} \quad (3)$$

Where $M_{ij}$ is a vector of the marketing choices (j = 1 for coops; 2 for private and 0 for traditional channel) of $i^{th}$ farmer, $\beta_j$ is a vector of channel-specific parameters. $\varepsilon_{ij}$ is the error term assumed to have a distribution with mean 0 and variance 1.

$X_{ij}$ is a vector of producer characteristics that together reflect the incentive, risks, capacity variables, and other shifters influencing the producer's indirect utility, and hence his/her market channel decision, and includes the following variables:

AGE is the number of years of the head of household. We hypothesize that age of household head will be negatively related to modern market channel choice and income which means that the older household head is less likely to participate in the modern channel and have less income. Younger farmers tend to be more enterprising, fast decision makers, and have capacity to adopt new technologies.

EDUCATION refers to years of schooling of the household head. We expect education to favour entry into modern market channels as it would facilitate adoption of new technologies and management practices. Education and age are also an indicator of management capabilities.

MEMBERSHIP is a proxy for social capital and we hypothesize that there is a positive relationship between membership of an association/cooperative/organization and participation in modern markets. Collective action allows small farmers to pool/aggregate their inputs/outputs to achieve economies of scale that enables them to access inputs and services and negotiate for better price for their outputs.

HERDSIZE represents overall herd size of dairy animals in 2002 to avoid endogenous problem. It can be considered a proxy for financial capability and production capacity of a farmer. We expect a positive effect of this variable, as it is linked to marketable volume considered desirable (by the buyer) because it reduces transaction costs.

RISK is measured as a coefficient of variation (CV) of milk prices received by farmers. , Price risk is likely to be negatively related with market choices, which means higher the risks more likely a farmer is to participate in modern market channels.

ROAD is the distance to a paved road measured in kilometers and is expected (as a measure of transaction costs facing the producer as well as infrastructure) to be negatively affect the choice of modern channel.

We have tried household's distance from nearest market (MARKET), establishment of new milk collection/chilling centres in post-2002(COLLECTION CENTRE), and distance from milk collection centre as instrumental variables in the farmers' marketing channel choices. We assume that these variables do not have any direct impacts on farmers' milk production but may have indirect impacts on marketing channel choices.

MARKET is the distance to a market measured in kilometers (as a measure of transaction costs facing the producer). Longer distance to the market is expected to have positive effect on modern market channel participation.

NEW COLLECTION CENTES is the number of new processing facilities/milk collection centres set up in the village in post-liberalization period (after 2002). Setting up new facilities is expected to have a positive effect on choice of modern channels.

DISTANCE FROM MARKET is proxy for access to alternative markets. We expect it to have negative association with modern market channel participation.

We have used multinomial logit regression using the weights discussed earlier to estimate the determinants of market channel choice equation because this model fits multiple discrete choice variables. The multinomial logit model results will then be used to construct the selection-correction term (Inverse Mill's ration) for individuals selecting each channel (Green 2003). In the second stage the Inverse Mill's ratio will be included in impact regression estimation to control for selection bias.

*Effects of Market Channel Choices on Income, Employment and Technology*

Farmer's market channel choices are hypothesized to have significant or not significant impact on various technological and economic parameters, such as income, productivity, employment and technology (breed composition). Here we estimate income, employment and technology functions, again endogenously stratifying for the three market channels. Since the separation of producers by market channel introduces a bias derived from an endogenous stratification of market channels, this bias need to be corrected. The regression equations are estimated for the group accessing modern channels and those

accessing traditional channels. The estimators used in this production function use the Inverse Mills' ratio (IMR) as a regressor calculated from the multi-nomial logit function for the market choice presented before.

For the second set of research questions related to the impact on farmers' marketing choices, $M_j$, and their impacts on farmers' income, employment, and technology ($Y_{ij}$), we have the following specifications:

$$Y_{ij} = \beta_0 + \beta_1 \text{ AGE} + \beta_2 \text{ EDUCATION} + \beta_3 \text{ MEMBERSHIP} + \beta_4 \text{ ROAD} + \beta_5 \text{ PRICERISK} + \beta_6 \text{ VETSERVICES} + \beta_7 \text{ HERD} + \beta_7 \text{ IMR} + u_{ij} \quad (4)$$

$Y_{ij}$ is a set of variables that are hypothesized to be affected by the farmer's marketing choices ($M_{ij}$). In the study, we identify the following impact variables: dairy income (Rs./dairy animal/household/day); milk yield (litres/day); employment (hours/litre of milk); and technology (percentage of crossbred cows in dairy herd). $\beta_i$ are the estimation parameters.

