INTERNATIONAL FOOD
POLICY RESEARCH INSTITUTE
sustainable solutions for ending hunger and poverty

Supported by the CGIAR

IFPRI Discussion Paper 00814

October 2008

Improving Farm-to-Market Linkages through Contract Farming

A Case Study of Smallholder Dairying in India

Pratap S. Birthal
Awadhesh K. Jha
Marites M. Tiongco
Clare Narrod

Markets, Trade and Institutions Division

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

The International Food Policy Research Institute (IFPRI) was established in 1975. IFPRI is one of 15 agricultural research centers that receive principal funding from governments, private foundations, and international and regional organizations, most of which are members of the Consultative Group on International Agricultural Research (CGIAR).

FINANCIAL CONTRIBUTORS AND PARTNERS

IFPRI's research, capacity strengthening, and communications work is made possible by its financial contributors and partners. IFPRI receives its principal funding from governments, private foundations, and international and regional organizations, most of which are members of the Consultative Group on International Agricultural Research (CGIAR). IFPRI gratefully acknowledges the generous unrestricted funding from Australia, Canada, China, Finland, France, Germany, India, Ireland, Italy, Japan, Netherlands, Norway, South Africa, Sweden, Switzerland, United Kingdom, United States, and World Bank.

AUTHORS

Pratap S. Birthal, International Crops Research Institute for the Semi-Arid Tropics
Principal Scientist

Awadhesh K. Jha, National Centre for Agricultural Economics
Senior Research Associate

Marites Tiongco, International Food Policy Research Institute
Postdoctoral Fellow, Markets, Trade and Institutions Division

Clare Narrod, International Food Policy Research Institute
Senior Research Fellow, Markets, Trade and Institutions Division

Notices

[1] Effective January 2007, the Discussion Paper series within each division and the Director General's Office of IFPRI were merged into one IFPRI–wide Discussion Paper series. The new series begins with number 00689, reflecting the prior publication of 688 discussion papers within the dispersed series. The earlier series are available on IFPRI's website at www.ifpri.org/pubs/otherpubs.htm#dp.

[2] IFPRI Discussion Papers contain preliminary material and research results. They have not been subject to formal external reviews managed by IFPRI's Publications Review Committee but have been reviewed by at least one internal and/or external reviewer. They are circulated in order to stimulate discussion and critical comment.

Contents

List of Tables

List of Figures

ACKNOWLEDGMENTS

The authors gratefully acknowledge the Food and Agriculture Organization (FAO) that funded this research through the Livestock, Environment and Development (LEAD) Initiative. In particular, they would like to acknowledge Dr. Henning Steinfeld for developing the initial idea and for facilitating funding of the project. The authors also acknowledge the cooperation of the Indian Council of Agricultural Research in New Delhi for conducting this study. Many thanks are also due to Dr. Ramesh Chand, formerly Acting Director of the National Centre for Agricultural Economics and Policy Research in New Delhi, for his support right from inception of this study. An earlier draft of this paper was produced under a joint IFPRI-FAO collaboration entitled "Contract farming of milk and poultry in India: Partnerships to promote the environmentally friendly and equitable intensification of smallholder market-oriented livestock production." The authors would like to acknowledge the valuable insights and suggestions received from Achilles Costales of the Pro-Poor Livestock Policy Initiative (PPLPI) at FAO, Christopher Delgado of the Agriculture and Rural Development at the World Bank, and Pramod K. Joshi of the National Centre for Agricultural Economics and Policy Research, which significantly improved the manuscript.

The authors are also grateful to the many individuals who helped in the conduct of field surveys, data scrutiny, and analysis. Special thanks are due to the field staff of the integrated firms and dairy farmers for their cooperation, and the field investigators who conducted this survey. This study would not have been possible without their commitment. Finally, the authors gratefully acknowledge Shirley Raymundo and Joy Fabela for the excellent administrative support and for their efforts in formatting the present manuscript.

Needless to say, all observations and conclusions are those of the authors: they alone are responsible for any shortcomings. No comment or opinion expressed in this manuscript should be viewed as an indication of the effective or ineffective handling of the Indian dairy sector.

ABSTRACT

Contract farming is emerging as an important form of vertical coordination in the agrifood supply chain in India, and its socioeconomic consequences are attracting considerable attention in public policy debates. This study is an empirical assessment of the costs and benefits of contract farming in milk using information generated through field surveys in the western state of Rajasthan. Contract farming is found to be more profitable than independent production. Its major benefits come from a reduction in marketing and transaction costs, which are otherwise much higher in the open markets. Contract farming also contributes toward improving milk yield and reducing production costs, albeit not significantly. Dairy producers also benefit from provision of services and technical advice by integrators/firms who secure milk supplies from farmers through contract. The benefits of contract farming vary by scale of operation. Economies of scale are also important determinants of competitiveness, in which large farms (both contract and independent) have lower per unit cost due to buying of inputs in bulk and greater access to markets. Smallholders, on the other hand, derive significant benefits from a reduction in marketing and transaction costs due to their participation in contract farming.

Keywords: contract farming, smallholder dairying in India, marketing and transaction costs, milk supply chain, treatment effects model, mass balance approach

1. INTRODUCTION

Sustained income growth and urbanization are causing rapid changes in the "food consumption, production and marketing" in India. Over the last two decades, there has been a rapid increase in per capita consumption of high-value foods like fruits, vegetables, milk, meat, egg and fish, while consumption of food grains remained almost unchanged (Kumar et al. 2007). On the supply side, these commodities generate higher returns per unit of land and labor compared to food grains (Joshi et al. 2004). Demand-driven growth in high-value food production is expected to create significant income and employment opportunities for producers, especially smallholders (that is; those who own less than 2 hectares of land) who comprised 58 percent of the rural households in 2003 (Government of India 2006), and largely practice staple-based subsistence agriculture to ensure their household food security. However, changing dietary patterns towards high-value foods are putting pressure on small farms to diversify away from staples and derive gains from market-oriented, high-value agricultural production (Pingali et al. 2005).

Some are apprehensive that small farm diversification toward high-value food commodities may come under stress, as the production and marketing requirements of these commodities are different from staples. High-value agriculture requires more capital, quality inputs, improved technologies, and extension support, and smallholders face problems in accessing these (Key and Runsten, 1999; Eaton and Shepherd, 2001). Most high-value food commodities are perishable, and are thus subject to high post-harvest losses. Such commodities need immediate transportation to the markets or consumption centers; others may require cold storage or processing into a less perishable form. Local rural markets for high-value commodities in India are scarce, and post-harvest infrastructure (such as transportation, storage and processing) is inadequate. Furthermore, sales in distant urban markets increase transaction costs (defined here as the costs of searching for information as well as travel, transportation, and personnel time). These costs are higher for smallholders who often have small, marketable surpluses (Birthal et al. 2005a), sale of which in distant markets is costly. Further, the food quality standards that are becoming more stringent in the domestic and world markets, creating a barrier to their participation in markets.

Vertical coordination of the food supply chain through cooperatives, producers' associations, and contract farming is one of the few alternatives that can facilitate small farms' diversification by improving their access to markets and 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 (Glover and Kusterer, 1990; Key and Runsten, 1999; Holloway et al. 2000; Warning and Key, 2002; Patrick 2004; Birthal et al. 2005a; and Ramaswami et al. 2006).

There is a strong tradition of agricultural cooperatives in India, especially in dairy and sugar production. In 2002-03, dairy cooperatives procured over 7 percent of the milk produced, and the sugar cooperatives contributed 51 percent to the total sugar production. With increased market liberalization, contract farming is emerging as an important form of vertical coordination.[1]

Contract farming is an important mechanism for sharing production and market risks which tend to be higher in perishable commodities. For instance, in contract farming of broilers, Ramaswami et al. (2006) found integrators/firms assuming most of the market and price risk and helping producers mitigate production risks through support services. Sharing of risk and reducing transaction costs thus enables contract producers to reap more profits compared to independent producers (Birthal et al. 2005a).[2] The potential benefits of contract farming to producers and integrators are summarized in Table A.1 of Appendix A.

[1] In the context of dairy business, it is notable that entry of the private processors was restricted primarily to protect the dairy cooperatives from too much competition.

[2] Transaction costs are associated to the costs incurred in obtaining information relative to the undertaking of the transaction (price information, market location, searching potential trading partners).

Contract farming is, however, viewed with skepticism. Some argue that contract farming is a partnership between unequal players, with the producer being the weaker party; thus, the producer is seen as vulnerable to exploitation by the dominant party, the "integrator." The processing and marketing firms 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 favors production of cash/commercial commodities which require greater investment in specific assets. In light of market imperfections, high-asset specificity renders producers poor bargainers (Wilson 1990; Little and Watts, 1994; Singh 2002). Overemphasis on commercial commodities may also render producers vulnerable to food shortages and price fluctuations. Farmers' excessive dependence on firms for credit may likewise lead to a vicious cycle of indebtedness. Moreover, cash crops that require more irrigation water, fertilizers, and pesticides may lead to degradation of natural resources (Singh 2002). Another criticism of contract farming is that it discriminates against smallholders in order to avoid the costs incurred by negotiation, monitoring and enforcement of contracts with a large number of smallholders (Glover and Kusterer, 1990; Little and Watts, 1994; Key and Runsten, 1999; Singh 2002).

Empirical evidence on the true costs and benefits of contract farming in developing countries is scarce and largely anecdotal. This study tries to fill this gap: it quantifies the costs and benefits of contract farming in milk production in India. The study also attempts to provide an empirical basis for promotion of vertical coordination in agricultural commodities in developing countries dominated by small farms. Specifically, the study investigates:

1. Costs and benefits of contract farming in milk in India;
2. Factors which encourage and/or hinder farmers' participation in contract farming;
3. The role of contract farming in improving the efficiency of production and reducing marketing and transaction costs;
4. Sharing of risks and incentives in contract farming among contract growers and integrators; and
5. Differences between independent and contract farms at different scales of production concerning profits per unit of output earned by farmers, and how management of manure and waste disposal affects profitability and the ability to use waste generated from livestock operations on one's own farm.

The study tests the following hypotheses:

1. Contract farming increases smallholders' income;
2. Contracting reduces production and marketing risks;
3. Contract farming is more profit-efficient than independent farming at similar levels of scale;
4. Profits of contract farms are less sensitive to transaction costs than are independent farms at similar scale; and
5. Contract farming can be extended to a large group of smallholders in cases where both social and financial incentives to smallholder contract producers are advantageous.

There is little empirical support from existing literatures to either accept or reject these hypotheses. The emerging empirical literature shows that, despite being efficient producers, smallholders lose in the marketplace because of high transaction costs (Holloway et al. 2000, Delgado et al. 2008, Birthal et al. 2005a, Davis 2005). Improving smallholders' access to market through innovative institutions like contract farming is considered essential to enhance their income.

2. VERTICAL COORDINATION IN THE MILK SUPPLY CHAIN

Institutions such as cooperatives, producers' organizations, and contract farming emerge in response to market failures.[3] Dairy producers are often unable to access market outlets, good quality inputs, improved technologies, essential information, and animal health and breeding services.

The milk market in India is fragmented, having both formal and informal segments (see Figure 1), but the bulk of milk trade flows through a number of informal supply chains.[4] Producers sell fresh milk directly to rural as well as urban consumers. The sale to rural consumers is limited. Direct transactions are prominent in urban and peri-urban areas where dairy producers supply milk to urban consumers. This practice is more prominent among smallholders. 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, or hotels and/or in the urban milk market (*mandi*), if at all. Through direct transactions, producers are able to retain much of the price paid by consumers, but cost of the search for buyers and delivery can be very high. From the buyer's perspective, there is also uncertainty as to the quality of the milk.

Another important functionary in the milk market 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 vendors advance credit to producers—mainly smallholders—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, but they rarely provide inputs, services or information to the producers. In the absence of competition, credit-linked supply chains are often exploitative of the producers, especially when there is a considerable seasonality in milk production. During a flush season, vendors and sub-contractors do not procure the entire marketable surplus, and they pay less than the market price.

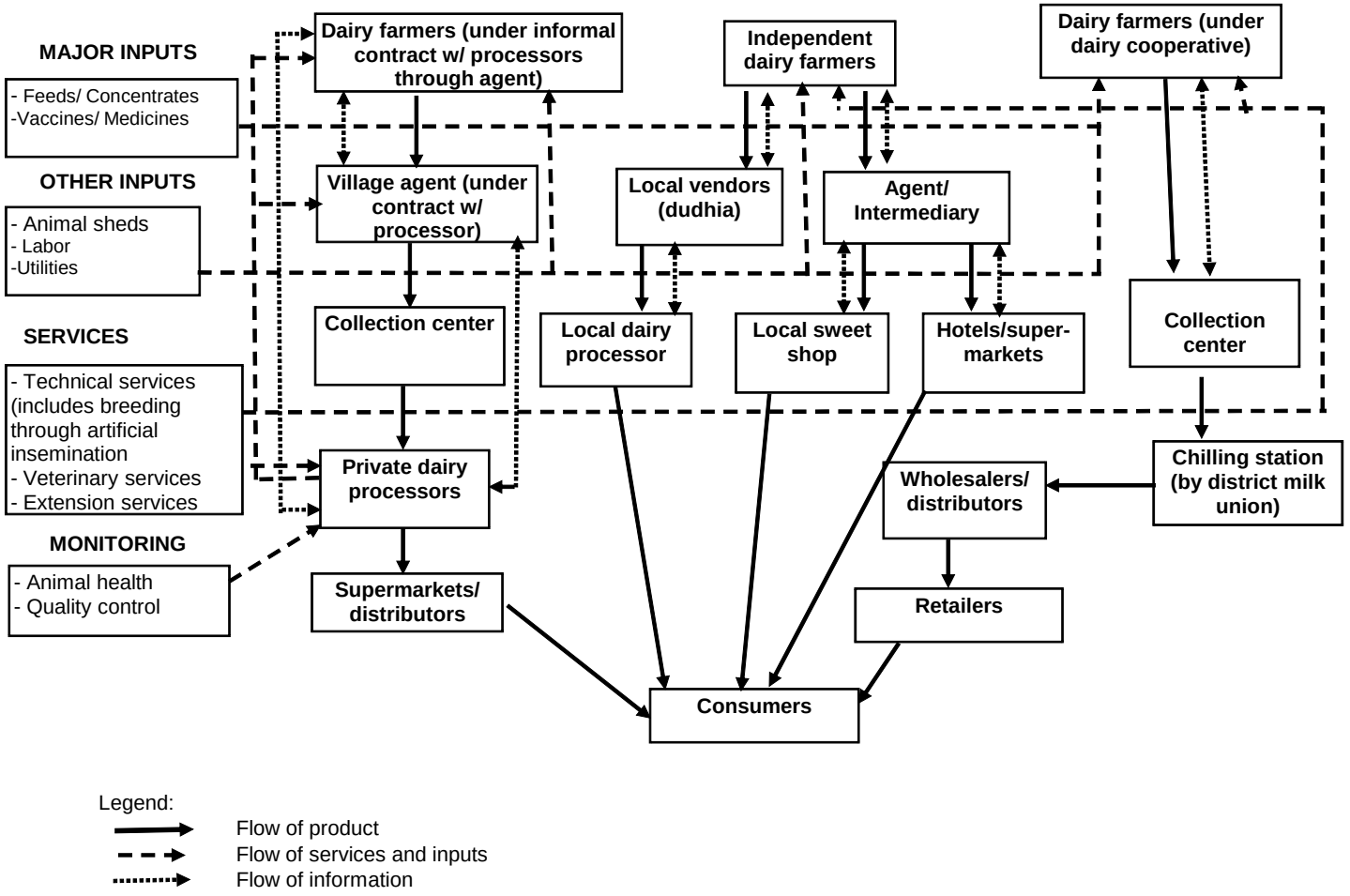
Cooperatives and private processors are the two most important players in the formal milk market. They use one or another variant of vertical coordination to source raw material requirements. Dairy cooperatives, however; are more dominant, and have evolved over time as an important institution for dairy development. Most private dairy processors source milk through direct or indirect contracts with producers.[5] Both cooperatives and private processors provide inputs and services to the willing producers to improve production and quality of milk as well as to mitigate production risks.

