

SUBJECT III
IMPLICATIONS OF CORPORATE ENTRY INTO
AGRICULTURAL INPUT AND OUTPUT MARKETS AND ITS
IMPACT ON SMALL PRODUCERS AND CONSUMERS

Farm-Level Impacts of Vertical Coordination of the
Food Supply Chain: Evidence from Contract
Farming of Milk in India

Pratap S. Birthal*, **Awadhesh K. Jha****, **Marites M. Tiongco†**
and Clare Narrod†

I

INTRODUCTION

Agriculture and agri-food marketing system in India have been undergoing some fundamental changes since initiation of the economic reforms process in 1991. Three notable, but interrelated changes, that have occurred until now include: (i) a significant shift in the food consumption pattern away from staple foodgrains towards high-value foods, such as fruits, vegetables and animal products, and hence a faster growth in their demand (Kumar and Birthal, 2007); (ii) a strong tendency of diversification of agriculture towards high-value food commodities as to meet their growing demand (Birthal and Taneja, 2006; Birthal *et al.*, 2007); and (iii) a transition in the food marketing system from traditional *ad hoc* transactions dominated by intermediaries towards institution-driven coordinated supply systems, like co-operatives, growers' associations and contract farming that beside coordinating demand and supply also address consumer concerns regarding food safety and quality (Birthal *et al.*, 2005; Birthal and Joshi, 2007; Birthal, 2008; Delgado *et al.*, 2008; Roy and Thorat, 2008).

Such policy-induced changes and adjustments in agriculture and agri-food marketing system are likely to impact the welfare of millions of farmers. Compared to foodgrains, high-value food commodities generate larger returns to land, labour and capital (Joshi *et al.*, 2006; Weinberger and Lumpkin, 2005); and their fast expanding demand is an opportunity for millions of farmers, especially small farmers to enhance their income by diversifying their production portfolio towards these

*International Crops Research Institute for the Semi-Arid Tropics, Patancheru – 502 324 (Andhra Pradesh),
**Sanjay Gandhi Institute of Dairy Technology, Patna – 800 020 (Bihar) and †International Food Policy Research
Institute, Washington, D.C., U.S.A.

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commodities. The capability of small farmers to expropriate the emerging opportunities in the high-value segment of agriculture is often questioned because of their lack of access to profitable markets, capital, improved technology, quality inputs, information, and support services (Glover and Kusterer, 1990; Key and Runsten, 1999; Holloway *et al.*, 2000). Most high-value food commodities are perishable and require immediate transportation to markets or consumption centers; cold storage or processing into less perishable forms, while local rural markets for these are thin and selling in distant urban markets is non-remunerative due to high transportation and transaction costs. These costs are higher for small farmers who produce and market smaller quantity (Birthal *et al.*, 2005). Thus, the lack of access to markets reduces incentives to produce high-risk high-value food commodities (Holloway and Ehui, 2002).

Vertical coordination of the food supply chain through co-operatives, producers' associations, and contract farming is one of the few alternatives that can facilitate small farms' diversification by reducing price risks and transaction costs. Contracts that provide credit, technology, inputs, information, extension services, and risk mitigation help producers improve production efficiency; develop commercial culture; and augment income and employment (Warning and Key, 2002; Patrick, 2004; Birthal *et al.*, 2005; Ramaswami *et al.*, 2006; Miyata *et al.*, 2007).

Contract farming is, however, viewed with skepticism. There is an argument that contract farming is a partnership between unequals, and the 'producers' being a weaker party is vulnerable to exploitation by the dominant party, the "firms/integrators". The integrators may extract monopsonistic rent in the output markets by manipulating terms and conditions to their advantage (Little and Watts, 1994; Singh, 2002). In addition, contract farming often favours production of cash/commercial commodities that require investment in specific assets, and when the markets are imperfect, the high-asset specificity renders farmers poor bargainers (Little and Watts, 1994; Singh, 2002). The contract farming is also criticised for its bias against small farmers. The integrators/processors to avoid the transaction costs of contracting (negotiation, monitoring and enforcement of contracts) with a large number of smallholders often prefer having contracts with a few large producers (Glover and Kusterer, 1990; Little and Watts, 1994; Key and Runsten, 1999).

Empirical evidence on the true costs and benefits of contract farming is scarce and anecdotal. In this paper, we attempt to quantify the costs and benefits of contract farming of milk and also identify factors that influence farmers' participation in contract farming. Our hypothesis is that contract farming benefits producers more by reducing marketing and transaction costs than by causing improvements in productivity. The paper is organised as follows. The next section describes briefly the data used in this paper, and is followed by a section describing contractual arrangements between dairy producers and processors. Section IV presents analytical approach used to examine the impact of contract farming on income, and the results are discussed in Section V. The concluding remarks are made in the final section.

II

DATA

We use primary data from a household survey conducted in two purposively selected districts- Jaipur and Sikar- that have high milk production potential as well as a greater scope for commercialisation of dairying. Jaipur is the capital city and 50 per cent of its population is urban, while Sikar is an adjoining district to Jaipur and supplies considerable amount of milk to consumers in Jaipur. A number of dairy players, including co-operatives, private firms, and vendors, operate in the local milk markets in these districts. Some important firms operating in these districts include GK Dairy Industries, Modi Dairy, and Lotus Dairy.

