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## **Do Dairy Co-operatives Enhance Milk Production, Productivity and Quality? Evidences from the Indo-Gangetic Plain of India**

**Anjani Kumar, P. Shinoj and Shiv Jee\***

### **ABSTRACT**

Dairy development of India has been acclaimed as one of the most successful development programmes in the world. The co-operatives were conceived as the main vehicle for implementing dairy development programmes in India and much of the success of the 'White Revolution' in the country is attributed to co-operative framework of the dairy development strategies. Nonetheless, the potential of the dairy co-operatives in the context of emerging globalised markets is often questioned. The emergence of several integrated marketing models backed by giant multinationals is posing stiff competition to the co-operative models of milk marketing. In this backdrop, this study examines the impact of co-operatives at the farm level based on the data collected from 675 dairy farming households in three states of India - Bihar, Punjab and Uttar Pradesh. These states represent geographical and institutional diversity of milk production and marketing in the country. This study aims at analysing the impact of dairy co-operatives on the farmers' performance with the adoption of milk quality and safety practices. The findings indicate that the stature of the co-operatives as the multifunctional entity for dairy farmers of rural India is still intact. A cross comparison between the member and the non-member farmers of the dairy co-operatives suggests that the scale of farming and level of adoption of improved animals have been significantly higher for member farmers. Similarly, the co-operative member households contributed significantly higher quantity of milk at higher levels of productivity than their non-member counterparts. The co-operative members were found to have better market access for selling milk. Per unit cost of milk production was on the lower side for the members and they realised higher price of milk than the non-member farmers. More importantly, the members were relatively better adopters of milk safety and hygiene practices and had lower additional cost of compliance and that in turn would promote better compliance. Further, the paper identifies the major factors that enabled the dairy farmers to participate in co-operatives. The results of the Probit analysis suggested that the socio-economic and demographic factors like education, experience, scale of farming, size of holdings, caste affiliation, etc. determine the participation of dairy farmers in co-operatives. The membership in the co-operatives gives a distinct advantage to dairy farmers for enhanced milk yield, productivity and quality, and thereby increases their competitiveness in the domestic and international markets. The potential of dairy co-operatives need to be fully exploited in the country, and to empower them further, new initiatives should be vigorously pursued.

**Keywords:** Dairy co-operatives, Milk production and pricing

**JEL:** C83, Q13, Q11

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\*Principal Scientist (on deputation to the ICRISAT), Scientist (Sr. Scale) and Data Entry Operator, respectively, National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi-110012.

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## I

## INTRODUCTION

Dairy development in India has been acclaimed as one of the most successful development programmes in the world. The co-operatives were conceived as the main vehicle for implementing dairy development programmes in the country, and much of the success of the 'White Revolution' in India is attributed to the co-operative framework of the dairy development strategies. The network of dairy co-operatives expanded considerably, especially after the launch of the Operation Flood in 1970. In 2010-11, more than 14 million dairy farmers were associated with dairy co-operatives. The functioning of the dairy co-operatives is based on the collective action, which is supposed to be inclusive and participatory. It is assumed for assisting smallholders' engagement in milk markets, contributing to improvement in production and productivity, and finally enhancing the farmers' income and welfare. Several studies have shown that integration with co-operatives have benefited the farmers and indeed have served as a catalyst for linking Indian dairy smallholders to the markets—domestic as well as global markets (Cunningham, 2009; Kumar, 2010; BIRTHAL *et al.*, 2007, 2009; Candler and Kumar, 1998 ).

Nonetheless, the potential of dairy co-operatives in the context of emerging globalised markets is often questioned. The emergence of the many integrated marketing models, backed by giant multinationals, is posing a stiff competition to the co-operative model of milk marketing. However, the earlier studies suggest that farmers' participation in dairy co-operatives has resulted in a significant increase in milk production and productivity and has reduced per unit cost of milk production (Kumar, 2010; BIRTHAL *et al.*, 2007, 2009; Mergos and Slade, 1987; Candler and Kumar, 1998; Shukla and Brahmankar, 1999; Singh and Das, 1994; Singh, 1996; Singh and Pundir, 2000). Co-operatives are also indicated to help smallholders reduced transaction costs in accessing inputs, information, technology and remunerative markets (Stockbridge *et al.*, 2003; Lele, 1981). The empirical evidence also shows that co-operatives have lead members to achieve higher output prices, reduced transaction costs and increased profits (Berdegue, 2001; Holloway *et al.*, 2000; BIRTHAL *et al.*, 2009, Kumar *et al.*, 2010, Kumar *et al.* 2011a) and enhanced complying with the stringent food safety standards (Roy and Thorat 2008, Narrod *et al.*, 2009; Kumar *et al.*, 2011a,b). Further, cooperatives enhance vertical integration of dairy market and also facilitate delivery of inputs and veterinary care services to the participants. In this backdrop, the objective of this study is to further examine the impact of co-operatives at the farm level. In particular, the impact of co-operatives would be assessed on the adoption of food safety measures in milk production.