We estimate the system for each market channel independently using a Zellner's seemingly unrelated regression (SUR) model to exploit potential correlation across errors in four impact equations.

**Economometric Analysis Results**

**Determinants of Market Channel Choice – Multinomial Logit Estimates**

Estimates of first-stage channel selection results of the Heckman procedure (multinomial logit coefficients and marginal effects of market channel choice) are presented in Table 7. Three instrumental variables are included in the first-stage estimation that are not part of the second-stage estimation for identification (Hamilton and Nickerson, 2003). The first variable (new milk collection centres set up post-2002) meaures the impact of abolition of milkshed area requirement under MMPO. The second instrumental variable is distance from market, which captures marketing opportunities available to the milk producer. The third instrumental variable is distance from new milk collection centre which has facilitated access to new market opportunities. While these developments have facilitated access to market, their effects are similar among different types of milk producers/market players. These factors have not directly affected milk production because no *a priori* advantages

have resulted for any of the producers. Because they represent industry level developments over time that all producers/industry players enjoy, they are appropriate instruments.

Tradional market channel is chosen as the base category and all coefficients on traditional channel are set to zero. The marginal effects are evaluated using the sample means of all variables. An important feature is that the sum of the margional effects of any variable on all the three channels should be zero by definition. The parameters of this model can be interpreted as the effects on the probability of selecting cooperatives/modern private channel of an infinitesimal change in each independent continuous variable and the discrete change in the probability for dummy variables. As shown in Table 8, the model is highly significant and correctly predicts about 80 per cent of the observed outcomes. Almost all the parameters have the expected sign, with varying degree of significance.

The multinomial logit analysis shows very interesting results. The most important finding is that herd size is significant determinant of market channel participation in modern market channels but with different impact. For example, in the case of organized private dairy market channel, there is positive impact of herd size on market participation, as herd size increases farmers shift supplies to organized private dairy channels. In contrast, in the case of cooperatives this relationship is negative, thereby indicating that as herd size increases, farmers shift from cooperatives to other channels. The possible explanation is that farmers receive the same price in cooperatives irrespective of quantity of milk, while in the case of private dairies and even traditional market channels, large producers get price incentive/higher price because of higher bargaining power as well as lower transaction costs. The results clearly show that modern private dairy plants and traditional channels prefer supplies from large farmers who can supply large quantitites of quality milk.

As expected age of head of household is negatively related to participation of smallholder dairy farmers in modern channels and is statistically significant in private dairy channels. A one year increase in age is predicted to raise the probability of being in this traditional channel but reduces the chances of being in the other two channels. In the case of education the results show a statistically significant postive imapct in the case of cooperatives and private dairy plants.

Membership of a farmers' group/association/cooperatives significantly determines smallholder dairy producers participation in modern markets. Membership is positively

related to market choice; this means that if a farmer is a member of farmers' group/association/cooperatives, he is likely to participate in modern markets. The relationship is much stronger in the case of cooperatives which shows the strength of dairy cooperatives in India. It is also known that collective action enables small farmers to attain better bargaining power, economies of scale, and reduced transcation costs. The results show that majority of farmers in cooperative market channel produce individually (as economies of scale in milk production are almost absent) but market collectively (as economies of scale in marketing and processing of milk are very significant).

Interestingly, selling to modern marketing channels is positively correlated with distance from paved road, which indicates that those milk producers located in areas with less road connectivity may still be part of modern marketing channels. From our dsicussions with traditional marketing channel operators we learnt that many organized dairy plants (cooperatives as well as private) have set up milk collection centres in rural areas while traditional channel operators procure milk from areas near urban centres to reduce transportation costs and exploit market opportunities in big cities.

Price risk is another important impediment to market entry as well as to adoption of improved technologies and investment in productive assets, thereby compounding the market participation effects. Lower prices, greater price risk, or both will typically discourage smallholder market participation. Price risk has a significant effect on modern market channel participation. Price risks appear to affect entering the modern channel positively; i.e. as price risk increases farmers tend to shift to modern channels because of transparent and stable pricing policies adopted by cooperatives and organized private dairies. Traditional channel players pay marginally higher price to milk producers during the lean season but inter-seasonal price fluctuations are high and sometimes they disappear from the market during a period of high production (flush season).