From each of the selected district, two blocks¹ with a higher degree of commercial dairying were selected. These are Amer and Chomu from Jaipur, and Sri Madhopur and Dataramgarh from Sikar. An important consideration for their selection was the presence of private dairy processors in these blocks. A random sampling was done to select 10 villages from the identified blocks - two to three villages from each block. Before selection of farm households, a few focused group discussions were also conducted with dairy producers as to determine the limits of classification of dairy farmers into small, medium, and large producers *ex ante*. Accordingly, the dairy farmers having less than 4 milch animals at the time of survey were classified as small, those having 4-6 milch animals as medium, and above 6 milch animals as large/commercial farmers. In each village, dairy producers (excluding members of dairy co-operatives, if any) were identified and classified as contract and independent producers.² A sample of 150 contract producers and 150 independent producers was randomly drawn imposing that the sample from each farm size category (small, medium and large) is approximately equal. The survey was conducted in November 2005. The information on milk production and transaction was collected only once for the preceding day or week, because of time and budgetary constraints. The survey should have ideally been undertaken on a regular interval, at least a few times a year to capture seasonal variation in milk yield, feeding rates and prices.

Table 1 provides key characteristics of the contract and independent milk producers. On average, compared to an independent dairy producer, a contract producer was older in age, had a larger land holding, a larger family size and more number of workers. They, however, do not differ significantly in their schooling and animal holdings. These observations also hold when contract and independent producers are compared at a similar scale that is small, medium and large.

TABLE I. SELECTED CHARACTERISTICS OF CONTRACT AND INDEPENDENT DAIRY PRODUCERS

(1)	Contract				Independent			(9)
	Small (≤ 3 milch animals)	Medium (4-6 milch animals)	Large (> 6 milch animals)	All	Small (≤ 3 milch animals)	Medium (4-6 milch animals)	Large (> 6 milch animals)	
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
No. of observations	50	49	51	150	50	51	49	150
Age of the head of the household (years)	42.9** (9.32)	44.2 (8.99)	48.3*** (8.91)	45.2*** (9.30)	40.5 (8.23)	44.8 (7.76)	44.1 (8.64)	43.1 (8.37)
Years of schooling of the household head	6.3 (5.09)	7.2 (4.48)	7.1 (6.23)	6.8 (5.31)	7.2 (4.11)	6.8 (4.68)	6.7 (4.83)	6.9 (4.52)
Family size	9.1 (3.87)	10.9*** (3.92)	14.2 (5.09)	11.4** (4.80)	8.8 (3.77)	9.0 (3.42)	13.9 (6.18)	10.6 (5.12)
No. of workers/household	4.6 (1.85)	5.3*** (2.05)	6.3 (2.48)	5.4** (2.25)	4.3 (1.79)	4.0 (1.69)	6.4 (2.84)	4.9 (2.40)
Landholding (ha/household)	2.7*** (2.12)	3.2* (1.98)	6.3*** (4.27)	4.2*** (3.41)	1.7 (1.44)	2.8 (2.32)	4.7 (2.87)	3.2 (2.60)
Milch animals (No./household)	2.40 (0.70)	4.61 (0.64)	9.06 (2.43)	5.39 (3.17)	2.44 (0.64)	4.55 (0.70)	9.47 (5.18)	5.45 (4.19)

Note: Figures in parentheses are standard deviations. ***, ** and * significantly different over their counterpart independent producers at 1, 5 and 10 per cent respectively.

III

MILK MARKETING SYSTEMS AND CONTRACT FARMING

India is the largest producer of milk in the world. In 2006-07 it produced 97 million tonnes of milk (<http://www.nddb.org/statistics/milkproduction.html>). Approximately, half of the total milk produced enters the market mostly through informal channels (Anon, 2007). This is also true in the state of Rajasthan where milk marketing is largely unorganised. The producers sell fresh milk directly to rural as well as urban consumers. Direct transactions are prominent in urban and peri-urban areas and are more pronounced among small-scale producers. Some large producers from remote rural locations also sell supply milk directly to urban consumers. In general, large producers sell milk to sweet shops, restaurants and hotels and in urban milk market (*mandi*). In the case of direct transactions, producers are able to retain much of the price paid by the consumers, but the cost of the search (for buyers) and milk delivery can be very high. Another important functionary in the milk market in India is the local milk vendor, who buys milk from producers and sells it directly to urban consumers and/or to sweet shops, restaurants or hotels. Sometimes the vendor advances credit to the producers - mainly small-scale producers - to ensure a regular supply of milk. Sub-contracting also exists in informal markets. Some small-scale processors who are unable to invest in milk procurement infrastructure obtain milk supplies through contractors who collect milk for them on a commission basis. Like vendors, contractors also provide credit to the producers.