Milk is an integral part of the diet in India, and a key source of energy, essential amino acids and micronutrients for the majority of the vegetarian population of the country. Milk is a perishable product and thus is a potential source of food poisoning and diarrhoeal diseases. It is, therefore, important that any effort to increase milk

production and productivity must pay further attention to comply with on-farm food safety practices to ensure clean and safe milk production. In fact, the government has been supporting milk co-operatives for strengthening infrastructure for quantity and clean milk production. Therefore, this study aims to fill this knowledge gap through incorporation of adoption of milk quality and safety practices in the analysis of the impact of dairy co-operatives on farmers' performance. The remainder of this paper is organised as follows: Section III describes survey techniques, data and analytical method used in the study, and Section IV presents the findings and the final section deliberates on the implications for policy and further research.

## II

### DATA AND METHODOLOGY

*Data:* The study is based on the primary data collected in the year 2007 at the farm level in three states of India—Bihar, Punjab, and Uttar Pradesh.<sup>1</sup> These states capture the geographical as well as institutional diversity of milk production and marketing in the country. They are among India's largest milk-producing states, accounting for 5.5 per cent, 8.9 per cent, and 18 per cent, respectively, of the national milk production. However, stark variations exist across them in terms of milk productivity and per capita milk availability. Punjab exhibited the highest level of per capita milk availability (962 g/day) and milk productivity (7.9 kg/day/milking animal), and Bihar was one with the lowest per capita milk availability (only 170 g/day) and milk productivity (3.7 kg/day/milking animal) (Department of Animal Husbandary, Government of India). In Uttar Pradesh, milk productivity (3.9 kg/day/milking animal) and milk availability (273 g/day/person) levels were higher as compared with Bihar but were substantially lower than Punjab. Three districts, one from each state, selected purposively, were Patna in Bihar, Roopnagar in Punjab, and Aligarh in Uttar Pradesh. Three administrative blocks were randomly selected from each selected district, and from each selected block, three villages were randomly selected. From each block, 75 dairy households were selected for the survey. At the village level, the number of sample households was decided in proportion to the village population. The sample households were post-stratified into different categories, namely, landless, marginal, small, medium and large households. Thus, 225 households were selected from each state, making a total sample of 675 dairy farming households. Care was taken to have a fair representation of all categories of households. The data gathered covered a wide range of information on household, farm, and milk marketing practices being followed as well as compliance with food safety measures in milk production at the farm level.

### *Methodology*

The first step is to identify and select appropriate impact indicators. There could be an umpteen number of indicators which can indicate effectiveness of farmers'

integration with milk co-operatives. The analytical approach of this study is built on a cross-sectional data collected through a field survey. The different dimensions of impact of the co-operative on farmers' performance are expressed in terms of some critical indicators. These indicators include herd size and its composition, milk production and productivity, market access and adoption of food safety standards.

To make a comparative assessment of the adoption status of compliance with food safety measures across different farm categories, an index of adoption of food safety practices was developed based on the weighted scores of different components of the food safety practices. The 42 practices followed by the dairy farmers were grouped under four categories—animal health, hygienic milking, hygienic storage, and maintenance of the hygienic premises and surrounding environment. These four categories were accorded weights of 0.30, 0.35, 0.20, and 0.25, respectively, based on their relative importance in ensuring milk safety.<sup>2</sup> The number of practices followed in each category was multiplied by respective weight and then summed over all the categories to obtain a weighted score of adoption of the food safety practices. Thus, the food safety index,  $I_j$ , of a farm household was represented as follows.

$$I_j = \sum w_j n_j \quad \dots (1)$$

Where  $w$  = Weight of the  $j$ -th hygienic category ( $j = 1$  to  $4$ ), and

$n$  = Number of practices related to the  $j$ -th hygienic category adopted by farm households. The score obtained was standardised by dividing maximum possible score. Thus, the food safety score will vary from 0 to 1.