As expected provision of veterinary services is predicted to raise the probability of being in cooperatives and/or organized private marketing channels. Milk collection centres set up in the post-liberalization period (post-2002)) has turned out to be a significant determinant of market channel participation. The coefficient is positive and statistically significant in the case of organized private dairy farmers but non-significant in the case of cooperatives. The possible explanation is that many private companies set up milk processing plants in the

post-liberalization era, when the milk shed area requirement was abolished. This shifted dairy farmers from traditional channels as well as cooperatives to private sector plants.

Distance to milk collection centre is negatively correlated with modern market channel participation, which indicates that as distance of milk collection centre increases, farmers tend to sell their output to traditional marketing channels as most of the traditional channel players collect milk from the farmer's doorsteps.

The probability of selecting modern channels rises with increase in distance from the market; however its influence is insignificant in the case of cooperatives but statistically significant in the case of private sector channels. This may be explained by the fact that there has been an increasing trend of private dairies procuring milk directly from farmers through milk collection centres or through agents.

We generate the Inverse Mill's Ratio (IMR) of this multinomial logit model and then include it as an explanatory variable in the estimation of impact regressions.

**Impacts of Market Channel Choice on Income, Employment, and Technology**

Table 9 provides the second-stage impact results using gross dairy income, milk yield, employment, and share of crossbred animals as dependent variables. Ideally, our dependent variable should be *net* dairy income. Unfortunately, accurate data on the value of some of inputs are difficult to obtain. This is particularly true of inputs for which markets are not well developed, such as labour, home grown feeds, and fodder; in some cases costs data are missing. As a consequence we use *gross* dairy income per animal per household as the dependent variable in the second stage of the Heckman model.

The Inverse Mills' Ratio corrects the error terms in the impact equations to achieve consistent and unbiased estimates. Justification for the Heckman procedure is found in the table as the Inverse Mill's Ratio coefficients are significantly positive in the case of modern channels, indicating a positive selection of modern marketing channels. It is also interpreted as unobserved characteristics of one marketing channel influencing income relative to other channels. The Heckman results suggest that the overall influence of marketing channel choice on income is driven in part by an endogenous selection process.

The coefficient estimates in Table 9 are used to determine whether and how household characteristics, incentives, farm size, and other factors affect farm income. The results

indicate that age is not statistically significant for the traditional marketing channel, but is negative and significant for modern channels ($p<0.1$). The results also indicate that education as hypothesized has positive performance effect for modern channels (cooperatives and private). While modern channels demand minimum quality standards from producers, tradtional channels are not so strict about food safety and quality issues. Educated producers are more capable of meeting these standards. Membership has significant positive impact on income in the case of cooperatives but is not statistically significant in the case of modern private and traditional channels. As expected distance from road has a negative effect on income for all channels but is statistically insignificant. Herd size has a negative effect on income for cooperatives indicating inverse relationship between farm size and income. The possible explanation for this inverse realtionship could be that managerial efficiency of small farms has been able to offset scale efficiencies if any. Provision of veterinary services has positive effect on income for all marketing channels but is siginificant for cooperatives only as cooperatives have very strong backward linkages with producers and provide breeding, animal healthcare facilities, and extension services to producer members. Price risk has negative effect on farm income in the case of cooperatives and traditional channels but positive and significant for organized private channels. Overall, the influence of marketing channel choice on income is driven in part by an endogenous selection process.

Herd size has a statistically significant negative effect on employment in all channels indicating that increase in herd size replaces labour with machinery. Membership does have a significantly negative effect on employment. Age of head of household has a positive effect on employment in the case of both modern and traditional channel farmers but is statistically significant in the case of modern channel farmers. Price risk has a negative impact on employment generation.

Age has statistically a significant negative effect on the proportion of crossbred dairy animals in the case of modern private sector channels, indicating that young farmers adopt modern technologies more. Membership has a positive effect on adoption of crossbreeding technology in the case of modern market channel farmers. Provision of veterinary services also has a positive impact on crossbreeding technology but is statistically significant in the case of cooperatives and organized private channel farmers.

Education and membership have a positive impact on milk productivity while age has a negative or non-significant impact on productivity. Herd size has inverse relationship with milk productivity in the case of modern channel farmers. Price risk also has a negative impact on productivity.

**Conclusions**

*Dairy Market Restructurings*

While modern marketing channels have emerged in the Indian dairy sector, the traditional sector is still dominant. Farmers sell nearly 85 per cent of milk to traditional channels. The share of the modern organized sector is growing but at a slow pace.