[3] Market failure exists when there is asymmetric information between the buyer and the seller regarding the quality of the product, product markets might break down all together – presenting a need for coordination through contracting. When information on production technology needed for efficient production and optimum quality and the desired characteristics of the product do not exist producers find it hard to adjust to the changing demands of consumers, thus providing the need for forms of vertical coordination or integration.

[4] The formal segment of the market is defined here as the registered entity recognized by the government, and is governed by a set of rules and regulations legally binding the sellers and buyers. The informal segment is also governed by some rules and regulations, but there is no assurance that the terms and conditions will be honored by both contracting parties, and the enforcement of the terms and conditions largely depends on mutual trust between contracting parties. The formal sector for marketing of milk includes cooperatives and private dairy processors, while the informal sector or the so-called "traditional milk market sector" consists of vendors and market intermediaries.

[5] The private sector participates in agriculture in a number of ways. The private sector may provide inputs and services, or it may buy outputs with or without contracts. In India, private firms practice various types of contracts, including bilateral (whereby provision of inputs and services occurs against buying of outputs or by buying of outputs by a single firm); or multilateral (whereby different input and service-supplying firms are engaged by the firm buying the output).

Figure 1. Milk supply chain in Rajasthan



Source: Adapted from Sharma et al. 2003.

A number of private players were found to operate in the local milk market in the study area, that is, Rajasthan. These include cooperatives, private dairy processors, and vendors. Most of these groups were using contracts representative of either market specification, or resource-providing contracts,[6] or a combination of the two, depending on the farmers' requirements. Three main dairy processing companies were operating in the study area, namely; GK Industries, Modi Dairy, and Lotus Dairy. Each of these followed a common approach to sourcing milk from producers. Dairying was largely concentrated among smallholders, and contracting with a large number of small dairy producers was costly for processors because of substantial costs in information search, and negotiation and enforcement of the contract. The processors therefore did not have much choice but to take milk from small producers. The way they addressed this situation was to make agreements 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 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. This type of arrangement is a variant of a marketing specification contract that binds the sellers and buyers to specific conditions of commodity exchange (such as quality, price, quantity, payment procedures, sharing of costs and risks, moral hazards, and dispute settlement). This type of contractual arrangement is prevalent in Rajasthan, the study area and, because dairying is largely concentrated among smallholders, proliferating in India where contracting with a large number of small dairy producers is very costly for a private processor because of the high transaction costs (in terms of search and negotiation, and enforcement of the contract). The agent motivates producers to supply milk to the firm, 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 contract is generally for three years, and can be renewed or reneged with prior notice. The agent/producer provides the space for milk collection, and the firm provides necessary equipment—such as weighing scales, milk analyzers, milk coolers, and water geysers used for temporary storage of milk—at no cost to the agent. Operational expenses, except the cost of electricity and water usage, are borne by the agent. 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. Unintentional risks to firm-installed assets (such as machine failure or wear and tear) are borne by the firm. Risks arising due to non-compliance of specified quality standards are the responsibility of the agent.

A majority of the contract producers (94 percent) had an informal understanding with the agent to supply milk (see Appendix A, Table A.2). They can sell any amount of milk to the firm provided the agent is assured of a regular supply and good quality (based on fat and SNF [solids non-fat] content) of milk.[7] There was no restriction on quantity by the firm regardless of flush or lean seasons. Each producer/supplier was provided with a passbook for recording transactions with respect to quantity, fat and SNF content, and payments.

The agreement was also defined by the commitment of the producer to supply milk at a certain time and quality required by the firm through its agent, so the price of milk was determined on the basis of fat and SNF contents. In determining the milk price, the firms also considered the prices paid by other competitors in the neighborhood. Payments to the producers were generally made at an interval of 10 to 15 days. Most producers received payment in full and on time.

The integrator/processor provided feed, medicines, vaccines, and mineral mixtures to the willing producers—generally at lower than the market prices—because the integrator purchased these inputs in bulk. Veterinary services were provided on demand and at nominal rates. The agent provided the inputs

[6] 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.

[7] In general, processors expect producers to supply unadulterated milk with normal fat content of 3-4 percent in cow's milk, and 6 to 8 percent in buffalo milk.

and services, the costs of which were deducted from the milk payments. The advisory services related to management of animals were provided free of charge. The integrator/processor monitored the contracts to avoid any conflict between the producers and the agent. This monitoring was done by regular visits of firms' representatives to the milk producers to check if they have concerns about the contract farming practices, and to monitor and ensure the timely availability of milk. The firm's representative monitored the animals for their yield levels, feed intake, health, and nutrition, including cases of adulteration of milk by the producers, if any. In cases of dispute, the producers usually report it to the firm staff, and then the staff act as negotiators in order to resolve disputes mutually.

The milk supply chain is undergoing a transformation in India, from a traditional *ad hoc*, vendor-dominated system toward a coordinated supply chain. Initially, the coordinated supply chain emerged in the form of cooperatives due to initiatives of the National Dairy Development Board. However, with liberalization of the dairy industry in 1991, and the subsequent phasing out of the Milk and Milk Products Order (MMPO) in 2002, [8] the private processors have been entering into the milk market in a big way, and they use formal or informal contracts to procure milk from the dairy farmers through their appointed agents. The entry of the private processors into the milk market has infused greater economic competition, resulting in a disciplining of the informal traders/vendors who hitherto had exploited the dairy farmers.

[8] At present, MMPO puts no restriction on setting up new processing capacity, and does away with milk shed area approach,, in which it uses the milk shed as the area of demarcation for firms to secure supplies . Registration under MMPO is now only for enforcing food safety and quality.

3. HOUSEHOLD SURVEY AND ANALYTICAL APPROACH USED

To examine the impact of contract farming, a household survey was conducted in the western state of Rajasthan. Livestock is an important source of livelihood for the rural population in the state, primarily because a large part of Rajasthan is characterized as semi-arid and arid, with an annual rainfall of about 500 millimeters. Irrigation is limited to about one-third of the cultivated area; thus, agriculture is largely dependent on rain.

Dairying in Rajasthan

Rajasthan is an important milk-producing state in India. With a contribution of over 9 percent to total Indian milk production, it is the third largest producer of milk after Uttar Pradesh (18 percent) and Punjab (10 percent) (Table 1). Buffalo is an important milch species in Rajasthan, representing a 53 percent share of in-milk animals, and a 59 percent share in milk output. Indigenous cows are the second most important milch species. The contribution of crossbred cows is negligible.

Table 1. Dairy stock, milk production and yield in Rajasthan (1993-2004)

Item	TE* 1993/94	TE2003/04	Percent change
In-milk dairy animals (‘000)			
Crossbred cows	24 (0.6)	57 (1.0)	138.8
Indigenous cows	1777 (47.6)	2193 (38.7)	23.4
Buffaloes	1703 (45.6)	3019 (53.2)	77.3
Goats**	230 (4.9)	402 (5.1)	75.0
Total	3733	5671	51.9
Milk production (‘000 tons)			
Crossbred cows	46 (1.0)	120 (1.5)	161.4
Indigenous cows	1792 (37.9)	2238 (28.5)	24.9
Buffaloes	2437 (51.6)	4671 (59.4)	91.6
Goats	449 (9.5)	837 (10.6)	86.4
Total	4724	7867	66.5
Milk yield (kg/annum)			
Crossbred cows	1918	2098	9.4
Indigenous cows	1008	1021	1.2
Buffaloes	1432	1547	8.1
Goats**	1957	2084	6.5

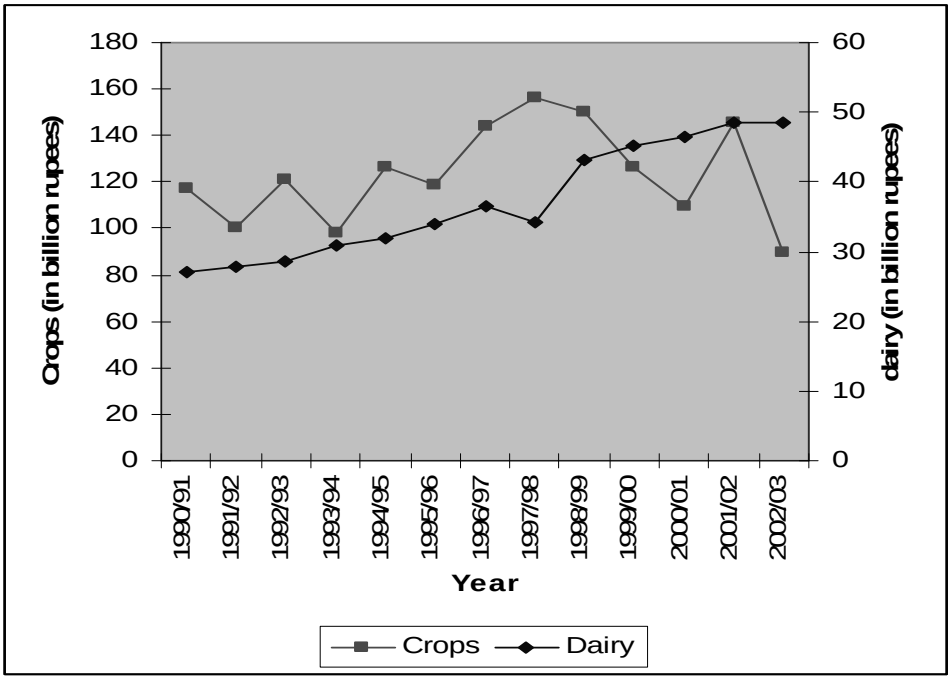
Source: Derived from GOI data (various issues): *Basic Animal Husbandry Statistics.*
Notes: * TE stands for triennium ending
** Goats are listed in a cow equivalent, whereby 10 goats are assumed equal to one adult cow.
Figures in parentheses represent a percentage of the total of the specific sub-head.

Average milk yield of buffaloes and indigenous cows in Rajasthan is comparable to the national average, but has not shown any significant improvement. Most of the incremental milk production since 1993-94 came from increases in the number of animals, which may not be sustainable in the long run.

Dairying in Rajasthan is likewise dominated by smallholders. In 2003, smallholders comprised 57 percent of the rural households and controlled 55 percent of the bovine population (that is, cattle and buffaloes). Average size of landholding in the state is 2.7 hectares, which is twice the national average of

1.4 hectares. However, the low and erratic rainfall renders the majority of the rural population vulnerable to income shocks of crop failure. Livestock thus acts as an insurance against crop failure, and helps consumption smoothening in periods of scarcity (Figure 2). The proportional contribution of dairying to agricultural income shows wide year-to-year fluctuations, but in absolute terms, it has been increasing continuously. In 2002-03, dairying contributed 30 percent to the agricultural income in the state.

Figure 2. Value of dairying versus crops in Rajasthan (1990-2003)



Source: Compiled from GOI data (various issues): *National Accounts Statistics.*

Milk marketing in the state of Rajasthan is largely unorganized. During 2003-04, the state had 9,643 dairy cooperative societies with about 534,000 dairy producer-members delivering 378,000 tons of milk, equivalent to 4.7 percent of the milk produced in the state, but lower than the all India average of 7.2 percent. Moreover, dairy processing facilities in Rajasthan are inadequate. The state has 27 processing plants, 10 of which belong to the private sector. These figures imply that there is considerable scope for the private sector to participate in milk markets in the state through institutional arrangements like contract farming.

Data and Survey

Two districts—Jaipur and Sikar—were purposively selected for the household survey. These districts have a high milk production potential as well as a greater scope for commercialization of dairying. Jaipur is the state capital and 50 percent of its population is urban. Sikar is an adjoining district supplying considerable amount of milk to urban consumers in Jaipur. A number of dairy players, including cooperatives, private firms, and vendors, operate in the local milk markets in these districts. In fact, in recent years, many private firms have entered the milk markets here. Some important firms include GK Dairy Industries, Modi Dairy, and Lotus Dairy. In addition, the Rajasthan Cooperative Dairy Federation also has a strong network of cooperatives in these districts.