The additional cost of compliance with the food safety measures due to a change/supplementation in different measures was calculated based on the data generated from the field survey as per Equation (2).

$$\text{Additional Cost of Compliance} = \text{Potential Cost of Compliance} - \text{Actual cost of Compliance} \quad \dots (2)$$

For details, kindly see Kumar *et al.*, (2011).

#### IV

#### INDICATORS OF IMPACT FOR DAIRY CO-OPERATIVES

Are co-operatives significantly better compared to non-member farmers in terms of different indicators mentioned above? This section gives a comparative performance of members and non-members of dairy co-operatives in terms of distinct indicators.

### *Herd Size and Quality of Animals*

The summary comparison of the co-operative and independent farmers indicates that cooperative farmers have relatively bigger size of the herd and also qualitatively the composition of the herd size is better than the counterpart (Table 1). The average herd size of co-operative dairy farmer was found to be 5.6 Standard Animal Units (SAU), as compared to 3.6 SAU for non-co-operative farmers. Similarly, on an average, 54 per cent of bovine milch animals with co-operative dairy farmers were of improved breed, while only 40 per cent of the milch animals of non-co-operative dairy farmers were of improved type. The significant difference is pervasive across different states. The herd size of co-operative dairy farmers in Bihar was about 68 per cent bigger than their non-co-operative counterpart. The level of adoption of improved breeds on dairy co-operative farmers in Bihar is almost three times higher than non-co-operative farmers.<sup>3</sup> On similar lines, both herd size and the level of adoption of improved breeds were found significantly higher for co-operative members than non-members in Punjab and Uttar Pradesh too.

TABLE 1. HERD SIZE AND ADOPTION OF IMPROVED BREEDS AMONG CO-OPERATIVE AND INDEPENDENT FARMERS

States (1)	Herd size (TLU) (No. /hh)			Adoption of improved/cross-bred animal (per cent)		
	Member (1)	Non-member (2)	t-Value (3)	Member (4)	Non-member (5)	t-value (6)
Bihar	4.2	2.5	2.27**	56.7	20.5	6.11***
Punjab	5.8	3.6	4.11***	52.0	33.6	4.29***
Uttar Pradesh	5.9	4.7	1.27*	66.5	51.8	2.00**
All	5.6	3.6	5.26***	53.8	39.8	5.04***

Source: Authors' calculations based on field survey.

Note: \*\*\*, \*\*, \* indicate 1, 5 and 10 per cent level of significance, respectively.

### *Milk Production and Productivity*

One of the questions most often asked is about the impact of co-operatives on the milk production and productivity. To assess the impact of co-operatives on milk production and productivity, the household milk yield was assessed separately for co-operative and independent farmers. Table 2 shows that the average yield contribution from the co-operative farmer is about 14 litres of milk per day with a productivity of 6 litres per milch animal per day, and independent farmer was 8 litres with a productivity of 5.3 litres. There is a great difference in the level of the household milk production and productivity between member and non-member farmers of the dairy co-operative society. The co-operative members appear to have gained considerably in the least developed state, Bihar. The household milk production contribution from co-operative dairy farmers was more than three times in comparison to independent dairy farmers. Similar findings in this regard were obtained from Punjab and Uttar Pradesh.

TABLE 2. HOUSEHOLD MILK PRODUCTION AND PRODUCTIVITY

States (1)	Household milk production (litres/day)			Milk productivity (litres/animal/day)		
	Member (2)	Non-member (3)	t-Value (4)	Member (5)	Non-member (6)	t-Value (7)
Bihar	9.0	2.6	5.21***	6.4	3.8	4.70***
Punjab	14.4	8.2	4.37***	6.4	5.4	2.64***
Uttar Pradesh	17.3	13.1	1.97**	6.5	5.9	0.82
All	13.9	8.0	6.34***	6.4	5.3	4.17***

Source: Same as Table 1.

Note: \*\*\*, \*\*, \* indicate 1, 5 and 10 per cent level of significance, respectively.

### Market Access

There was significant difference between milk sold by the co-operative and independent dairy farming households in the villages. On an average, the dairy farmer associated with co-operatives sold 9.5 litres of milk per day against 5.5 litres only by the independent farmers. However, marketed milk as a percentage of milk production does not seem to differ much among member and independent households. Both of them sold out more than two-third of their household milk production (Table 3). Though more or less same in terms of proportion of milk sold, the relatively lower availability of milk for domestic consumption indicates prevalence of distress sale by non-member households.