Consistent with the findings of the local meso study, the rapid restructurings of downstream dairy processing and to some extent wholesale and retail markets have not penetrated into farm procurement. Overall, milk sold directly to modern channel accounts for less nearly 15 per cent of the marketed surplus. The dominance of the traditional channel is an indication of a very competitive and cost-effective traditional market in linking producers and consumers. It is possible that high transaction costs also act as a barrier. However, issues of hygiene and quality of milk being sold through traditional channels require attention.

We found that there was no significant difference between modern dairy channels and traditional dairy channels in terms of herd size, milk output volume, and price as well as in terms of upgradation with respect to improved breeds and productivity. However, we found that relative growth in terms of output volume outstripped relative growth in upgradation. This indicates that farmers have been able to make efficient and effective use of new technologies and management practices as well as scaling up herd size.

*Determinants of Farmers' Marketing Choices*

Small dairy farmers and the poor are not excluded from cooperatives but are excluded from modern private sector channels. There is evidence of herd size affecting the farmer's choices of selling their produce to modern channels. In case of cooperatives, large farmers are opting out and shifting to either the modern private sector or the traditional sector as they receive price incentives for large supplies. Large farmers have better opportunity to participate in modern private sector channels.

Age and education are important determinants of marketing channel choice in the case of

the modern private sector. Young and more educated farmers have better chances of inclusion in the modern private sector channel.

Market infrastructure such as road, provision of veterinary services, distance from milk collection centre, markets, milk collection centres, price risks, etc. are found to have significant effect on farmers' marketing choices.

*Impacts of Marketing Restructurings and Marker Channel Choices on Farmers*

The second stage results of the Heckman model show that education, membership of producers' association/cooperatives, provision of veterinary services, and herd size have significant impact on cooperative marketing channel farmers' income while in the case of modern private sector education and price risk have significant impact on income. For traditional market channel farmers, dairy income is significantly determined by price risk and herd size. Modern market channel farmers have higher dairy income than traditional channel farmers, which is explained by higher yields obtained by modern channel farmers but they receive lower prices than traditional market channel farmers.

## References

Balsevich, F., J. Berdegue, and T. Reardon, (2006), "Supermarkets*, New-Generation Wholesalers, Tomato Farmers, and NGOs in Nicaragua,*" World Bank, 2006(3).

Berdegué, J.A., F. Balsevich, L. Flores, and T. Reardon. (2005), "Central American Supermarkets' Private Standards of Quality and Safety in Procurement of Fresh Fruits and Vegetables," *Food Policy,* 30(3), 254-69.

Birthal, Pratap S., P.K. Joshi, and Ashok Gulati (2007), "Vertical Coordination in High-Value Food Commodities: Implications for Smallholders" in R. K. Joshi, Ashok Gulati, and Ralph Cummings Jr. (Ed.); *"Agricultural Diversification and Smallholders in South Asia*, New Delhi: Academic foundation, New Delhi.

Dries L. and Swinnen J.F.M. (2004), "Foreign Direct Investments, Vertical Integration and Local Suppliers: Evidence from the Polish Dairy Sector," *World Development,* 32 (9),. 1525-44.

Greene, W.H. (2000), Econometric Analysis, New Jersey: Prentice-Hall.

Hamilton, B. H., and J.A. Nickerson (2003), "Correcting for Endogeneity in Strategic Management Research," *Strategic Organization*, 1(1), 53-80.

Hu, D., T. Reardon, S. Rozelle, P. Timmer, and H. Wang (2004), "The Emergence of Supermarkets with Chinese Characteristics: Challenges and Opportunities for China's Agricultural Development," *Development Policy Review*, 22, 557-86.

Joshi, P. K., Ashok Gulati, and Ralph Cummings Jr. (2007), *Agricultural Diversification and Smallholders in South Asia,* New Delhi: Academic foundation.

McFadden, D. (1976), "Quantal Choice Analysis: A Survey,*" Annals of Economic and Social Measurement*, 5, 363-90.

Ministry of Agriculture (2006), *"Basic Animal Husbandry Statistics 2006,* Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India, New Delhi.

Ministry of Agriculture (2007), *National Dairy Plan 2007-08 to 2021-22,* Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India, New Delhi.

National Dairy Development Board (2007), *Annual Report 2006-07.* Anand: National Dairy Development Board.