In each selected district, two blocks[9] with a higher degree of commercial dairying were identified in consultation with officials of the Department of Animal Husbandry and Dairying. These were Amer and Chomu from Jaipur, and Sri Madhopur and Dataramgarh from Sikar. One of the considerations for selection was the presence of private dairy processors in these blocks. A random sampling was done to select 10 villages from these identified blocks: three villages each in the Chomu (Jaipur) and Sri Madhopur (Sikar) blocks, respectively; and two villages each in the Amer (Jaipur) and Dataramgarh (Sikar) blocks.

Before selection of farm households, focus group discussions were organized with the dairy producers (both contract and independent) and integrators (milk collection agents and representatives of the firms) to understand the nature of dairy production, marketing methods, and market participants. Because scale of production is central to this study, one of the aims of the focus group discussions was to determine the limits of classification of dairy producers into small, medium, and large producers, ex ante. Accordingly, dairy farmers having less than 4 milch animals at the time of survey were classified as small; those having 4 to 6 milch animals as medium; and more than 6 milch animals were classified as large/commercial farmers.

In each village, dairy producers who were not members of a dairy cooperative were identified and classified as contract and independent producers.[10] A sample of 150 contract producers and 150 independent producers was randomly drawn, and the sample from each farm size category (small, medium and large) was approximately equal (Table 2). Among the independent producers, over 60 percent of them sell milk to vendors, and the rest sell it to consumers in the nearby urban markets. The proportion of independent producers selling milk to vendors is almost similar across farm sizes.

Table 2. Distribution of sample dairy farm households in Rajasthan, 2005

	Small (<=3 animals)		Medium (4-6 animals)		Large (>6 animals)		Total sample
	Contract	Independent	Contract	Independent	Contract	Independent	
Total							
Targeted	50	50	50	50	50	50	300
Actual	50	50	49	51	51	49	300
By District							
Jaipur	21	32 (15)*	18	29 (16)*	26	24 (16)*	150
Sikar	29	18 (14)*	31	22 (15)*	25	25 (17)*	150

Source: Compiled from the IFPRI-NCAP Household Survey, 2005.
Note: * Figures in parentheses represent the number of farmers supplying milk to vendors.

The survey was conducted in November 2005, and the information was collected from the households in pre-tested questionnaires by investigators specifically trained for this survey. The information collected includes: household demographics; land and livestock inventory; cropping pattern; use of chemical fertilizers and manure, and manure management; nonfarm income; milk production and marketed surplus; input use and prices; sources of animal breeding and health services; and transaction costs in acquisition of inputs and sale of output, among other data. Contract producers were also asked to provide information regarding terms and conditions of the agreement. In addition, milk collection agents appointed by the firm were interviewed to understand the processes of vertical coordination and associated problems therein.

[9] Block is a sub-division of a district.

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

There is considerable intra-year variation in milk yield and feeding rates. To capture this, the survey should have ideally been undertaken on a regular interval- at least a few times a year. But because of time and budgetary constraints, the survey was conducted only once, and generated information on production and sale-related activities for the preceding day or week.

Analytical Approach Used

Estimation of Production and Transaction Costs, and Net Revenue

The data generated through field surveys was used to estimate and compare 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 fodder [11] (such as dry fodder, green fodder and concentrate feeds); feed additives like mineral mixtures; as well as medicines, vaccines and human labor (owned and hired labor).

Information on different inputs used and their prices were obtained from the respondents to estimate production costs. Production costs were estimated separately for in-milk cows and buffaloes, and were expressed in rupees per unit (liter) of milk output. 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. Labor cost was estimated using the agricultural market wage rate in Rajasthan[12] of 70 rupees- approximately US$1.5 per day. The total cost was divided by total milk production to arrive at the unit cost of production. The information collected on input use and output pertain to the day before the date of the interview.

In estimating transaction costs (such as costs of search, acquisition and processing of information, costs of negotiating the terms and conditions of transaction, and the costs of monitoring and enforcement of the exchange), we tried to quantify several of the tangible transaction costs incurred by the producers in acquisition of information and inputs, and marketing of outputs. These include cash costs of communication, transport, hired labor, and the imputed cost of family labour. A few producers, especially non-contract producers, occasionally combined other activities with input and output transactions, which have resulted in a higher transaction cost than the actual cost associated with these transactions. To disentangle the effect of nondairy-related activities, 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 nondairy activities based on the volume of different transactions.

Estimating transaction costs proved quite complex, especially for inputs, as producers procured inputs in bulk, especially dry fodder and concentrate. Farmers were asked to provide information on the date of last purchase, the quantity purchased, and costs of transportation, travel, and labor time associated with acquisition of such inputs. All these costs were aggregated and the cost per unit of an input was estimated. The unit cost of acquisition was multiplied by the amount of the particular input fed to in-milk animals on that day. The total transaction cost was divided by output produced on that day to get the cost per unit of output.

Transaction costs in disposal of milk were straightforward. The total costs (travel, transportation, and labor) 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.

Both production and transaction costs were categorized as pecuniary and nonpecuniary costs. Pecuniary costs include all costs of production except the cost of owned personnel time, which was categorized as a nonpecuniary cost. The costs incurred by the producer in acquisition of information about

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

[12] 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 labor, especially in developing countries with considerable disguised unemployment. Ideally, the opportunity cost of labor should be used in valuation of owned labor. In India, market wages for agricultural workers vary widely across states and regions depending on the demand and supply situation; so too does the opportunity cost of labor (Gulati and Kelley, 1999).

prospective buyers, sources of inputs, services, and prices of inputs and outputs, inputs and services, as well as about disposal of milk were considered as transaction costs. These include the cost of travel, transportation and personnel time.

Net revenue was estimated as the difference between the realized sale price and its unit cost of production. The unit cost of 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

Differences in net revenue of the contract and independent producers need not necessarily be attributed to contract farming. This may be caused by differences in unobservable characteristics (like management skills) of the two groups of producers. A comparison of average revenue thus could be biased. To correct for the bias, a standard treatment effects model was used (Greene 2003).

$$R_i = a + bC_i + cX_i + \varepsilon_i \tag{1}$$

$$C_i = \gamma_1 + \gamma_2 Z_i + u_i \tag{2}$$

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 with a private processor, and 0 if one does not participate in any contractual arrangement. 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 estimate of equation (1), is likely to be biased, however; 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) (logit) 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, predicted values (also known as the inverse Mills ratio) from equation (2) can be used as an instrument (of C_i) in equation (1).

Manure Management: The Mass Balance Approach[13]

To examine whether a farmer has the ability to use all of the manure generated on his own farm, the farm's balance of manure nutrients relative to the farm's potential to use the nutrients through crop production was calculated using household survey data. The amount of chemical fertilizer applied per land unit was also included to compute the mass balance of nutrients. Land assimilation capacity was estimated to determine whether it could assimilate all the nutrients produced on the farm, and then the amount of manure sold off-farm, if any, was subtracted It is important to determine to what extent are farms internalizing the environmental pollution arising from their production activities, and whether there is a difference in manure management between contract farms and independent farms.

Manure contains nitrogen, phosphorus, and potassium which, if not used or disposed of in a safe manner, can seep into the water table and cause groundwater pollution. The balance of manure nutrients relative to the farm's potential to use the nutrients through crop production, T_h^n, was calculated using survey data. The amount of chemical fertilizer applied was also included to compute the mass balance of nutrients. Land assimilation capacity was estimated to determine whether it could assimilate all the nutrients produced on the farm, and then the amount of manure sold off-farm, if any, was subtracted.

[13] Methodology on mass balance calculation is mainly drawn from the approach of Delgado et al. (2008).

Total nutrient deposition from livestock for each household was estimated using the dung evacuation rates of different species by age and sex,[14] where the total nutrient deposited by household *h* is the sum of the nutrient produced by animals of type *l* in household *h*. Data on fertilizer use were added to the calculations to derive total nutrient use on the farm, using the following formula:

$$T_h^n = \sum_l \alpha_l^n AU_{lh} + CF_h^n + Mpurch_h^n - Msold_h^n \tag{3}$$

where: *l* = animal type ; *n* = nutrient type; *h* = household; T_h^n = total nutrient *n* deposited by household; AU_{lh} = animals of type *l* in household *h;* CF_h^n = form of nutrient *n* applied as commercial fertilizer by household *h; Mpurch* is manure purchased by household, *Msold* is manure sold off the farm by household; and α_l^n = the amount of nutrient *n* produced per animal of type *l.*

The capacity of the land to absorb nutrients was estimated based on the existing cropping pattern of the sample households and the nutrient uptake rates of different crops. The capacity for each household to use the nutrients produced by their livestock was computed as the area planted to crop *i* by the household multiplied by the nutrient uptake of the crops planted on the land.

$$U_h^n = \sum_i \beta_i A_i \tag{4}$$

where: *Ai* = area planted to crop *i* by household *h*; β_i= absorptive capacity for nutrient *n* per unit of land; U_h^n = removal of nutrient *n* by all crops on the farm.

Equation (4) provides estimates of the uptake of nutrient *n* on farm *h* and equation (3) provides estimates of nutrient *n* deposited through manure and chemical fertilizers. Thus, subtracting (3) from (4) provides an estimate of the balance of nutrient *n* on farm *h*. This result indicates a household's potential assimilative capacity of nutrients based on the current number of animals and cropping pattern. A positive mass balance implies that there is sufficient land to assimilate the nutrients produced, while a negative mass balance suggests that there is not enough land to absorb those (Delgado et al. 2008).

[14] Dung evacuation rates were taken from Birthal et al. (2005b).

4. FARM CHARACTERISTICS OF CONTRACT AND INDEPENDENT PRODUCERS

This section compares socioeconomic characteristics of the contract and independent producers, and what may have encouraged or discouraged them to participate in contract farming.

Demographic Characteristics

The independent producers were relatively younger than the contract producers; however, the difference was marginal (see Table 3). Interestingly, smallholders in both cases were younger compared to others. They also did not differ much in their educational attainment, with 7 years of formal schooling, on average.

The average family size of contract and independent producers was almost the same—about 11 members per household. The average family size is quite large because of a strong tradition of joint families, where married sons along with their spouses and children live with their parents. The family composition, too, was almost similar with about half of the family members effectively available to work. However, dairy farmers of large farms tend to have a larger family size, and apparently have a workforce comprised of more family members than other smaller farms.

Crop production was the main occupation for both contract and independent producers. However, dairying was the main occupation[15] for 33 percent of the contract producers, and 41 percent of the independent producers. For the majority of smallholder dairy producers, crop production was also the main occupation. On average, dairying contributed 41 percent to the total income of contract producers, and 46 percent for independent producers. Crop production, in both categories, accounted for half of the total income, and the rest came from nonfarm sources. In contrast, the contribution of dairying was less in the case of smallholder dairy producers.

Ownership of Assets, and Access to Infrastructure and Services

Land

The average size of landholding of contract dairy producers was 4.2 hectares, compared to that of independent producers at 3.2 hectares (Table 4). Dairying, however, has a high degree of association with landholding size. The cross-tabulation on households' dairy production and ownership of land by scale also showed that 44 percent of small dairy producers under contract farming had small landholdings (of less than 2.0 hectares). Their proportion however declined with the increase in scale of dairy production. Only about 10 percent of the small landholders had a large dairy herd (equal to or more than 6). Among independent small dairy producers, 2 percent had no land, and another 68 percent had a landholding size of less than 2 hectares. Here, too, the proportion of small landholders having large dairy herd was almost the same as in the case of contract producers.

Dairy Animals

Table 4 also shows the average herd size of different categories of dairy farms. Average dairy herd (in-milk and dry) of the contract and independent producers was pretty much the same (approximately 5.4 dairy animals). In comparing farm size too, there was little difference in the herd size between contract and independent producers.

Buffalo is the main milch species owned by both contract and independent producers. Buffaloes comprised 83 percent of the dairy stock of contract farms, and 91 percent of independent farms.

[15] "Main occupation" is defined in this context as the occupation contributing more than 50 percent to household income.

Table 3. Selected demographic characteristics of contract and independent producers in Rajasthan, 2005

	Contract				Independent			
	Small (<=3 animals)	**Medium (4-6 animals)**	**Large (>6 animals)**	**All**	**Small (<=3 animals)**	**Medium (4-6 animals)**	**Large (>6 animals)**	**All**
No. of observations	50	49	51	150	50	51	49	150
Age of the head of the household (in 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)
Average years of schooling	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 effective workers per 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)
Main occupation (%)								
Crop production	68.0	52.0	54.0	58.0	70.0	48.0	55.1	57.3
Dairying	22.0	40.0	38.0	33.3	28.0	50.0	44.8	40.7
Nonfarm	10.0	8.0	8.0	8.7	2.0	2.0	2.1	2.0
Annual household income (Rs/household)	114401* (68497)	173163*** (71213)	305611** (133345)	198608*** (125119)	97560 (60256)	133703 (45903)	251095 (136944)	160003 (110528)
Percent share of crops	56.5	48.1	49.8	50.6	57.1	47.3	48.7	50.0
Percent share of livestock	32. 3	44.3	42.7	41.1	38.6	49.8	46.1	45.6

Source: IFPRI-NCAP Household Survey, 2005.

Note: Figures in parentheses are standard deviations. The numbers marked with the symbols ***, **, and * are statistically significant at 1, 5, and 10 percent level of significance, respectively.