Co-operatives and private processors are the two most important players in the formal milk market in India. In 2007-08, Rajasthan had 13681 dairy co-operative societies with about 645,000 dairy producer-members delivering 496,000 tonnes of milk (<http://www.nddb.org/achievement/physical-progress.html>), equivalent to 5.2 per cent of the milk produced in the state. Dairy processing facilities in Rajasthan are still inadequate, with about 27 processing plants, 9 of which belong to the private sector (http://dahd.nic.in/stat_files/BAHS2006web.pdf). Most private dairy processors source milk through direct or indirect contracts. These contracts are representative of either market specification, or resource-providing contract³ or a combination of the two.

Often the firms find it costly to contract directly with a large number of small-scale producers because of substantial costs in information search, and negotiation and enforcement of the contract. The way they address this situation is to make agreement with a local villager who acts as an intermediary (that is to say, an agent) between the firm and the dairy producers, rather than to make an agreement with the individual producers. The firm ensures that the agent is an apolitical and non-controversial person, capable of motivating producers to supply milk to the firm. The agent procures milk, helps the firm in dissemination of information, distribution of inputs, and provision of services, and makes payments to the producers. The agreement is informal, but specifies terms and conditions with respect to the quantity, quality and price of milk; contract duration; mode of payments; sharing of costs and risks; moral hazards; dispute settlement and so on.

The agent/producer provides the space for milk collection, and the firm provides the necessary equipment - such as weighing scales, milk analysers, milk coolers, and water geysers used for temporary storage of milk—at no cost to the agent. Operational expenses are borne by the agent, while the costs of transportation of milk from the collection center to the firms' processing plant are borne by the firm. The contract agreement also provides for risk-sharing mechanisms, duration of the contract and the conditions for termination or renewal of the contract.

A majority of the contract producers have an informal understanding with the agent to supply milk. They can sell any amount of milk to the agent/firm provided the agent is assured of a regular supply and good quality (based on fat and SNF [solids non-fat] content) of milk.⁴ Each producer-supplier is provided with a passbook for recording transactions with respect to quantity of milk supplied, fat and SNF content, and payments. The price of milk is determined on the basis of fat and SNF contents, but most firms also consider the prices paid by other competitors in the local market. Payments to the producer-suppliers are generally made at an interval of 10 to 15 days. The integrators/processors provide feed, medicines, vaccines, and mineral mixtures to the willing producers through the agents - generally at lower than the market prices - because the integrators purchase these inputs in bulk. Veterinary services are provided on demand and at nominal rates and advisory services are provided free of

charge. The integrators/processors monitor the contracts to avoid any conflict between the producers and the agent.

IV

ANALYTICAL APPROACH

Estimation of Costs and Returns

Using survey data we estimated and compared profits for contract and independent dairy producers. Costs include expenses incurred on production and marketing of milk as well as on acquisition of information, inputs and services. Production costs include expenses on variable inputs: feeds and fodder⁵ (such as dry fodder, green fodder and concentrate feeds); feed additives like mineral mixtures; as well as medicines, vaccines and human labour (owned and hired labour). Quantities of inputs fed to in-milk animals by a household were multiplied by their unit prices and were aggregated to arrive at the total cost of inputs. Labour cost was estimated using market wage rate prevailing in Rajasthan.⁶

The marketing and transaction costs incurred by the producers in the acquisition of information and inputs, and marketing of outputs were also quantified. These costs include cash costs of communication, transport, hired labour, and the imputed cost of family labour. A few producers, especially non-contract producers, occasionally combined other activities with input and output transactions, which could have resulted in a higher transaction cost than the actual cost associated with these transactions. To segregate the effect of non-dairy related activities, the respondents were asked to report time spent in dairy-related transactions only. Travel and transportation costs incurred in joint transactions were apportioned between dairy and non-dairy activities based on the volume of different transactions.

Marketing and transaction costs in the disposal of milk were straightforward. The total costs (travel, transportation, communication and labour) incurred in disposal of milk were divided by the amount of milk sold. Adding the unit cost in acquisition of inputs and disposal of output provides total transaction costs per unit of output. Net revenue was estimated as the difference between the realised sale price and its unit cost of production. The production and transaction costs, price, and net revenue of contract producers were compared with those of independent producers to examine the economic effect of contract farming.

Correction for Selectivity Bias in Assessment of Impacts

The difference in the net revenue of contract and independent producers need not necessarily be due to contract farming. It may be due to difference in unobservable characteristics (like management skills) of the two groups of producers. A

comparison of average revenue thus could be biased. To correct this bias, we apply a standard treatment effects model (Greene, 2003).

$$R_i = a + bC_i + cX_i + \varepsilon_i \quad \dots(1)$$

$$C_i = \gamma_1 + \gamma_2 Z_i + \dot{u}_i \quad \dots(2)$$

Where R_i is the net revenue of the i -th producer, C_i is a dummy variable taking the value 1 if one participates in a contract farming, and 0 if one does not participate. X_i is a vector of the variables believed to affect the net revenue and ε_i is a zero mean random variable; while b measures the impact of contracting on net revenue. An ordinary least squares (OLS) estimate of equation (1) is likely to be biased because of the effects of unobservable factors. Thus, ε_i (which contains within it the random unobservable factors) will be correlated with C_i . To correct for selectivity bias, equation (2) is estimated with a contract/independent producer as a binary dependent variable (C_i) and a set of explanatory variables Z_i . Variables in Z_i will overlap with variables in X_i . Identification requires that there should be at least one variable in Z_i that is not in X_i . Then, the predicted values (also known as the inverse Mills ratio) from equation (2) can be used as an instrument (of C_i) in equation (1).