Reardon, T. and C. P. Timmer (2005), "The Supermarket Revolution with Asian Characteristics." paper presented at the International Conference on Agricultural and Rural Development in Asia, Philippines.

Reardon, T. and C.P. Timmer (2007), "Transformation of Markets for Agricultural Output in Developing Countries Since 1950: How Has Thinking Changed?" in R.E. Evenson and P. Pingali, Handbook of Agricultural Economics, Agricultural Development: Farmers, Farm Production, and Farm Markets. Amsterdam: Elsevier, 2808-55:

Schwentesius, R. and Manuel, A. G., (2002), "Supermarkets in Mexico: Impacts on Horticulture Systems," *Development Policy Review*, 20(4), 487-502.

Sharma, Vijay Paul (2006), "Trade Liberalization and Indian Dairy Industry," paper presented at the International Symposium on *Institutional Structures for Sustaining Livelihoods through Dairying in a Competitive Environment,* National Dairy Development Board, November. 15

Sharma, Vijay Paul (2007), "India's Agrarian Crisis and Smallholder Producers' Participation in New Farm Supply Chains Initiatives: A Case Study of Contract Farming," W.P. No 2007-08-01. Ahmedabad: Institute of Management, August.

Sharma, Vijay Paul and Raj Vir Singh (2007), *Regoverning Markets: India Meso-level Study,* Regoverning Markets Projects Report, Ahmedabad: Indian Institute of Management.

**Table 1 Dairy Cooperatives and Modern Private Sector presence in the Major Milk Producing States in India**

| *Milk procured by coops (% of production) – TE 2004-05* | *% of milk output procured by coops-states – TE 2004-05* | *Share in total milk procured by coops – TE 2004-05* | *Share in national milk production – TE 2004-05* | *Share of private dairy plants in 2006* | *Traditional sector* |
|---|---|---|---|---|---|
| Above national average | ***84.9% (Strong coops)*** Gujarat (30.4), Karnataka (19.9), Maharashtra (16.3), Tamil Nadu (11.6), Kerala (6.7) | ***69.6%*** Gujarat (29.1), Karnataka (12.8), Maharashtra (14.9), Tamil Nadu (9.3), Kerala (3.5). | ***26.9%*** Gujarat (7.3), Karnataka (4.6), Maharashtra (7.2), Tamil Nadu (5.3), Kerala (2.5). | ***34.8 (31.9)* (Moderate Organized Private Sector)*** Maharashtra (25.3), Karnataka (2.6) | ***Moderate Presence*** |
| Below National average | ***24.2% (Moderate coops)*** Andhra Pradesh (5.5), Rajasthan (5.6). Bihar (3.7), Madhya Pradesh (2.0),Orissa (4.4), West Bengal (3.0) | ***18.8%*** Andhra Pradesh (5.4), Rajasthan (6.8). Bihar (2.3), Madhya Pradesh (1.9),Orissa (0.7), West Bengal (1.7) | ***34.1%*** Andhra Pradesh (7.9), Rajasthan (9.1). Bihar (4.6), Madhya Pradesh (7.1),Orissa (1.2), West Bengal (4.2) | ***11.7 (14.6)* (Weak Organized Private Sector)*** Rajasthan (3.5), Madhya Pradesh (3.1), Andhra Pradesh (2.8), West Bengal (2.1) | ***Weak – Moderate Presence*** |
| | ***8.3% (Weak coops)*** Uttar Pradesh (1.8), Punjab (4.0), Haryana (2.5) | ***10.8%*** Uttar Pradesh (4.4), Punjab (4.5), Haryana (1.9) | ***34.7%*** Uttar Pradesh (19.3), Punjab (9.5), Haryana (5.9) | ***52.1 (50.7)* (Strong Organized Private Sector)*** Uttar Pradesh (33.7), Punjab (10.3), Haryana (8.0) | ***Strong Presence*** |

**: shows percentage share in total capacity in organized private sector*
*Source: NDDB (2007), MoA (2006)*

**Table 2 Distribution of Sample Households: State-wise and Marketing Channel-wise**

| *State* | *Modern Market Suppliers* | | *Traditional Market Suppliers* | *Total* |
|---|---|---|---|---|
| | *Cooperatives* | *Private* | | |
| Gujarat | 93 | 28 | 20 | 141 |
| Haryana | 26 | 21 | 38 | 85 |
| Punjab | 38 | 20 | 22 | 80 |
| Uttar Pradesh | 41 | 1 | 26 | 68 |
| **TOTAL** | **198** | **70** | **106** | **374** |

