Policy and scale factors influencing efficiency in dairy and poultry production in Bangladesh

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Executive summary

Demand for animal products has been increasing rapidly in Bangladesh due to income and population growth and urbanisation. The expanding market has the potential to create income and employment opportunities for small-scale and poor livestock producers if they can produce and sell market-demanded products at competitive costs and prices. This opportunity may be lost if investment, fiscal and capital market policies are distorted in a way that favour large-scale producers. Therefore, the overall objective of this study was to assess the efficiency of dairy and poultry producers in Bangladesh to identify policy options for assisting small-scale operators to develop economically viable and ecologically sustainable production enterprises for participating in the rapidly-expanding urban and rural markets for milk, poultry and eggs. The theoretical framework was based on the premise that small-scale producers may be able to compete with large-scale producers in the expanding market if they fulfil two conditions: if smallholders earn higher profit/unit of output as they need to earn a reasonable income to stay in business with low-volume of output, and if smallholders are more profit-efficient in the use of their limited resources, i.e. use fewer resources/unit of profit generated.

For analysis of dairy enterprises, a stratified sample of 120 farms with crossbred dairy cows (CBC farms) and 40 farms with local cows (LBC farms) from two *thanas* (sub-districts) in each of Manikgonj, Pabna and Shirajgonj districts were studied. For analysis of poultry enterprises, a stratified sample of 120 layer and 120 broiler farms were selected from Gazipur and Kishoreganj districts. Data were collected on a recall basis in two rounds covering a period of six months in each round, thus the actual sample size for analysis was doubled. Survey data were used to estimate farm profit/unit output while profit efficiency was measured by using stochastic frontier profit function.

Empirical results of the analysis of sample dairy farms show that both gross margin and net profit/litre of milk increased as farm size increased, and net profit increased at a faster rate as farm size increased due to higher milk yield and higher milk prices but lower/unit cost as farm size increased. Share of major cost items—feeds and labour—show similar pattern across farm sizes for CBC farms, indicating that management regime for CBCs are similar, but larger LBC farms spend a higher share of cost on concentrate feeds compared to smaller farms.

Analysis of stochastic frontier profit function and inefficiency model was fitted to LBC and CBC farms. In case of CBC farms, the results show that among the selected variables price of dry roughage, price of veterinary treatment, value of herd and access to credit significantly influence profit. Price of dry roughage and veterinary treatment significantly reduced profit indicating that all farmers did not pay optimal price for these inputs and services. On the other hand, the fixed factors like value of total herd and access to credit (a proxy for financial capital) significantly increased profit of this type of dairy farms indicating that larger scale and liquidity enhanced profit. In case of LBC farms, the negative effect of wage rate on profit indicates that all farms did not pay optimal price for hired labour, and positive effects of price of green roughage indicate that its marginal productivity might be higher than its price. The positive effects of fixed factors like total herd value and annual fixed labour indicate that there was economy of larger scale.

The mean economic efficiency of CBC and LBC farms was 44 and 55%, respectively, and inefficiency decreased as farm size increased. It means that there is ample scope to raise farm

profitability by improving economic efficiency and minimising profit loss of 56 and 45%, respectively. Among the factors affecting inefficiency, it was found that demand-driven extension contact by the farmer, possession of pasture land and proportion of crossbred cows in the total dairy herd reduced inefficiency of CBC farms. The result implies that better quality animals in a herd supported by adequate good quality feed and extension advice to deal with production constraining problems reduce inefficiency. In case of LBC farms, education, dairy herd size, and pasture land reduced inefficiency.

Breeds, management practices, economy in feed purchases, choice of market outlets when prices are different, access to credit for liquidity and to extension contact at times of real need to solve a production constraint are significant variables affecting profitability and efficiency of dairy farms. Policy interventions that may ease constraints in each of these areas and targeting those policies to smaller farms who face these constraints more than the larger farms may contribute to increase overall efficiency of the dairy sector. Policies towards infrastructure, pollution, access to capital and credit, and rural organisation may affect the comparative advantage of smallholders vs. large enterprises and may determine if large-scale producers will capture the growing market and drive out the small-scale producers making them remain poor as before.

In case of poultry production, most farmers sold output at the farm gate to traders coming to buy and in case of contract growing, output was delivered to the contracting farm. Prices were apparently very competitive. Average net return/100 eggs increased with farm size because larger farms were able to economise on costs of DOCs, feeds and veterinary costs due to larger volume of purchase. In case of layer farms, average net return/100 birds did not differ significantly between sizes of farms.

Results of the stochastic frontier profit functions show that mean economic efficiency of broiler and layer farms was 30 and 82%, respectively. Mean average economic efficiency of both broiler and layer farms increased with farm size. In case of broiler farms, feed price and price of veterinary inputs significantly reduced profit, either because some farms paid higher than optimal price or the marginal value product of these inputs were significantly lower than the respective prices. In case of layer farms, price of DOCs significantly affected profit negatively indicating that the sample farms did not pay competitive price for DOCs.

In case of broiler farms, the number of batches produced in a year, mean weight at sale, space used/bird and number of extension contacts significantly reduced inefficiency. Larger farms achieved higher efficiency not only due to better cost economy in purchasing feeds, DOCs and veterinary services but also due to better technical performance of the flock. Extension contacts might have contributed to better technical performance.

In case of layer farms, cost economy especially for feeds, veterinary services and DOCs' transportation significantly enhanced the efficiency of larger farms. However, two factors—number of batches produced simultaneously and space used/bird—increased inefficiency. The reasons could be that efforts were distributed thinly between batches resulting in poor technical performance, on the one hand, and perhaps space was not optimally used/100 birds to produce enough eggs, on the other.

Marketing arrangements for outputs and inputs, e.g. contract farming and direct selling to traders, and access to credit did not significantly influence profit efficiency as perhaps the effects of these

factors have been captured by other factors representing either technical performance or cost economy.

Thus, small-scale broiler producers have high potential of increasing their relative efficiency in terms of better use of existing technology and efficient allocation of resources. Among the policy factors that can contribute to improving relative efficiency of smallholders is the incidence in visits of technicians providing extension and veterinary services at the farm thus reducing the mortality rate of broilers. In the case of layer farms, average efficiency is high but the relative efficiency of small farms could be further improved through better use of existing technology to increase productivity as in the case of broiler farms.

1 Introduction

1.1 Background

During the last three decades a structural transformation has taken place in the Bangladesh economy. The country has achieved self-sufficiency in food grain production due to appreciable growth rate in the sector but the share of agriculture in GDP has declined relative to other sectors and within the agriculture sector, while the share of livestock sub-sector has increased relative to crop, fisheries and forestry. The livestock share of agricultural income increased from 7.6% in 1973–74 to 12.9% in 1998–99 and is projected to increase to 19.9% in 2020. During 1973/74–1989/90, livestock output grew at 5.2% per annum compared to 1.7% for crop output and 2.6% for agricultural output in general (Hossain and Bose 2000). During 2001/02–2004/05, agricultural output grew at 5.5% while livestock output alone grew at 5.5% against the crop output growth of 0.36% (negative crop output growth was observed in 2001/02 and 2004/05 due to flood). Milk production in the country increased from 1.29 million tonnes in 1987–88 to 2.1 million tonnes in 2004. However, current national production is inadequate to meet demand. Due to increased production, import of powdered milk decreased from 55 thousand tonnes in 1991–92 to about 16 thousand tonnes in 2002, but still constitutes about 30% of total supply.

These changes have been prompted by a rapid growth in demand for livestock products due to income and population growth and urbanisation. This is part of a phenomena observed throughout the developing world. From the beginning of the 1970s to the mid-1990s, the market value of the increase in meat and milk consumption in the developing countries was approximately US$ 155 billion (in 1990 dollars), more than twice the market value of increased cereals consumption under the Green Revolution. The demand growth for livestock products in the developing world is expected to continue well into the new millennium, creating the opportunity for a veritable Livestock Revolution if the increased demand can be met from increased domestic production. Producers may gain through increased income and employment and consumers through access to cheaper livestock products. Evidence from field studies in developing countries show that rural poor and landless households typically derive a larger share of their cash income from livestock than do well-off farmers (Delgado et al. 1999).

Dairy and poultry are the most important livestock enterprises produced by smallholder crop–livestock farmers in Bangladesh. Milk production still remains predominantly at the hands of small-scale mixed farms and landless households with 1–2 local cows, who produce 70–80% of the milk in the country. Dairy development efforts through cross-breeding, milk collection and processing for urban markets are limited to a number of milk sheds covering a tiny part of the country and to medium to large farms. On the other hand, poultry is the most widely-held livestock species by smallholder farmers, especially poor and landless households. In many cases, poultry serve as the first of a 'livestock asset ladder' in that a family may start with a few chicken and gradually acquire a goat, then a cow through accumulated income and savings (Todd 1998). Until recently such traditional rural smallholder producers raising scavenging poultry using non-descript indigenous breeds were the only source of poultry and eggs in both rural and urban markets.

Attempt to introduce improved breeds of poultry birds was initiated as early as 1935 by the provincial government in state poultry farms. Later, these were distributed to rural farmers. In 1947, six poultry farms were established in different places in this country for supplying eggs and chicks

to the farmers. During this period, several small poultry farms were also established under village aid programme for rural development. In 1962–63, the Directorate of Livestock Services established 91 small poultry units in 91 *thanas* with the objective of supplying improved types of birds to rural farmers. In recent years, the Department of Livestock Services (DLS) and the Bangladesh Rural Advancement Committee (BRAC), a non-governmental organisation (NGO), developed a smallholder poultry model through trial and error targeting poor and landless, especially women, to use poultry as a vehicle for poverty alleviation. During 1992–2002, through three large projects funded by the Danish International Development Agency (DANIDA), International Fund for Agricultural Development (IFAD), Asian Development Bank (ADB) and the Government of Bangladesh, the model has been extended to about 875 thousand poor and landless households in 195 *thanas* (Islam and Jabbar 2003).

However, these efforts apparently failed to cope with rapidly rising urban demand for poultry meat and eggs. In response to this market opportunity, beginning from the early 1990s, a commercial poultry (broiler and layer) sector has emerged using intensive production techniques (exotic and crossbred birds, concentrate feeds and drugs) and with technical and policy support (subsidised credit, local production and import of DOCs, drugs etc).

Income elasticity of demand for milk was estimated to be 1.62 compared to 1.19 for meat and eggs in 1995–96, and these are projected to be 0.65 and 0.63, respectively, in 2020. Milk production in the country need to grow by 4.2–5.6% and meat and egg production by 4.7–5.9% per annum to meet increased demand (Hossain and Bose 2000). Achievement of such a high growth rate in the livestock sector has the potential to create employment and income generation for a large number of smallholder producers and others involved in dairy and poultry production, processing and marketing, and get them out of poverty. Dairy and poultry generate more regular cash income and their production, processing and marketing generate more employment/unit value added compared to crops (Asaduzzaman 2000; Omore et al. 2002). Like most of the developing countries, a goat, a milking cow or some chicken can provide a key income supplement for the landless and otherwise asset poor in Bangladesh. The question is whether rural poor will benefit from the potential Livestock Revolution in the country and if so how.

The question arises because experiences in other rapidly growing countries in East Asia and elsewhere show that growing demand for livestock products have been mainly met by large-scale urban/peri-urban production enterprises. Traditional small-scale/poor producers captured an insignificant share of the expanding market. Small-scale producers are often unable to compete with the large-scale producers due to low productivity, limited output and access to input and output markets. Moreover, public policy often supported and subsidised industrial livestock production, promoting economies of scale but ignored its equity, environment and health consequences (de Haan et al. 1997; Delgado 2004). There may be large economies of scale in processing livestock-origin food products, but less in production once market distortions favouring large producers are either removed or otherwise balanced for smaller farmers through market-oriented means. Distortions in domestic capital markets may promote inefficient, large-scale livestock production in the peri-urban areas of developing countries. These policies may distort the pattern of livestock development and ultimately cannot be sustained. Further, poor environmental regulations, distortions in the marketing chain that prevent competition from small farmer areas, and lack of legal accountability for pollution may promote large-scale urban/peri-urban livestock enterprises that are unable to adequately dispose of waste materials. Where lack of appropriate

policies or presence of policy distortions promote large-scale commercial livestock production and disadvantage small-scale producers, there will be a need to make relevant policy interventions so that efficiency and equity considerations receive due attention and smallholder market-oriented enterprises can participate fairly in the expanding market.

An area of special concern within the context of the Livestock Revolution in developing countries is that it will involve rapidly increased use of concentrate feeds. Most developing countries mix their own brands of locally available feeds and import substantial quantities of concentrates. These trends will both continue and increase rapidly. Both private and public policies towards importation and marketing of concentrates, infrastructure creation for concentrates, extension of feed technologies, and credit for purchased feed use will be key for preserving the ability of smaller and poorer producers to continue to participate in an expanding livestock sector.

In Bangladesh, achievement of high growth rate in the livestock sector as indicated earlier need to take place through a strategy that will involve removal of current and potential constraints in dairy and poultry production, as well as processing and marketing that limit smallholder participation in these activities. The alternative might be that large-scale producers will capture the growing market and drive out the small-scale producers making them remain poor as before. The newly-established commercial poultry farms were fairly small in the early 1990s but the average size of farm has been increasing over time. Dairy production enterprises are still fairly small but in major milk sheds where most dairy development programmes are concentrated by both the government and NGOs, dairy herd sizes are slowly increasing. However, rapid industrialisation of poultry and dairy production for the wrong reasons could harm the mechanism of income generation for the poor. The extent to which these scale increases are due to economic efficiency or hidden subsidy are unclear as empirical evidence on these are almost non-existent. This study is expected to cover this information gap to some extent.

1.2 Objectives

The overall objective of this study is to identify policy options for assisting small-scale operators to develop economically viable and ecologically sustainable production enterprises for participating in the rapidly expanding urban and rural markets for milk and poultry meat and eggs in the country. The specific objectives are:

1) To analyse if small- and large-scale dairy and poultry producers use different strategies for adapting their productions systems and marketing approaches to meet rapidly expanding urban demand for milk, poultry meat and eggs through for example:
   (a) strategies for dealing with expanding competition including seeking niche markets, contacts with customers etc.
   (b) increased vertical coordination with large-scale processors
   (c) strategies involving collective action, such as forming input supply and marketing co-operatives to benefit from economies of scale.
2) To identify the ways that government policies and non-government and private sector practices concerning production, importation, and marketing of inputs, e.g. concentrate livestock feeds, veterinary and AI services, impact differently on large- and small-scale dairy and poultry producers, and on the continued viability of small-scale production. Specifically identify and quantify if possible:

(a) any policies/practices that explicitly or implicitly take into account differences in scale of operations
(b) differences in farm gate unit prices of milk, broiler and eggs and inputs between large and small producers
(c) differences in actual unit costs incurred by sellers of inputs and buyers of milk, broiler and eggs in dealing with small- and large-scale producers; attribute these differences to either genuine economies of scale or differential implicit or explicit subsidies to different scale producers
(d) differences in terms (e.g. credit), timeliness of deliveries, information services etc.
(e) the extent to which these differences in costs and prices are due to recoupment of higher costs or risks of doing business with small-scale operators or to lower efficiency of distribution systems serving smallholders; how are these differences separate from differences due to greater bargaining power or political clout of large producers.

The paper is organised as follows. In section 2, the theoretical model applied to measure farm efficiency and sources of data are described. In section 3, some general characteristics of the sample dairy farms are discussed followed by specification of the empirical econometric model and results in section 4. In sections 5 and 6, a similar discussion is presented on sample poultry farms. Summary and conclusions are presented at the end.

2 Analytical methods and sources of data

2.1 Measuring farm-specific efficiency of dairy and poultry producers

A major objective of this study was to assess the efficiency of the sample dairy and poultry farms and identify the sources of any inefficiency, especially those related to policy and scale effects, so that appropriate policy recommendations could be made to alleviate them. In order to do that, descriptive analysis of the general characteristics of the sample data and econometric analysis for measuring profit efficiency were conducted.

Theoretically, in a competitive market environment, more efficient users of inputs eventually drive less efficient ones out of the market unless less efficient producers have non-economic objectives to continue production, e.g. use family labour with low or no opportunity cost, and preference for own food production. In general, smallholders need to be more efficient in the use of inputs and make higher profits/unit of output to survive and earn a living due to low volume of business. Larger producers may survive with low unit profit because of larger volume of business; in fact such producers may deliberately push unit profit to low levels to squeeze out smaller producers from market (Delgado et al. 2003). Evolution of the industrialisation of poultry production in Brazil, Thailand and India also shows that public policy supported technology transfer, joint venture investment and other incentives to the private sector may enhance the process of intensification and scaling up of the industry (Farrelly 1996).