Table 4. Size of land and livestock holding of dairy producers in Rajasthan, 2005

	Contract				Independent			
	Small (<=3 animals)	**Medium (4-6 animals)**	**Large (>6 animals)**	**All**	**Small (<=3 animals)**	**Medium (4-6 animals)**	**Large (>6 animals)**	**All**
No. of observations	50	49	51	150	50	51	49	150
Size of landholding (ha)	2.7***	3.2*	6.3***	4.2***	1.7	2.8	4.7	3.2
	(2.12)	(1.98)	(4.27)	(3.41)	(1.44)	(2.32)	(2.87)	(2.6)
Per capita land (ha)	0.30***	0.32	0.46***	0.37***	0.20	0.34	0.35	0.31
	(0.30)	(0.24)	(0.36)	(0.32)	(0.17)	(0.29)	(0.25)	(0.25)
Percentage of small	44.0	28.6	9.8	27.3	68.0	39.2	12.2	40.0
No. of dairy animals/household (in-milk plus dry)								
In-milk cows	0.02	0.20*	1.33***	0.53***	0.06	0.08	0.53	0.22
	(0.14)	(0.68)	(1.72)	(1.22)	(0.24)	(0.27)	(1.56)	(0.93)
Dry cows	0.02**	0.06	1.14**	0.41*	0.10	0.10	0.67	0.29
	(0.14)	(0.24)	(1.64)	(1.09)	(0.36)	(0.30)	(1.57)	(0.97)
In-milk buffaloes	1.68	2.73*	4.02	2.82	1.56	2.55	4.10	2.73
	(0.71)	(0.91)	(2.54)	(1.88)	(0.64)	(0.73)	(2.11)	(1.69)
Dry buffaloes	0.68	1.61*	2.57***	1.63***	0.72	1.82	4.16	2.22
	(0.66)	(0.91)	(1.92)	(1.50)	(0.57)	(0.89)	(2.44)	(2.09)
Total	2.40	4.61	9.06	5.39	2.44	4.55	9.47	5.45
	(0.70)	(0.64)	(2.43)	(3.17)	(0.64)	(0.70)	(5.18)	(4.19)

Source: IFPRI-NCAP Household Survey, 2005.
Note: Figures in parentheses are standard deviations. Figures marked with the symbols ***, **, and * are statistically significant at 1.5 and 10 percent level of significance, respectively.

Access to Infrastructure and Services

Table 5 presents availability of infrastructure and services in the surveyed villages. As the contract and independent producers were from the same villages, these facilities were equally accessible to both groups.

Transport facilities are important for exchange of commodities between the rural and urban areas. Every surveyed village in both districts was connected by roads. Access to communication services is also equally important, as farmers need information on various aspects of production and marketing. Every village in the study had telephone facilities. Postal services were available in 40 percent of the villages in Jaipur district, and 60 percent of the villages in Sikar district.

Table 5. Availability of infrastructure and services in selected villages (percentage of villages) in Rajasthan, 2005

	Jaipur district	Sikar district
No. of villages	5	5
Road connectivity	100	100
Railway connectivity	0	0
Telecommunication services	100	100
Postal services	40	60
Cooperative credit society	40	60
Regional rural bank	0	0
Commercial bank	0	0
Animal feed/input shop	40	0
Public veterinary services	20	20
Private veterinary services	20	80
Milk collection center	80	100

Source: IFPRI-NCAP Household Survey, 2005.

Institutional credit facilities were not available in most of the villages. With respect to primary cooperative credit societies, only 20 percent of the villages in the Jaipur district had these, while 40 percent of the villages in the Sikar district had them. None of the villages in both districts had a commercial or regional rural bank.

Accessibility to animal health and breeding services was restricted to a few villages. Only 20 percent of the villages in both districts had government-owned veterinary hospitals/dispensaries. However, 80 percent of the villages in Sikar, and 20 percent in Jaipur had private veterinarians. Animal feed shops were available only in 40 percent of the villages in Jaipur district. Private milk collection centers existed in all the sampled villages in Sikar, and 80 percent of the sampled villages in Jaipur district.

5. COSTS AND NET REVENUES OF CONTRACT VERSUS INDEPENDENT DAIRY FARMS

Comparison of Averages

This section assesses the impact of contract farming on milk yield, production costs, transaction costs, output prices, and profits.[16] The analysis focuses on buffalo milk, as a majority of the producers did not maintain cows. Ownership of buffalo was widespread; over 97 percent of the independent and contract producers maintained buffaloes.

Table 6 provides information on selected parameters for contract and independent producers. Average milk yield was 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 was also high when compared to vendors in the village; these vendors are those who assemble milk from different producers and sell milk in the open market.

The unit cost of production was estimated at 8.6 rupees (Rs) per liter for the contract producers, which was not significantly different than that of independent producers.[17] However, independent producers selling to vendors incurred higher labor costs. The labor cost to contract producers was 6 percent less compared to those who sell in the open market, and 12 percent less compared to those who sold to vendors. The corresponding difference in feed costs was 5 and 3 percent, respectively.

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

Although unit cost of production was almost similar for contract and independent producers, transaction costs made milk production more costly for the latter, especially for those selling in the open market. The total production and transaction costs per unit of output increased to 11.3 rupees per liter for independent sellers in the wet market, to 9.8 rupees per liter for sellers to vendors, and to 9.4 rupees per liter for contract producers. Transaction costs were as high as 22 percent of the total cost in the open market, and 9 percent under contract farming. Thus, the unit cost of milk production (production and transaction) for open market sellers was 21 percent higher compared to contract producers, and 5 percent higher compared to those selling to milk vendors.

Output price was higher in the open market. The average open market price was 12.9 rupees per liter, which was about 6 percent higher compared to that offered under contract, and 9 percent more than that offered by vendors. This is understandable as integrators and vendors also incurred costs in the procurement and transportation of milk. The output price paid by vendors was almost the same as that offered by integrators. This implies that the local milk market is competitive, which is largely due to the presence of integrators.

[16] Transaction costs in milk markets were estimated for the amount of milk marketed irrespective of its origin.
[17] A breakdown of cost categories is given in Appendix A, Table A.3.

Table 6. Yield, costs, prices and profit in milk production on contract and independent farms in Rajasthan, 2005

	Contract	Independent		Significance of mean difference	
		Open market	Vendors	Contract vs. open market	Contract vs. vendors
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
Labor[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
Labor[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
Nonpecuniary	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: IFPRI-NCAP Household Survey, 2005.

Notes: [a]Labor costs are the implicit cost of family labor. Use of hired labor is almost absent. Figures marked with the symbols ***, **, and * are statistically significant at 1.5 and 10 percent level of significance, respectively NS stands for "no significant."

Net revenue per unit of output, excluding family labor costs, was higher for contract producers (at Rs 6.2/liter) compared to independent producers, but not significant. This was almost the same as realized by independent producers selling in the open market, but 5 percent 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 labor). Net revenue for contract producers was about twice of that realized by independent producers selling in the open market, and about 1.5 times that of those selling to vendors.

In summary, contract farming did not appear to make any significant difference in milk yield and cost of production among milk producers, but it helped improve farm profitability by reducing transaction costs. The output price under contract farming was lower than the open market price, but the producers were compensated by a substantial reduction in transaction costs in terms of profit margins gained from selling directly to processors/integrators as opposed to through vendors or other intermediaries. 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 profit for contract producers need not necessarily be due to their marketing arrangement with processors. There could be a number of unobservable factors (like management skills) that might cause a difference in the profits of contract and independent producers; thus, a comparison of 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. Producers' experience, educational attainment, endowments of land, dairy stock, and access to nonfarm income sources were considered to be important factors influencing their decision to participate in contract farming. The dependent variable is binary and it takes a value of 1 if a producer participates in contract farming, and is otherwise zero. Experience is proxied by age of head of the household, and it is expected that with experience, producers would be in a better position to analyze 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 competing uses of labor in crop and dairy production. This association is especially true for households with large landholdings, because these landholders are involved in mixed farming (crop and dairy). 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 realize cost economies of scale in marketing. Households' access to nonfarm income sources could have a positive influence as the labor scarcity may discourage such households to sell 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 nonfarm 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 unit of output 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 labor availability per animal, could be important determinants of farm profits. The results of the standard treatment effects model are presented in Table 7. The estimates from the logit model (presented in column 2 of Table 7) suggest that the probability of participation in contract farming is significantly higher for those who were more experienced at dairy farming. Thus, dairy producers who have more experience see the benefits of contract farming over open market arrangements. Educational attainment may also positively influence dairy producers' participation decisions, but not significantly. In other words, producers' experience is more pronounced than their education in its effect on their participation decisions.

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 labor, and easy access to the milk market through contract farming eased the labor 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, smallholders faced higher transaction costs in the open milk market, but they benefited the most from easy access to markets through vertical coordination, which implies that contract farming is not biased against smallholders. Access to nonfarm income sources has a positive influence on producers' decision to participate in contract farming but is not significant, probably due to the fact that access to nonfarm income sources is limited to a small proportion of the households.

Columns 3 and 4 in Table 7 shows the result of the profit equations where the dummy for contract production is instrumented by the predicted probabilities from the logit equation. In both equations, coefficients of the inverse Mills ratio were negative and significant, thereby indicating that correction for selectivity bias is important in the model.

Table 7. Results of the standard treatment effects model

Explanatory variables	Dependent variable		
	Contract producer =1 otherwise =0	Net revenue over total costs (Rs/litre)	Net revenue over pecuniary costs (Rs/litre)
Age of the decision maker (in years)	0.0313**	-	-
	(0.0155)		
Schooling (years)	0.0262	0.0346*	0.0183
	(0.0286)	(0.0208)	(0.0148)
Landholding (ha)	0.0686***	-	-
	(0.0207)		
Milch stock (No.)	-0.1043**	0.1007***	0.0163 (0.0215)
	(0.0447)	(0.0303)	
Access to nonfarm income =1; otherwise =0	0.5037	-	-
	(0.4174)		
Contract producer=1; otherwise=0	-	1.9074**	1.1076**
		(0.7892)	(0.5624)
Labor (workers/milch animal)	-	-0.1080	-0.0735
		(0.1091)	(0.0787)
Livestock-related assets (Rs/milch animal)	-	0.000033*	0.000022*
		(0.000017)	(0.000012)
Environmental mitigation cost (Rs/liter)		-0.83	-0.22
		(0.38)**	(0.27)
Inverse Mills ratio	-	-1.0994**	-0.6046*
		(0.5016)	(0.3577)
Constant	-1.7266	1.5146***	5.1534
	(0.7793)**	(0.4788)	(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: IFPRI-NCAP Household Survey, 2005.

Notes: Figures in parentheses are standard errors. Figures marked with the symbols ***, **, and * are statistically significant at 1.5 and 10 percent level of significance, respectively.

The coefficient with contract producers was positive and significant in both equations, confirming the observation that participating in milk contract farming was more profitable compared to independent production. This result was further supported when Tiongco et al. (2007) estimated the average treatment effect of contract farming on the participants using nearest neighbor matching across the variables considered. Although not economically important, the average effect was an increase in the net returns of contract farms by 0.07 rupees per liter, which is around 3 percent of the actual profit gained by contract farms (Tiongco et al. 2007). Moreover, the coefficient of farm assets was positive, suggesting that profits can be improved with better management of animals through, for example, provision of better housing sheds.

The coefficient related to labor carried a negative sign but was not significant. It nonetheless gives an indication of the overuse of labor in dairy production. However, as expected, education contributed significantly toward improving net revenue. The coefficient on the herd size was positive and

significant in the equation with profit over total cost as the dependent variable. Nevertheless, this suggested that there exist economies of scale in labor use in securing profit per unit of output. The effect of the cost of environmental mitigation was negative and significant in the first equation (the dependent variable included all costs of production); but not significant in the second (where the dependent variable included all costs of production except family labor costs). 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.

Despite the evidence that contract farming yields higher profits, not all producers participated in it. The main reason for their non-participation was that contract farming was a new concept in the region, and a majority of the dairy producers were still in the process of weighing the advantages and disadvantages of contract farming. Some important reasons for non-participation in contract farming were elicited. Among the most important of these reasons reported in the survey results were under-reporting of fat and SNF content by the milk collection agents; the lower price of milk under contract farming; under-weighing of milk; and the distant location of the milk collection centers (Table 8). These reasons appeared to be perceptions based on unsupported information, however; as only one-sixth of the independent producers had previously participated in the contract farming scheme. Nevertheless, 47 percent of the independent producers showed their willingness to participate in contract farming.

Table 8. Reasons for non-participation in contract farming in Rajasthan, 2005 (as a percent based on respondent answers)

	Producers selling to:		
	Vendors	**Market**	**All**
Under-weighing of milk	40.9	36.8	39.3
Under-reporting of fat and SNF	71.0	54.4	64.7
Milk at a lower than market price	46.2	52.6	48.7
Distant location of milk collection center	17.2	28.1	21.3
Was previously involved in contract farming	11.8	24.6	16.7
Willing to participate in contract farming	49.5	42.1	46.7
Total number of sample producers	93	57	150

Source: IFPRI-NCAP Household Survey, 2005.

Smallholder Competitiveness under Contract Farming

It is evident from the results presented in the previous section that contract farming entails significant economic benefits to producers. The question of the distribution of benefits, however, remains. Two important questions in this context are:

1. Do smallholders participate in contract farming?; and
2. Are they competitive in production and marketing?

In this section, competitiveness of smallholder dairy production under contract farming is examined.

Competitiveness can be defined as the ability of a farm/firm to compete with others in the marketplace. It can be measured in terms of productivity, cost, and profitability. Given that every producer faces the same market, the one who produces the same quantity at a lower cost can be termed as more efficient. In other words, the unit cost of production should be lower for him or her when compared to others. However, apart from cost, quality is an important factor in determining competitiveness. It influences the output price, which means that profitability is a more relevant measure of competitiveness in such a situation. In this study, dairy producers face three different market segments: contract farming,

the open market, and vendors. It was noted earlier in this discussion that the milk price did not differ much within these segments, but differed significantly across these segments. Transaction costs likewise vary significantly across these segments. Thus, the ultimate measure of competitiveness is profitability.

Table 9 compares the means of key variables of competitiveness for different categories of dairy producers. Under contract farming, the average milk yield of small farms was 9.3 liters per animal per day, which was as much as that of the large farms. However, smallholders incurred a marginally higher cost in production than the medium and large dairy producers.[18] On average, the imputed cost of family labor worked out to be 3.1 rupees per liter on small farms compared to Rs 2.7 per liter on medium farms, and Rs 2.2 per liter on large farms. The cash costs or pecuniary costs were also slightly higher for smallholders. These relationships give an indication that there are economies of scale in costs of dairy production and particularly so in labor use. This result is due to two factors: First, some activities such as feeding, watering, and supervision were undertaken jointly; thus, the labor requirement did not vary much by scale. Second, although the absolute labor use in larger herds was higher, these herds produced more and the labor used per unit of output produced/marketed was less.