*Source: Survey Data*

**Table 3 Selected Statistics on the Dairy Farmers Populations by States (averages)**

| *Statistic* | *Gujarat* | *Haryana* | *Punjab* | *Uttar Pradesh* | *All States* |
|---|---|---|---|---|---|
| Age household head (years) | 41.9 | 49.3 | 48.6 | 51.7 | 46.7 |
| Level of education of household head (years) | 4.0 | 7.1 | 7.8 | 6.7 | 6.1 |
| Household size (number) | 5.7 | 6.2 | 5.5 | 6.9 | 5.9 |
| Head's experience in dairy (years) | 19.5 | 23.4 | 28.3 | 29.9 | 23.8 |
| Herd Size (number) | 9 | 6 | 5 | 5 | 7 |
| Crossbreed Cow | 3 | 1 | 1 | 1 | 2 |
| Local Cow | 2 | 0 | 0 | 0 | 1 |
| Buffalo | 4 | 5 | 4 | 4 | 4 |

*Source: Survey Data*

**Table 4 Selected Socio-economic Statistics on the Dairy Farmers Populations (Modern vs. Traditional Channel)**

| | *Modern Channel Farmers* | | | *Traditional Channel* |
|---|---|---|---|---|
| *Farm characteristics* | *Coops* | *Private* | *Coops & Private* | |
| Age of head of household (years) | 46.2 | 44.9 | 45.9** | 48.8 |
| Educational level of head of household (years) | 6.3 | 5.8 | 6.1 | 5.7 |
| Highest education level of any HH member (years) | 17 | 14 | 17 | 15 |
| Head's experience in dairy farming | 23.8 | 21.1 | 23.1** | 25.7 |
| Size of household | 5.8 | 5.9 | 5.8* | 6.2 |

*** p <0.01, ** p <0.05, * p <0.10.

*Source: Survey Data*

**Table 5 Herd Size, Composition and Milk Production Related Differences of Selected Households (Modern vs. Traditional vs. Channel)**

| *Farm characteristics* | *Organized/Modern Channel* | | | *Traditional Channel* |
|---|---|---|---|---|
| | *Coops* | *Private* | *Coops & Pvt.* | |
| Herd size in 2006 | 6.4 | 11.2 | 7.7 | 7.2 |
| Crossbreed Cow | 1.8 | 4.4 | 2.4 | 1.5 |
| Local Cow | 1.2 | 1.4 | 1.3 | 0.3 |
| Buffalo | 3.4 | 5.4 | 4.0 | 5.4 |
| Percentage of herd with crossbred cows | 28.1 | 39.3 | 31.2 | 20.8 |
| Percentage of herd with Buffaloes | 53.1 | 48.2 | 51.9 | 75.0 |
| Milk Output (litres/day) | 29.8 | 49.4 | 34.9 | 46.5 |
| Milk sales as percentage of total production | 83.0 | 78.1 | 76.0 | 84.2 |
| Distance to milk collection centre (km) | 1.4 | 1.0 | 1.3 | 2.9 |
| Distance to metalled road km) | 4.4 | 3.5 | 3.8 | 2.8 |
| Distance to main market (km) | 5.7 | 5.9 | 5.8 | 6.2 |
| Operational land holding size (ha) | 1.9 | 2.1 | 2.0 | 1.2 |
| Price (Rs./litre) | | | | |
| Cow | 12.80 | 13.78 | 13.18 | 14.11 |
| Buffalo | 14.16 | 15.85 | 15.05 | 16.28 |
| Cow: Fat (%) | 4.3 | 4.1 | 4.3 | 4.0 |
| SNF (%) | 8.5 | 8.4 | 8.5 | 8.4 |
| Buffalo: Fat (%) | 6.7 | 6.4 | 6.6 | 6.4 |
| SNF (%) | 8.7 | 8.7 | 8.7 | 8.6 |