V

RESULTS AND DISCUSSION

In this section we assess the impact of contract farming on milk yield, production costs, transaction costs, output prices, and profits.⁷ The analysis focuses on buffalo milk, as a majority of the sample producers did not maintain cows, while over 97 per cent of the independent and contract producers maintained buffaloes. Amongst the independent producers, over 60 per cent of them sell milk to vendors, and the rest sell it to consumers in the nearby urban markets.

Comparison of Averages for Contract and Independent Producers

Table 2 provides information on selected parameters for contract and independent producers. The average milk yield is slightly higher for contract producers compared to independent producers selling to consumers in the open market, which includes wholesale and retail shops, sweet shops, restaurants, fast food centers, and hotels. The milk yield is also high when compared to those who sell to vendors who collect milk from producers and sell milk in the open market.

TABLE 2. YIELD, COSTS, PRICES AND PROFIT IN MILK PRODUCTION ON CONTRACT AND INDEPENDENT FARMS, 2005

(1)	Independent			Significance of mean difference	
	Contract (2)	Open market (3)	Vendors (4)	Contract vs. open market (5)	Contract vs. vendors (6)
No. of producers	150	57	93		
Milk yield (l/in-milk animal/day)	9.30 (1.45)	9.00 (1.67)	9.24 (1.47)	NS	NS
Production costs (Rs./l)					
Feed	5.82 (1.10)	5.99 (1.03)	5.85 (1.14)	NS	NS
Labour ^a	2.76 (0.97)	2.87 (0.82)	3.05 (0.95)	NS	**
Total	8.58 (1.65)	8.86 (1.41)	8.90 (1.73)	NS	NS
Transaction costs (Rs./l)					
Transport	0.14 (0.11)	0.79 (0.42)	0.12 (0.07)	***	NS
Labour ^a	0.67 (0.32)	1.68 (0.73)	0.81 (0.57)	***	**
Total	0.81 (0.37)	2.47 (0.81)	0.93 (0.55)	***	NS
Total costs (Rs./l)					
Pecuniary	5.96 (1.14)	6.78 (1.04)	5.97 (1.17)	***	NS
Non-pecuniary	3.43 (1.12)	4.55 (1.39)	3.86 (1.24)	***	**
Total	9.39 (1.82)	11.33 (1.71)	9.83 (2.00)	***	NS
Price (Rs./l)	12.16 (0.67)	12.93 (0.58)	11.88 (0.38)	***	***
Net revenue over total cost (Rs./l)	2.77 (2.00)	1.60 (1.78)	2.05 (2.08)	***	**
Net revenue over pecuniary cost (Rs./l)	6.20 (1.28)	6.15 (1.09)	5.91 (1.24)	NS	NS

Source: Field survey.

^a Labour costs are the implicit cost of family labour. Use of hired labour is almost absent.

***, **, and * are statistically significant at 1, 5 and 10 per cent level of significance, respectively. NS stands for "not significant".

The unit cost of production was estimated at Rs 8.6 per litre for the contract producers, not significantly different than that of the independent producers. However, independent producers selling to vendors incurred higher labour costs. The labour cost to contract producers was 6 per cent less compared to those who sell in the open market, and 12 per cent less compared to those who sold to vendors. The corresponding difference in feed costs was 5 and 3 per cent, respectively.

Producers incurred costs in the acquisition of inputs and disposal of milk. Contract farming has reduced these costs significantly. On an average, a contract producer incurred transaction costs of Rs. 0.8 per liter of milk, which was about three times less than that for the independent producers selling in the open market. The producers selling to vendors also faced much lower marketing and transaction costs, but slightly more than that faced by the contract producers. The independent producers selling in the open market faced higher cash costs on travel and transportation, and also spent more labour hours in milk marketing.

Although the unit cost of production was almost similar for contract and independent producers, marketing and transaction costs made milk production costlier for the latter, especially for those selling in the open market. The total costs (production plus marketing and transaction costs) increased to Rs. 11.3 per litre for

independent sellers in the open market, to Rs. 9.8 per litre for sellers to vendors, and to Rs. 9.4 per litre for contract producers. Marketing and transaction costs were as high as 22 per cent of the total cost in the open market, as compared to 9 per cent under contract farming. Thus, the unit cost of milk production (including marketing and transaction cost) for open market sellers was 21 per cent higher compared to contract producers, and 5 per cent higher compared to those selling to milk vendors.

Milk prices were higher in the open market. The mean open market price was Rs.12.9 per litre, which was about 6 per cent higher compared to that offered under contract, and 9 per cent more than that offered by vendors. This is understandable as the integrators and vendors also incurred costs in the procurement and transportation of milk. Milk price paid by vendors was almost the same as that offered by the integrators. This implies that the local milk market is competitive, which is largely due to the presence of integrators.