TABLE 3. MARKETED MILK AMONG CO-OPERATIVE AND INDEPENDENT FARMERS

States (1)	Member (2)	Non-Member (3)	(litres/day) t-value (4)
Bihar	5.5 (60.7)	1.2 (44.5)	2.32**
Punjab	9.8 (67.9)	5.1 (62.3)	2.50**
Uttar Pradesh	13.2 (76.2)	9.8 (75.0)	1.08
All	9.5 (68.1)	5.5 (68.7)	3.27***

Source: Same as Table 1; Figures in parentheses indicate percentage of the household milk production.

### Economics of Milk Production

The contribution of the dairy co-operatives in enhancing the economic welfare is perhaps the most important indicator that attracts or induces dairy farmers to become members of the dairy co-operative society. The integration with dairy co-operatives would be preferred if the farmers visualise the potential of co-operative in enhancing their economic welfare. The operational economics of milk production by co-operative and independent farmers are given in Table 4. The summary comparison of operating profits suggests that the dairy co-operative farmers are significantly better than independent farmers. On an average, co-operative dairy farmers fetch an operating profit of Rs 2.60 per litre as compared to only 0.30 per litre by independent farmers (Table 4). Consequently, returns to family labour per hour or per unit of milk production is significantly higher for co-operative farmers than independent farmers.

Though, previous findings are mixed in this regard, majority of the studies have reported higher profits for the farmers associated with dairy co-operatives (Birthal *et al.*, 2007, 2009; Sharma *et al.*, 2009; Sarker and Ghosh, 2008 ).

TABLE 4. ECONOMICS OF MILK PRODUCTION

Particulars (1)	(₹/litre)	
	Member (2)	Non-member (3)
Costs incurred per litre of milk production	11.5	12.3
Dry fodder	3.8	3.7
Green fodder	0.9	1.0
Concentrates	4.5	4.4
Family labour	2.2	3.0
Veterinary cost	0.2	0.2
Net price received for milk sold (per litre)*	14.2	12.6
Margin (₹ per litre)*	2.6	0.3
Return of family labour (₹ per hour)*	8.5	0.6
Return of family labour (₹ per litre)***	4.6	3.2

Source: Same as Table 1.

Note: \*\*\* and \* indicate 1 and 10 per cent level of significance, respectively.

#### *Adoption of Food Safety Measures in Milk Production*

The increase in consumer demand for greater food safety and quality along with the complex nature of food safety hazards, greater attention for compliance with the food safety measures at the farm level is advocated. Food safety measures compliance at the farm level is vital to ensure quality and safety of the produce being consumed at the end of the chain. The issues of food safety in milk are often debated in the media and the governments have been taking several measures for ensuring clean milk production. However, the outcome seems to be far from satisfactory. More than 26 per cent of the samples collected randomly by the Food Safety Standards Authority of India failed to meet even the basic requirements of being a safe product (FSSAI, 2012). It is in this context, co-operatives can play an enabling role in promoting adoption of food safety measures at the farm level by involving and sensitising farmers about the potential benefits of the safety measures. Empirically, co-operatives appear to have brought about a positive change in enhancing adoption of milk safety measures by the farmers' (Table 5). As evident from the respective food safety scores, the level of compliance with food safety measures in milk production was found

TABLE 5. FOOD SAFETY SCORE ACROSS STATES

State (1)	Member (2)	Non-member (3)	t-value (4)
Bihar	0.45	0.40	1.55*
Punjab	0.53	0.49	4.13***
Uttar Pradesh	0.48	0.43	1.51*
All	0.52	0.43	11.58***

Source: Same as Table 1; \*\*\*, \*\*, \* indicate 1, 5 and 10 per cent level of significance, respectively.



significantly higher for the farmer-members of co-operatives in all states than the counterpart.

Further, co-operatives have helped farmers to reduce the cost of compliance for adoption of milk safety measures at the farm level. While the additional cost of compliance for member farmers was Rs. 0.41/litre of milk, it was higher at Rs. 0.50/litre for non-member farmers (Table 6). This pattern was uniform across states, with the highest differential found in Bihar. The additional cost for compliance with food safety measures may dissuade farmers to adopt better safety and hygienic practices for milk production. However, the results show that dairy farmers can offset their additional cost significantly by getting integrated with co-operatives.