*Source: Survey Data*

**Table 6 Growth and Upgradation by Dairy Farmer Type between 2002 and 2007**

| | Organized Coop. Channel farmer | | | Organized Pvt. Channel farmer | | | Traditional Channel farmer | | |
|---|---|---|---|---|---|---|---|---|---|
| | **2002** | **2007** | **Growth** | **2002** | **2007** | **Growth** | **2002** | **2007** | **Growth** |
| Herd size | 4.3 | 6.4 | 48.8 | 8.4 | 11.2 | 33.3 | 5.3 | 7.2 | 35.8 |
| Crossbred Cow | 17.8 | 28.1 | 10.3 | 38.6 | 39.3 | 0.7 | 15.6 | 20.8 | 5.3 |
| Output Volume (lit./day) | 23.6 | 29.8 | 26.3 | 37.3 | 49.4 | 32.4 | 31.7 | 46.5 | 46.7 |
| Price (Rs./lit) | | | | | | | | | |
| Cow Milk | 10.95 | 12.80 | 16.9 | 11.02 | 13.78 | 25.0 | 10.96 | 14.11 | 28.7 |
| Buffalo Milk | 13.53 | 14.16 | 4.7 | 14.36 | 15.85 | 10.4 | 14.54 | 16.28 | 12.0 |
| Milk yield | | | | | | | | | |
| Cow | 4.3 | 4. 5 | 4.6 | 4. 5 | 4.7 | 4.4 | 4.3 | 4.5 | 4.6 |
| Buffalo | 5.2 | 5. 3 | 1.9 | 5.0 | 5.4 | 8.0 | 5. 3 | 5.6 | 5.7 |

*Source: Survey Data*

**Table 7 Multinomial Logit Estimates of the Milk Marketing Channel Choice Equation**

| *Independent Variables* | *Coefficient Estimates* | | *Marginal Effects* | | |
|---|---|---|---|---|---|
| | *Coops* | *Private* | *Coops* | *Private* | *Traditional* |
| Constant | -6.7403*** (1.8332) | -4.7790*** (1.938) | - | - | - |
| Age (years) | -0.0312 (0.0308) | -0.1021*** (0.0380) | -0.0007 | -0.0021 | 0.0028 |
| Education (years) | 0.283*** (0.0900) | 0.2356*** (0.0840) | 0.0063 | 0.0047 | -0.0110 |
| Membership (yes =1; no = 0) | 3.1138** (1.5321) | 2.9361* (1.7831) | 0.0761 | 0.0588 | -0.1349 |
| Distance from Road (km) | 0.6378*** (0.1800) | 0.8134*** (0.1809) | 0.0155 | 0.0164 | -0.0319 |
| Herd Size (number) | -0.1091* (0.0564) | 0.0205 (0.0534) | -0.0027 | 0.0005 | 0.0022 |
| Veterinary Services (yes =1; no = 0) | 6.0371*** (0.8636) | 2.4850** (1.0174) | 0.1492 | 0.0479 | -0.1972 |
| Price Risk (%) | 1.1056*** (0.2404) | 1.0184*** (0.2636) | 0.0270 | 0.0204 | -0.0474 |
| Distance from Milk Collection Centre (km) | -0.2963*** (0.0868) | -0.6503*** (0.1483) | -0.0070 | -0.0132 | 0.0202 |
| Distance from Market (Km) | -0.1093* (0.0550) | -0.1114* (0.0657) | -0.0028 | -0.0023 | 0.0004 |
| Post-2002 Milk Collection Centre (yes =1; no = 0) | 1.9279 (3.1378) | 3.2080* (1.7977) | 0.0463 | 0.0651 | -0.1114 |
| Number of observations | | 374 | | | |
| Log likelihood function | | -93.3967 | | | |
| Restricted Log likelihood | | -315.1223 | | | |
| $Chi^2$ | | 443.4512 | | | |

a. Notes: Figures in parentheses show standard errors; ***p <0.01, **p <0.05, *p <0.10.
b. The dependent variable is market channel choice: $M_k$ = 1 for cooperatives, $M_k$ = 2 for organized private and $M_k$ = 0 for traditional channel. Traditional channel is used as base category.

**Table 8 Frequencies of Actual and Predicted Outcomes – Multinomial Logit Model Results**

| *Actual* | *Predicted* | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | *Total* |
| 0 | 89 | 12 | 5 | *106* |
| 1 | 29 | 148 | 21 | *198* |
| 2 | 25 | 30 | 15 | *70* |
| *Total* | *143 (74.1%)* | *190 (95.9%)* | *41 (58.6%)* | *374* |