Net revenue per litre of milk over paid-out costs was higher for contract producers (at Rs. 6.2/litre) than for independent producers, but not significantly. This was almost the same as realised by independent producers selling in the open market, but 5 per cent more compared to those selling to vendors. The difference, however, became significant when the net revenue was estimated over total costs (including imputed costs of family labour). Net revenue for contract producers was about twice of that realised by independent producers selling in the open market, and about 1.5 times that of those selling to vendors.

Table 3 compares means of key economic variables for different categories of dairy producers. Under contract farming, the average milk yield on small farms was 9.3 litres per animal per day, which was as much as that on large farms. Smallholders, however, incurred marginally higher cost in production. This relationship gives an indication that there are economies of scale in costs of dairy production, and mainly to economies in labour use.

Economies of scale are significant in marketing. A smallholder dairy farmer incurred Rs. 0.9 per litre of milk as marketing and transaction costs, compared to Rs. 0.8 per litre by a medium dairy farmer and Rs. 0.7 per litre by a large dairy farmer. Labour costs accounted for a sizeable proportion of total of these costs. The total cost (production plus marketing and transaction) per unit of output on small farms was about 18 per cent more compared to that of large farms and 4 per cent more than that on medium farms. The difference in paid-out costs alone however was not much. Milk prices were strikingly the same for all categories of contract producers, implying that contract farming did not practice price discrimination among producers. Net revenue over total cost was higher for large dairy producers. The difference was 63 per cent over smallholders and 39 per cent over medium producers. This difference, however, narrowed down considerably when net revenue was estimated over paid-out costs. In other words, scale economies, especially in labour use are important determinants of producers' competitiveness.

TABLE 3. COMPARATIVE ECONOMICS OF MILK PRODUCTION ON CONTRACT AND INDEPENDENT FARMS BY FARM SIZE, 2005

(1)	Contract			Independent					
	Small (≤3)	Medium (4-6)	Large (>6)	Open market			Vendor		
				Small (≤3)	Medium (4-6)	Large (>6)	Small (≤3)	Medium (4-6)	Large (>6)
(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	
Yield (l/in-milk animal/day)	9.30	9.44	9.16	9.08	9.19	8.73	9.39	9.18	9.2
Production costs (Rs./l)									
Paid-out	5.73	5.82	5.44	5.82	5.93	6.30	5.56	6.01	5.99
Family labour	3.12	2.73	2.17	3.14	2.92	2.41	3.27	3.16	2.75
Total	8.85	8.55	7.61	8.96	8.85	8.71	8.83	9.17	8.74
Marketing and transaction costs (Rs./l)									
Paid-out	0.16	0.15	0.11	0.95	0.84	0.78	0.11	0.12	0.12
Family labour	0.75	0.67	0.57	2.00	1.20	1.20	1.04	0.74	0.68
Total	0.91	0.82	0.68	2.95	2.04	1.98	1.15	0.86	0.80
Total cost (Rs./l)									
Paid-out	5.89	5.97	5.545	6.77	6.77	7.08	5.67	6.13	6.11
Family labour	3.87	3.4	2.742	5.14	4.12	3.61	4.31	3.9	3.43
Total	9.76	9.37	8.29	11.91	10.89	10.69	9.98	10.03	9.54
Milk Price (Rs./l)	12.12	12.14	12.13	12.88	12.90	12.99	11.84	12.09	12.1
Net return over total cost (Rs./l)	2.36	2.77	3.84	0.97	2.07	2.30	1.86	2.06	2.56
Net return over paid-out cost (Rs./l)	6.23	6.17	6.59	6.11	6.13	5.91	6.17	5.96	5.99

From smallholders' perspective, it is rather more appropriate to compare these parameters at similar scale between contract and independent producers. This would provide an insight on the extent of benefits derived by a particular category of producers on being associated with contract farming. Let us first examine contract producers versus independent producers supplying milk to vendors. Smallholder producers supplying milk to vendors were as efficient (in production) as their counterpart contract producers. They, however, faced higher marketing transaction costs compared to smallholder contract producers. Thus, total cost was less for smallholder contract producers. They got a better output price and thus higher profits. Medium and large contract producers also incurred less cost of production as well as transaction. They got marginally higher price, but significantly higher profits.

As compared to open market transactions, contract farming is more beneficial for all categories of dairy producers. Major benefits accrue from reduction in marketing and transaction costs. For independent producers, these costs were estimated Rs. 2.9 per litre of milk for smallholders, Rs. 2.5 per litre for medium producers and Rs. 2.0 per litre for large producers. These were about 3 times more than those for their counterpart contract producers. The unit cost of production for small and medium contract producers was marginally less than their counterparts selling in open market. The difference, however, was higher in case of large producers. On the whole, total cost per unit of output to contract producers was less than that for independent market suppliers, to the extent of 20 per cent in the case of small and medium producers and

30 per cent in the case of large producers. The independent market suppliers realised better prices compared to the contract price, this, however, did not fully compensate the costs they incurred in marketing. The profit (over total cost) under contract farming to all categories of producers was much higher than that realised by their counterparts in open market. Smallholder contract producers realised more than twice the profits over their counterparts selling in open market. This ratio declined with increase in scale. The difference in profits of contract and independent producers, however, narrowed down considerably when opportunity cost of family labour was assumed to be zero.