TABLE 6. COST OF COMPLIANCE FOR ADOPTION OF MILK SAFETY MEASURES

States (1)	Member (2)	Non-member (3)
Bihar	0.47	0.67
Punjab	0.42	0.47
Uttar Pradesh	0.32	0.40
All	0.41	0.50

Source: Same as in Table 1.

By and large, the findings suggest that co-operatives have a positive impact on the herd size and its quality, milk production, productivity and profitability. It also has a positive impact on the adoption of the milk safety measures with reduction in additional cost of compliance. In other words, these findings prove that further expansion of co-operatives may induce an increase in milk production and productivity as well as improve milk quality. The integration of dairy farmers with the co-operative would also thereby enhance their overall competitiveness in milk production.

## V

### DETERMINANTS OF PARTICIPATION IN DAIRY CO-OPERATIVES

The above indicators explicitly suggest that the dairy farmers associated with co-operatives are better placed than their independent counterpart. Now, the pertinent question is why there are farmers still not associated with co-operatives? These farmers are rearing their cattle in the same area, facing similar production environments and having similar access to infrastructure and markets. To decipher the role of different factors in explaining the association of dairy farmers with dairy co-operative societies (DCS), probit analysis was carried out with membership in DCS (member-1, non-member – 0) as the dependent variable. The choice of the explanatory variables included in the analysis was guided by previous empirical literature on this issue (Roy and Thorat, 2008; Sharma *et al.*, 2009, Kumar *et al.*, 2011; Fisher and Qaim, 2012; Abebaw and Haile, 2013 etc.) and the relevance of the

variables in the specific settings. Educational status of the households (divided in four classes, viz., illiterate, primary, secondary and above secondary), size of the farm households, herd size of dairy animals, experience of the farmers in the number of years engaged in dairy farming and economic status of the households measured in terms of annual income were taken as independent variables. These variables capture the important personal and household characteristics. Apart from these, dummy variables<sup>4</sup> corresponding to the land class, state and caste, to which the households belonged to, were also included as explanatory variables to account for unobserved agro-climatic, institutional, policy and socio-economic diversities among the sample states.

TABLE 7. PROBIT ESTIMATION: FACTORS DETERMINING PARTICIPATION/ASSOCIATION IN DAIRY CO-OPERATIVE SOCIETIES

Dependent variable – Co-operative member (member-1, non-member – 0)		
Variable (1)	Coefficient (2)	Robust standard error (3)
Constant	-2.2243***	0.2970
Education class (illiterate = 0, primary = 1, secondary = 2 & above secondary = 3)	0.1309**	0.0671
Household size (no.)	-0.0231	0.0172
Herd size (no.)	0.0515**	0.0253
Experience in dairy (year)	0.0095**	0.0047
Annual household income (₹)	-0.0004	0.0005
Land class 1 (marginal = 1 otherwise = 0)	-0.0130	0.2102
Land class 2 (small = 1 otherwise = 0)	0.1951	0.2411
Land class 3 (medium = 1 otherwise = 0)	0.5033**	0.2486
Land class 4 (large = 1 otherwise = 0)	0.5970**	0.3062
Caste (SC/ST = 1, otherwise = 0)	-0.4924**	0.2142
State 1 (Bihar = 1, otherwise = 0)	1.9463***	0.1847
State 2 (Punjab = 1, otherwise = 0)	0.5633***	0.1949
No. of observations	675	
Pseudo R <sup>2</sup>	0.352	
Wald Chi square	198.7***	

Note: \*\*\* and \*\* denotes significance at 1 and 5 per cent level, respectively.

The results of the probit regression are presented in Table 7. The model was significant at 1 per cent level as indicated by the Wald Chi square statistic. Mandatory check for heteroscedasticity was undertaken using heteroscedastic probit model, and the corresponding likelihood ratio suggested absence of heteroscedasticity. The estimates of the model suggested significant positive relationships between co-operative memberships of farmers and their education status, experience in dairying, and size of herd in their farm. This finding is quite intuitive in the sense that, exposure gained through better education and experience in dairying as well as larger scale of farming enhances farmers' inclination towards participation in co-operatives. On the other hand, household size and economic status did not matter in determining the DCS membership of a dairy farmer. Among the various land classes, medium and large farmers had better probability of becoming co-operative members than other smaller