However, 'efficiency' conventionally measured in terms of farm financial profits ignore many hidden transaction costs, market distortions due to policy and externalities that may not be scale-neutral (Delgado 2003). Transaction costs are costs of obtaining and processing market information, negotiating contracts, monitoring agents and enforcing contracts for market exchange (North 1989; Hoff and Stiglitz 1990). Transaction costs are often intangible, linked to asset, information, market power and reputation of a firm. That is why such costs are unique and specific to an individual production or marketing unit, so each unit conducts exchanges on the basis of its own transaction costs. However, larger farmers' ability to push unit profit to low levels may sometimes be derived not from their true efficiency and market power but from policy distortions, e.g. subsidies, tax concessions, import facilities and externalities, e.g. pollution without penalties. Even in a competitive market environment a large and a small farm from the same locality may produce products of similar quality but the large farm may be able to sell the product to upmarket high income consumers at higher prices while the small producer may sell at local markets or to low-income consumers at low prices. This difference may arise because the large producer may have better access to market information and the means to provide consumers with information about its products, may have acquired the trust of the consumers about the quality of its products and the reliability of supplies while the small producer may not have the means to cover all these costs of transactions on its own. The small producer may overcome some of these constraints and reach the high price market by joining a co-operative or other form of organisation or as a contract producer of a large-scale integrator, who will do the processing and marketing under a reputed brand name, thereby reducing transaction costs for individual smallholder producers (Farrelly 1996; Runsten and Key 1996; Jabbar and Seré 2004).

Stochastic frontier production function model is considered appropriate for efficiency measures when the farms are operating under different prices and factor endowments (Ali and Flinn 1989). Within a profit-function context, profit efficiency is defined as the ability of a farm to achieve the highest possible profit, given the prices and levels of fixed factors of that farm. Profit frontier is represented by an industry best-practice profit for any given level of prices and fixed factors as illustrated in Figure 1. Interaction between farm-specific prices (P_{ij}) and levels of fixed factors (S_{kj}) allows the profit frontier to be farm specific. Profit inefficiency in this context is defined as profit loss from not operating on the profit frontier, given farm specific prices and resource base. For instance, if a farm is operating at point A, profit efficiency is defined as AB/CB, and profit inefficiency as (1 - AB/CB).

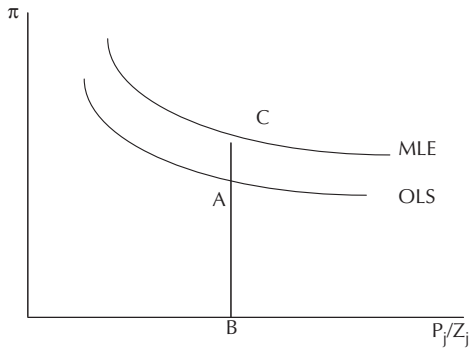


Figure 1. *Frontier (MLE) and average (OLS) stochastic profit function.*

The stochastic profit function is usually defined as:

$$\pi_j = f(W_{ij}, S_{jk}).\ \exp e_j \qquad (1)$$

where π_j is normalised profit of the jth farm defined as gross revenue less variable cost, divided by farm specific output price (e.g. price of milk); W_{ij} is the price of the ith variable input faced by the jth farm divided by output price; S_{jk} is the level of k_{th} fixed factor on the farm; e_j is an error term and j = 1, ….,n, is the number of farms. If equation 1 is estimated by ordinary least squares (OLS) an average profit function is derived as shown in Figure 1. Following Kmenta (1971), Ali and Flinn (1989) and Huang et al. (1986), the upper bounded profit frontier may be estimated by postulating that the error term contains two independent components: a one sided error term (u_j) representing economic inefficiency and a random error with normal properties (v_j). Thus,

$$e_j = v_j - u_j \qquad (2)$$

where v_j is distributed $N(0, \sigma^2_{ij})$, is a two-sided error term representing the usual random effect of any system, and $u_j > 0$ is a one-sided error term representing profit inefficiency in that it measures profit shortfall (π_j) from its maximum possible frontier value. Thus if $u_j = 0$, the farm lies on the profit frontier, obtaining maximum profit given the prices it faces and level of fixed factors. If $u_j > 0$, the farm is inefficient and losses profit because of inefficiency.

If u has half-normal distribution, i.e. u is distributed as the absolute value of an $N(0, \sigma^2_{ij})$ variable, the population mean and variance of u are estimated as (Maddala 1977):

$$E(u) = \sigma_u \sqrt{(2/\pi)} \quad (3)$$

and

$$V(u) = (\pi-2)/\pi \quad (4)$$

Following Jondrow et al. (1982), farm-specific estimates of inefficiency can be calculated as:

$$E(u_j) = \sigma^*[f(.)/ (1-F(.) - e_j\lambda/\sigma] \quad (5)$$

where $\sigma^2 = \sigma^2_u + \sigma^2_v$, $\lambda = \sigma_u/\sigma_v$, $\sigma = \sqrt{\sigma^2_u + \sigma^2_v}$

$\sigma_*^2 = \sigma^2_u .\sigma^2_v / \sigma$

and f(.) and F(.) are the standard normal density and cumulative distribution functions, respectively.

The frontier profit function defined in (1) with an error structure defined in (2) is estimated using Maximum Likelihood Estimation (MLE) techniques (Aigner et al. 1977). Battese and Coelli (1992) have shown that profit efficiency of the jth farm is given by $\exp(-u_j)$ and profit inefficiency is $(1 - \exp(-u_j))$.

In the literature on efficiency analysis, two approaches are available for explaining profit inefficiency: a two stage estimation procedure and a single stage estimation procedure. In the two stage estimation procedure, farm specific inefficiency is estimated using stochastic frontier function and then predicted inefficiencies are regressed with farm specific socio-economic variables to identify reasons for inefficiencies (Pitt and Lee 1981; Ali and Flinn 1989; Battese and Coelli 1989; Bravo-Ureta and Evenson 1994). In the single stage approach a stochastic frontier model is used in which the inefficiency effects (U_i) are expressed as an explicit function of a vector of firm-specific variables and a random error and the parameters are estimated simultaneously in a single step. The two-stage estimation procedure has been widely used but it has a problem of inconsistency in its assumption regarding the independence of the inefficiency effects in two estimation stages. The two-stage estimation procedure is unlikely to provide estimates which are as efficient as those that could be obtained using a single-stage estimation procedure (Kumbhakar et al. 1991; Reifschneider and Stevenson 1991). Battese and Coelli (1993) argued that socio-economic variables should be incorporated directly in the frontier function because such variables may have a direct impact on efficiency.

In this study, the single-stage approach has been used for estimation of parameters. The empirical models and the variables used in the equations for dairy and poultry are discussed later.

2.2 Selection of the study areas

Dhaka city is the principal urban market for dairy and poultry products. The supply hinterland for Dhaka is virtually the whole country though certain geographical and administrative units serve as major supply sources. Moreover, commercial dairy and poultry production enterprises are concentrated in geographically different parts of the country. Therefore, different study areas had to be targeted for sampling dairy and poultry producers.

The districts of Manikganj, Pabna and Sirajganj cover a significant part of the milk sheds that serve Dhaka and these were selected purposively for the study. The climatic condition of all the three districts is warm and humid but moderately cold during the winter. The rainy season lasts from May to October while winter lasts from the middle of November to February.

Pabna and Sirajganj districts are located on the west of the river Jamuna and this was a major obstacle to supply milk quickly to Dhaka. After the construction of the Jamuna bridge, this problem has been largely solved. All three districts are now well connected with Dhaka by road. Communication network within each district is also good. In the rainy season, boats are used for transportation in some low-lying areas in all the three districts.

Total population in Manikganj is 1.3 million with a density of 978 persons/km^2. The total population of Pabna and Sirajganj is 2.3 million and 2.6 million, respectively, with density of 952 and 1070 persons/km^2, respectively, which are higher than the national average. The literacy rate in Manikganj is 42%, in Pabna 49% and in Sirajganj 42%.

The main occupation and the source of livelihood of most of the people in the study areas is agriculture. Average size of holding is 0.68, 0.81 and 0.76 ha, respectively, in Manikganj, Pabna and Sirajgang districts. They operate crop–livestock mixed farming. Some people work as seasonal labour, rickshaw puller and small-scale trader. Urban people are employed in government or non-governmental organisations or by the small private businesses and some are themselves traders.

Livestock population in the three districts is shown in Table 1. About 60% of farmers in the study area have crossbred cattle though nationally less than 10% of the farmers have them. Milk Vita, the milk producers' co-operative, has major activities in all three districts with a large network of milk collection points and several cooling facilities before transporting milk in bulk to the main processing centre in Dhaka. In Pabna district, BRAC has recently started collecting milk alongside Milk Vita.

Table 1. *Livestock population in the selected districts.*

Type of livestock	Manikganj	Pabna	Sirajganj
No. of cattle and buffalo	256,176	389,256	461,930
No. of goat and sheep	166,220	354,714	274,212
No. of fowl and duck	1,015,842	1,904,688	2,432,841

Source: BBS (1999).

For selection of study areas for poultry farms, preliminary observations indicated that Gazipur and Kishoreganj districts had the highest concentration of commercial farms established since the early 1990s. So these two districts were purposively selected for the study. The DLS–BRAC smallholder poultry model targeted to poor and landless, especially women, is distributed in remote rural areas, and they were too small compared to the smallest size commercial farms, so those were not considered for sampling in this study.

Gazipur is located about 40 km north of metropolitan Dhaka city, well connected by road and rail. The district has a growing non-farm sector and it is the home of several large public sector institutions, being located near Dhaka. In 1998, there were over 26,712 non-agricultural enterprises in the district employing 129 thousand people of which about 11% were women. About 34% of all the establishments are located in urban areas whereas 66% are located in rural areas (BBS 1999). The land is flood free and good for poultry farming.

Kishoreganj is located about 120 km north of Dhaka and is fairly well connected by road and rail. The district is primarily agricultural and a good part of the land is flood prone making it unsuitable for commercial poultry farming. In 1998, total population of Gazipur district was 1.94 million with a density of 1116 persons/km^2. Total population of Kishoreganj district was 2.78 million with a density of 1033 persons/km^2. The literacy rate in Gazipur was 59% and that in Kishoreganj 39.6%.

2.3 Selection of sample farms

For selection of dairy farms, in each selected district two *thanas* (sub-districts) having good concentration of crossbred cattle were selected purposively in consultation with the DLS. The selected *thanas* are Manikganj Sadar and Shibalay in Manikganj, Sathia and Bera in Pabna, and Sirajganj Sadar and Baghabari in Sirajganj district.

During a reconnaissance visit, two broad types of farms were identified: those having crossbred cows with or without local cows (henceforth called CBC farms) and those having only local cows (henceforth called LBC farms). However, a comprehensive list of dairy farms was not available for these *thanas* to define the population and draw sample. The DLS provided a list of commercial dairy farms having crossbred cows, and some of them had received credit in the 1990s through the special dairy development programme. On checking in the field, it was found that some of these farms no longer had crossbred cows, some had fewer or larger number of cows than was reported in the list. Therefore, it became necessary to prepare a list of population first and classify them according to size before drawing sample and it was done in consultation with the local DLS staff as well as Milk Vita staff at milk collection points. The collected information indicated that in the sample *thanas* small, medium and large dairy farms could be defined as those having 1–3, 4–5 and over 5 cows, respectively.

It was decided at the project planning meeting held in May 2000 that a sample 120 CBC and 40 LBC farms would be studied and that this would constitute panel for which two rounds of survey would be conducted, thereby increasing the size of the overall sample. Therefore, the number of CBC farms in the selected districts and *thanas* were stratified into three size groups, then the sample of 120 farms were distributed approximately proportionally to the districts, *thanas* and farm sizes. Then 40 LBC farms were also distributed to each cell to allow comparison. While the selected CBC farms could be identified from a prior list, the corresponding LBC farms in a location were drawn at random on the spot. Data were collected on a recall basis in two rounds covering a period of six months in each round. Thus information was available from a sample of 320 farms (Table 2).

For selection of poultry farms, some differences between Gazipur and Kishoreganj districts had to be noted. Poultry farms established in Gazipur are generally older than those in Kishoreganj. The farms in Gazipur are independent enterprises and they depend on a network of feed and poultry equipment traders as well as buyers of products. On the other hand, a high proportion of smaller operators in Kishoreganj are contract growers of a large integrated enterprise, which provides input

services and market outlet to the contract growers. While most farms in Gazipur produce eggs, most farms in Kishoreganj produce broiler. However, in the initial period, there was a balance between layer and broiler farms in Gazipur, and later a shift towards layer farming took place. Apparently this dynamics is still in place—farms sometimes change from one type to the other apparently based on their own perception of market potential and sometimes poor performance in one type may encourage a change towards another. However, quantitative figures about the extent of these changes and the proportion of farms involved in such changes were not collected.

Table 2. *Distribution of sample dairy farms by type and size of farms and district.*

Farm type and district	Number of farms by farm size			
	Small	Medium	Large	All farms
CBC farms				
Manikganj	44	28	18	90
Pabna	44	28	18	90
Sirajganj	28	20	12	60
Total	116	76	48	240
LBC farms				
Manikganj	26	6	–	32
Pabna	20	6	2	28
Sirajganj	18	2	–	20
Total	64	14	2	80

A list of poultry farms by type for each of the two districts was prepared based on unpublished information available from the DLS and the Poultry Farmers' Association. Then 60 broiler farms and 60 layer farms were selected at random from the two districts and they were distributed proportionally to three size groups. Small farms were defined as those having up to 1000 birds, medium as having 1001–2000 birds and large as those having over 2000 birds. Data were collected in two rounds on half-yearly basis, so the sample was considered as a panel giving total sample size of 240 (Table 3).

Table 3. *Distribution of sample poultry farms by size and district.*

Farm type	Small	Medium	Large	All
Broiler				
Gazipur	26	8	6	40
Kishoreganj	34	28	18	80
Total	60	36	24	120
Layer				
Gazipur	38	38	20	96
Kishoreganj	14	6	4	24
Total	52	44	24	120

During the first survey, it was found that some selected farms had changed the type of enterprise (layer to broiler and vice versa) and/or changed the size (became larger or in a few cases smaller). Therefore, the changed status of the farm was recorded and it was put in the appropriate category (type or size) and the sample distribution was adjusted by taking account of the changes. During the second round, some farms were found to have closed business, while a few changed to a different category. In this case, closed businesses were dropped while data for the changed farm type was collected putting it in the changed category. Considering each round as an independent sample, data were obtained from a total of 110 broiler and 129 layer farms, which also reflected the changes in the size and type of farms sampled originally.

3 Descriptive analysis of sample dairy farms

3.1 Demographics

The average age of the owners of CBC farms was 38 years with little variation between sizes of farms, which for LBC farms was 42 years with small farms having slightly younger owners. CBC and LBC farm owners had an average of 6 and 5 years of schooling, respectively. For CBC farms, small farm owners had the highest level of schooling followed by medium and large farm owners.

Taken all the sample farms, the average family size for small, medium and large farms was 4.9, 5.8 and 7.4 persons, respectively, with little difference between CBC and LBC groups. Small farms used a higher proportion of family labour in dairying compared to medium and large farms that used a higher proportion of hired labour. Female and child labour participation in dairying was higher among small farms and also among LBC farms (Table 4).

Table 4. *Average family size and daily labour use for dairying by farm size.*

	Small	Medium	Large	All farms
Average Family size	4.9	5.8	7.4	5.4
CBC farms	4.9	5.4	7.3	5.4
LBC farms	4.7	7.9	9.0	5.3
Daily labour use in dairy (Person hour)				
CBC Farms	12.7	15.4	19.3	14.5
Family labour	9.7	10.4	12.9	10.4
Male	5.0	5.5	8.0	5.6
Female	4.3	4.5	4.7	4.4
Children	0.4	0.4	0.2	0.4
Hired labour	3.0	5.0	6.4	4.1
Male	2.9	4.8	6.2	3.9
Female	0.1	0.2	0.2	0.2
LBC farms	11.3	17.3	20.9	13.4
Family labour	8.3	12.3	14.5	9.3
Male	3.9	7.5	8.0	4.7
Female	3.9	4.4	6.0	4.1
Children	0.5	0.4	0.5	0.5
Hired labour	3.0	5.0	6.4	4.1
Male	0.6	5.3	0.0	1.4
Female	0.0	0.0	0.0	0.0

Source: Field survey.

3.2 Cattle, land holdings and sources of family income

The dairy farms have other animals, e.g. draft cattle and young animals (Table 5). The proportion of dairy animals in the herd is 45% for CBC and 56% for LBC farms. Proportion of dairy animals in the herd is generally slightly higher for larger farms in both groups.

The small, medium and large CBC farms had an average of 1.17, 1.06 and 1.49 ha of land, respectively. The corresponding figures for LBC farms are 0.99, 2.27 and 1.34 ha, respectively. However, most farms have access to common grazing land, called *bathan*, for seasonal grazing (see more on feeds below). Apart from homestead, the main use of the land was for crop production.

Crop residues are the principal forms of roughage for livestock. Only the large CBC farms and the medium LBC farms used a small amount of land, 0.016 and 0.032 ha, respectively, exclusively for livestock feeding. This explains why land size did not have direct correlation with total or dairy herd size.