In sum, contract farming did not appear to make any significant difference in milk yield and cost of production, but it helped to improve farm profitability by reducing marketing and transaction costs. By farm size, all categories of contract producers realised more profits than their counterpart independent producers. The benefits were, however, skewed towards large producers. The milk price under contracts was lower than the open market price, but the contract producers were compensated by a substantial reduction in marketing transaction costs. In fact, this compensation amounted to much more than the price difference. Another major effect of contract farming was that it has induced competition in the rural milk markets, which otherwise were being dominated by vendors who often exploited the producers by paying less than the market price. Further, by providing some inputs and services, especially compound feed to producers at their doorsteps and at a price lower than the market price, the firm could reduce its unit cost of production.

Results of the Treatment Effects Model

Higher profits obtained with contract need not necessarily be due to their marketing arrangement with processors. These could be due to differences in the unobservable characteristics (like management skills) of the producers. A comparison of the average profit of the contract and non-contract producers could be biased.

This bias has been corrected using the 'standard treatment effects model'. In the first step of this approach, a logit model was estimated to identify the factors that influence a producer's decision as to whether or not to participate in contract farming. The dependent variable takes a value of 1 if a producer participates in contract farming, and is otherwise zero. Producers' experience, educational attainment, endowments of land, dairy stock, and access to non-farm income sources were considered important in producers' decision to participate in contract farming. Experience was proxied by age of head of the household, and it is expected that with experience, producers would be in a better position to analyse the costs and benefits of alternative marketing channels. Education enhances this capacity further. A priori, the effect of education on producers' decision to participate in contract farming is indeterminate. The influence of land on decisions about participation is expected to be positive, because of the competing uses of labour in crop and dairy production.

The size of the dairy herd is expected to have a negative influence, given that the milk price is higher in the open market, and producers realise cost economies of scale in marketing. Households' access to non-farm income sources could have a positive influence as the labour scarcity may discourage such households to sell milk in the open market. A dummy variable is introduced in the model to capture its effect; it takes a value of 1 if a household has income from non-farm sources; otherwise, it is zero.

In the second step, a 'standard treatment effects model' was estimated using predicted probabilities from the logit model as an instrumental variable, with profit per litre of milk as the dependent variable. Besides participation in contract farming, it was also expected that education, as well as the ratios of fixed capital per animal and labour availability per animal, could be important determinants of farm profits.

The results of the 'standard treatment effects model' are presented in Table 4. The estimates from the logit model (col. 2 of Table 4) suggest that the probability of

TABLE 4. RESULTS OF THE STANDARD TREATMENT EFFECTS MODEL

Explanatory variables (1)	Dependent variable		
	Contract producer =1 otherwise =0 (2)	Net revenue over total costs (Rs./litre) (3)	Net revenue over pecuniary costs (Rs./litre) (4)
Age of the decision maker (in years)	0.0313** (0.0155)	-	-
Schooling (years)	0.0262 (0.0286)	0.0346* (0.0208)	0.0183 (0.0148)
Landholding (ha)	0.0686*** (0.0207)	-	-
Milch stock (No.)	-0.1043** (0.0447)	0.1007*** (0.0303)	0.0163 (0.0215)
Access to non-farm income =1; otherwise =0	0.5037 (0.4174)	-	-
Contract producer=1; otherwise=0	-	1.9074** (0.7892)	1.1076** (0.5624)
Labour (workers/milch animal)	-	-0.1080 (0.1091)	-0.0735 (0.0787)
Livestock-related assets (Rs./milch animal)	-	0.000033* (0.000017)	0.000022* (0.000012)
Environmental mitigation cost (Rs./litre)	-	-0.83 (0.38)**	-0.22 (0.27)
Inverse Mills ratio	-	-1.0994** (0.5016)	-0.6046* (0.3577)
Constant	-1.7266 (0.7793)**	1.5146*** (0.4788)	5.1534 (0.3408)***
Chi-squared	20.11***	-	-
R-squared	-	0.0896	0.0394
Adjusted R-squared	-	0.0705	0.01928
F-test	-	4.71***	1.94*
No. of observations	294	294	294

Source: Field survey.

Figures in parentheses are standard errors. ***, **, and * are statistically significant at 1, 5 and 10 per cent level of significance, respectively.

participation in contract farming is significantly higher for those who are more experienced in dairy farming. Educational attainment also positively influenced dairy producers' participation decisions, but not significantly.

Landholding size, as expected, had a positive and significant effect on producers' decision to participate in contract farming. This effect occurred because large landholders were short on labour, and easy access to the milk market through contract farming eased the labour constraint. The coefficient of dairy stock is negative and statistically significant, and occurred because price in the open market was higher and large producers experienced economies of scale in marketing costs. In other words, small producers face higher marketing and transaction costs in the open milk market, but they benefit the most from easy access to markets through vertical coordination, which implies that contract farming is not biased against small producers. Access to non-farm income sources had a positive influence on producers' decision to participate in contract farming but was not significant, probably due to the fact that access to non-farm income sources was limited to a small proportion of the households.