Economies of scale are significant in transaction costs. A smallholder incurred Rs 0.9 per liter of milk as transaction costs, compared to Rs 0.8 per liter by a dairy farmer of a medium-sized farm, and Rs 0.7 per liter by a dairy farmer of a large farm. Also, nonpecuniary costs accounted for a sizeable proportion of total transaction costs.

The total cost (production and transaction) per unit of output of small farms was about 18 percent more than that of large farms, and 4 percent more than that of medium farms. The difference in pecuniary costs was, however; minor, suggesting that smallholder are as competitive in milk production as large farm dairy producers, and scaling up of dairying activity would further improve their competitiveness.

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 as compared to the total cost was, however, higher for large farm dairy producers. The difference in net revenue as a percentage of total cost for large farm dairy producers was 63 percent more than for smallholders and 39 percent more than medium-sized farm producers. These differences narrowed considerably when profit was estimated over pecuniary costs. In other words, economies of scale are important determinants of producers' competitiveness, especially when it comes to use of labor.

From the smallholders' perspective, it is more appropriate to compare competitiveness at a similar scale between contract and independent producers. This would provide insight into the extent of benefits associated with contract farming derived by a particular category of producers. Table 9 shows the parameters of competitiveness of independent producers by farm size.

First, competitiveness based on farm size among contract producers was examined vis-à-vis producers selling milk to vendors. Smallholder producers supplying milk to vendors were as efficient in terms of production as their counterpart contract producers. Nevertheless, they faced higher transaction costs compared to smallholder contract producers. Thus, total costs were lower for smallholder contract producers. They got a better output price and thus higher profits. The difference in various parameters of competitiveness in the case of small producers was statistically insignificant (see Appendix A, Table A.4). Medium and large contract producers also incurred lower costs of production and lower transaction costs. They got only a marginally higher price, but significantly higher profits.

As compared to open market transactions, contract farming is more beneficial for all categories of dairy producers. The major benefits accrue from a reduction in transaction costs. For independent producers, transaction costs were estimated to be Rs 2.9 per liter of milk for smallholders, Rs 2.5 per liter for medium producers, and Rs 2.0 per liter for large producers. These transaction costs were about three times more than their counterpart contract producers, a highly significant difference. The unit cost of production for small and medium contract producers was marginally less than their counterparts selling in

[18] Although labor use varies with herd size, the difference is not great, as there are a number of activities that can be performed simultaneously without much labor requirement. For example, in-milk animals of the same species are in general fed together or are taken for grazing and water together.

the open market. The difference was more stark in the case of large producers. On the whole, the total cost per unit of output to contract producers was less than that for independent market suppliers, with 20 percent less in the case of small- and medium-sized farm producers, and 30 percent in the case of large producers. The independent market suppliers realized better prices compared to the contract price; this did not fully compensate for the transaction costs they incurred in marketing. The profit (over total cost) under contract farming to all categories of producers under contract farming was much higher than that realized by their counterparts in the open market. Smallholder contract producers realized more than twice the profits of their counterparts selling in the open market. This ratio declined with the increase in scale. In fact, a smallholder contract producer earned more profit than what a large producer realized in the open market. The difference in profits of contract and independent producers narrows considerably when the opportunity cost of labor is assumed to be zero. Yet the large contract producers stand to gain over their counterparts in the open market. At similar scale, differences in most of the parameters between the contract and open market of competitiveness are statistically significant (see Appendix A, Table A.4).

These results show that the benefits of contract farming are skewed toward large producers primarily because of the economies of scale in production, a large part of which are due to labor use. While assessing the impact of contract farming, Birthal et al. (2005a) also observed significant economies of scale in production and marketing. Despite economies of scale, smallholders gained from participation in contract farming primarily due to a reduction in transaction costs of marketing, which otherwise would have been much higher.

Table 9. Economics of milk production by farm size under contract farming

Cost items	Contract			Independent					
				Open market			Vendor		
	Small (<=3)	Medium (4-6)	Large (>6)	Small (<=3)	Medium (4-6)	Large (>6)	Small (<=3)	Medium (4-6)	Large (>6)
Production costs (Rs/l)									
Feed	5.73	5.82	5.44	5.82	5.93	6.3	5.56	6.01	5.99
Labor	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
Transaction costs (Rs/l)									
Transport	0.16	0.15	0.11	0.95	0.84	0.78	0.11	0.12	0.12
Labor	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)									
Pecuniary	5.89	5.97	5.545	6.77	6.77	7.08	5.67	6.13	6.11
Nonpecuniary	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 pecuniary cost (Rs/l)	6.23	6.17	6.59	6.11	6.13	5.91	6.17	5.96	5.99
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
Yield (l/in-milk animal/day)	9.3	9.44	9.16	9.08	9.19	8.73	9.39	9.18	9.2
No. of observations	47	48	47	16	20	21	35	31	30

Source: IFPRI-NCAP Household Survey, 2005.

Beyond Profits

A qualitative assessment of impacts based on the producers' response is discussed in this section of the paper. Access to markets and support services is expected to induce farmers to expand their scale of production and productivity. Contract farming did not appear to have made any significant effect on herd expansion. Only 20 percent of the contract producers indicated that they added to their herd after their association with the contract scheme. The effect of contract farming on adoption of technology was not encouraging. Only 15 percent of the producers adopted preventive vaccination of their animals to protect their herds against diseases. Adoption of other technologies such as urea treatment of fodder was almost negligible.

Nevertheless, the effect of contract farming on milk yield appeared to be positive. More than half (54 percent) of the dairy producers reported an increase in herd productivity. Increase in milk yield could be due to increased use of inputs and/or management practices. Increase in milk yield at higher cost might not be in the interest of producers. This was not supported by the profitability analysis, as the unit cost of production was less for contract producers. This was further substantiated by the producers' response to the question regarding the impact of contract farming on the cost of production; 60 percent of the producers indicated that they could reduce the cost of production after their association with contract farming scheme. The expansion in herd size and increase in its yield had a positive impact on household income. Over one-third of the farmers reported an increase in their income.

These results need to be viewed with caution considering the fact that contract farming in the region was only introduced 3 to 4 years ago; thus, the real impact is yet to be realized. Nevertheless, the above indicators clearly support the hypothesis that contract farming creates opportunities for farmers to invest in livestock and adopt productivity-enhancing practices and technologies by providing an easy access to markets.

For the processors, contract farming is an important tool to ensure an adequate supply of raw material of desired quality without investing in acquisition and maintenance of animals. If the firm were fully vertically integrated, it would have made substantial investment in land, livestock, machinery, and equipment, which would require a very high amount of capital. Further, it would have had to incur substantial costs in supervision of hired labor employed for maintenance of assets, including animals. Through contract farming, the firm could minimize production risks and minimize supervision or monitoring costs. However, the problem of opportunism remains. Producers may tend to be opportunistic in case the terms and conditions (formal or informal) are not adhered to, or are not as attractive as offered by other competitors, if present in the local milk market. This may affect raw material supply to the integrator, resulting in lower capacity usage of the processing plant. This would adversely affect the firm's competitiveness in the market as well. The firm can, however, reduce the problem of opportunism by making terms and conditions attractive and monitoring contracts continuously.

Management of Environmental Externalities in Dairying

To examine if a farmer has the ability to use all the manure produced on the farm, the nutrient balance is estimated based on the mass balance approach presented in Section 3.3. Dairy households were asked how they disposed of the manure generated from their dairy operations.

The dung produced was used largely as manure (Table 10). About 88 percent of contract producers and 95 percent of independent producers reported having used dung as fertilizer for field crops. Dung is also used as a domestic fuel, but the proportion of households reporting using dung for fuel use was limited to 12 percent of contract producers, and 5 percent of independent producers. The market for manure was limited; only a small proportion of dairy producers purchased manure from other farmers.

Dairy producers disposed of dung in open spaces as well as in specially constructed manure pits. Nearly 45 percent of contract producers as well as independent producers stored manure in pits. But a majority of smallholders disposed of manure in the open. To date, there are no regulations governing manure management and no penalty for negative externality in Rajasthan.

Table 10. Management of livestock manure (%)

	Contract				Independent			
	Small	**Medium**	**Large**	**All**	**Small**	**Medium**	**Large**	**All**
Use dung as manure	100.0	100.0	100.0	100.0	98.0	100.0	98.0	98.7
Use dung as fuel	20.0	14.3	2.0	12.0	4.0	7.8	2.0	4.7
Sell manure	0.0	2.0	0.0	0.7	4.0	2.0	2.0	2.7
Purchase manure	10.0	0.0	0.0	3.3	0.0	2.0	0.0	0.7
Manure disposal in the open	74.0	59.2	35.3	56.0	68.0	43.1	49.0	53.3
Manure disposal in pits	26.0	40.8	64.7	44.0	30.0	56.9	51.0	46.0

Source: Based on the IFPRI-NCAP Household Survey, 2005.

As alternative uses of dung were not reported by a majority of the producers, it was assumed that all the dung produced on the farm was used as manure. Manure production was estimated using dung evacuation rates by Birthal et al. (2005b), and wet dung was converted into a dry matter equivalent.[19] Nutrients from chemical fertilizers were also added to nutrients derived from manure to arrive at the total amount of nutrient incorporated in the soil.

The total uptake of a nutrient is the potential of crops to remove that nutrient from the soil.[20] Nutrient uptake is estimated for all the crops grown on the farm. The mass balance is thus equal to the nutrient uptake by all the crops minus the nutrient incorporated in the soil in the form of manure and inorganic fertilizers.

Table 11 shows nutrient mass balance for nitrogen (N), phosphorus (P), and potash (K). Uptake of all nutrients exceeds the supply in all categories of farms which means that nutrient mass balance is positive; farms are not creating a surplus that will cause environmental problems over time. Nutrient mass balance is not positive on all farms. The mass balance for nitrogen is negative in 16 percent of the sampled farms and for phosphorus in 10 percent of the sampled (see Appendix A, Table A.5). Also, there are some farms where mass balance is marginally positive—especially for nitrogen—leading to a possibility that these may reflect a negative mass balance in the years to come, particularly with increasing commercialization of agriculture and animal husbandry. Nevertheless, the results indicate that in general there is enough land to assimilate nutrients, thus demonstrating a greater scope for internalization of the potential negative externalities of dung manure.

[19] Dung evacuation rates are as follows: in-milk cattle= 6.9kg; dry cattle= 6.5kg; heifers/calves 5.1kg; in-milk buffalo 8.2kg; dry buffalo 7.4kg; adult male cattle= 5.9kg; adult male buffalo=8.1kg; heifers/calves= 5.7kg. One kg of wet dung is equivalent to 273 gm of dry dung. The dung manure contains 0.6%N, 0.15% P, and 0.45% K.

[20] Nutrient uptake rates were quoted from the Indian Council of Agricultural Research (ICAR) (2006).

Table 11. Nutrient mass balance in different categories of dairy farms (kg/ha)

	Contract producers			Independent producers		
	N	**P**	**K**	**N**	**P**	**K**
Small						
Uptake	77.4	66.1	98.2	84.5	75.1	113.0
Total supply	39.5	18.9	12.7	52.2	21.8	18.4
From manure	17.0	4.2	12.7	24.2	6.1	18.2
Medium						
Uptake	81.1	62.1	105.6	81.2	69.7	107.1
Total supply	35.0	16.6	11.2	35.7	16.8	11.7
From manure	14.9	3.9	11.2	15.6	3.9	11.7
Large						
Uptake	78.5	44.3	95.1	82.1	69.5	101.9
Total supply	23.4	11.1	8.0	24.0	11.0	7.7
From manure	10.7	2.7	8.0	10.3	2.6	7.7

Source: IFPRI-NCAP Household Survey, 2005.

Note: N stands for nitrogen, P stands for phosphorus, and K stands for potash.

6. CONCLUSIONS AND IMPLICATIONS FOR SCALING UP OF CONTRACT FARMING IN MILK

Summary and Conclusions

Contract farming is emerging as an important form of vertical coordination in agrifood markets in India, and its economic and social consequences are attracting considerable attention in the food policy debates. This study has examined the effects of contract farming in dairying on productivity, production and transaction costs, milk prices, and profitability.

India's dairy sector is dominated by smallholders, and contracting with a large number of them is costly for the processors. The processors do not have much choice but to take milk from smallholder producers. The problem of the higher cost of contracting with small producers is overcome by contracting with a single person in the village—often an agent—who acts as an intermediary between the processor and producers.

The study found that contract farming is more profitable than independent production. The main benefit came from reducing the transaction costs in disposal of milk. Contract farming also contributed toward improving milk yield and reducing production costs. The overall impact, however, was not significant. Another major effect of contract farming is that it increased competition in local milk markets. The local buyers such as vendors paid almost the same price as those offered under the contract.

The price of milk in the open market was higher than the contract price. However, higher transaction costs in the open market outweighed the price advantage. The milk price (net of transaction costs) was higher than both the open market price and the price paid by other buyers in the local market. This fact does not mean that because integrators are the dominant party they can extract monopsonistic rent in the output market.

The benefits of contract farming were skewed toward large producers mainly due to economies of scale in the use of family labor in production and disposal of milk. At similar scales of production, smallholders derived significant benefits from a reduction in transaction costs due to contract farming.

The issue is one of replication of 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 for the private sector through the Agricultural Produce Marketing Act. Specific to dairy markets, the Milk and Milk Products Order (MMPO) has been phased out to allow private industry to establish new processing units and expand their processing capacity. Lack of infrastructure remains an important constraint to growth, especially in remote areas. Investment in public infrastructure such as roads and transportation will induce private sector investment in food processing. The present cold storage capacity is capable of catering to only about 10 percent of the total output of perishables.

At present, contract farming in most Indian states is not supported by legal provisions. Therefore, legislation is necessary to ensure that producers are not discriminatory in their practices and that they minimize opportunistic behavior and provide an effective means of dispute settlement in contract farming. Policy intervention is also needed to ensure that smallholders are not excluded from such innovations.