land classes, as indicated by the significant levels of the corresponding dummy estimates. Another notable finding is that farmers belonging to lower caste categories (SC/ST) had less probability of becoming a co-operative member in relation with their higher caste counterparts. The negative and significant coefficient of the caste dummy clearly brings out this fact. These findings indicate lack of inclusiveness in development of co-operatives in the study area as both marginal holders and backward category farmers find lower chances to become beneficiaries. Proactive measures are therefore required to correct this anomaly and make all social and economic categories to be equal partners in the process of development. Similarly, state dummies indicate significant probability for farmers to become members of DCS in the respective states. This implies that state level factors associated with socio-economic, policy and institutional settings are important determinants in enhancing the participation of farmers in cooperatives.

In a nutshell, the above probit regression unambiguously suggests that the socio-economic and demographic factors like education, experience, scale of farming, size of holdings, caste affiliation, etc., determine whether a dairy farmer is inclined to participate in co-operatives or not.

## V

### CONCLUSIONS

Co-operatives have been the backbone of India's dairy development strategy ever since the Operation Flood project was launched in the early 1970s. Their enabling role in making an average Indian dairy farmer self-sustainable has been well acclaimed globally. The findings of this paper indicate that the status of co-operatives as a multifunctional entity for the dairy farmers of rural India is still intact. A cross comparison between the member and non-member farmers of the dairy co-operatives suggests that the scale of farming and level of adoption of improved animals has been significantly higher for the member farmers. Similarly, the co-operative member households contributed significantly higher quantity of milk at higher levels of productivity than the non-member counterpart. The co-operative members also had better market access for selling their milk. They could produce milk at a lower per unit cost and realised higher prices than the non-member farmers. More importantly, these farmers were relatively better adopters of milk safety and hygiene practices and had lower additional cost of compliance that in turn would promote better compliance. The paper identified the major factors that enabled dairy farmers to participate in co-operatives. The results of the probit analysis suggested that the socio-economic and demographic factors like education, experience, scale of farming, size of holdings, caste affiliation, etc. determine participation of dairy farmers in the co-operatives. The study therefore concludes that membership in co-operatives gives a distinct advantage for the dairy farmers to enhance their milk production, productivity and quality and thereby increase their competitiveness in both domestic and international markets. The

potential of this institution has not so far been fully exploited in the country, and initiatives to further empower them would pay rich dividends in future.

#### NOTES

1. The selected district in Uttar Pradesh is more representative of Western Uttar Pradesh.
2. As per the expert opinion, different practices have differential impact on food safety.
3. Though the level of adoption of improved breeds differs considerably across states, it may not be fully reflected on milk yield levels as local breeds in sample districts are comparably good yielding.
4. The categories considered for the variables land class, state and caste are: Land class: landless, marginal (<1ha), small (1-2 ha), medium (2-4 ha) and large (>4 ha); State: Bihar, Punjab and Uttar Pradesh; Caste: Low caste (SC/ST) and High caste (OBC, General, etc.)