Table 5. *Dairy herd size according to type and size of farm.*

Farm type	Average herd size by farm size							
	Small		Medium		Large		All farms	
	Total herd	Dairy cows	Total herd	Dairy cows	Total herd	Dairy cows	Total herd	Dairy cows
CBC farms	5.68 (0.20)	2.41 (0.09)	8.85 (0.22)	3.97 (0.14)	13.26 (0.16)	6.32 (0.48)	7.75 (0.12)	3.46 (0.14)
LBC farms	4.69 (0.28)	2.08 (0.12)	13.57 (0.16)	4.86 (0.59)	12.50 (0.25)	6.50 (0.50)	6.44 (0.32)	3.63 (0.19)

Figures in parentheses are standard error of means.
Source: Field survey.

The sample farms are engaged in a mixed portfolio of activities as evidenced by the sources of their income. Livestock share of annual income was 37% for CBC farms and 32% for LBC farms. Livestock share of annual income increased with farm size (Table 6). Although livestock is not yet a specialised enterprise for large farms, it is becoming a major source of income alongside crops and over time has the potential to become a specialised enterprise.

Table 6. *Sources of family income by farm type and size.*

Farm type and sources of income	Proportion of total income by farm size			
	Small	Medium	Large	All farms
CBC farms				
Crops	35	28	27	32
Livestock	34	40	45	37
Fisheries	2	–	–	1
Business	17	25	22	20
Salaries/wages	9	6	6	7
Remittances, rent and other income	4	1	–	3
Total	100	100	100	100
LBC farms				
Crops	40	38	30	39
Livestock	28	42	70	32
Fisheries	–	–	–	–
Business	15	19	–	15
Salaries/wages	13	1	–	10
Remittances	5	–	–	4
Total	100	100	100	100

Source: Field survey.

3.3 Breeds of dairy cattle and related issues

3.3.1 General context

Smallholders in the country use local non-descript breed(s) of cattle with very low milk yield potential. Indiscriminate breeding over a long period and use of a high proportion of these cows for draft without adequate feed supplementation has further reduced the milk yield potential of these animals. Cross-breeding programme for improving local dairy cattle was initially introduced during

the later period of the British rule in certain areas with high potential for dairy development and such programmes were redesigned several times with foreign technical assistance in more recent years. Artificial insemination (AI) facilities have been extended to dairy sheds to sustain breed improvement efforts. More recently, the government allowed commercial import and distribution of exotic breeds of cattle with subsidised credit for rapid development in the sector. As a result of these efforts, average milk yield of cows in designated milk sheds covering a small portion of the country is higher than the rest of the country. However, in the absence of a long-term breeding policy and strategy, these fragmented and discontinuous efforts have already resulted in the loss of genetic diversity and genetic potential of local breeds without making significant improvement in genetic make up of the national dairy population (Jabbar 2004). Currently less than 10% of cattle population in the country contain exotic blood of varying proportion though about 60% of dairy animals may have such blood in small milk sheds where targeted milk marketing and input supply systems are operational. Without designing and implementing a viable breeding policy and strategy, the long-term sustainability of the dairy sector can't be ensured because without this neither the quality of the asset—the dairy animal—nor its productivity can be improved in the long run.

3.3.2 Breeds of cattle on sample farms

The LBC farms reared local non-descript breeds while CBC farms reared a mixture of crossbred and local cows or only crossbred cows. About 63% of the cows in the sample CBC farms were crossbred and 37% local (Table 7). Proportion of crossbred cows in the dairy herds increased as farm size increased. Among the crossbreds, about 50% are Frisian crosses with local zebus; the others are Jersey, Sahiwal and Red Sindhi crosses. Composition of crossbreds is fairly similar across sizes of farms.

Table 7. *Breed composition of dairy herds of CBC farms by size of farm.*

	Small		Medium		Large		All farms	
	No. of cows	%	No. of cows	%	No. of cows	%	No. of cows	%
All CBCs	198	59.3	112	65.9	128	68.5	438	63.4
Frisian cross	106	31.7	57	33.5	58	31.0	221	32.0
Jersey cross	44	13.2	20	11.8	26	13.9	90	13.0
Sahiwal cross	24	7.2	16	9.4	22	11.8	62	9.0
Red Sindhi cross	24	7.2	19	11.2	22	11.8	65	9.4
Local	136	40.7	58	34.1	59	31.6	253	36.6
All breeds	334	100.0	170	100.0	187	100.0	691	100.0

Source: Field survey.

3.3.3 Sources of dairy cows and breed related information

About 70% of the dairy cows of CBC farms were bred on own farm while 30% were purchased. About 76% of the cows of LBC farms were bred on own farm while 24% were purchased. Among CBC farms, medium farms purchased a lower proportion of their cows compared to small and large farms. Among LBC farms, share of purchased cows decreased with farm size (Table 8). About three-quarters of CBC farms and over half of the LBC farms purchased at least one cow in their herds. Among CBC farms who purchased cows, 58% did so from local markets, 39% from other farmers and 3% from government farms. A higher proportion of medium size farmers depended on local

markets for stock. Among the LBC farms who purchased cows, 77% did so from local markets and 23% from other farmers. Market dependence was about the same for all sizes of farms.

Table 8. *Proportion of dairy cows purchased and proportion of farms purchasing by type and size of farm.*

	Small	Medium	Large	All farms
CBC farms				
% of cows purchased	32	24	33	30
% of farms purchasing	73	76	85	76
LBC farms				
% of cows purchased	27	23	18	24
% of farms purchasing	53	57	50	53

Source: Field survey.

In the early 1990s, exotic cows were imported and distributed at subsidised prices due to shortage of good quality breeding stock in the country. In view of this situation, sample farmers were asked if they could easily acquire breeding stock to expand their herd or replace local cows. About 80% of both CBC and LBC farms responded that they could acquire breeding stock from local sources and there was little difference in the response pattern between sizes of farms. This is a reflection of the fact that own breeding or purchases from local markets or farms is the norm as there is no stock breeding farm in either public or private sector in the country.

Asked about sources from where they learned about the various crossbreds, their characteristics and performances, 63% of the CBC farms said they got it from other farmers, 18% got it from the DLS, 9% from the market and 10% from dairy co-operatives, magazines and other sources (Table 9). It appears that although about 75% of purchased cows came from local markets, 63% of information about cows came from other farmers, indicating that irrespective of where the breeding stock is purchased, farmers depend a lot on each other for information about breeds and their performances. There is no system for keeping progeny records by individual farmers or by any agency, so producers' own selection process is the basis for maintenance and improvement of any breed quality.

Table 9. *Proportion of CBC farms by size according to sources of information about breeds.*

Information sources	Small	Medium	Large	All farms
Other farms	64	75	35	63
DLS	14	18	35	18
Market	11	–	20	9
Dairy co-operatives, magazine and others	11	7	10	10
All sources	100	100	100	100

Source: Field survey.

3.3.4 Production characteristics of cows

3.3.4.1 Age of cows, age at first calving and calving interval

In general, CBCs on the sample farms were on average a year younger than the local cows, and local cows on CBC farms were slightly younger than those on LBC farms (Table 10). Among the crossbreds, Frisian crosses were about a year younger than Sahiwal and Red Sindhi crosses. There was no significant difference in this pattern between sizes of farms.

Table 10. *Age of dairy cows by breed and farm type.*

Farm type and breed	No. of cows	Average age (years)
CBC farms		
All CBCs	641	5.97 (0.19)
Frisian cross	322	5.92 (0.15)
Jersey cross	125	5.44 (0.16)
Sahiwal cross	100	6.23 (0.20)
Red Sindhi cross	94	6.54 (0.25)
Local breeds	188	7.16 (0.18)
LBC farms		
Local breeds	206	7.36 (0.23)

Figures in parentheses are standard error of means.
Source: Field survey.

On average, all cows on CBC farms, both local and crossbred, gave the first calf at significantly earlier age than cows on LBC farms (Table 11). On CBC farms, local cows calved at a slightly older age than crossbreds in general but they calved at a slightly lower age than Sahiwal crosses. This means that local cows are also managed better on CBC farms alongside crossbreds than local cows on LBC farms. This may be due to management knowledge spill over to a lower productive technology. Generally age at first calving of crossbreds decreased as farm size increased but for local cows on CBC farms, age at first calving was lowest on medium farms followed by large and small farms. On LBC farms, age at first calving increased with farm size.

Table 11. *Age at first calving by breed and type and size of farm.*

Farm type and breed	Age at first calving (months)						All farms	
	Small		Medium		Large		Mean	SE
	Mean	SE	Mean	SE	Mean	SE		
CBC farms								
All CBCs	34.54	1.84	32.50	1.34	29.63	2.55	32.59	1.16
Frisian	34.25	1.04	28.28	1.44	31.10	1.44	31.48	0.75
Jersey	33.70	1.09	34.70	0.79	28.59	2.60	32.55	0.92
Sahiwal	35.57	2.77	38.36	1.71	30.14	2.94	35.00	1.45
Red Sindhi	36.09	2.47	38.83	1.42	26.53	3.23	33.88	1.53
Local	38.98	1.43	31.36	2.28	33.31	2.06	34.45	1.16
LBC farms								
Local	38.79	1.28	40.20	1.54	42.43	1.64	39.49	0.93

SE = Standard error of means.
Source: Field survey.

On average, calving interval was 0.5–0.7 months longer for local breeds compared to crossbreds, but the differences were not statistically significant (Table 12). Average calving interval of local cows on LBC farms was slightly longer than those on CBC farms. Among the crossbreds, calving interval was slightly higher for Sahiwal and Red Sindhi crosses. In general, calving interval of all the crossbreds decreased slightly as farm size increased. For local breeds, calving interval was lowest on medium farms. In interpreting these results, it needs to be noted that the cows are of different ages and lactations, which might influence calving interval to some extent.

Table 12. *Calving interval (months) by type and size of farm and breed.*

Farm type and breed	Small	Medium	Large	All farms
CBC farms				
All CBCs	12.15 (0.76)	12.13 (0.63)	11.30 (0.69)	11.92 (0.44)
Frisian	12.05 (0.42)	11.63 (0.40)	11.17 (0.48)	11.71 (0.25)
Jersey	10.99 (0.82)	11.43 (0.52)	10.90 (0.77)	11.10 (0.44)
Sahiwal	13.04 (0.82)	12.04 (0.68)	10.76 (0.88)	12.03 (0.47)
Red Sindhi	12.50 (0.96)	13.42 (0.92)	12.37 (0.62)	12.83 (0.53)
Local	12.55 (0.62)	11.95 (0.47)	12.57 (0.55)	12.39 (0.32)
LBC farms				
Local	12.45 (0.37)	10.75 (0.38)	10.82 (0.66)	12.58 (0.27)

Figures in parentheses are standard error of means.
Source: Field survey.

3.3.4.2 Average daily milk yield and highest daily milk yield

On average, crossbred cows produced twice as much milk/cow per day than local cows, and local cows on CBC farms produced about a litre more milk/cow per day than those on LBC farms (Table 13). Among the crossbreds, Jersey and Frisian crosses produced more milk than Sahiwal and Red Sindhi crosses, and Red Sindhi crosses gave the lowest yield. This pattern was observed for all sizes of farms. On CBC farms, yield difference across farm sizes for different breeds were not significant but on LBC farms, yield was significantly lower for small farms. However, in interpreting these results, it needs to be noted that the cows are of different ages, lactations and stages of lactation. The results are valid provided these parameters are randomly distributed across the sample cows. The results may be different, if any, or all these parameters have significant effect on daily yield.

Table 13. *Average daily milk yield/cow by type and size of farm and breed.*

Farm type and breed	Daily milk yield (litre)						All farms	
	Small		Medium		Large		Mean	SE
	Mean	SE	Mean	SE	Mean	SE		
CBC farms								
All CBCs	8.2	0.5	8.3	0.6	7.6	0.7	8.0	0.4
Frisian cross	8.7	0.4	8.7	0.4	7.9	0.5	8.5	0.3
Jersey cross	9.4	0.5	7.5	0.8	8.1	0.8	8.6	0.4
Sahiwal cross	7.1	0.6	8.3	0.6	8.1	0.7	7.8	0.4
Red Sindhi cross	5.1	0.4	6.7	0.7	5.8	0.9	5.8	0.4
Local	4.9	0.3	4.1	0.4	5.5	0.4	4.9	0.2
LBC farms								
Local	3.5	0.2	5.1	0.3	5.5	0.5	4.1	0.2

SE = standard error of means.
Source: Field survey.

Highest daily milk yield received during the current lactation of a cow may indicate to some degree its milk yield potential though, as mentioned earlier, this could be influenced by the age and the lactation number of the cow. The results show that the highest yield received for the crossbreds was 38% higher than the average yield; for the local cows on CBC farms it was 33% higher than the average yield, and for local cows on LBC farms it was 37% higher (Table 14). Among the crossbreds, highest yield for Red Sindhi was 28% lower than that for Frisian and Jersey crosses and 20% lower than that for Sahiwal cross. For all the crossbreds combined, the differences across farm size were not significant but for specific breeds there were some differences. For example, highest

yield for Red Sindhi cross was lowest on small farms and highest on medium farms, for local cows on CBC farms highest yield was highest on large farms and lowest on medium farms, and on LBC farms highest yield increased with farm size.

Table 14. *Highest daily milk yield/cow by breed and type and size of farm.*

Farm type and breed	Highest daily milk yield (litre)						All farms	
	Small		Medium		Large			
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
CBC farms								
All CBCs	10.8	0.5	11.2	0.6	11.3	0.6	11.1	0.3
Frisian cross	11.5	0.4	12.1	0.4	12.1	0.4	11.8	0.2
Jersey cross	11.9	0.7	9.7	0.8	12.1	0.8	11.4	0.4
Sahiwal cross	9.9	0.4	10.6	0.5	11.1	0.6	10.5	0.3
Red Sindhi cross	6.8	0.4	10.0	0.8	8.8	0.7	8.4	0.4
Local	6.5	0.4	5.4	0.4	7.3	0.3	6.5	0.2
LBC farms								
Local	5.0	0.3	6.4	0.2	7.6	0.5	5.6	0.2

SE = Standard error of means.

Source: Field survey.

3.3.4.3 Lactation length

Average lactation length for all crossbreds combined and locals did not differ significantly and lactation length of local cows did not differ between CBC and LBC farms. However, among the crossbreds, Red Sindhi had the lowest lactation length (Table 15). Lactation length for both crossbreds and local cows decreased with farm size indicating that larger farms perhaps stop milking when feeding become uneconomic in relation to yield, but smaller farms may keep on milking until the yield nearly stops because they may not spend much cash on feeds so the marginal value product can be pushed to a low level before stopping milking.

Table 15. *Lactation length (days) by breed and type and size of farm.*

Farm type and breed	Farm size							
	Small		Medium		Large		All farms	
	Mean	SE	Mean	SE	Mean	SE	Mean	S.E
CBC farms								
All CBCs	255	16	248	20	220	21	243	11
Frisian cross	258	9	250	11	229	15	248	7
Jersey cross	252	16	273	24	236	23	253	11
Sahiwal cross	267	19	240	21	242	19	250	11
Red Sindhi cross	235	21	225	22	158	25	207	13
Local	273	13	254	17	216	14	245	9
LBC farms								
Local	215	12	293	12	311	24	247	9

SE = Standard error of means.
Source: Field survey.

3.4 Feeds, feeding and related issues

3.4.1 General context

The primary purpose of keeping cattle in the country is for draft. Crop residues are primary sources of feed. Scarcity of land means smallholders give priority to food grain production and they have

little incentive to produce feed for animals unless they are highly productive and cash income generating. Use of concentrate feed is also influenced by yield response of the feed and market return from milk. Given that dairy population is limited by the available land, intensive production using high quality feed will be required to increase productivity. In the early 1990s, the government banned export of all livestock feed ingredients to help domestic livestock production, which has eased the situation slightly. Milk Vita and BRAC have established small feed manufacturing plants that supply such feeds to their respective milk collection areas. Molasses from sugar mills is being exported and sold domestically to selected individuals or organisations at low unit prices for manufacturing urea molasses blocks (UMB). However, immediate large margins can be made by reselling molasses in the open markets, so there is incentive for such firms or organisations to request much larger quantities than required for manufacturing UMB; they even resell the entire quantity rather than manufacturing UMBs. Consequently, UMB supply is unstable and inadequate in the country. The Agricultural Technology Development Project approached the Bangladesh Sugar and Food Industries Corporation (BSFIC) and individual sugar mills to allow UMB manufacturing plants to be established at the sugar mill on a contract basis by private entrepreneurs. The BSFIC agreed to this proposal in principle but has not implemented it yet (Khan 2002).

Overall, the options currently available in the country for good quality feed supply are not adequate and efficient for operating an improved dairy sector and improving dairy productivity and meet market demand. However, increased mechanisation of crop production is gradually reducing the need for draft animals creating an opportunity for expanded and improved feed supply for increased dairy population. Economically viable options for both forage production and supply of concentrate feeds, however, have to be found out as supply of high-quality feeds remain a major problem for the sector.