Another restraining factor is the multiplicity of food laws. Until August 2006, there were as many as 15 laws implemented by different ministries and departments. Such a bureaucracy resulted in filling out unnecessary paperwork and delays in getting approval for establishing new food processing units. With passage of the Food Safety & Standards Act of 2006, eight food laws were integrated into this Act. The main objective of this act is to systematically and scientifically develop the food processing industry and shift from a regulatory regime to self-compliance. The Act provides for a single food authority comprised of representatives from different ministries related to food safety and standards; the food processing industry and consumer organizations; and food technologists and farmers' organizations.

To induce investment in food processing, there is also a need to reduce taxes on food products. In addition, market fees and other *octroi* in procurement of raw material and processed foods are levied sales

tax and excise duties. Together, these could be as high as 25 percent of the sale price in the case of many processed foods (***Hindu Business Line*** 2005).

Rising demand for food and nonfood processed products is creating the growth of their organized retailing. At present, organized retailing comprises about 2 percent of the total retail sales in India, and has attracted some domestic business groups into food retailing (Birthal et al. 2005). Some of these retail food chains are sourcing raw materials through contract farming. However, foreign direct investment (FDI) is not allowed in food retailing in India on the grounds that it would displace a large number of small traders and create unemployment. Allowing FDI in food retailing may spur the growth of supermarkets, which may help strengthen backward linkages.

Liberalization of dairy markets is expected to boost dairy sector growth. The question is: Will dairying remain a smallholder activity? Increasing commercialization may displace smallholders from the marketplace or aid them to scale up their operations to participate in commercial production. In India, the average milk production for 63 percent dairy households is ≤1000 liters per annum (Birthal 2007). Only 15 percent of the households produce more than 2000 liters of milk per annum, and they account for about half of the total milk produced in the country. In other words, for a majority of the households, dairying is likely to remain subsistence-oriented with little if any surplus for the market unless there are market opportunities for them at their doorstep. Nevertheless, smallholders do participate in commercial dairying. Birthal (2007) found considerable participation of small landholders in commercial dairying; that is, about 65 percent of the households producing 2000 to 5000 liters per annum, and 55 percent producing more than 5000 litres of milk per annum were small landholders (those possessing ≤2 hectares). What this implies is that smallholders are capable of scaling up their production if they can overcome some of the production and marketing constraints.

Potential Effects of the Scaling Up of Contract Farming in Milk

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.

Increasing commercialization of dairy production will put pressure on the livestock service delivery system. Intensification of production is likely to be accompanied by a number of diseases with potential risks to animals and public health. Although the public extension system in India is well developed in terms of infrastructure and manpower, the delivery of services is inefficient (Ahuja et al. 2000). To meet the growing demand for livestock services will require either improving the efficiency of public institutions or facilitating privatization of the livestock services. However, in view of the scarcity of public financial resources, it is envisaged that the private service delivery system, accompanied by increasing vertical coordination and, in many instances, the processors/integrators too, will emerge as an important source of service providers.

In the process of commercialization, management of animal waste will draw considerable public attention. At present, there is sufficient scope to mitigate negative environmental externalities due to animal dung being used as fertilizer for field crops, as manifested by positive nutrient mass balances. The nutrient mass balance is likely to remain positive for some time, even if contract farming leads to intensification of dairy production. One must be cautious of this generalization, however, because the nutrient mass balance depends on intensification of crop production and is location-specific. For instance, nutrient mass balance could be positive on the margin or even negative in regions with a high degree of crop intensification or in peri-urban areas with a high degree of commercial dairy production. In fact, animal waste management is becoming an important issue in urban and peri-urban commercial dairy production systems. Yet, to date, there are no regulations governing waste disposal management.

The global market for dairy products is increasing, but exports from developing countries is limited on account of the high level of protection to the dairy sector and stringent quality controls in developed countries, with which developing country producers are not yet fully able to comply. India's

presence in the global trade of dairy products is almost negligible, partly because of the above factors and partly due to lack of economies of scale in dairy processing. In other words, to be competitive in the global market, processors will have to make sizeable investments in food safety and quality control measures. Moreover, there is also a need to improve efficiency in processing by investing in technologies and improving the scale of its operations.

Food safety is likewise becoming an important issue in the domestic markets, driven by the demand from high-end consumers. It is therefore necessary on the part of the processors and the government to orient producers for quality-driven markets. This will require investment in development of human resources in terms of increasing producers' awareness about quality standards, and imparting to them the skills needed for quality control measures.

At present, vertical coordination (like cooperatives as well as private processors) is largely concentrated in "favored regions"—that is, those areas with milk production as well as public infrastructure like roads and adequate cold chain—primarily because the processors face lower transportation costs in these areas. Public investment in rural infrastructure in "less favored regions" is necessary to induce processors to work in these areas. Otherwise, imbalances in regional economic growth will persist. Evidence suggests that, with the necessary infrastructure in place, vertical coordination has been able to promote growth in regions considered to be unfavorable for dairy production. Punjab, for example, has agroecological conditions similar to that of this study region, and the company Nestle India Limited was able to revolutionize milk production in semi-arid regions of Punjab through vertical coordination (Birthal et al. 2005a). The results from this study in Rajasthan also indicate that, given adequate infrastructure and an enabling policy environment, vertical coordination has the potential to contribute toward improving the performance of dairy production in these otherwise "less favored" environments.

Dairy markets in India have been liberalized to induce private processors to strengthen backward linkages with the producers through institutions like contract farming. However, this has not been backed up by legal instruments that provide protection to producers as well as to processors against problems like moral hazards, wilful defaults, and the like. A proactive role by the government is needed to provide adequate legal protection to facilitate sharing of risks and benefits for both contracting parties.

APPENDIX: A: SUPPLEMENTARY TABLES

Table A.1. Incentives for contract farming

Risks/hazards in livestock	Benefits of contract farming to:	
	Integrator, buyer, trader	**Contract grower (contractor)**
No capital	Access to investment opportunities in livestock; facilities construction	Access to capital
Loss of capital	Incentive to contract grower to renew capital	Protection against systematic loss
Loss of animal	Protection against careless labor	Protection against diseases
Quality of animal	Assurance of product	Access to better stock
Reliability of output price	Reliability of supply	Reliability of outlet
Quality and price of inputs	Quality gain for integrators and cheaper inputs due to economies of scale in bulk purchasing	Quality assurance, availability, and/or credit
Timing/availability of outputs	Ability to meet demand further up the supply chain when needed	Timing and availability of management; timely outlet
Labor supervision	Absence of labor supervision; integrators provide technical assistance	Absence of daily supervision
Land tenure	Access to land without owning	Own or rent land
Environmental regulation	Avoidance of legal responsibility for pollution	
Knowledge deficiency	Technical assistance and veterinary care provided to grower	Access to extension
Free-rider risk	Better health control as monitoring is strictly implemented	Better health control

Source: Derived from Delgado and Tiongco, 2005.

Table A.2. General information about the contract between dairy farmers and integrators

Item	Small contract producers	Medium contract producers	Large contract producers	All
1. Average years in contract farming	3.6	3.9	4.1	3.9
2. Any formal/informal contract (% indicating yes)	97.7	87.8	98.0	94.4
3. Conditions to become contract grower (%):				
a. Amount of milk	3.1	6.3	10.1	6.9
b. Fat and SNF* content	60.9	59.4	47.2	58.4
c. Dairy herd	1.6	1.6	5.6	3.2
d. Reputation	31.3	31.3	27.0	29.5
4. Appropriateness of milk price (% indicating yes)	90.0	85.4	56.9	77.2
5. Restriction on milk supply in flush season (% indicating no)	98.0	100.0	96.1	98.0
6. Any milk holidays (% no)	95.9	97.9	96.0	96.6
7. Conditions leading to stoppage of milk supply (% indicating yes):				
a. Under-weighing	33.9	41.2	38.9	38.1
b. Under-reporting of fat and SNF*	41.9	47.1	33.3	40.6
c. Refusal to lift milk	22.6	10.3	13.9	15.4
d. Misbehavior	1.6	1.5	13.9	5.9
8. Dispute resolution (% indicating yes) tactics:				
a. Reporting to firm staff	56.0	73.5	70.9	66.9
b. Resolving mutually	40.0	22.5	21.8	27.9
c. Stopping of milk supply	4.0	4.1	7.3	5.2
9. Frequency of visit by the firm staff (% indicating yes):				
a. Occasionally	45.9	61.5	41.9	49.6
b. On call	24.3	25.6	44.2	31.9
c. Weekly	0.0	5.1	0.0	1.7
10. Monitoring parameters (% indicating yes):				
a. Milk yield	10.5	15.6	15.4	14.3
b. Animal health	42.1	15.6	23.1	24.7
c. Animal nutrition	31.6	6.3	3.9	11.7
d. Adulteration	15.9	62.5	57.7	49.4
11. Timeliness in payment (% indicating yes, i.e., on time):	98.0	95.9	98.0	97.3
12. Checking of fat and SNF regularly	61.7	81.2	84.3	76.0

Source: IFPRI-NCAP Household Survey, 2005.

Note: * SNF stands for “solid non-fat.”

Table A.3. Details of production and transaction costs in dairy (Rs/liter)

Production/transaction categories	Contract			Independent					
				Open market			Vendor		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Production cost									
Dry fodder	2.12	1.98	1.92	2.25	2.25	2.09	2.2	2.04	2.03
Green fodder	0.29	0.44	0.37	0.39	0.46	0.34	0.36	0.42	0.41
Grain	1.681	1.645	1.7	1.75	1.801	2.305	1.63	1.9	1.89
Cattle feed	1.096	1.02	0.845	0.93	0.996	0.917	0.96	1.05	1.02
Oil cake	0.323	0.68	0.557	0.35	0.334	0.622	0.22	0.42	0.52
Others	0.22	0.055	0.048	0.15	0.089	0.026	0.19	0.18	0.12
Labor	3.12	2.73	2.17	3.14	2.92	2.41	3.27	3.16	2.75
Transaction cost									
Inputs									
Transport cost	0.138	0.123	0.084	0.167	0.137	0.149	0.0791	0.0921	0.0967
Travel cost	0.025	0.027	0.021	0.032	0.03	0.024	0.0345	0.031	0.024
Personnel time cost	0.242	0.292	0.281	0.315	0.211	0.204	0.921	0.651	0.6
Total	0.405	0.442	0.386	0.514	0.378	0.377	1.0346	0.7741	0.7207
Output									
Transport cost	-	-	-	0.0864	0.121	0.132	-	-	-
Travel cost	-	-	-	0.668	0.553	0.479	-	-	-
Personnel time cost	0.501	0.379	0.291	1.681	0.989	0.996	0.1155	0.0851	0.0784
Total	0.501	0.379	0.291	2.4354	1.663	1.607	0.1155	0.0851	0.0784
Total cost	9.76	9.37	8.29	11.91	10.89	10.69	9.98	10.03	9.54

Source: IFPRI-NCAP Household Survey, 2005.

Table A.4. T-values for various firms

Cost items	Contract vs. Open Market			Contract vs. Vendors		
	Small	**Medium**	**Large**	**Small**	**Medium**	**Large**
Feed	-0.31408	-0.36855	-2.94091	0.64075	-0.75758	-2.22047
Labor	-0.09025	-0.69638	-1.31814	-0.73497	-1.9401	-2.91304
Total A	-0.2618	-0.69287	-2.91745	0.050968	-1.7823	-2.95394
B. Transaction cost						
Travel & transport	-10.3366	-10.1365	-11.7988	1.786182	1.454494	-0.59003
Labor	-9.04217	-4.31008	-5.59886	-2.3697	-0.98265	-1.29362
Total B	-13.7229	-9.42217	-9.95839	-1.895	-0.52937	-1.35216
Total cost (A+B)						
Total pecuniary cost	-2.99952	-2.59414	-5.16734	0.799693	-0.62646	-2.2212
Total nonpecuniary cost	-4.36104	-2.18863	-3.46262	-1.6673	-1.98385	-2.88684
Total	-12.6057	-7.7782	-14.4736	-1.46933	-3.7992	-9.56628
Milk price	-2.30249	-2.07136	-0.06583	0.853994	0.167577	0.113239
Net return over pecuniary cost	0.272844	0.08438	1.58472	0.137505	0.516507	1.522692
Net return over total cost	3.154987	1.735257	4.014275	1.435099	2.108737	3.965304
Yield (kg/animal)	0.039761	0.047568	0.088011	-0.02063	0.062065	-0.00993

Source: IFPRI-NCAP Household Survey, 2005.
Note: T-values above 1.6448 and 2.3263 are significant at 5% and 1%, respectively.

Table A.5. Distribution of farms according to nutrient mass balance

Range (kg/ha)	N	P	K
Negative balance			
>50	3.7	1.3	0.0
40-50	1.3	0.0	0.0
30-40	1.0	0.3	0.0
20-30	2.7	2.7	0.0
10-20	3.7	5.3	0.0
0-10	3.3	0.0	0.7
Positive balance			
0-10	6.0	5.7	0.7
10-20	5.3	12.7	0.3
20-30	10.0	19.7	1.0
30-40	10.3	11.7	1.7
40-50	15.3	5.7	1.7
>50	37.3	35.0	94.0
Total	100.0	100.0	100.0

Source: IFPRI-NCAP Household Survey, 2005.
Note: N stands for nitrogen, P stands for phosphorus, and K stands for potash.

APPENDIX B: GROWTH PROSPECTS OF THE DAIRY SECTOR AND THE SMALLHOLDERS

Milk Production

India is the largest producer of milk in the world. Milk production that had been stagnating around 20 million tons until 1970 increased to over 86 million tons in the TE—that is to say, the triennium ending average—for 2003-04 (see Table B.1). In monetary terms, milk is now the largest agricultural activity in India, with an 18 percent share of the agricultural output (GOI 2005).

Dairying is practiced throughout the country, but more prominently in the northern and western regions where it accounted for 23 and 21 percent of the agricultural sector output in 2002-03, respectively (GOI, 2004). Of total milk production in the country, the northern region contributed 37 percent and the western region 31 percent during TE 2005-06.