**Table 9 Impact of Milk Market Channel Choice on Gross Dairy Income, employment, milk yield and share of improved breeds, 2006**

| | *Income* | | | *Employment* | | |
|---|---|---|---|---|---|---|
| *Variable* | *Coops* | *Private* | *Traditional* | *Coops* | *Private* | *Traditional* |
| Constant | 88.5739 (11.6835) | 52.501 (13.9558) | 86.859 (21.894) | 0.5064 (0.0953) | 0.1713 (0.1782) | 0.6152 (0.0988) |
| Age | -0.2961*** (01570) | -0.1477** (0.0992) | 0.5398 (0.3438) | 0.0022*** (0.0012) | 0.0206* (0.0038) | 0.00205 (0.0015) |
| Education | 0.1030 (0.3324) | 0.9400 (0.7541) | -0.5017 (0.884) | 0.0115* (0.0027) | -0.0024 (0.0096) | 0.0018 (0.0039) |
| Membership | 16.8618* (4.827) | -1.2633 (11.1385) | -33.1126 (29.2065) | -0.1694* (0.0394) | -0.3731* (0.1422) | -0.2866** (0.1318) |
| Distance from Road | -1.2063 (1.0376) | -0.8109 (0.9121) | -0.8446 (1.5082) | 0.0125 (0.0084) | -0.0031 (0.0116) | -0.0047 (0.0060) |
| Price Risk | -0.9054 (0.7694) | 3.6395* (1.2663) | -9.0901** (4.093) | 0.0295* (0.0062) | -0.0786* (0.0161) | -0.041** (0.0184) |
| Veterinary & Feed Service | 11.2941* (3.9958) | 1.4543 (3.6369) | 0.9201 (17.821) | -0.1609* (0.0326) | -0.1253* (0.0464) | -0.2068** (0.0804) |
| Herd Size | -2.7676* (0.6256) | -0.1050 (0.1781) | 2.305** (1.1101) | -0.0366* (0.0051) | -0.0071* (0.0022) | -0.0373* (0.005) |
| IMR | 15.6060* (2.6012) | 3.6501* (1.8929) | 8.869 (12.2952) | -0.0588* (0.0212) | -0.2553* (0.0497) | -0.035 (0.0554) |
| No. of obs. | 198 | 70 | 106 | 198 | 70 | 106 |
| $R^2$ | 0.38 | 0.41 | 0.34 | 0.31 | 0.61 | 0.65 |
| | *Yield* | | | *Crossbred Cows* | | |
| | *Coops* | *Private* | *Trad.* | *Coops* | *Private* | *Trad.* |
| Constant | 6.0587 (0.8503) | 2.9946 (0.928) | 5.2401 (1.3791) | -15.8075 (7.7654) | 20.959 (13.4828) | 3.5896 (7.2020) |
| Age | -0.0231** (0.0114) | 0.0076 (0.0198) | 0.0356 (0.0216) | 0.1064 (0.1044) | -0.5425** (0.289) | -0.0028 (0.1131) |
| Education | 0.0239 (0.0241) | 0.09581*** (0.0515) | -0.0212 (0.0556) | 0.1636 (0.2209) | -0.1632 (0.7286) | 0.3499 (0.2907) |
| Membership | 1.1923* (0.3513) | -0.0771 (0.7406) | -1.9274 (1.8397) | 9.5875* (3.2082) | 22.1604** (10.761) | -0.5047 (9.6070) |
| Distance from Road | -0.0669 (0.0755) | -0.0608 (0.0665) | -0.0373 (0.095) | 0.2248 (0.6896) | -0.7305 (0.8812) | -1.7627* (0.4961) |
| Price Risk | 0.0226 (0.0560) | 0.2588* (0.0842) | -0.5608** (0.2578) | 0.6129 (0.5114) | 2.5892** (1.2234) | 1.3415 (1.3463) |
| Veterinary & Feed Service | -0.9991* (0.2908) | 0.1546 (0.2418) | 0.1079 (1.1225) | 9.7613* (2.6558) | 2.2575 (3.5136) | 5.5041 (5.862) |
| Herd Size | -0.2106* (0.0455) | -0.9992 (0.0118) | 0.1601** (0.0699) | 2.7758* (0.4158) | 0.619* (0.172) | 0.8391** (0.3651) |
| IMR | 1.189* (0.1893) | 0.2628 (0.2588) | 0.5431 (0.7744) | -2.422 (1.7289) | 8.8087** (3.761) | -9.0078** (4.0443) |
| No. of obs. | 198 | 70 | 106 | 198 | 70 | 106 |
| $R^2$ | 0.42 | 0.47 | 0.58 | 0.43 | 0.48 | 0.70 |

Notes: Notes: Figures in parentheses show standard errors; *** p <0.01, ** p <0.05, * p <0.10.