3.4.2 Feeding practices, types of feeds used and their sources

Among CBC farms, 64% practice stall feeding and 36% practice a mixture of grazing and stall feeding (Table 16). The proportion of CBC farms practicing stall feeding increases as farm size decreases, perhaps because smaller dairy farms have more land constraint to practice grazing. Among LBC farms, 48% practice stall feeding and 52% practice a mixture of stall feeding and grazing. A higher proportion of medium farms practice stall feeding than small farms.

Paddy straw, wheat/maize straw, green grass, sugarcane tops, vegetable waste are the main roughages and cereal grain, rice bran, wheat bran, pulse bran, oil cake, salt, vitamin-mineral premix, molasses are the main types of concentrate feeds used by the sample dairy farmers. Among the roughages, paddy straw and green grass are principal sources while among concentrates rice bran, wheat bran, pulse bran and oil cakes are the principal sources for both CBC and LBC farms though CBC farms use more concentrate feed/cow than LBC farms.

CBC farms purchased 49% of paddy straw, the main dry roughage, and 25% of green grass; the remainder was produced on-farm. LBC farms purchased 44% of paddy straw and 11% of green grass. A small amount of green grass was purchased in cut-and-carry form, most of the green grass was actually purchased as grazing right in the *bathans*. Farmers pay a fee/season on the basis of the number of cows grazed. Dependence on purchased roughages vary across feed types and sizes of farms depending on sufficiency of own feed in relation to the herd size.

Table 16. *Feeding practice used by the farms by type and size of farms.*

Farm type and practice	% farms by size						All farms	
	Small		Medium		Large			
	No.	%	No.	%	No.	%	No.	%
CBC farms								
Grazing and stall feeding	41	30	27	41	17	45	85	36
Stall feeding	94	70	39	59	21	55	154	64
All	135	100	66	100	38	100	239	100
LBC farms								
Grazing and stall feeding	35	55	6	43	1	50	42	52
Stall feeding	29	45	8	57	1	50	38	48
All	64	100	14	100	2	100	80	100

Source: Field survey.

Over 85% of all types of grain-based concentrate feeds and 100% of minerals, molasses and mixes are purchased, while the remainder are produced on-farm. Farmers often buy different ingredients according to their own liking and adaptation to their animals and feed them either as single items or by mixing different ingredients. Unlike poultry feed mixes, there is hardly any concentrate feed mix available in the market that is suitable for dairy. The Milk Vita reportedly supplied about 10% of its members with some feed mixes and BRAC has also established a feed mill recently for supply of concentrate feed. However, little evidence of use of such feed was observed among the sample of this study.

3.4.3 Volume and frequency of purchased concentrate feeds

Dry roughages such as paddy straw are purchased generally in bulk during or immediately after the harvesting season and such transactions occur between farms. Less frequent purchases of small quantities at other times as needed is also common. Such transactions also occur between farms but in a few places small feed markets operate.

The volume of concentrate feed purchased varies according to farm type. On average, the CBC farms purchased nearly double the quantity of concentrate feed in a year (9622 kg) than the LBC farms (5133 kg) (Table 17). The volume of concentrate feed purchased per order varied according to feed type. However, the main feeds being rice bran, wheat bran, pulse bran and oil cake, the average quantities of these items are also given in Table 17. The CBC farms purchased twice as much per order (88 kg) compared to the LBC farms (39 kg). The medium and large farms purchased higher quantities at a time than the small farms, as would be expected. In case of CBC farms, the quantity of concentrate feed purchased per order increased as the farm size increased.

Of all the surveyed dairy farms, only 39% had contractual arrangements with the concentrate feed suppliers. The proportion of farms having contractual arrangement increased with farm size (Table 18). The volume of concentrate feed purchased per order under contractual arrangement varies according to feed type. However, the main feeds being rice bran, wheat bran, pulse bran and oil cake, the average quantities of these items are given in Table 18. Over 50% of CBC farms buy 100–500 kg at a time, about 15% buy over 500 kg at a time; among LBC farms over 70% buy less than 100 kg at a time. A higher proportion of larger farms buy larger quantities at a time, which would be expected.

Table 17. *Annual purchase of concentrate feed/farm per year and quantity purchased per order by type and size of farm.*

Type of farm	Quantity of concentrate feed purchased (kg)							
	Small		Medium		Large		All farms	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Kg purchased/year								
CBC farms	7240	622	10,029	800	17,519	1507	9622	530
LBC farms	2113	264	19,861	7808	6020	1180	5133	1464
All farms	5583	462	11,647	1469	16,929	1487	8500	550
Kg purchased/order								
CBC farms	69	11	99	13	136	17	88	8
LBC farms	23	3	113	37	33	2	39	8
All farms	54	7	101	12	130	16	76	6

SE = Standard error of means.
Note: Purchase/year includes all concentrate feeds while purchase per order is shown only for rice bran, wheat bran, pulse bran and oil cake.
Source: Field survey.

Table 18. *Proportion of farms having contractual agreements with feed supplier and quantity per order under contract by type and size of farm.*

Farm type	Small	Medium	Large	All farms
% farms having contract				
CBC farms	40	49	47	43
LBC farms	25	29	100	28
All farms	35	45	50	39
Kg/order under contract CBC farms				
Up to 100 Kg	46	22	–	32
101 to 500 Kg	51	44	80	54
Over 500 Kg	3	33	20	14
All farms	100	100	100	100
LBC farms				
Up to 100 Kg	88	50	–	73
101 to 500 Kg	12		100	18
Over 500 Kg	–	50	–	9
All farms	100	100	100	100

Source: Field survey.

Among CBC and LBC farms, 81 and 73%, respectively, purchase weekly (Table 19). Apparently, larger farms buy feed more frequently than smaller farms perhaps because they use more concentrate feed, and volume of purchase and frequency may be partly determined by cash flow and nature of contracts with the feed sellers.

Under contractual arrangement, 97% of CBC farms and all LBC farms purchased feed on credit. Some farms occasionally paid in cash or a combination of cash and credit or even a small advance.

3.4.4 Feed prices

Prices of feed may vary by farm type, farm size and volume of purchase per order. Prices of major feeds like rice straw, green grass, rice bran, wheat bran, pulse bran and oil cake are presented in Table 20. In case of CBC farms, prices of rice straw, green grass and wheat bran were found to decrease as farm size increased, an indication of cost economy due to larger volume of purchases

per order. In case of LBC farms, the small farms paid lower prices for rice straw, green grass, rice bran, wheat bran and pulse bran than the medium and large farms.

Table 19. *Frequency of concentrate feed purchase under contractual arrangement by type and size of farm.*

Farm type and purchase frequency	% farms by size			
	Small	Medium	Large	All farms
CBC farms				
Weekly	78	75	100	81
Fortnightly	18	12	–	13
Over two weeks	4	13	–	6
All	100	100	100	100
LBC farms				
Weekly	63	100	100	73
Fortnightly	12	–	–	9
Over two weeks	25	–	–	18
All	100	100	100	100

Source: Field survey.

Table 20. *Feed prices paid by type and size of farm.*

Farm and feed type	Feed price (BDT*/kg) by farm size							
	Small		Medium		Large		All farms	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
CBC farms								
Rice straw	1.51	0.04	1.34	0.04	1.41	0.08	1.45	0.03
Green grass	1.02	0.04	0.91	0.06	0.81	0.09	0.96	0.03
Rice bran	1.32	0.10	1.24	0.15	1.25	0.23	1.29	0.08
Wheat bran	8.16	0.13	8.12	0.15	7.43	0.41	8.06	0.10
Pulse bran	4.01	0.40	3.48	0.54	6.47	0.75	4.17	0.30
Oil cake	6.46	0.31	7.08	0.38	7.02	0.58	6.70	0.23
LBC farms								
Rice straw	1.35	0.04	1.40	0.13	1.50	0.50	1.36	0.04
Green grass	0.96	0.06	0.91	0.14	1.10	0.10	0.96	0.05
Rice bran	1.04	0.14	1.49	0.28	2.00	1.00	1.14	0.12
Wheat bran	7.26	0.38	7.68	0.68	8.50	0.50	7.37	0.33
Pulse bran	2.05	0.45	3.18	1.03	4.00	4.00	2.30	0.41
Oil cake	6.74	0.40	6.07	0.97	7.50	1.50	6.64	0.36

* In 2004, US$ 1 = Bangladeshi taka (BDT) 59.513.
SE = Standard error of means.
Source: Field survey.

3.5 Access to credit, extension and veterinary services

3.5.1 Registration of farms and membership in organisations

There is no legal requirement for farmers to register with any government agency for farming. However, farmers have the option to become members of several government organisations, e.g. the DLS and Krishi Bank for obtaining credit and input services, and of several non-government organisations, e.g. Milk Vita (the dairy producer's co-operative), BRAC, Grameen Bank, Proshika, and Aasha for obtaining credit, input services and market outlet for milk. In the sample, 42% each of CBC and LBC farms were members of Milk Vita and 3% of both CBC and LBC farms were

members of BRAC, both involved in milk collection and supply of some concentrate feeds and AI services.

3.5.2 Access to credit

Historically, formal institutional credit in the agricultural sector has been targeted principally to the crop sector though the situation has changed recently and credit supply to the livestock sector has increased. Currently two specialised agricultural banks— the Bangladesh Krishi Bank (BKB) and the Rajshahi Krishi Unnayan Bank (RKUB)—provide credit for livestock. Livestock credit accounts for less than 10% of total loan disbursement of these two agricultural lending institutions. Lending activities of BKB and RKUB in some recent years are shown in Table 21. Several public sector commercial banks and a number of NGOs, notably Grameen Bank, BRAC and Proshika also provide livestock credit. In addition, the government sometimes advances livestock credit through specialised projects to targeted areas and activities. All the NGO loans and a good proportion of BKB and RAKUB loans are short-term loans targeted to poor and the landless, and delivered in most cases through small groups. Other loans are medium- and long-term disbursed for large animals and for larger-scale commercial production of different types of livestock.

Table 21. *Livestock credit activities of BKB and RAKUB, selected years (BDT* × 10^6).*

Year	BKB			RKUB		
	Dairy	Poultry	Draft cattle	Dairy	Poultry	Draft cattle
1993–94	216.9	42.6	456.9	28.3	0.1	150.1
1994–95	248.9	80.4	445.9	32.4	0.2	132.4
1997–98	145.6	16.3	213.0	47.7	0.1	179.1
1998–99	227.3	1.87	322.6	57.5	0.3	187.4
1999–00	127.5	19.0	156.2	80.1	1.0	190.5

* In 2004, US$ 1 = BDT 59.513.
Source: Khan (2002).

Forty-two percent of the sample CBC farms and 22% of LBC farms borrowed for the dairy enterprise, while any borrowing by the sample farmers for any other activity was not recorded. All the borrower LBC farms were small but among CBC farms, 36% of small, 56% of medium and 42% of large farms borrowed (Table 22). All the borrowing LBC farms borrowed from NGOs but CBC farms borrowed from diverse sources. Only small CBC farms borrowed from milk traders. The reasons for not borrowing or borrowing from a particular source were not available.

Table 22. *Amount of loan received/borrower by sources, size and type of farm.*

Farm type and source of credit	Small		Medium		Large		All farms	
	% farms borrowed	BDT*/ borrower	% farms borrowed	BDT/ borrower	% farms borrowed	BDT/ borrower	% farms borrowed	BDT/ borrower
CBC farms								
Milk traders	6.8	11,400	0	na	0	na	3.3	11,400
Commercial banks	11.3	25,000	16.5	28,333	25.2	20,000	14.4	26,000
Agricultural banks	6.8	12,500.	6.6	15,000	8.4	20,000	6.6	15,000
NGOs	11.3	9,500	32.9	16,600	8.4	11,333	17.7	12,429
LBC farms								
NGOs	22	11,500	0	na	0	na	22	11,500

na = not applicable.
* In 2004, US$ 1 = BDT 59.513.
Source: Field survey.

3.5.3 Access to veterinary services

Vaccination, internal parasite control, clinical assessment, AI, and bull service were the important veterinary services used by the dairy producers (Table 23). In case of CBC farms, the highest proportion of farmers used internal parasite control (79%) followed by AI (61%) and vaccination service (52%). In case of LBC farms, the highest proportion of farmers used internal parasite control (48%) followed by vaccination (41%), bull service (38%) and AI (29%).

Among the CBC farms, 55% farmers received vaccination services from the Department of Livestock Services (DLS), 31% from Milk Vita and 14% from BRAC or other NGOs. Among LBC farms, the corresponding figures are 47, 50 and 3%, respectively. In case of CBC farms, 52, 56 and 64% of small, medium and large farms, respectively, received services from the DLS; among LBC farms, the corresponding figures are 50, 40, and 0%, respectively. Among CBC farms, 30, 36 and 24% of small, medium and large farms, respectively, received services from Milk Vita; among LBC farms, the corresponding figures are, respectively, 43, 64 and 100%. The services of Milk Vita were accessible to its members, especially those who regularly delivered milk. Therefore, difference in sources of services was not always due to size or type of farm but was partly a result of these relationships. In general, the services of DLS were more accessible to larger CBC farms that generally invest more in the health of their highly productive animals compared to rearers of local breeds. However, where a farmer had the opportunity to choose between sources of a service, quick access and the quality of service often determined the choice. About 95% of CBC farms and all LBC farms considered the available vaccination services satisfactory. However, 85% of large CBC farms considered the available vaccination services satisfactory.

3.6 Marketing and prices of milk

3.6.1 General context

In rural areas, milk is traditionally consumed in liquid form (boiled to avoid spoilage and micro-organisms) and in the form of sweets and curd; a very small portion is converted to ghee (clarified butter). Taking the country as a whole, most of the milk is marketed through informal channels by producers and traders to local consumers and processors (for making sweets, curd and ghee) in both rural and urban areas. Dhaka city is the largest single urban consumption centre for which milk collection, processing and marketing (in the form of pasteurised milk, butter and ice-cream) was organised in the mid-1970s through Milk Vita—a milk producers' co-operative. Although this was organised along the Indian Amul pattern, Milk Vita did not perform very well until 1990, so its processing capacity remained under used. Since 1990, Milk Vita has expanded its network of milk collection points in several milk sheds, cooling facilities at sub-stations and processing facilities at some central points. As a result, milk collection, processing and marketing increased substantially. Limited number (about 10%) of Milk Vita members also receive AI services, better feeds and credit, which has resulted in some marginal increase in productivity in the milk sheds where Milk Vita operates. Only recently, BRAC—an NGO—has established milk processing facility and has started milk collection from the same milk sheds. Grameen Bank has also started a similar programme recently to diversify the income earning opportunities of its landless credit groups in a few northern districts. Informal traders serving rural and small town consumers and processors of milk and milk products also operate in these milk sheds, thus creating a competitive environment

for the producers as well as urban consumers. However, all the formal organisations are interested in maximising milk collection from current production to use their processing facilities and meet high urban market demand, but none of these organisations have any programme for long-term development of the dairy sector and ensure sustained long-term productivity and supply. Whether the current marketing systems— both formal and informal— are functioning efficiently from the point of view of smallholder producers, urban consumers and the society at large is also not known.

Table 23. *Proportion of sample farms using different types of veterinary service.*

	% farms used a service by size of farm			
	Small	Medium	Large	All farms
CBC farms				
Vaccination service	42	65	66	52
Internal parasitism control	81	76	76	79
Clinical assessment	4	15	5	8
Disinfections	24	26	37	26
AI	57	65	68	61
Bull service	12	21	32	18
Regular examination	7	12	11	9
Other services	15	23	18	18
LBC farms				
Vaccination service	38	57	50	41
Internal parasitism control	44	57	100	48
Clinical assessment	3	–	–	3
Disinfections	13	29	–	15
AI	30	29	–	29
Bull service	34	43	100	38
Regular examination	6	–	–	5
Other services	13	23	18	16

Source: Field survey.

3.6.2 Market outlet and terms of payment for milk sold

Among the sample CBC farms, 79% sold milk both in the morning and in the evening and 20% sold only in the morning. Among the LBC farms, 53 sold twice and 45% sold only in the evening. Usually more small LBC farms sold evening milk, few medium and large farms did so. This difference arose mainly because most local cows are not milked twice a day, and if they are, the evening milk is more often consumed at home.

Overall, Milk Vita was the principal buyer of both morning and evening milk of both CBC and LBC farms (Table 24). Local processors, hotels, sweet shops and individual households as a group was the second and traders who buy milk for distant markets was the third most important buyers. BRAC was the fourth with marginal presence. However, the proportion of farms selling milk to Milk Vita increased with farm size for both CBC and LBC farms. Among the CBC farms, the proportion of farms selling to traders decreased with farm size and sales to the other types of buyers was the same for all sizes. Among the LBC farms, a higher proportion of small farms sold to local processors etc. but a lower proportion sold to traders compared to medium and large farms. This implies that the formal milk marketing outlet is used more by larger farmers perhaps because they supply larger volumes of more uniform quality.