Table B.1. Regional patterns of milk production in India (1982-2005)

Year	India	North	West	South	East	Northeast
	(millions tons)		%	(% share)		
TE 1982-83	31.8	37.0	29.3	19.5	12.2	1.9
TE 1992-93	53.4	36.8	30.4	19.3	12.0	1.6
TE 2005-06	92.6	36.8	30.8	20.6	10.5	1.3
			Annual compound growth (%)			
1980-81 to 1989-90	5.6	5.2	5.7	6.5	6.2	3.6
1990-91 to 1999-2000	4.4	4.3	4.3	5.6	2.0	2.2
2000-01 to 2005-06	3.6	3.4	3.0	1.0	6.1	2.7

Source: GOI. (various issues), Basic Animal Husbandry Statistics.

Milk production grew significantly over the last two decades. In the 1980s, it increased at an annual rate of 5.6 percent. This trend was robust everywhere except in the northeast. It subsequently slackened, with annual growth dropping to 4.4 percent during the 1990s, and lowering to 3.6 percent between 2000 and 2001, and 2003 and 2004. The decelerating trend of the 1990s prevailed throughout the country, except in the eastern and northeastern states.

Growth in milk production resulted from both an increase in animal numbers as well as increased productivity (Birthal and Taneja, 2006). At 1000 kilograms per annum, the productivity of dairy cows in India remains low, amounting to about half of the global average.

Consumption of Dairy Products

Annual per capita milk consumption increased from 43 kilograms in 1983 to 59 kilograms in 1993-94; and rose to 74 kilograms between 1999 and 2000 (see Table B.2). The rate of increase was highest in the 1990s.

The regional pattern of milk consumption corresponded closely to the production pattern. During 1999-2000, per capita milk consumption was highest in the north, followed by the west, south, and east (Table B.2). This pattern did not change over the last 17 years, despite significant interregional differences in the annual rate of increase during the 1990s.

Table B.2. Average per capita consumption of milk in India (kg/annum) (1982-2000)

Year	India	North*	West	South	East
1983	43	72	50	31	21
1993-94	59	103	70	44	29
1999-2000	74	104	77	51	33

Source: Derived from Kumar and Birthal (2004).

Note: * The North does not include the hill states of Himachal Pradesh, Jammu and Kashmir.

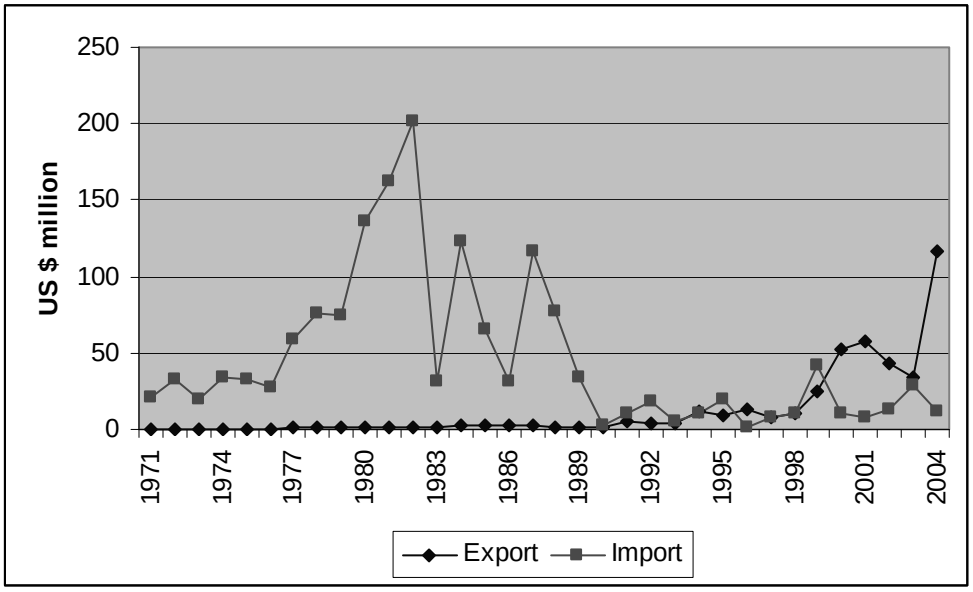
The increase in milk consumption was not confined to any specific group of consumers, but was widespread. Kumar and Birthal (2004) observed that per capita milk consumption was positively associated with income; interestingly, proportionate increase in consumption has been highest among households at the lower end of the income distribution. Moreover, per capita milk consumption was higher for urban consumers than for those from rural areas, but the rural-urban dichotomy in consumption was narrowing. These trends imply that demand for milk grows faster with a sustained rise in per capita income, especially among the poor.

The changes in the Indian "food basket" (that is, agribusiness) were driven by a sustained rise in per capita income and rapid growth in urban populations. Between 1981 and 2001, per capita income grew at about 4 percent a year, and in the urban population it averaged 3 percent a year. Assuming that these trends will continue, we expect a substantial increase in demand for dairy products in the near future (Delgado et al. 1999, and Rao et al. 2004).

Trade in Dairy Products

Until recently, India imported a substantial amount of dairy products. In 1982, dairy products worth US$202 million were imported (Figure B.1). This comprised 62 percent of the total livestock sector imports (Birthal and Taneja 2006). Most imports were in the form of food aid. However, with sustained growth in milk production due to government-supported programs, imports fell sharply during the 1990s.

Figure B.1. Trends in exports and imports of dairy products from India (1971-2004)



Source: FAOSTAT.

India's dairy exports have been increasing, especially since the mid-1990s (Figure B.1). In 1999, India exported dairy products worth US$25 million. At the same time, India's dairy exports portfolio also diversified away from traditional products like ghee and dry whole milk toward dry skim milk and casein (Birthal and Taneja 2006).

India has a competitive advantage in milk production but it lacks competitiveness in the world market (Table B.3). The producer price of milk in India has remained lower than that of the United States, but prices of processed products in India are much higher than the world prices. This difference occurs largely on account of inefficiency in processing and distortions in world trade. Another factor is that the United States and the European Union provide huge protection to their dairy sectors; the producer subsidy in 2002 was equivalent to 46 and 49 percent, respectively (Birthal and Taneja, 2006). A reduction in such protection would enable India to have increased access to world markets, especially for skimmed milk powder.

Table B.3. Wholesale prices of livestock products in India, the United States, and the world (in US$/ton) (1995-2005)

Year	Producer prices		Product prices					
	Cow milk		Butter		Skimmed milk powder		Whole milk powder	
	India	U.S.	India	World	India	World	India	World
1995	210	285	3155	1800	2136	2045	3335	2051
1996	208	328	3222	1698	2220	1922	3457	1959
1997	217	293	3053	1540	2096	1735	3283	1758
1998	204	342	2820	1715	1941	1444	3039	1701
1999	205	317	2703	1331	1982	1319	3147	1477
2000	213	271	2571	1204	1933	1871	3105	1847
2001	206	331	2548	1293	1882	2043	3047	1976
2002	203	267	2513	1056	1608	1380	2602	1389
2003	219	276	2784	1353	1974	1761	3194	1804
2004	233	355	3107	1788	2387	2018	3864	2020
2005	245	335	3241	2128	2433	2223	3938	2261

Source: Compiled from data from the following: FAOSTAT, www.faostat.org for producer prices; GOI (various years), Agricultural prices in India; and FAO, www.fao.org/es/esc/prices. Oceania indicative export prices.

Markets and Prices

The rapid growth in milk production was achieved by strengthening vertical linkages between rural producers and urban consumers through the network of dairy cooperatives under the umbrella of the Indian National Dairy Development Board (NDDB). From 2003 to 2004, India had over 108,000 dairy cooperatives, about eight times more than during 1980-81; and the number of individual farmer members in dairy cooperatives increased from 1.7 million to 12 million during this period (Table B.4). At the same time, there was also a significant increase in milk procured by dairy cooperatives, from less than 1 million tons during 1980-81 to 6.4 million tons during 2003-04. In other words, dairy cooperatives procured over 7 percent of the milk produced in the country during 2003-04. Of the total milk procured, 15 percent was processed into value-added products, and the rest was sold as pasteurized liquid milk.

Table B.4. Indicators of growth of dairy cooperatives in India (1980-2004)

	1980-81	1990-91	2003-04
No. of dairy cooperative societies (DCS)	13,284	63,415	108,574
Farmer members (in '000)	1,747	7,482	11,994
Members/DCS	118	132	110
Milk procured ('000 tons/year)	935	3,541	6,381
Milk procured (as % of total production)	3.0	6.6	7.2
Milk procured/DCS (tons/year)	70.4	55.8	58.8
Milk procured/ member (tons/year)	0.54	0.47	0.53
Milk processed (% of procured milk)		17.1	14.5
No. of dairy plants		428	748
Cooperative		180	232
Private		248	516

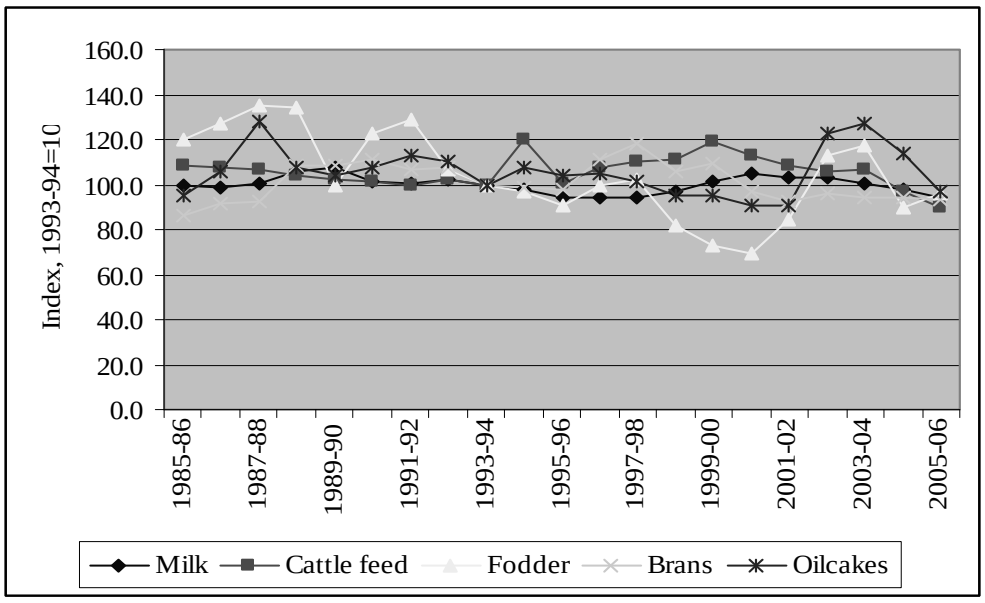
Source: Compiled from data of the National Dairy Development Board (NDDB), 2005.

Growth in dairy cooperatives happened in a protectionist environment where cooperatives were protected from competition through regulatory and fiscal measures. Historically, the entry of the private sector in the dairy industry was regulated through licensing, quotas, and zoning. To protect the domestic industry from foreign competition, imports were regulated through quantitative restrictions and tariffs. However, following the economic reforms program, since 1991 the dairy sector has been deregulated, which has resulted in an increase in the number of private dairy processing plants from 248 in 1991, to 516 during 2003-04. Although there was no verifiable information available on the amount of milk procured by the private sector, it is estimated that the private processors procured about 10 to 15 percent of the milk output (Birthal and Taneja, 2006). In other words, the informal sector remained dominant in the milk markets, producing a share of about 65 to 70 percent in the marketed surplus, which accounts for about 50 percent of the output. Informal milk markets were dominated by vendors collecting milk from the producers and selling it in the urban markets.

Demand for milk in India is income-elastic and increasing fast. Informal milk traders expropriate benefits from the expanding demand. Individually, producers have small, marketable surpluses and depend largely on the vendors for marketing. The seasonality of milk production, coupled with an unstable market, offers opportunities to informal milk traders to exploit producers. Producers are more vulnerable to exploitation in the states where neither the cooperatives nor the private processing industry is strong. For instance, two-thirds of the milk procured by dairy cooperatives come from the states of Gujarat, Maharashtra, Karnataka, and Tamil Nadu (Birthal and Taneja 2006). Similarly, three-fourths of the private processing facilities are concentrated in the states of Uttar Pradesh, Maharashtra, Punjab, and Haryana (Birthal and Taneja, 2006).

The wholesale price of milk remained low during the 1990s (as shown in Figure B.2), primarily because of increased production. In recent years, milk prices have improved, an outcome stemming from a significant decline in output growth. The price of cattle feed fluctuated during these years in a way similar to the milk price. Similarly, oil cake prices declined during the 1990s, and then increased in early 2000. These circumstances indicate a need for producers to find ways to improve animal productivity through adoption of cost-effective technologies and better management practices. In addition, there is a need to provide producers better access to markets and to strengthen processing infrastructure.

Figure B.2. Trends in real wholesale prices of milk and feed ingredients (1981-2002)



Source: GOI, Office of the Economic Advisor, Ministry of Commerce and Industry, New Delhi. www. eaindustry.nic.in. Accessed on June 2006.

Dairying and Smallholders

Smallholders comprise a large force in India's agricultural sector: They comprise about 58 percent of the rural households (Table B.5). Their average size of landholding is too small to provide them with an adequate livelihood in crop production. For such land-scarce households, dairying is an important source of livelihood. During 2002-03, smallholders controlled 74 percent of the country's cattle; 70 percent of all buffalo; 77 percent of small ruminants, and 80 percent of the poultry production. They are capable of producing at a lower cost given the availability of family labor. Most—more than two-thirds of the labor force engaged in dairying—were women (Birthal and Taneja, 2006). Growth in milk production is expected to contribute toward improvements in rural income distribution and women's empowerment.

Table B.5. Distribution of land and livestock holdings in India, 2003

	Landless	Small (<2ha)	Medium (2-4ha)	Large (>4ha)	All
			% share		
Type of household	31.9	58.4	6.2	3.5	100.0
Cattle	0.6	73.6	14.7	11.1	100.0
Buffalo	0.6	70.3	15.4	13.7	100.0
Sheep and goat	2.1	77.2	9.6	11.1	100.0
Poultry	4.4	80.1	6.9	8.6	100.0
			Average size (no. of animals/100 households)		
Cattle	2	131	247	331	104
Buffalo	1	62	127	204	51
Sheep and goat	4	85	99	203	64
Poultry	17	169	136	306	123

Source: Compiled from GOI data, 2006.