#### REFERENCES

- Birthal, P.S., P.K. Joshi and Ashok Gulati (2007), "Vertical Coordination in High-Value Food Commodities: Implications for Smallholders", in P.K. Joshi, Ashok Gulati and Ralph Cummings Jr. (Eds.) (2007), *Agricultural Diversification and Smallholders in South Asia*, Academic Foundation, New Delhi, pp.405-40.
- Birthal, P.S.; Awadhesh K. Jha, Marites M. Tiongeo and Clare Narrod (2009), "Farm-Level Impacts of Vertical Coordination of the Food Supply Chain: Evidence from Contract Farming of Milk in India", *Indian Journal of Agricultural Economics*, Vol. 64, No. 3, July-September, pp.481-95.
- Berdegue, J.A. (2001), *Co-operating to Compete. Associative Peasant Business Firms in Chile*, Ph.D. Thesis, Wageningen University and Research Centre, Department of Social Science, Communication and Innovation Studies Group: Wageningen, The Netherlands.
- Candler, W. and N. Kumar (1998), *India: The Dairy Revolution: Impact of Dairy Development in India and the World Bank's Contribution*, The World Bank Operation Evaluation Department (OED), The World Bank, Washington, D.C., U.S.A.
- Cunningham, K. (2009), *Rural and Urban Linkages: Operation Flood's Role in India's Dairy Development*, Discussion Paper 924, International Food Policy Research Institute, Washington D.C., U.S.A..
- FSSAI (2012), *Website of Food Safety Standards Authority of India*, available at [www.fssai.gov.in](http://www.fssai.gov.in) accessed in December, 2012.
- Fisher, E. and M. Qaim (2012), "Linking Smallholders to Markets: Determinants and Impacts of Farmer Collective Action in Kenya", *World Development*, Vol.40, No.6, pp.1255-68.
- Government of India, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture.
- Holloway, G.; C. Nicholson, C. Delgado, S. Staal and S. Ehui (2000), "Agro Industrialization Through Institutional Innovation: Transaction Costs, Co-operatives and Milk-Market Development in the East-African Highlands", *Agricultural Economics*, Vol.23, pp.279-288, <http://dx.doi.org/10.1111/j.1574-0862.2000.tb00279.x>.
- Kumar, Anjani (2010), "Milk Marketing Chains in Bihar: Implications for Dairy Farmers and Traders", *Agricultural Economics Research Review*. Conference Issue, pp.469-77.
- Kumar, Anjani; Steven J. Staal, Lucy Lapar and Isabelle Baltenweck (2010), "Traditional Milk Market in Assam: Potential for Income and Employment Generation", *Indian Journal of Agricultural Economics*, Vol. 65, No.4, October-December, pp.747-59.
- Kumar, Anjani, Steven J. Staal and Dhiraj K. Singh (2011a), "Smallholder Dairy Farmers' Access to Modern Milk Marketing Supply Chain in India", *Agricultural Economics Research Review*, Vol.24, No.2, pp.243-253.
- Kumar, Anjani, I.A. Wright, and D.K. Singh (2011b), "Adoption of Food Safety Practices in Milk Production: Implications for Dairy Farmers in India", *Journal of International Food and Agribusiness Marketing*, Vol.23, No.4, pp.330-344.

- Kumar, Anjani and P.K. Joshi (2012), *Structural Transformation in Indian Dairy Sector*, National Centre for Agricultural Economics and Policy Research, New Delhi, Project Report (Unpublished).
- Lele, U. (1981), "Co-operatives and the Poor: A Comparative Perspective", *World Development*, Vol.9, No.1, pp.55-72.
- Mergos, George and Roger Slade (1987), *Dairy Development and Milk Cooperatives: The Effect of a Dairy Project in India*, World Bank Discussion Paper No. 15, Washington, D.C., U.S.A.
- Narrod, C.; D. Roy, J. Okello, B. Avendano, K. Rich and A. Thorat (2009), "Public-Private Partnerships and Collective Action in High Value Fruit and Vegetable Supply Chains", *Food Policy*, Vol.34, No.1, pp.8-15.
- Roy, Devesh and Amit Thorat (2008), "Success in High Value Horticultural Export Markets for the Small Farmers: The Case of Mahagrapes in India", *World Development*, Vol.36, No.10, pp.1874-90.
- Sarker, Debnarayan and Bikash Kumar Ghosh (2008), "Economics of Milk Production in West Bengal: Evidence from Co-operative and Non-co-operative Farms", *East West Journal of Economics and Business*, Vol.11, Nos.1&2, pp.132-152.
- Sharma, V.P., Kaplesh Kumar and R.V.Singh (2009), *Determinants, Costs, and Benefits of Small Farmer Inclusion in Restructured Agrifood Chains: A Case Study of Dairy Industry in India*, Paper presented in 19<sup>th</sup> IAMA Annual World Forum and Symposium, June, 2009, Budapest, Hungary.
- Stockbridge, M., A. Dorward and J. Kydd (2003), *Farmer Organizations for Market Access: A Briefing Paper*. Wye College, University of London, UK.
- Shukla, R.K. and S.D. Brahmankar (1999), *Impact Evaluation of Operation Flood on Rural Dairy Sector*, National Council of Applied Economic Research, New Delhi.
- Singh. K. and V.M. Das (1984), *Impact of Operation Flood I at the Village Level*, Research Report No. 1, Institute of Rural Management, Anand, India.
- Singh, Katar and R.S. Pundir (2000), *Co-operatives and Rural Development in India*, Research Paper 17, Institute of Rural Management, Anand.
- Singh, R.K.P. (1996), "Dairy Co-operatives: Organizations of the Poor in Bihar", in R. Rajagopalan (Ed.) (1996), *Rediscovering Cooperation, Vol. 3-Co-operatives in the Emerging Context*, Institute of Rural Management, Anand.