Table 24. *Buyer type of morning and evening milk by type and size of farm.*

Farm type and buyer type	% farms selling to buyer type by size of farm							
	Small		Medium		Large		All farms	
	Morning	Evening	Morning	Evening	Morning	Evening	Morning	Evening
CBC farms								
Milk Vita	31	41	45	53	54	65	39	48
Local hotels/sweet shops/ households	32	24	29	31	30	26	30	26
Traders	32	28	26	16	16	9	28	21
BRAC	5	8					3	4
All buyers	100	100	100	100	100	100	100	100
LBC farms								
Milk Vita	36	73	46	86	100	100	39	76
Local hotels/sweet shops/ households	38	15	15	–	–	–	33	12
Traders	23	6	38	14	–	–	25	7
BRAC	3	6	–	–	–	–	3	5
All buyers	100	100	100	100	100	100	100	100

Source: Field survey.

Among the CBC farms, 16% of morning milk sellers and 20% of evening milk sellers delivered their milk at farm gate. Among LBC farms, the corresponding figures are 9 and 5%, respectively. In all other cases, milk has been delivered either at a designated collection point (Milk Vita, BRAC and some traders) or to the shop or home of the buyer, or in some cases milk was sold at a market place. The delivery point is primarily a function of the market outlet used for selling, e.g. Milk Vita and BRAC always collect milk at designated points, but in case of some informal buyers, the contract may define whether the delivery will be at farm gate or at the buyer's door. Therefore, the delivery point used by different sizes of farms has a relationship with the type of outlet used for selling milk.

To deliver morning milk, 81% of CBC farms selling milk delivered milk on foot, 9% used a rickshaw van and 10% used bicycle. Among LBC farms, 91% delivered on foot, 1% used van and 7% used bicycle. To deliver evening milk, 83, 10 and 7% of CBC farms delivered on foot, used a rickshaw van and a bicycle, while 86, 8 and 6% LBC farms used these modes respectively. Rickshaw vans were used mainly by larger farmers to deliver larger volume of milk.

Milk Vita and BRAC usually buy milk on weekly credit, i.e. the payment is made one week in arrear. In about 5% cases they also pay cash; this may happen on the pay day when some sellers may be paid on the spot. However, traders and local processors including individual households either pay cash or in arrear or a combination of cash and credit (from one week up to one month). These terms may also vary according to time of buying milk, size and type of farm (Tables 25 and 26).

It appears that for morning milk, traders pay primarily in cash, especially to LBC farms, and weekly credit is the second most important form of payment and it is more frequently used to pay CBC farms. The same pattern is observed across sizes of farms. In case of local processors, shops and households, cash is the main form of payment to LBC farms followed by cash–credit combination and weekly credit but for CBC farms, cash–credit combination is followed by cash and weekly credit. The pattern is also about the same across sizes of farms.

Table 25. *Mode of payment for morning milk by traders and local milk processors according to size and type of farm.*

Type of buyer and terms of payment	% milk sellers by size and type of farm							
	Small		Medium		Large		All farms	
	CBC	LBC	CBC	LBC	CBC	LBC	CBC	LBC
Traders								
Cash	52	67	53	100	67	–	54	75
Weekly credit	31	27	29	–	33	–	31	20
Both cash and credit	17	7	18	–	0		15	5
All terms	100	100	100	100	100	–	100	100
Local processors, shops and households								
Cash	32	50	53	–	9	–	30	46
Weekly credit	29	13	29	50	36	–	30	15
Both cash and credit	39	38	8	50	5	–	41	38
All terms	100	100	100	100	100	–	100	100

Source: Field survey.

Table 26. *Mode of payment for evening milk by traders and local milk processors according to size and type of farm.*

Type of buyer and terms of payment	% milk sellers by size and type of farm							
	Small		Medium		Large		All farms	
	CBC	LBC	CBC	LBC	CBC	LBC	CBC	LBC
Traders								
Cash	29	50	25	100	67	–	31	67
Weekly credit	43	–	50	–	33	–	44	–
Both cash and credit	29	50	25	–	–	–	26	33
All terms	100	100	100	100	100	–	100	100
Local processors, shops and households								
Cash	25	60	33	–	12	–	25	60
Weekly credit	33	40	27	–	44	–	33	47
Both cash and credit	42	–	40	–	44	–	42	–
All terms	100	100	100	–	100	–	100	100

Source: Field survey.

For evening milk, traders pay primarily in cash to LBC farms followed by a cash–credit combination while weekly credit, cash and cash–credit combinations are used, in that order, for CBC farms. Local processors, shops etc. also pay primarily in cash to LBC farms but cash–credit combination, weekly credit and cash are the modes used to pay CBC farms. Generally, the same pattern is observed across sizes of farms.

3.6.3 Milk prices

Milk prices varied by buyer type and farm size. While Milk Vita offered the same unit price irrespective of the size of farm or the volume of purchase from a seller, unit prices paid by traders and local processors, two other most important buyers, increased with farm size perhaps because they were able to reduce marketing and transactions cost with larger quantities purchased from a seller. Also there were differences between morning and evening prices (Tables 27 and 28). In case of CBC farms, the highest milk price was received from the local processor, sweet shops and households (BDT 17.39/litre) followed by BRAC (BDT 15.88/litre). The average prices of morning

milk of LBC and CBC farms were almost similar (about BDT 16/litre). However, the CBC farms received higher average price of evening milk than the LBC farms.

Table 27. *Farmer prices for morning milk by buyer type and farm type.*

Type of buyer	Price (BDT*/litre)							
	Small		Medium		Large		All farms	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
CBC farms								
Traders	15.32	0.52	16.20	0.44	17.20	1.16	15.80	0.38
Milk Vita	15.61	0.23	15.59	0.34	15.37	0.32	15.56	0.17
Local processors, shops, households	17.59	0.41	16.57	0.39	18.33	0.95	17.39	0.30
BRAC	15.88	0.67	na	na	na	na	15.88	0.67
All buyers	16.04	0.20	15.91	0.24	16.20	0.36	16.03	0.14
LBC farms								
Traders	15.57	1.22	na	na	na	na	15.57	1.22
Milk Vita	15.63	0.36	15.85	0.68	15.75	1.25	15.68	0.30
Local processors, shops, households	17.34	0.40	18.67	0.67	na	na	17.52	0.37
BRAC	15.00	0.31	na	na	na	na	15.00	0.31
All buyers	16.13	0.29	16.39	0.60	15.75	1.25	16.17	0.25

* In 2004, US$ 1 = BDT 59.513.
SE = Standard error of means.
Source: Field survey.

Table 28. *Farmer prices for evening milk by buyer and farm types.*

Farm and buyer types	Price (BDT*/litre)							
	Small		Medium		Large		All farms	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
CBC farms								
Traders	15.82	0.33	16.13	0.88	17.25	1.31	16.01	0.31
Local processors/households	17.73	0.63	17.27	0.52	18.88	0.74	17.78	0.37
Milk Vita	16.20	0.23	16.11	0.23	16.36	0.31	16.21	0.14
BRAC	17.03	0.27	na	na	na	na	17.03	0.27
All	16.45	0.20	16.47	0.25	17.04	0.34	16.56	0.14
LBC farms								
Traders	16.17	1.36	16.00	na	na	na	16.13	0.97
Local processors/households	15.13	0.88	na	na	na	na	15.13	0.88
Milk Vita	15.73	0.75	16.33	0.65	17.25	0.25	15.95	0.57
BRAC	16.50	0.50	na	na	na	na	16.50	0.50
All	15.75	0.56	16.29	0.55	17.25	0.25	15.91	0.44

* In 2004, US$ 1 = BDT 59.513.
SE = Standard error of means.
Source: Field survey.

3.7 Costs and returns of milk production

Two measures of returns were compared—gross margin (gross return–variable costs) and net profit (gross return–total costs). Opportunity cost of family labour was the principal fixed cost. Both measures of returns generally increased as farm size increased for CBC farms; for LBC farms, gross margin was the lowest for medium farms but net profit increased as farm size increased (Table 29). Also differences in gross margin between farm size groups was lower than for net profit, i.e. profit/unit of milk increased faster than gross margin as farm size increased.

Table 29. *Costs and returns (BDT*/litre) of milk by farm type and size.*

Farm type and size	Small	Medium	Large	All farms
CBC farms				
Total variable cost	8.31	7.97	7.74	8.16
Total fixed cost	2.66	1.78	1.67	2.31
Total cost	10.97	9.75	9.41	10.47
Gross return	16.15	16.23	16.48	16.24
Gross margin	7.84	8.26	8.74	8.08
Net profit	5.18	6.48	7.07	5.77
LBC farms				
Total variable cost	8.70	10.02	5.83	8.76
Total fixed cost	5.32	2.81	2.75	4.85
Total cost	14.02	12.83	8.58	13.61
Gross return	15.92	16.34	16.50	16.11
Gross margin	7.22	6.32	10.67	7.35
Net profit	1.90	3.51	7.92	2.50

* In 2004, US$ 1 = BDT 59.513.

Source: Field survey.

These differences arose partly because of differences in volume of output, milk yield/cow, price of milk/litre and also costs of inputs/unit. For example, fixed cost/litre was the highest in small farms for both CBC and LBC categories and this was partly because of lower volume of output in relation to the resources devoted to its production. Moreover, yield and price of milk/unit increased as farm size increased and cost/unit generally decreased as farm size increased. Overall, total cost/litre was 50% higher for CBC farms compared to LBC farms. In case of small, medium and large farms, CBC farms had 66, 20 and 60% higher costs (Table 30). Fixed costs were much lower than variable costs and fixed costs were also generally smaller for larger farms, so the main differences in total costs were due to differences in variable costs. However, the cost structures of CBC farms show that the shares of feed and labour costs are about the same across sizes of farms indicating that CBC farms are managed about the same manner across sizes of farms, while among LBC farms, larger farms spend a higher share of costs on feeds, especially on concentrates. The CBC farms spent 38% and LBC farms spent 26% of total cost on concentrate feeds.

Table 30. *Structure of average cost of milk production by farm type and size.*

Cost category	% of total cost							
	Small		Medium		Large		All Farms	
	CBC	LBC	CBC	LBC	CBC	LBC	CBC	LBC
Dry roughage	13.3	16.0	13.9	23.0	14.7	16.0	13.6	17.0
Green grass	8.8	14.0	7.0	7.0	5.1	6.0	8.0	13.0
Concentrate feed	36.5	24.0	42.9	32.0	40.1	39.0	38.4	26.0
Veterinary drugs and treatment	0.5	0.01	0.9	0.01	1.4	0.01	0.7	0.01
Unskilled/casual labour	11.2	2.0	11.1	13.0	17.2	0.0	12.3	3.0
Transportation	2.0	2.0	2.0	2.0	2.3	5.0	2.0	2.0
Interest on operating capital	3.5	4.0	2.1	2.0	1.4	2.0	2.9	3.0
Total variable cost	75.8	62.0	81.8	78.0	82.3	68.0	77.9	64.0
Depreciation	2.0	2.0	2.0	2.0	2.3	5.0	2.0	2.0
Family labour	22.2	36.0	16.2	20.0	15.5	27.0	20.1	34.0
Total fixed cost	24.2	38.0	18.2	22.0	17.7	32.0	22.1	36.0
Total cost	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field survey.

4 Econometric analysis of sample dairy farms

4.1 Specification of the empirical model

In order to gain efficiency in parameter estimation (as explained earlier) we used a single stage estimation procedure (Coelli and Battese 1996). So, we specified a normalised stochastic frontier profit function model with inefficiency variables as follows:

$$\ln\pi_i = \ln a + \Sigma\beta_i \ln W_{ij} + \Sigma S_{ij} + v_i - u_i \qquad (6)$$

and

$$u_i = \delta_0 + \Sigma\delta_k Z_{ik} \qquad (7)$$

where π_i, W_{ij} and S_{ij} are defined earlier in (1); Z_{ik} is firm-specific socio-economic variables affecting efficiency; the subscripts i, j, and k refer to jth farmer, ith and kth parameters or variables.

We specified an empirical normalised stochastic frontier profit function for CBC farms using the functional form of (6) and (7). The variables included are as follows:

π_i = Normalised profit (gross revenue minus variable costs) of jth dairy farm (BDT)

W_{i1} = Normalised wage rate of jth farm

W_{i2} = Normalised feed price of dry roughage feed of jth farm

W_{i3} = Normalised feed price of green roughage feed of jth farm

W_{i4} = Normalised feed price of concentrate feed of jth farm

W_{i5}= Normalisd price of veterinary treatment

S_{i1} = Value of house and equipment

S_{i2} = Annual fixed labour used (persondays)

S_{i3} = Value of total dairy herd (BDT)

S_{i4} = Land holdings (ha)

S_{i5} = Dummy for access to credit as a proxy for liquidity (yes =1, No = 0)

Z_{i1} = Age of the head of household (years)

Z_{i2} = Educational level of head of household (years)

Z_{i3} = Proportion of crossbred cow in total dairy herd

Z_{i4} = Extension contact by various veterinary organisations (No. of visits)

Z_{i5} = Extension contact by farmers (No. of visits)

Z_{i6} = Mean distance to feed market (km)

Z_{i7} = Mean distance to milk sale outlet (km)

Z_{i8} = Dummy for selling milk at market place (yes =1, No = 0)

Z_{i9}= Dummy for selling milk at collection point of Milk Vita (yes =1, No = 0) and

Z_{i10}= Dummy for having pasture land (yes =1, No = 0).

Gross margin rather than net profit is used as the dependent variable because wages for fixed family labour and fixed capital are not farm specific; rather they are constant for a given area. The independent variables are self explanatory except the variable 'proportion of crossbred cows in the herd'. CBC farms had local as well as crossbred cows. Apart from cows, other types of animals, e.g. followers, bulls, oxen for draft were also kept. Among crossbreds, Frisian, Jersey, Sahiwal and Red Sindhi crosses with local cows have been raised. Farms may have any one of these crossbreds or a combination of them. These breeds differ in size (body weight), feed needs and milk yield, and therefore there was a need to standardise cow units to define the dairy herd size rather than using simple head counts. This was done based on ratios of average body weight of adult cows of different breeds, and since Frisian was the most common crossbred kept, all cows were converted to Frisian equivalent. The conversion factors used for cows are as follows: Frisian crosses = 1, Sahiwal crosses = 0.8, Red Sindhi crosses = 0.7, Jersey crosses = 0.6, local = 0.2. For other categories animals, the following common conversion factors were used: bulls = 0.5, heifer/steer = 0.2, calf = 0.01.

Proportion of crossbred cows in the herd increased with herd size, so both herd size and proportion of crossbred cows in the herd could not be simultaneously included in the inefficiency part of the model. Separate showed that the model with 'proportion of crossbred cows in the herd' as a variable gave a better fit than the model with herd size as a variable.

We also estimated normalised frontier profit function separately for LBC farms using the same set of variables as in the CBC farm function except that the variable 'proportion of crossbred cows in the herd' was replaced by a variable called 'dairy herd size in Frisian cow equivalent'. For appropriate comparison, cows of LBC farms were also converted to Frisian equivalent.

The normalised stochastic frontier functions were estimated using MLE technique in a single stage estimation procedure using a software Frontier 4.1 (Coelli 1994).

4.2 Results and discussion

4.2.1 Estimation of frontier profit function

The parameters and estimates of normalised frontier profit function and inefficiency models for CBC and LBC farms are presented in Tables 31 and 32. Both the estimated models are statistically significant as judged by log-likelihood ratio test. In the case of CBC farms, the variance ratio parameter γ, is significantly different from zero and comparatively large (0.999) in the (0,1) interval within which γ lies. This result implies that difference in actual profit from maximum profit between farms mainly arose from differences in farmer practices rather than random variability. However, in case of LBC farms, the variance ratio was very small (0.242) implying that the difference between actual and maximum profit arose from differences both in farm practices and random variability. These differences between CBC and LBC farms might arise due to differences in nature and quality of technology packages used. While CBC farms used a more homogenous package of technologies (breed characteristics, feed rations, health inputs, management practices), LBC farms used more heterogeneous technology packages—animals of different quality, size and yield potential, feeds of various types and quality etc. Thus random variability was a much bigger factor in case of LBC farms.

In case of CBC farms, the results show that among the selected production variables, price of dry roughage, price of veterinary treatment, value of herd and access to credit are significant (Table 31). Price of dry roughage and veterinary treatment significantly reduced profit of CBC farms indicating that all farmers did not pay optimal price for these inputs and services. On the other hand, the fixed factors like value of total herd and access to credit (as proxy for financial capital) significantly increased profit of this type of dairy farms indicating that larger scale helped to enhance profit.

Table 31. *Maximum likelihood estimates of parameters of the normalised stochastic frontier profit function and inefficiency model of CBC farms*.