In general, smallholders are efficient in production, but inefficient in marketing because of having a small, marketable surplus and poor linkages to markets. Selling in distant urban markets entails high transaction costs. Institutional arrangements that improve their access to markets are considered to reduce transaction costs and alleviate production constraints. Empirical evidence from India pointing to this effect is, however, limited. In a study of contract farming in milk, Birthal et al. (2005a) found that contract producers face transaction costs that are 90 percent less than that of independent producers, and smallholders benefited the most from contracts. Earlier work by Candler and Kumar (1998) looked at the performance of dairy cooperatives in India and found that smallholders likewise benefited the most from improved access to markets enabled by the cooperatives.

To strengthen vertical coordination in agricultural products, the central and state governments have taken some important initiatives. The Agricultural Produce Market Committee (APMC) Act that restricted commodity transactions within the state-designated markets has been amended to facilitate direct transactions between producers and processors. The state governments are also providing fiscal incentives to agro-processors who establish backward linkages with farmers. In addition, and as noted earlier in this discussion, other factors enabling private investment include the phasing out of the Milk and Milk Products Order, and reduced excise duties on processed dairy products and corporate taxes, both of which make it more favorable for attracting private investment.

REFERENCES

Ahuja, V., P.S. George, S. Ray, K.E. McConnell, M.G.P. Kurup, V. Gandhi, D. Umali Deininger and C. de Haan, 2000. *Agricultural services and the poor: Case of livestock health and breeding services in India*. Indian Institute of Management, Ahmedabad, India; The World Bank, Washington, D.C.; and the Swiss Agency for Development and Cooperation, Bern, Switzerland.

Anonymous. 2005. Food processing industry still divided on allowing FDI in retail sector. *The Hindu Business Line*, September 28.

Birthal, P. 2007. *Linking smallholder livestock producers to markets*. Working Paper 8. New Delhi: National Centre for Agricultural Economics and Policy Research.

Birthal, P.S., P.K. Joshi, and A. Gulati. 2005a. *Vertical coordination in high-value food commodities: Implications for smallholders*. Markets, Trade, and Institutions Division Discussion Paper No. 85. Washington, D.C.: International Food Policy Research Institute.

Birthal, P.S., and Parthasarathy Rao. 2002. *Crop-livestock systems in India: Research and policy issues.* Policy brief no. 1. International Crops Research Institute for the Semi-arid Tropics, Patancheru, India.

Birthal, P.S., S.N. Mishra, A.K. Dixit, and G. Tripathi. 2005b. *India's livestock feed balance and its environmental implications*. Project report. New Delhi: National Centre for Agricultural Economics and Policy Research.

Birthal, P.S., and V.K. Taneja. 2006. Livestock sector in India: Opportunities and challenges for smallholders. Paper presented in the international workshop on *Smallholder livestock production in India: Opportunities and challenges*. Indian Council of Agricultural Research, New Delhi; and the International Livestock Research Institute, Nairobi. New Delhi: January 31-February 1, 2006.

Candler, W., and N. Kumar. 1998. *India: The dairy revolution*. Washington, D.C.: The World Bank.

Davis, J.R. 2005. *How can the poor benefit from the growing markets for high value agricultural products?* In http://www.nri.org. accessed on June 2007.

Delgado, C., and M. Tiongco. 2005. *Contract farming of milk and poultry in India: Partnerships to promote the environmentally friendly and equitable intensification of smallholder market-oriented livestock production.* A project proposal submitted by IFPRI to the Food and Agriculture Organization (FAO) and the International Fund for Agricultural Development (IFAD). Washington, D.C.

Delgado, C., M. Rosegrant, H. Steinfeld, S. Ehui, and C. Courbois. 1999. *Livestock to 2020: The next food revolution*. Food, Agriculture, and the Environment Division Discussion Paper 28. IFPRI (International Food Policy Research Institute), Washington, D.C., USA; FAO (Food and Agriculture Organization), Rome, Italy; and ILRI (International Livestock Research Institute), Nairobi, Kenya.

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 # 157. Washington, D. C.: International Food Policy Research Institute.

Eaton, C., and A.W. Shepherd. 2001. *Contract farming: Partnership for growth*. FAO Agricultural Services Bulletin No. 145. Rome: Food and Agriculture Organization.

FAO (United Nations Food and Agriculture Organization). 2007. FAOSTAT database. http://faostat.fao.org. Accessed on June 2007;

FAO. 2007. *Oceania indicative export prices.* Accessed on April 2007.

Glover, D., and K. Kusterer. 1990. *Small farmers, big business: Contract farming and rural development.* New York: St. Martin's Press.

GOI (Government of India). (various years.) *Agricultural prices in India*. New Delhi: Directorate of Economics and Statistics, Ministry of Agriculture.

_____. (various years). *Basic animal husbandry statistics*. New Delhi: Department of Animal Husbandry and Dairying, Ministry of Agriculture.

_____. (various years). *Index number of wholesale prices in India*. New Delhi: Ministry of Commerce and Industries.

_____. 2006. *Livestock ownership across operational land holding classes in India, 2002-03*. New Delhi: National Sample Survey Organization, Ministry of Statistics and Programme Implementation.

_____. 2005. *National accounts statistics*. New Delhi: Central Statistical Organization, Ministry of Statistics and Programme Implementation.

_____. (various years.) *National accounts statistics*. New Delhi: Central Statistical Organization, Ministry of Statistics and Programme Implementation.

Greene, W. 2003. *Econometric analysis*. Englewood Cliffs, New Jersey: Simon and Schuster.

Gulati, A., and T. Kelley. 1999. *Trade liberalization and Indian agriculture*. New Delhi: Oxford University Press.

Holloway, G., C. Nicholson, C. Delgado, S. Staal, and S. Ehui. 2000. Agro-industrialization through institutional innovations: Transaction costs, cooperatives and milk market development in the East African highlands. *Agricultural Economics* 23: 279-288.

ICAR (Indian Council of Agricultural Research). 2006. *Handbook of agriculture*. New Delhi: The Indian Council of Agricultural Research.

IFPRI-NCAP. 2005. Household survey dataset 2005. IFPRI-FAO Contract Farming in India Project. Washington, D.C. International Food Policy Research.

Joshi, P.K., A. Gulati, P.S. Birthal, and L. Tewari. 2004. Agricultural diversification in South Asia: Patterns, determinants and policy implications. *Economic and Political Weekly* 12: 2457-2467.

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* 27: 381-401.

Kumar, P., and P.S. Birthal. 2004. Changes in consumption and demand for livestock and poultry products in India. *Indian Journal of Agricultural Marketing* 18(3): 110-123.

Kumar, P, Mruthyunjaya and PS Birthal. 2007. Changing consumption pattern in South Asia. In: Agricultural Diversification and Smallholders in South Asia (PK Joshi, Ashok Gulati and Ralph Cummings Jr., Eds.). Academic Foundation, New Delhi, India.

Little, P., and M. Watts. 1994. *Living under contract: Contract farming and agrarian transformation in Sub-Saharan Africa*. Madison: University of Wisconsin Press, Madison.

National Cooperative Development Corporation (NCDC) Undated. In http://ncdc.nic.in/sugar_division.htm. Website of National Cooperative Development Corporation. Accessed on April 2006.

NDDB (National Dairy Development Board). 2005. *Annual report*. Anand, Gujarat: National Dairy Development Board.

Organisation for Economic Co-operation and Development (OECD). Undated. *World prices*. http://www.oecd.org. Accessed on June 2007.

Parthasarathy, R., P.S. Birthal, D. Kar, S.H.G. Wickramaratne, and H.R. Shrestha. 2004. *Increasing livestock productivity in mixed crop-livestock systems in South Asia*. Patancheru, India: International Crops Research Institute for the Semi-Arid Tropics.

Patrick, I. 2004. *Contract farming in Indonesia: Smallholders and agribusiness working together*. ACIAR Technical Report No. 54. Canberra: Australian Centre for International Agricultural Research.

Pingali, P., Y. Khwaja, and M. Meijer. 2005. *Commercialization of farms: Reducing transaction costs.* Agricultural and Development Economics Division ESA Working Paper No. 05-08. Rome: Food and Agriculture Organization.

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 91. Washington, D.C.: International Food Policy Research Institute.

Sharma, V.P., S. Staal, C. Delgado, and R.V. Singh. 2003. *Policy, technical, and environmental determinants and implications of the scaling–up of milk production in India*. Annex III, Research Report of IFPRI (International Food Policy Research Institute)–FAO (Food and Agriculture Organization) Livestock Industrialization Project Phase II. Washington, D.C.: International Food Policy Research Institute.

Singh, S., 2002. Contracting out solutions: Political economy of contract farming in the Indian Punjab. *World Development* 30: 1621-1638.

Tiongco, M., C. Narrod, and C. Delgado. 2007. *Contract farming for equitable intensification of smallholder market-oriented livestock production: Lessons learned and best practices.* A working paper based on the synthesis report of the IFPRI-FAO (International Food Policy Research Institute and the Food and Agriculture Organization) Contract Farming of Milk and Poultry in India Project. Washington, D.C.: International Food Policy Research Institute.

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* 30: 255-263.

Wilson, A. 1990. The political economy of contract farming. *Review of Radical Political Economics* 18: 47-70.

RECENT IFPRI DISCUSSION PAPERS

For earlier discussion papers, please go to www.ifpri.org/pubs/pubs.htm#dp.
All discussion papers can be downloaded free of charge.

813. *Policy options and their potential effects on Moroccan small farmers and the poor facing increased world food prices: A general equilibrium model analysis*. 2008. Xinshen Diao, Rachid Doukkali, Bingxin Yu, 2008.

812. *Norway: Shadow WTO agricultural domestic support notifications*. Ivar Gaasland, Robert Garcia, and Erling Vårdal, 2008.

811. *Reaching middle-income status in Ghana by 2015: Public expenditures and agricultural growth.* Samuel Benin, Tewodaj Mogues, Godsway Cudjoe, and Josee Randriamamonjy, 2008.

810. *Integrating survey and ethnographic methods to evaluate conditional cash transfer programs*. Michelle Adato, 2008.

809. *European Union: Shadow WTO agricultural domestic support notifications.* Tim Josling and Alan Swinbank, 2008.

808. *Bt Cotton and farmer suicides in India: Reviewing the evidence.* Guillaume P. Gruère, Purvi Mehta-Bhatt, and Debdatta Sengupta, 2008.

807. *Gender, caste, and public goods provision in Indian village governments.* Kiran Gajwani and Xiaobo Zhang, 2008.

806. *Measuring Ethiopian farmers' vulnerability to climate change across regional states.* Temesgen Deressa, Rashid M. Hassan, and Claudia Ringler, 2008.

805. *Determinants of agricultural protection from an international perspective: The role of political institutions.* Christian H.C.A. Henning, 2008

804. *Vulnerability and the impact of climate change in South Africa's Limpopo River Basin.* Sharon Shewmake, 2008.

803. *Biofuels, poverty, and growth: A computable general equilibrium analysis of Mozambique*. Channing Arndt, Rui Benfica, Finn Tarp, James Thurlow, and Rafael Uaiene, 2008.

802. *Agricultural exit problems: Causes and consequences*. Derek Headey, Dirk Bezemer, and Peter B. Hazell, 2008.

801. *Cotton-textile-apparel sectors of India: Situations and challenges faced*. Jatinder S. Bedi and Caesar B. Cororaton, 2008.

800. *Cotton-textile-apparel sectors of Pakistan: Situations and challenges faced*. Caesar B. Cororaton, Abdul Salam, Zafar Altaf, and David Orden, with Reno Dewina, Nicholas Minot, and Hina Nazli, 2008.

799. *Race to the top and race to the bottom: Tax competition in rural China*. Yi Yao and Xiaobo Zhang, 2008.

798. *Analyzing the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia*. Temesgen Deressa, R.M. Hassan, Tekie Alemu, Mahmud Yesuf, Claudia Ringler, 2008.

797. *Economic transformation in theory and practice: What are the messages for Africa*? Clemens Breisinger and Xinshen Diao, 2008.

796. *Biosafety at the crossroads: An analysis of South Africa's marketing and trade policies for genetically modified products.* Guillaume P. Gruère and Debdatta Sengupta, 2008.

795. *Publish or patent? Knowledge dissemination in agricultural biotechnology*. An Michiels and Bonwoo Koo, 2008.

794. *Agricultural growth and investment options for poverty reduction in Malawi.* Samuel Benin, James Thurlow, Xinshen Diao, Christen McCool, Franklin Simtowe, 2008.

793. *China: Shadow WTO agricultural domestic support notifications*. Fuzhi Cheng, 2008.

792. *India: Shadow WTO agricultural domestic support notifications*. Munisamy Gopinath, 2008.

791. *Agricultural growth and investment options for poverty reduction in Zambia.* James Thurlow, Samuel Benin, Xinshen Diao, Henrietta Kalinda, and Thomson Kalinda, 2008.

790. *Agricultural growth and investment options for poverty reduction in Uganda*. Samuel Benin, James Thurlow, Xinshen Diao, Allen Kebba, Nelson Ofwono, 2008.

789. *Agricultural public spending in Nigeria*. Tewodaj Mogues, Michael Morris, Lev Freinkman, Abimbola Adubi, and Simeon Ehui; *with* Chinedum Nwoko, Olufemi Taiwo, Caroline Nege, Patrick Okonji, and Louis Chete, 2008.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

www.ifpri.org

IFPRI HEADQUARTERS

2033 K Street, NW
Washington, DC 20006-1002 USA
Tel.: +1-202-862-5600
Fax: +1-202-467-4439
Email: ifpri@cgiar.org

IFPRI ADDIS ABABA

P. O. Box 5689
Addis Ababa, Ethiopia
Tel.: +251 11 6463215
Fax: +251 11 6462927
Email: ifpri-addisababa@cgiar.org

IFPRI NEW DELHI

CG Block, NASC Complex, PUSA
New Delhi 110-012 India
Tel.: 91 11 2584-6565
Fax: 91 11 2584-8008 / 2584-6572
Email: ifpri-newdelhi@cgiar.org