Columns 3 and 4 in Table 4 contain the results of the profit equations where the dummy for contract production is instrumented by the predicted probabilities from the logit equation. In both the equations, coefficients of the inverse Mills ratio are negative and significant, thereby indicating that correction for selectivity bias is important in the model. The coefficient of participation in contract farming is positive and significant in both the profit equations, confirming the observation that contract farming is more profitable compared to independent production. Moreover, the coefficient of farm assets is positive, suggesting that profits can be improved with better management of animals for example, through provision of better housing sheds. The coefficient related to labour is a negative but not significant. It nonetheless gives an indication of the overuse of labour in dairy production. However, as expected, education contributed significantly toward improving net revenue. The coefficient on the herd size is positive and significant in the equation with profit over total cost as the dependent variable. Nevertheless, this suggests that there exist economies of scale in labour use in securing profit per unit of output. The effect of the cost of environmental mitigation⁸ is negative and significant in the first equation but not significant in the second of the standard treatment effects model. This implies that having a higher degree of environmental mitigation effort per unit of output is associated with having a lower profit per unit of output for dairy farmers.

VI

CONCLUSION AND IMPLICATIONS

Contract farming is emerging as an important form of vertical coordination in agri-food markets in India, and its economic and social consequences are attracting considerable attention in the food policy debates. In this paper we have examined the

effects of contract farming on milk on productivity, production and costs, prices, and profitability.

We found contract farming more profitable than independent production. The main benefit came from reducing the marketing and transaction costs in the disposal of milk. Contract farming also contributed toward improving milk yield and reducing production costs. A major effect of contract farming was that the entry of private processors could enhance competition in the local milk markets. The local buyers such as vendors paid almost similar price as those offered under the contract. The price of milk in the open market though was higher than the contract price; the higher marketing and transaction costs in the open market outweighed the price advantage.

The results of this study have some important implications for strengthening vertical coordination. First, the issue is one of replication of such successful institutional innovation on a large scale. Until recently, a major hurdle in the spread of such institutions was the legal restrictions on direct transactions between producers and processors. The Government of India has now opened up agricultural markets including dairy markets for the private sector. This however needs to be accompanied by investment in public infrastructure such as roads, transportation and communication that reduce transaction costs.

Second, small-scale producers face higher transaction costs, and they benefit more from institutions that reduce marketing and transaction costs. The question however is: Will they be involved in such institutional arrangements? The processing and marketing firms, to avoid transaction costs of contracting with a large number of small producers, often prefer contracts with producers who are capable to supplying large volumes and complying with safety and quality standards. This implies that small-scale producers may be displaced from the marketplace. As to reduce the cost of contracting with small producers, the processors should employ intermediate contracts, producer-agent-processor or encourage producers' associations. In a small farm economy, contracting with small producers also reduces supply risks to the processors.

Third, governments should create a level playing field for the growth of right kind of market institutions, promote competition among various market players, and encourage smallholders to form producers' organisations to deal with agribusiness firms. Besides, there is a need to provide some legal measures that protect producers as well processors against opportunistic tendencies.

Fourth, the scaling up of vertical coordination is likely to have several direct and indirect consequences for various stakeholders in the supply chain as well as for the economy as a whole. The effects of the scaling up of contract farming will go beyond production, as its multiplier effects in terms of income and employment will be significant in secondary and tertiary sectors directly or indirectly related to agribusiness supply chains.

NOTES

1. Block is a sub-division of a district.

2. Farmers selling milk to firms through their designated agents on a regular basis are defined as “contract suppliers.” They may or may not avail inputs and services from the firms. Those who sell milk to vendors or directly to consumers in towns/cities are termed “independent producers.”

3. Market specification contracts are pre-harvest contracts that bind the sellers and buyers to specific conditions of commodity exchange, which include quantity, quality, price and timing. In resource-providing contracts, buyers provide some inputs, technology and services to the producers in exchange for a marketing agreement.

4. In general, processors expect producers to supply unadulterated milk with normal fat content of 3-4 per cent in cow’s milk, and 6 to 8 per cent in buffalo milk.

5. Self-produced feed and fodder were priced at prevailing market prices, as reported by the producers.

6. The cost of the “family labour” was estimated using the existing market wage rate in the region. Use of market wage rates often overestimates the true cost of owned labour, especially in developing countries with considerable disguised unemployment. Ideally, the opportunity cost of labour should be used in valuation of owned labour.

7. Marketing and transaction costs were estimated for the amount of milk marketed, and was considered as cost per unit of output.

8. Environmental mitigation cost includes all costs incurred in manure management to mitigate environmental externalities. This includes manure sales used for spreading on the fields of others, labor spent for collecting and drying of manure for sale, labour spent for spreading manure on own field, cost of removal of manure from the farm, and costs of manure pit or biogas digester or any other machinery/facility used for manure disposal.