Profit function variables	Coefficient	Inefficiency variables	Coefficient
Constant	3.117*** (0.407)	Constant	–2.272* (1.477)
Normalised wage rate (lnW_1)	–0.213 (0.179)	Age of the head of household (LnZ_1)	0.933** (0.393)
Normalised price of dry roughage feed (lnW_2)	–0.270** (0.184)	Educational level of head of household (lnZ_2)	0.038** (0.014)
Normalised price of green roughage feed (lnW_3)	0.352 (0.193)	Proportion of crossbred cows in the herd (lnZ_3)	–1.458** (0.713)
Normalised price of concentrate feed (lnW_4)	0.177 (0.131)	Number of extension contact by provider organisations (lnZ_4)	0.037* (0.024)
Normalised price of veterinary treatment (lnW_5)	–0.013* 0.009)	Number of extension contact by farmer (lnZ_5)	–0.114* (0.065)
Value of house and equipment (lnS_1)	–0.002 (0.004)	Mean distance to feed market (lnZ_6)	–0.016 (0.146)
Annual fixed labour (lnS_2)	–0.014 (0.106)	Mean distance to milk sale outlet (lnZ_7)	–0.014 (0.036)
Value of total herd (lnS_3)	0.752*** (0.089)	Dummy for selling milk at market place (Z_8)	–0.090 (0.409)
Land holdings (lnS_4)	0.042 (0.052)	Dummy for selling milk at Milk Vita collection point (Z_9)	–0.272 (0.382)
Dummy for access to credit (lnS_5)	0.236*** (0.077)	Dummy for having pasture land (Z_{10})	–0.483* (0.301)

Variance (σ^2) = 0.878***(0.154); $\gamma = (\sigma_u^2/\sigma_v^2)$ = 0.999***(0.000).
Log-likelihood function =–170.59; Test statistic λ = 64.19**
***, ** and * show statistical significance at 1 , 5 and 10% level respectively. Figures in parentheses are standard errors of estimates.
Source: Field survey and author's estimates.

In case of LBC farms, the parameters of wage rate, price of green roughage, annual fixed labour and value of total herd were found to be significant (Table 32). The negative effect of wage rate on profit indicates that all farms did not pay optimal price for hired labour, and positive effects of price of green roughage indicate that its marginal productivity might be higher than its price. The positive effects of fixed factors like total herd value and annual fixed labour indicate that there was economy of larger scale. The coefficient of credit access was not statistically significant. One possible reason was that few LBC farms obtained credit and the volume of credit rather than access *per se* might have been more important but the effect of volume could not be adequately captured by the credit dummy variable.

Table 32. *Maximum likelihood estimates of parameters of the normalised stochastic frontier profit function and inefficiency model of LBC farms.*

Profit function variables	Coefficient	Inefficiency variables	Coefficient
Constant	0.752 (0.994)	Constant	0.824 (1.084)
Normalised wage rate (lnW_1)	–1.713** (0.809)	Age of the head of household (LnZ_1)	0.573** (0.315)
Normalised price of dry roughage feed (lnW_2)	–0.314 (0.669)	Educational level of head of household (lnZ_2)	–0.050** (0.024)
Normalised price of green roughage feed (lnW_3)	1.388*** (0.493)	Dairy herd size in Frisian cow equivalent (lnZ_3)	–0.533** (0.243)
Normalised price of concentrate feed (lnW_4)	–0.580** (0.223)	Number of extension contact by provider organisations (lnZ_4)	0.699* (0.039)
Normalised price of veterinary treatment (lnW_5)	0.005 (0.017)	Number of extension contact by farmer (lnZ_5)	1.621* (0.766)
Value of house and equipment (lnS_1)	–0.137 (0.233)	Mean distance to feed market (lnZ_6)	–0.120 (0.149)
Annual fixed labour (lnS_2)	0.902*** (0.209)	Mean distance to milk sale outlet (lnZ_7)	1.219*** (0.320)
Value of total herd (lnS_3)	0.602*** (0.180)	Dummy for selling milk at market place (Z_8)	–0.173 (0.430)
Land holdings (lnS_4)	0.205 (0.211)	Dummy for selling milk at Milk Vita collection point (Z_9)	–0.190 (0.391)
Dummy for access to credit (lnS_5)	0.048 (0.178)	Dummy for having pasture land (Z_{10})	–0.701** (0.290)

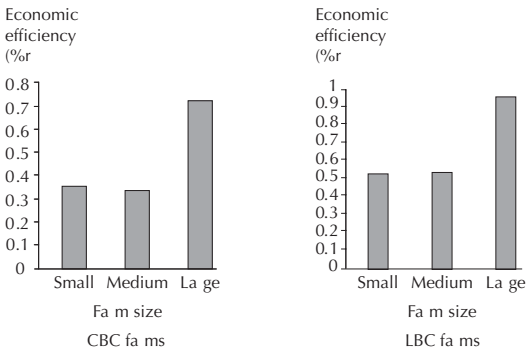
Variance (σ^2) = 0.116***(0.046); $\gamma = (\sigma_u^2/\sigma_v^2)$ = 0.242(0.432).
Log-likelihood function = –11.43; Test statistic λ = 28.49**.
***, ** and * show statistical significance at 1, 5 and 10% level, respectively. Figures in parentheses are standard errors of estimates.
Source: Field survey and authors' estimates.

4.2.2 The determinants of inefficiency

The mean economic efficiency of LBC farms is higher than that for CBC farms but the range, standard deviation and variance of farm-specific efficiency are almost similar for the two groups (Table 33). Average efficiency of small and medium farms did not differ significantly in case of either CBC or LBC farms but in both cases, efficiency of large farms was significantly higher than the small and medium farms (Figure 2).

In case of CBC farms, out of 10 socio-economic variables specified for explaining inefficiency, 6 were found significant. The coefficients of age and education of the head of household are positive and significant at 5% level. The results imply that older farmers may be less efficient as they may not use up-to-date management methods. Also education is found to increase economic inefficiency, which is counter intuitive, but the type of education referred to here is of a general nature, which may not significantly improve technical management of the farm. Higher proportion of crossbred cows in the dairy herd significantly reduced inefficiency implying the importance of better quality animals for improving productivity and profit. Larger number of extension contact by provider organisation increased inefficiency of this type of dairy farms perhaps because such visits did not always take place for specific needs or when a production constraint was faced. On the other hand, larger number of extension visits to provider organisation by the farmers

themselves significantly reduced inefficiency as this might reflect visits taking place when there was a genuine demand to overcome a constraint that contributed to improved performance of the farm. Ownership or regular access to pasture land significantly reduced inefficiency as it allowed more flexibility in the use of good quality feed.



Source: Field survey.

Figure 2. *Average efficiency of CBC and LBC farms by size.*

Table 33. *Descriptive statistics for farm specific economic efficiencies of dairy farms with and without crossbred cows.*

Descriptive statistics	Farm specific economic efficiency	
	CBC farms	LBC farms
Minimum %	11	16
Maximum %	100	98
Mean %	44	55
Variance	24	30
Standard deviation	5	6
Skewness	67	37
Kurtosis	–48	–141

Source: Field survey and authors' estimates.

In case of LBC farms, the results were similar to CBC farms. Out of 10 socio-economic variables specified to explain inefficiency, the coefficients of age, education, dairy herd size, extension contact, distance to milk sale outlet and pasture land were significant. The explanations for age is similar to those mentioned earlier. Role of education in reducing inefficiency may be explained by the fact that within the limits of the productive capacity of local breeds, better education may help accessing and using inputs, services and information in better ways. Larger dairy herd size significantly reduced inefficiency by reducing cost/unit of feeds and other inputs. Larger number of extension contacts, both by the providers and by the farms, increased inefficiency perhaps because such visits were of a general nature and they did not take place to address any specific production constraining problem or some visits might have taken place to deal with problems such as treatment of certain disease which might have reduced morbidity or even mortality but did not add to the overall productivity of the local cows, whose production potential is generally very low and opportunities for yield increase are marginal compared to CBC cows whose yield potential and opportunities for improvement are much higher; so extension or other inputs are likely to make much more pronounced impact as was mentioned earlier. However, these are only plausible

explanations as there was no direct way of measuring the true impact of extension visit on technical or economic efficiency of dairy cow production from farm survey data.

Distance to feed market and the type of market outlet used for disposal of milk had no significant influence on efficiency of either CBC or LBC farms perhaps because the average prices did not differ significantly between the outlets; rather prices differed more between sizes of farms (see Tables 27 and 28), which also might have contributed to higher average efficiency of larger farms.

5 Descriptive analysis of sample poultry farms

5.1 Demographics

The owners of both broiler and layer farms were fairly young people. The mean age of the broiler farm owners was 36 and that of the layer farm owners was 33. Difference across farm size was not significant.

The average family size of the broiler farm owners was less than that of the layer farm owners (Table 34). Among layer farms, family size increased with the scale of farming. Among broiler farms, average size was slightly smaller for small farms compared to medium and large farms.

Table 34. *Family size of the respondent farmers by type and size of farm.*

Type of farm	Family size by size of poultry farm			
	Small	Medium	Large	All farms
Broiler	4.5	5.3	5.1	4.9
	(0.3)	(0.4)	(0.4)	(0.2)
Layer	4.7	5.3	9.2	5.8
	(0.3)	(0.5)	(0.7)	(0.3)

Figures in parentheses are standard error of means.
Source: Field survey.

Family members aged over 12 years were observed to be involved in various poultry farm activities, so data on education of family members above 12 years of age were collected. Overall, layer farmers had greater number of years of education/farm compared to broiler farmers (Table 35). Female education was generally higher among layer farms compared to broiler and conventional farms. Among layer farms, female education was higher in small and large farms compared to medium farms while among broiler farms, female education was higher among medium farms.

Table 35. *Education of family members by type and size of farm.*

Farm type		Mean school years of education/ family			
		Small	Medium	Large	All farms
Broiler	Total education (school years)	28 (3.0)	29 (4.1)	47 (4.6)	32 (2.2)
	% female years	32	41	38	37
Layer	Total education (school years)	36 (3.2)	41 (4.9)	78 (7.0)	46 (3.0)
	% female years	47	34	47	43

Figures in parentheses are standard error of means.

Source: Field survey.

On average, broiler and layer farms spent about the same amount of labour/person per day for poultry farming. Female share of labour was higher for smaller farms, especially for layer farms (Table 36).

The mean land holdings of the broiler farm owners was 0.72 ha compared to 4.5 ha for layer farms (Table 37). Generally a portion of the agricultural land was devoted to establish poultry farm, indicating that basically crop–livestock mixed farmers have diversified their income earning activities by introducing commercial poultry. Since this was a new venture, most small land owners might have started with broiler farming instead of layer farming perhaps because of lower

investment and skill requirement and quick returns from broiler. However, larger landholders might have entered the poultry business sooner than small landholders and more through layer than broiler (see Table 37).

Table 36. *Family labour input to poultry farming by type and size of farm.*

Farm type	Labour type	Size of farm			
		Small	Medium	Large	All farms
Broiler	Total person hours/day in	11.6	13.4	9.2	11.7
	poultry	(0.5)	(1.5)	(0.8)	(0.6)
	% female	24	24	8	22
Layer	Total person hours/day in	10.4	11.1	10.2	10.6
	poultry	(0.4)	(0.7)	(0.9)	(0.4)
	% female	32	15	1	19

Figures in parentheses are standard error of means.

Source: Field survey.

Table 37. *Land holdings of sample farms by type and size of farms.*

Farm type	Land type	Average land holdings by size (acres)			
		Small	Medium	Large	All farms
Broiler	Crop land	1.00	1.42	1.20	1.17
		(0.37)	(0.57)	(0.33)	(0.26)
	Homestead	0.28	0.28	0.85	0.39
		(0.04)	(0.04)	(0.26)	(0.06)
	Poultry	0.07	0.34	0.49	0.23
		(0.01)	(0.11)	(0.14)	(0.05)
	Total land	1.35	2.04	2.54	1.79
Layer	Crop land	4.50	5.49	8.06	5.59
		(1.98)	(2.24)	(3.99)	(1.43)
	Homestead	2.21	3.01	4.22	2.91
		(1.73)	(2.21)	(3.65)	(1.32)
	Poultry	1.81	2.83	4.10	2.65
		(1.74)	(2.22)	(3.65)	1.32
	Total land	8.52	11.33	16.38	11.15

Figures in parentheses are standard error of means.
Source: Field survey.

Both broiler and layer farms derived around 40% of their income from livestock, principally poultry, and livestock share of total income was generally higher for smaller farms (Table 38).

5.2 Some characteristics of poultry enterprises

Twenty-six percent of the layer farms had registered trade licenses from the local government authorities whereas only 5% of the broiler farms had licenses. About 67% of the large layer farms were registered. Apparently there was no legal requirement to obtain trade licenses or for registration for business enterprises established in rural areas. However, licenses were required to obtain credit from banks and other formal financial institutions. Some commercial farms may also like to use company or brand name to differentiate products and registration may help them do so as well as legally protect their trade marks.

Table 38. *Sources of family income by type and size of farm.*

Farm type	Sources of income	Proportion of total income by size of farm			
		Small	Medium	Large	All farms
Broiler	Crops	21	20	27	22
		(5)	(7)	(8)	(3)
	Livestock	43	35	30	38
		(6)	(8)	(7)	(4)
	Fisheries	4	2	6	4
		(3)	(1)	(2)	(1)
	Other business	22	33	21	23
		(5)	(8)	(7)	(4)
	Salaries/wages	11	9	17	11
		(4)	(4)	(8)	(3)
	Total	100	100	100	100
Layer	Crops	27	21	15	22
		(5)	(4)	(6)	(3)
	Livestock	28	57	48	42
		(3)	(6)	(9)	(3)
	Fisheries	6	3	2	4
		(4)	(2)	(2)	(2)
	Other business	16	9	28	16
		(5)	(3)	(6)	(3)
	Salaries/wages	23	10	6	15
		(6)	(4)	(3)	(3)
	Total	100	100	100	100

Figures in parentheses are standard errors.
Source: Field survey.

Forty percent of broiler farms were 1 to 3 years old, another 40% were 4–6 years old and 20% were 7–11 years old. In case of layer farming, 14% were 1–3 years old, 42% were 4–6 years old and 44% were 7–11 years old. Generally larger farms in both categories were older. The fact that a higher proportion of layer farms were over seven years old than broiler farms indicate that consumers perhaps accepted exotic poultry eggs earlier than they did exotic poultry meat. There may be several reasons for this pattern of change.

First, supply shortage in urban areas was more pronounced for local eggs than for local poultry meat, prompting consumers to change from local to exotic eggs sooner than they changed from local to exotic poultry meat.

Second, over time local eggs available in the market became smaller in size due to nutritional deficiency in village chicken but price remained relatively high due to consumer preference. This might have prompted some consumers to change to exotic eggs for better value of money in terms of quantity and food value even if the taste was less preferable.

Third, spoilage of local eggs remained high as these were generally collected over a number of days, then transported to cities. On the other hand, exotic eggs were generally available fresh generally on daily basis, so there was little risk of loss due to spoilage. This also means better value for money. It is likely that producers responded to these differing consumer behaviour by investing in layer farms sooner than in broiler farms.

On average a layer farm initially required 3.4 times more investment than a broiler farm (Table 39). Also a large broiler farm invested on average 3 times more money than an average small broiler

farm but a large layer farm invested on average 20 times more money than an average small layer farm. Another dimension of the comparison is that small broiler and layer farms invested about the same amount of money/farm but medium and large layer farms invested several times more money than average investment of medium and large broiler farms. Comparison of investment/100 birds show that initially a large broiler farm invested 1.45 times more money compared to a small broiler farm but a large layer farm invested 20 times more money compared to a small layer farm.

Table 39. *Capital investment by type and size of farm.*

Farm type	Statistics	Initial capital investment (BDT)*			
		Small	Medium	Large	All farms
Broiler	Value/farm	71,359 (8,182)	81,882 (12,231)	217,273 (68,256)	103,795 (17,279)
	Ratio	1.0	1.15	3.01	1.45
	Value/100 birds	11,694 (1,074)	9,267 (1,141)	25,060 (9,673)	13,822 (2,244)
Layer	Value/farm	64,425 (11,963)	156,125 (43,460)	1,312,692 (376,584)	347,937 (94,579)
	Ratio	1.0	2.42	20.37	5.40
	Value/100 birds	23,656 (3544)	28,740 (4295)	283,056 (170,821)	75,584 (34,534)

* In 2004, US$ 1 = BDT 59.513.
Figures in parentheses are standard error of means. Source: Field survey.

5.3 Egg production characteristics of layers

Small and medium layer farms managed a single batch of layer stock while the large farms simultaneously maintained two batches throughout the year. Average performance of small, medium and large farms with respect to age at first laying, weight at first laying, length of laying period, egg production/hen per period, and culling age are summarised in Table 40.

Performance with respect to each criteria differed between sizes of farms and between the two areas. The mean age at first laying was significantly lower in Gazipur (135 days) than in Kishoreganj (158 days), and it was lower for large (134 days) compared with small and medium farms (143 days). In Kishoreganj, mean age at first laying decreased as farm size increased while in Gazipur, mean age was the highest for medium farms. The mean weight at first laying was higher in Gazipur (1.42 kg) than in Kishoreganj (1.19 kg). The mean weight at laying was lower and more variable among small farms compared to medium and large farms. The mean length of laying period was much longer in Gazipur (422 days) than that in Kishoreganj (386 days). The length is highest and variability is also higher for large farms in both districts.

Egg production/hen per laying period was higher in Gazipur (348 days) than that in Kishoreganj (311 days). However, variability across farm size was fairly small in Gazipur but very large in Kishoreganj, where the large farms produced nearly 60 eggs more than small and medium farms although large farms in Kishoreganj had a shorter laying period. The mean culling age of birds was slightly higher in Gazipur (18.5 months) than that in Kishoreganj (18 months). It was highest for small farms in Gazipur and large farms in Kishoreganj.

Table 40. *Average egg production characteristics of layers by location and farm size.*

Characteristics and districts	Small	Medium	Large	All farms
Age at first laying				
Gazipur	132	143	135	135
	(40)	(9)	(9)	(31)
Kishoreganj	162	138	130	158
	(20)	(26)	(5)	(22)
All areas	144	142	134	142
	(37)	(12)	(8)	(31)
Weight at first laying (kg)				
Gazipur	1.26	1.69	1.55	1.42
	(0.42)	(0.15)	(0.17)	(0.39)
Kishoreganj	1.11	1.58	1.60	1.19
	(0.37)	(0.23)	(0.14)	(0.39)
All areas	1.20	1.67	1.56	1.35
	(0.41)	(0.16)	(0.16)	(0.40)
Length of laying period (days)				
Gazipur	421	408	455	422
	(43)	(58)	(124)	(71)
Kishoreganj	371	370	460	386
	(23)	(17)	(141)	(58)
All areas	409	403	456	415
	(44)	(56)	(120)	(70)
Egg production/hen per laying period (number)				
Gazipur	345	347	355	348
	(49)	(62)	(74)	(58)
Kishoreganj	301	303	360	311
	(45)	(22)	(85)	(49)
All areas	334	341	355	341
	(51)	(60)	(72)	(58)
Culling age (months)				
Gazipur	18.83	18.40	17.92	18.48
	(1.39)	(1.50)	(0.98)	(1.39)
Kishoreganj	17.71	17.67	20.00	18.08
	(0.95)	(1.15)	(2.83)	(1.51)
All areas	18.55	18.30	18.26	18.41
	(1.37)	(1.46)	(1.47)	(1.41)

Figures in parentheses are standard deviations.
Source: Field survey.

Overall, larger layer farms showed better technical performance in terms of age at first laying, mean weight at first laying, mean length of laying and mean egg production/hen in both the districts. Interaction of number of factors—technology package, especially breed, feed ration, vaccination and other management practices—might have contributed to differences in performance between sizes of farms or between the two areas but the specific contribution of these factors could not be ascertained. However, it may be mentioned that Gazipur has a much longer history of commercial poultry farming than Kishoreganj, so there could be a lot of sharing and standardisation of knowledge and experience but a good proportion of farms in Kishoreganj were contract growers associated with a large integrator and they used a standard technology package; so they were likely to face much less variation in performance.

5.4 Meat production characteristics of broilers

The small- and medium-scale farmers managed two batches of broiler at a time while the large farmers managed three batches simultaneously. On average, the number of days required to complete a batch slightly increased with the increase of scale of farming (Table 41). For instance, the average age of sale of broiler for the small, medium and large farms were 40, 41 and 42 days, respectively. It means that large farmers sold more grown up broiler. The mean weight of broiler at sale were 1.52, 1.56 and 1.61 kg for the small, medium and large farms, respectively. The farmers of Gazipur sold broilers one week younger than the farmers of Kishoreganj.

Table 41. *Average meat production characteristics of broilers by location and farm size.*

Characteristics and districts	Small	Medium	Large	All farms
Age at sale (days)				
Gazipur	36.2	34.2	37.8	36.1
	(2.9)	(2.4)	(4.1)	(3.1)
Kishoreganj	41.9	42.3	43.0	42.3
	(3.4)	(2.6)	(2.7)	(2.9)
All areas	39.7	40.9	41.7	40.5
	(4.3)	(4.1)	(3.7)	(4.1)
Weight at sale (kg)				
Gazipur	1.46	1.48	1.73	1.51
	(0.15)	(0.03)	((0.32)	(0.19)
Kishoreganj	1.56	1.58	1.58	1.57
	(0.14)	(0.09)	(0.13)	(0.12)
All areas	1.52	1.56	1.61	1.55
	(0.15)	(0.09)	(0.19)	(0.15)
Feed conversion ratio				
Gazipur	2.33	2.21	2.24	2.29
	(0.24)	(0.12)	(0.38)	(0.24)
Kishoreganj	2.39	2.38	2.40	2.39
	(0.20)	(0.16)	(0.17)	(0.18)
All areas	2.37	2.35	2.36	2.36
	(0.21)	(0.17)	(0.23)	(0.20)
Survival rate of birds (%)				
Gazipur	89	88	94	90
	(8)	(4)	(1)	(7)
Kishoreganj	97	96	95	96
	(2)	(2)	(4)	(2)
All areas	94	95	95	94
	(6)	(4)	(3)	(5)

Figures in parentheses are standard deviations.
Source: Field survey.

The weight at sale of broiler in Gazipur was 1.51 kg while it was 1.55 kg in Kishoreganj. In Kishoreganj, mean weight at sale was about the same for all sizes of farms but in Gazipur, large farms sold at a much higher weight than small and medium farms.

The mean feed conversion ratio was higher in Kishoreganj than in Gazipur. In Kishoreganj, the ratios were about the same across sizes of farms but in Gazipur, small farms had the best conversion ratio. The mean survival rate of birds was 96% in Kishoreganj and 90% in Gazipur.

The reason could be that most of the broiler farms in Kishoreganj were contract growers and were more integrated with the principal integrator (Aftab Bahumukhi Poultry Farm Ltd.) from which they received input services and technical assistance. In Kishoreganj, variability across farm size was small compared to that in Gazipur, where survival rate was higher on large farms, perhaps because of better management practices.

Overall, larger broiler farms showed better technical performance in terms of the key indicators like weight at sale and feed conversion ratio.

5.5 Access and prices of inputs and services

5.5.1 Day old chicks (DOCs)

For both layer and broiler farms, small farms bought DOCs from a variety of suppliers while medium and large farms bought from fewer suppliers. However, a specific small farm might have bought from one or two suppliers. For broiler farms, the situation was similar to the layer farms in Gazipur but in Kishoreganj, one hatchery supplied almost all the producers as these are contract growers of a large integrated farm (Table 42).

The sample farmers reported supply shortage of DOC in the market. To ensure timely delivery of DOCs, suppliers required advance contract and deposit of a portion of the contract value. The proportion of farms that paid advance deposits under contractual arrangements for DOCs of layer birds increased with farm size (Table 43). On the other hand, higher proportion of smaller broiler farms paid advance deposits.

The proportion of full amount paid as advance varied between district, size and type of farm (Table 44). Both types of farms in Gazipur paid a higher proportion as advance than in Kishoreganj where contract growers received supplies from the parent company.

After payment of advance, broiler and layer farms in Gazipur had to wait for an average of three and eight weeks for delivery of DOCs (Table 45). Large farms waited for longer periods. In Kishoreganj, broiler farms received supplies more or less immediately after payment of advance while layer farms had to wait for an average of 2 weeks. In general, larger farms had to wait for a longer period in both districts perhaps because of the larger number of chicks required to be supplied.

In Kishoreganj, medium and large layer farms purchased DOCs from suppliers located at longer distances compared to small farms (Table 46). Layer farms in Gazipur received supplies from fairly similar distances. Broiler farms in Gazipur received supplies from a longer distance than those in Kishoreganj and large broiler farms of Gazipur received supplies from a longer distance than small and medium farms.

Seventy-eight percent of broiler farms in Gazipur and 98% in Kishoreganj paid transport cost for delivery of DOCs or used own transport. In Gazipur, 71% of small, 83% of medium and 100% of large farms paid for transport or arranged own transportation. In Kishoreganj, differences between farm sizes were not very pronounced. Ninety-one percent of layer farms in Gazipur and 96% in Kishoreganj paid for delivery or arranged own transportation. In the remaining cases, suppliers delivered at own cost. Differences between sizes of farms were not pronounced.

Table 42. *Sources of DOCs for layer and broiler farms by size and location.*

Sources	% farms							
	Small		Medium		Large		All farms	
	Layer	Broiler	Layer	Broiler	Layer	Broiler	Layer	Broiler
Gazipur								
Breeder farm	5	–	5	–	–	20	4	3
Kazi hatchery	–	50	–	50	18	60	4	55
Chandana	10	10	21	–	–	–	12	6
Goalanda	17	–	11	–	9	–	12	–
Phoenix	38	5	37	–	55	20	40	6
BRAC	5	–	11	17	–	–	6	3
Usha hatchery	5	–	5	–	–	–	4	–
Pafuca hatchery	–	–	5	–	–		2	–
Dhaka hatchery	10	–	–	–	18	–	8	–
Paragon	–	10	–	–	–	–	–	6
United hatchery	–	–	–	33	–	–	–	6
Others	20	25	5	–	–	–	8	15
Total	100	100	100	100	100	100	100	100
Kishoreganj								
Breeder farm	19	–	–	–	–	–	8	–
Kazi hatchery	–	–	–	4	–	–	–	1
Goalanda	–	–	–	–	50	–	8	–
Phoenix	–	–	25	–	–	–	8	–
BRAC	17	–	–	–	–	–	8	–
Dhaka hatchery	–	–	–	–	50	–	8	–
Gazipur	–	–	25	–	–	–	8	–
Paragon	17	–	50	–	–	–	28	–
Kishorgong	17	–	–	–	–	–	8	–
Government farm	17	–	–	–	–	–	8	–
Baragram	17	–	–	–	–	–	8	–
Shovan hatchery	–	3	–	–	–	–	–	98
Aftab Ltd	–	97	–	96	–	100	–	1
Total	100	100	100	100	100	100	100	100

Source: Field survey.

Table 43. *Proportion of farms paid advance for supply of DOCs by type and size of farm.*

District	Type of farm	% farms paid advance			
		Small	Medium	Large	All farms
Gazipur	Broiler	57	67	40	56
	Layer	88	90	100	91
Kishoreganj	Broiler	29	14	–	18
	Layer	17	75	100	50
All areas	Broiler	40	24	9	29
	Layer	73	88	100	84

Chi squares significant at 1% level for Kishoreganj but not significant at 5% level for Gazipur.

Source: Field survey.

Table 44. *Proportion of the full amount paid as advance by location, size and type of farm.*

District	Farm type	% of full amount paid as advance			
		Small	Medium	Large	All farms
Gazipur	Broiler	31	19	20	27
		(36)	(12)	(20)	(31)
	Layer	31	44	47	39
		(21)	(16)	(27)	(22)
Kishoreganj	Broiler	11	9	0	8
		(26)	(27)		(23)
	Layer	2	15	35	15
		(4)	(10)	(6)	(15)
All areas		24	31	32	28
		(27)	(24)	(29)	(26)

Source: Field survey.

Table 45. *Waiting time for delivery of DOCs after advance payment by location and farm sizes.*

District	Farm type	Waiting time for delivery (weeks)			
		Small	Medium	Large	All farms
Gazipur	Broiler	2	3	4	3
		(3)	(3)	(4)	(3)
	Layer	7	7	12	8
		(5)	(4)	(13)	(7)
Kishoreganj	Broiler	0	0	0	0
	Layer	1	2	5	2
		(1)	(1)	(3)	(2)
All areas		4	5	8	5
		(5)	(4)	(11)	(7)

Source: Field survey.

5.5.2 Feeds

The quantity of feed purchased/broiler farm was directly related with size of farm (Table 47). Twenty-five percent of broiler farms in Gazipur, most of them large, and 93% in Kishoreganj had contractual arrangement with feed suppliers for periodic supply of feeds. Only one layer farm in each district had such arrangement. Unit price of mixed feed paid by broiler farms was slightly lower in Kishoreganj than in Gazipur but differences between districts and sizes of farms were not statistically significant.

Layer farms purchased different types of feed ingredients and often mixed themselves at the farm. The prices of ingredients were generally slightly higher in Kishoreganj than in Gazipur but they did not differ significantly between sizes of farms (Table 48). There is no clear pattern in these variations as smaller farms paid more for some ingredients while in other cases they paid less. What ultimately matters is the unit price for all the ingredients combined, but this could not be measured as there was no standard way of converting the ingredients into a single unit. Moreover, quality control in the feed industry is very poor (Khan 2002), so it is not clear if supplies of the same product sold in the market at the same price portray same quality. Feed cost/unit of output will be shown later.

Table 46. *Distance of DOCs suppliers from layer and broiler farms by district.*

Farm types and districts	Mean distance of suppliers by size of farm (km)			
	Small	Medium	Large	All farms
Layer farm				
Gazipur	17	11	19	16
	(16)	(10)	(28)	(18)
Kishoreganj	22	143	100	69
	(39)	(6)	(0)	(63)
All areas	18	28	31	24
	(22)	(46)	(39)	(35)
Broiler farm				
Gazipur	8	5	16	9
	(7)	(4)	(18)	(9)
Kishoreganj	4	3	3	3
	(7)	(1)	(1)	(4)
All areas	6	3	6	5
	(7)	(2)	(10)	(7)

Figures in parentheses are standard deviations.
Source: Field survey.

Table 47. *Quantity of mixed feed purchased (kg) and price/kg paid by sample broiler farms in one year.*

Items and districts	Small	Medium	Large	All farms
Quantity purchased/farm (kg)				
Gazipur	3,263	6,803	17,113	6,182
	(1,499)	(3,155)	(6,433)	(5,854)
Kishoreganj	6,890	10,893	16,724	10,504
	(2,440)	(2,670)	(7,454)	(5,601)
All areas	5,547	10,172	16,808	9,297
	(2,764)	(3,138)	(7,105)	(5,972)
Price/kg				
Gazipur	13.98	13.58	13.43	13.82
	(0.52)	(0.38)	(0.49)	(0.53)
Kishoreganj	13.56	13.52	13.56	13.55
	(0.20)	(0.23)	(0.20)	(0.21)
All areas	13.72	13.53	13.53	13.62
	(0.40)	(0.25)	(0.28)	(0.35)

Figures in parentheses are standard deviations.
Source: Field survey.

5.5.3 Veterinary inputs

Vaccination, internal parasite control and post mortem are the most common veterinary services used by the broiler and layer farms. Sixty percent of the broiler farms received vaccination services from the local drug stores and 36% from breeder farms (Note that it is unclear whether these drug stores had qualified and trained vaccinators or whether they have developed this skill by learning and by doing in response to a local demand for quick services as veterinary clinics may be found far away from the farm) (Table 49). Larger proportion of small farms received this service from drug stores but a larger proportion of medium and large farms received service from breeder farms. On the other hand, drug stores (63%) and DLS (27%) were the principal sources of vaccination service

for layer farms. Dependence on breeder farm was higher for large farms but dependence on DLS was larger for small farms.

Table 48. *Unit prices of feed ingredients paid by the sample layer farms by size and location.*

Feed ingredient	Price/kg in Gazipur (BDT*)				Price/kg in Kishoreganj (BDT)			
	Small	Medium	Large	All	Small	Medium	Large	All
Broken rice	7	na	na	7	8	na	na	8
Broken maize	8.03	8.15	8.06	8.09	12.59	7.29	9.30	10.51
Polish rice	7.08	7.21	7.27	7.16	7.40	7.77	8.70	7.53
Salt	11	11	11	11	10	9	10	10
Vitamin/minerals	155	151	156	154	160	170	145	162
Protein concentrate	36	36	36	36	36	35	36	36
Oyster shell	14	4	4	8	5	4	5	4
Soybean	14	14	14	14	16	14	15	15
Dot	255	273	271	265	240	285	na	263
Lysine	179	154	158	165	191	221	205	202
Mithiline	177	192	187	185	238	196	230	223
DCP	33	61	42	46	26	91	24	47

* In 2004, US$ 1 = BDT 59.513.
Source: Field survey.

When analysed by location, drug store was the main source of vaccination service in Gazipur with DLS as a distant second source (Table 49). Proportion of farms depending on drug store for this service in Gazipur decreased slightly as farm size increased but no clear pattern appeared among DLS service users. In Kishoreganj, drug store, breeder farm and DLS were the important suppliers of this service. A higher proportion of large and medium farms used drug store and a higher proportion of small and large farms used breeder farm for this service.

Farmers considered easy accessibility as the main reason for selecting a supplier of veterinary, especially vaccination services. The proportion of farms which gave weight on this criterion was the highest for large farms followed by medium and small farms in both Gazipur and Kishoreganj (Table 50). Good service or quality was the next important reason for choosing a supplier for veterinary services. However, in Kishoreganj, easy accessibility and contract was the main reason for choosing a supplier. Around 30, 56 and 45% of small, medium and large farms reported that they had received vaccination service as part of the contract with the principal farm.