REFERENCES

- Anon (2007), *Dairy India, 2007* (6th Edition), Dairy India Year Book, New Delhi.
- Birthal P.S. (2008), “Linking Smallholder Livestock Producers to Markets: Issues and Approaches”, *Indian Journal of Agricultural Economics*, Vol. 63, No. 1, January-March, pp.19-37.
- Birthal, P.S. and P.K. Joshi (2007), “Institutional Innovations for Improving Smallholder Participation in High-Value Agriculture: A Case of Fruit and Vegetable Growers’ Associations”, *Quarterly Journal of International Agriculture*, Vol. 46, No.1, pp. 49-68.
- Birthal, P.S., P.K. Joshi, and Ashok Gulati (2005), *Vertical Coordination in High-Value Food Commodities: Implications for Smallholders*, MTID Division Discussion Paper No. 85, International Food Policy Research Institute, Washington, D.C., U.S.A.
- Birthal, P.S., P.K. Joshi, Devesh Roy and Amit Thorat (2007), *Diversification of Indian Agriculture Towards High-Value Crops: The Role of Smallholders*, Discussion Paper No. 727, International Food Policy Research Institute, Washington, D.C., U.S.A.
- Birthal, P.S. and V.K. Taneja (2006), “Livestock Sector in India: Opportunities and Challenges for Smallholders”, in P.S. Birthal, V.K. Taneja and W. Thorpe, (Eds.) *Smallholder Livestock Production in India: Opportunities and Challenge*, National Centre for Agricultural Economics and Policy Research, New Delhi, and International Livestock Research Institute, Nairobi.
- Delgado, C., C. Narrod and M. Tiongco (2008), *Determinants and Implications of the Growing Scale of Livestock Farms in Four Fast-Growing Developing Countries*, IFPRI Research Report No. 157, International Food Policy Research Institute, Washington, D.C., U.S.A.
- Glover, D. and K. Kusterer (1990), *Small Farmers, Big Business: Contract Farming and Rural Development*. St. Martin’s Press, New York, U.S.A.
- Greene, W. (2003), *Econometric Analysis*, Simon and Schuster, Englewood Cliffs, New Jersey.

- Holloway, G., C. Nicholson, C. Delgado, S. Staal and S. Ehui (2000), Agro-Industrialisation through Institutional Innovations: Transaction Costs, Cooperatives and Milk Market Development in the East African Highlands, *Agricultural Economics*, Vol. 23, pp. 279-288.
- Holloway, G. and S. Ehui (2002), *Expanding Market Participation among Smallholder Livestock Producers: A Collection of Studies Employing Gibbs Sampling and Data from the Ethiopian Highlands*, Socioeconomics and Policy Research Working Paper No. 48, International Livestock Research Institute, Nairobi.
- Joshi, P.K. Laxmi Joshi and P.S. Birthal (2006), Diversification and its Impact on Smallholders: Evidence from a Study on Vegetables, *Agricultural Economics Research Review*, Vol. 19, No. 2, pp. 219-236.
- Key, N. and D. Runsten (1999), Contract Farming, Smallholders, and Rural Development in Latin America: The Organization of Agro-Processing Firms and Scale of Outgrower Production, *World Development*, Vol. 27, pp.381-401.
- Kumar, P., Mruthyunjaya and P.S. Birthal (2007), "Changing Consumption Pattern in South Asia" in P.K. Joshi, Ashok Gulati and Ralph Cummings Jr. (Eds.), *Agricultural Diversification and Smallholders in South Asia*, Academic Foundation, New Delhi.
- Little, P. and M. Watts (1994), *Living Under Contract: Contract Farming and Agrarian Transformation in Sub-Saharan Africa*, University of Wisconsin Press, Madison.
- Miyata, S., N. Minot and D. Hu (2007), *Impact of Contract Farming on Income*, Discussion Paper 00742, International Food Policy Research Institute, Washington, D.C., U.S.A.
- Patrick, I. (2004), *Contract Farming in Indonesia: Smallholders and Agribusiness Working Together*, ACIAR Technical Report No. 54, Australian Centre for International Agricultural Research, Canberra.
- Ramaswami, B., P.S. Birthal, and P.K. Joshi (2006), *Efficiency and Distribution in Contract Farming: The Case of Indian Poultry Growers*, MTID Discussion Paper No. 91, International Food Policy Research Institute, Washington, D.C., U.S.A.
- Roy, D. and A. 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. 1874-1890.
- Singh, S. (2002), "Contracting Out Solutions: Political Economy of Contract Farming in the Indian Punjab", *World Development*, Vol. 30, pp. 1621-1638.
- Warning, M. and N. Key (2002), "The Social Performance and Distributional Consequences of Contract Farming: An Equilibrium Analysis of the Archide de Bouche Program in Senegal", *World Development*, Vol. 30, pp. 255-263.
- Weinberger K.M. and T. Lumpkin (2005), *Horticulture for Poverty Alleviation: The Unfunded Revolution*, AVRDC Working Paper No. 15, World Vegetable Centre (AVRDC), Shanhua, Taiwan.