Ninety-three percent of broiler farms and 84% of layer farms were satisfied with the quality of veterinary services of their chosen suppliers. In case of broiler farms, the proportion of farms satisfied with the services of their chosen suppliers increased with farm size. Only 11% of small and 6% of large broiler farms expressed their dissatisfaction with veterinary services received. In case of layer farms, most of the small farms (93%) were satisfied with the vaccination services of their selected suppliers followed by the large farms (83%).

5.5.4 Credit

Only 21% each of broiler and layer farms borrowed for the poultry business (Table 51). Proportion of borrowers was highest among medium farms in both categories. Among the borrowing broiler farms, large farms borrowed only from agricultural bank, medium farms borrowed mainly from commercial banks and NGOs while small farms borrowed from diverse sources including private money lenders. Among the borrowing layer farms, large farms borrowed mainly from NGOs,

medium farms from friends and relatives and commercial banks, and small farms from a variety of sources.

Table 49. *Supplier of vaccination services by type and size of farm.*

Farm type/location	Supplier	% of farms used			
		Small	Medium	Large	All farms
Farm type					
Broiler	DLS	5	–	4	4
	Breeder farm	29	44	39	36
	Local drug store	66	53	57	60
	Aftab Ltd	–	3	–	1
	Total	100	100	100	100
Layer	DLS	34	23	22	29
	DLS laboratory	–	2	8	2
	Breeder farm	4	10	–	5
	Local drug store	62	64	70	64
	Total	100	100	100	100
Location					
Gazipur	DLS	19	15	23	17
	DLS laboratory	–	2	4	1
	Breeder farm	2	9	–	4
	Drug store	79	74	69	75
	Others		–	4	2
	Total	100	100	100	100
Kishoreganj	DLS	16	11	–	11
	DLS laboratory	–	–	5	1
	Breeder farm	24	44	41	33
	Drug store	60	42	54	54
	Aftab Ltd.	–	3	–	1
	Total	100	100	100	100

Note: Aftab Ltd is an integrated enterprise which supplied inputs and services, especially to its contract growers in Kishoreganj. It is possible that respondents actually referred to this farm when they mentioned 'breeder farm' as the source of vaccination service.

Chi-squares (χ^2) are significant for both Gazipur and Kishoreganj at 1% level of significance but not significant for broiler and layer farms at 5% level.

Source: Field survey.

Table 50. *Reason for choosing a supplier for veterinary service by location and farm size.*

Districts	Reason for choice	Percent of farms			
		Small	Medium	Large	All farms
Gazipur	Easy accessibility	40	78	85	57
	Good service/quality	17	22	15	18
	Cheap	6	–	–	3
	Unspecific	37	–	–	22
	All	100	100	100	100
Kishoreganj	Easy accessibility	28	39	45	33
	Good service/quality	9	6	9	8
	Have contract	30	56	45	39
	Unspecific	33			19
	All	100	100	100	100

Chi-squares (χ^2) are significant for both Gazipur and Kishoreganj at 1% level of significance.

Source: Field survey.

Table 51. *Proportion of farms borrowed and distribution of borrower farms by size and source of credit.*

	Small	Medium	Large	All farms
Broiler farms				
Proportion of farms borrowed	18	38	9	21
Distribution of borrowers by source				
Traders	10	–	–	4
Money lenders	–	8	–	4
Commercial banks	30	54	–	40
Agricultural Bank	10	8	100	16
NGOs	20	30	–	24
Farmers and Agricultural Bank	10	–	–	4
Money lenders, Agricultural Bank and NGOs	10	–	–	4
Commercial Bank, NGOs, money lender	10	–	–	4
Total	100	100	100	100
Layer farms				
Proportion of farms borrowed	18	38	9	21
Distribution of borrowers by source				
Friends and relatives	25	50	–	24
Traders	17	–	–	5
Money lenders	–	7	–	3
Commercial banks	33	22	–	24
Islami Bank	–	–	7	3
Agricultural Bank	–	7	14	29
NGOs	8	–	79	2
DLS	8	–	–	2
Friends, Agricultural Bank, NGOs and DLS	9	–	–	2
Friends, relatives, money lender	–	14	–	6
Total	100	100	100	100

Chi-square (χ^2) is significant at 1% level for both broiler and layer farms.
Source: Field survey.

Provision of credit for commercial poultry is not yet a very regular and well established practice among all the financial institutions—banks and NGOs—in the country. However, such credit is provided both under regular portfolio and under some development projects and there may be specific screening criteria for each type. Details of these as well as whether and how they might have affected farmers' decision to borrow or not, and the choice of a particular source for borrowing could not be ascertained in the survey.

At the time of the survey, average outstanding loan/borrower was about seven times higher for the layer farms compared to the broiler farms (Table 52). This was consistent with the level of investment by farm type as mentioned earlier. The size of outstanding loan varied according to farm type, size and source of credit.

5.6 Output marketing and prices

In Gazipur, all the sample broiler farms sold their birds to traders who usually come to farm gate and seek to purchase. If birds are ready for sale, then price is fixed by bargaining. On the other hand, 91% of the sample broiler farmers of Kishoreganj sold their birds to the principal farm with which they had contractual arrangement. Only a few small and medium broiler producers in Kishoreganj sold to private traders.

Table 52. *Outstanding loan of poultry farms (BDT*/borrower).*

Farm type and source of loan	Amount outstanding (BDT/borrower)			
	Small	Medium	Large	All farms
Broiler farms				
Money lenders, traders		15,000		15,000
Commercial banks	173,333	54,000		98,750
Agricultural Bank	20,000	19,000	200,000	79,667
NGOs	4,000	85,000		58,000
Commercial Bank, NGOs, money lenders	38,000			38,000
All sources	72,778	49,923	200,000	71,000
Layer farms				
Friends and relatives	95,000	106,250		102,500
Traders	30,000	.		30,000
Commercial banks	22,933	99,500		53,560
Agricultural Bank			1,459,000	1,459,000
NGOs	20,000			20,000
Friends, money lenders		10,000		10,000
Islami Bank			800,000	800,000
Friends, relatives, money lenders		10,000		10,000
All sources	50,600	80,143	1,334,857	499,215

* In 2004, US$ 1 = BDT 59.513.

Source: Field survey.

In both Gazipur and Kishoreganj, around 90% of the sample layer farms of all sizes sold eggs at farm gate. In Kishoreganj, 86% of medium farms and 75% of large farms sold at farm gate. In both areas, a small proportion of small and medium farms sold eggs at market place.

In Gazipur, all the small and large broiler farms and 67% of small farms sold for immediate cash while 33% of medium farms sold on weekly credit. On the other hand, weekly credit sale was the term of payment of 88, 89 and 100% of small, medium and large broiler farms in Kishoreganj. As contract grower farms they had assurance of purchase by the principal buyer and they received payments weekly after deduction of all costs for input services supplied by the contractor. Others sold for cash to traders.

In case of eggs, 86% of sellers in Gazipur sold for cash, 10% on weekly credit and 4% used a combination of cash and credit. In Kishoreganj, 96% sold on cash and 4% on weekly credit.

In Gazipur, the sample broiler farmers did not use any transport for marketing of their birds. The buyers purchased broilers at their farm gates and they arranged transportation to carry them from farms to markets. In Kishoreganj, the majority of farmers transported broiler to the buyers' place. Only 9% small and 14% medium farms sold at farm gate to traders.

In Gazipur, buyers were responsible for transportation of eggs from 85% of all farms: from 81, 93 and 81% of small, medium and large farms respectively. In Kishoreganj, buyers were responsible for transporting eggs from 61% of all farms: 67, 43 and 75% of small, medium and large farms respectively. The remaining farms transported their own eggs to the buyer or the market.

In Gazipur, broiler was sold at farm gate and it was transported from 56% farms by pick up and from 41% farms by rickshaw van. For larger farms, pick up was the commonly used means of transport. And van was the common form for 52% of small farms. On the other hand in Kishoreganj the mean distance of broiler transportation was 2.5 km. Pick up was used in 53% of farms and rickshaw van was used in 45% of farms.

In Gazipur, traders travelled an average distance of 32 km to buy eggs from farms; the highest distance travelled was for large farms (Table 53). In Kishoreganj, the distance of medium farms was the highest followed by large farms. Pick up was used in 38% farms of Gazipur and 35% farms of Kishoreganj (Table 54). Another important mode of transport used for carrying eggs was van in both areas.

Table 53. *Farm to market distance (average) travelled by traders to buy eggs by location and size of farm.*

District	Distance transported by buyers (km)			
	Small	Medium	Large	All farms
Gazipur	31	24	46	32
	(25)	(22)	(23)	(24)
Kishoreganj	2	101	55	41
	(1)	(49)	(52)	(55)
All areas	24	36	48	33
	(25)	(39)	(28)	(32)

Figures in parentheses are standard deviations.
Source: Field survey.

Table 54. *Means of transportation for eggs by farm size and location.*

District	Means of transportation	Percent of farms used			
		Small	Medium	Large	All farms
Gazipur	Van	52	28	5	33
	Pick up	33	38	53	38
	Truck	2	33	43	22
	Others	12	3	–	6
	All farms	100	100	100	100
Kishoreganj	Van	83	29	–	52
	Pick up	–	57	100	35
	Others	17	14	–	13
	All farms	100	100	100	100

Source: Field survey.

Thus there were quite few differences between the two districts in terms of marketing practices of broilers and eggs in terms of sale point, delivery mechanism, transportation use, mode of payment, distance from where traders came to purchase and reason for sale. The reasons for these differences are unclear though it may be guessed that they might have developed over time due to different production location (Gazipur is nearer to Dhaka), presence of contract growing in Kishoreganj, producer–trader relationships and networks that required regular business and establishment of trust.

5.7 Production and disposal of wastes

Average annual production of poultry excreta was 9, 37 and 43 t for small, medium and large broiler farms and 16, 27 and 107 t for layer farms in Gazipur. The overall average was 20 t for broiler and 39 t for layer farms. In Kishoreganj, broiler farms produced 12, 19 and 27 t for small medium and large farms, respectively, and layer farms produced 3, 29 and 65 t, respectively. The overall average was 18 t for broiler farms and 22 t for layer farms.

Poultry excreta were used in crop fields, fish ponds, for sale and other purposes. Broiler farms sold 51–59% of excreta while layer farms sold only 7–10% (Table 55). One-quarter of excreta of broiler

farms and about 75% of the excreta of layer farms was not disposed in any specific way, rather they were being piled in the backyard of the farms. The piled up excreta was increasingly becoming a problem, as many small and medium farms were built close to the households of the owners. Any effect on water bodies could not be ascertained, especially as Gazipur is a flood-free area and does not have many ponds for supplying surface water for domestic use. The situation in Kishoreganj was different as the area is largely flood prone with many sources of surface water for household use, which could be potentially polluted by improperly disposed excreta. Bad odour was the most common problem reported by farmers. Nearly all farms reported taking some measures, e.g. transfer to fields, ponds or sale at regular intervals, spread slightly to dry up, to minimise bad odour.

Table 55. *Disposal of poultry excreta by farm type and size.*

Uses/disposal pattern	% of total production			
	Small	Medium	Large	All farms
Broiler				
Crop field	21	7	19	16
Fish pond	4	5	6	5
Sold	51	59	52	54
Other uses/no specific use	24	29	23	25
Total	100	100	100	100
Layer				
Crop field	12	8	7	9
Fish pond	11	7	10	9
Sold	7	5	10	8
Other uses/no specific use	70	80	73	74
Total	100	100	100	100

Source: Field survey.

5.8 Volume of production and costs and returns

Average production of broiler/farm was almost double in Kishoreganj than that in Gazipur (Table 56). Average production of egg in Gazipur was 1.7 times higher than that in Kishoreganj.

Table 56. *Production of broiler and eggs by type and size of farm and location.*

Output type and districts	Small	Medium	Large	All farms
Live broiler, kg/broiler farm				
Gazipur	2,712	6,248	12,762	4,482
Kishoreganj	6,024	9,662	14,536	9,214
All areas	4,794	9,060	14,286	7,952
Eggs, number/layer farm				
Gazipur	116,212	266,464	1,078,471	375,382
Kishoreganj	54,418	255,813	653,168	227,362
All areas	103,141	264,807	1,010,422	348,690

Source: Field survey.

Broilers are sold at the farm on per head basis rather than on the basis of live weight. Although information on the average weight at sale were collected, application of that information for estimating costs and return/kg live weight was likely to be inaccurate because the weights were reported averages rather than actually measured weights for the period of data collection. Therefore, cost and return was estimated/100 broilers. Net return/100 broilers increased with farm size due to decreased/unit cost as larger farms were able to reduce variable costs, especially for DOCs

and feeds. Total cost was lowest for large farms though fixed costs were higher than for small and medium farms (Table 57). However, average benefit/cost ratios were about the same for different sizes of farms, the exact reason for which could not be ascertained. A plausible reason may be that standard technology packages were normally used though as shown earlier, technical performance varied across sizes of farms and between the two districts.

In case of layer farms, eggs are not weighed; so cost and return was calculated/100 eggs. Net return/100 eggs was the highest for medium farms but overall the differences between the size groups were not significant (Table 58). Cost structure did not differ much between sizes of farms. Average benefit/cost ratio was highest for medium farms followed by large and small farms.

Table 57. *Costs and returns/100 broilers by farm size.*

Costs and returns	Costs and returns (BDT*/100 birds)			
	Small	Medium	Large	All farms
Variable costs	4,985	4,963	4,776	4,937
	(81)	(92)	(187)	(60)
Casual labour	0	0	9	2
	(0)	0	(7)	(1)
DOCs	1,575	1,605	1,479	1,565
	(63)	(35)	(64)	(35)
Transport cost of DOCs	18	14	12	16
	(2)	(2)	(2)	(1)
Feeds	3,073	3,057	2,907	3,047
	(51)	(65)	(114)	(39)
Veterinary inputs and services	251	215	243	238
	(22)	(19)	(27)	(13)
Transport cost for broiler sale	18	23	17	19
	(3)	(4)	(3)	(2)
Others (electricity, interest on operating capital)	51	49	51	50
	(2)	(1)	(2)	(1)
Fixed costs	519	466	575	532
	(23)	(17)	(36)	(15)
Fixed labour	348	328	372	365
	(30)	(33)	(52)	(22)
Depreciation on house/building	125	102	144	121
	(9)	(8)	(19)	(6)
Depreciation on equipment	46	36	59	45
	(3)	(3)	(7)	(2)
Total cost	5,504	5,429	5,351	5,469
	(89)	(100)	(196)	(65)
Total gross return	5,838	5,801	5,781	5,815
	(55)	(77)	(45)	(37)
Net return	334	371	431	346
	(96)	(129)	(227)	(75)
Benefit–cost ratio	1.06	1.07	1.08	1.06

* In 2004, US$ 1 = BDT 59.513.
Source: Field survey.

Table 58. *Costs and returns/100 eggs for layer farms by farm size.*

	Costs and returns (BDT*/100 eggs)			
Costs and returns	Small	Medium	Large	All farms
Variable costs	97.89 (4.12)	88.12 (3.74)	99.33 (5.96)	94.55 (2.57)
Casual labour	0.03 (0)	0.17 (0)	0.15 (0)	0.11 (0)
DOCs	10.29 (0)	10.45 (0.10)	9.75 (0.48)	10.24 (0.17)
Transport cost for DOCs	0.13 (0)	0.10 (0)	0.08 (0)	0.11 (0)
Feeds	74.69 (0)	62.63 (0)	75.81 (0)	70.44 (0)
Veterinary inputs and services	4.29 (0)	4.95 (0)	3.95 (0.51)	4.46 (0.32)
Transport cost for egg sale	0.01 (0)	0.03 (0)	0.01 (0)	0.02 (0)
Others (electricity, interest on operating capital)	8.45 (0)	9.78 (0.45)	9.58 (0.72)	9.17 (0.31)
Fixed costs	35.45 (2.45)	21.65 (2.25)	23.12 (0)	27.84 (1.52)
Fixed labour	25.03 (0)	12.93 (0)	14.20 (0)	18.36 (1.24
Depreciation on equipment	6.09 (0)	5.44 (0.45)	5.12 (0)	5.65 (0.29)
Depreciation on house/building	4.32 (0)	3.28 (5.61)	3.80 (7.29)	3.83 (0)
Total costs	133.34 (8.52)	109.77 (12.72)	122.46 (14.74)	122.39 (7.51)
Total gross return	292.65 (39.50)	287.86 (20.50)	293.33 (28.30)	291.03 (18.0)
Net return	164.40 (21.20)	178.31 (28.20)	175.35 (19.30)	171.77 (21.51)
Benefit–cost ratio	2.19	2.62	2.40	2.38

* In 2004, US$ 1 = BDT 59.513.
Source: Field survey.

6 Econometric analysis of sample poultry farms

6.1 Specification of the empirical model

As in the case of dairy farms, a normalised stochastic frontier profit function model was specified with inefficiency variables as follows:

$$\ln\pi_i = \ln a + \Sigma\beta_i \ln W_{ij} + \Sigma S_{ij} + v_i - u_i \qquad (6)$$

and

$$u_i = \delta_0 + \Sigma\delta_k Z_{ik} \qquad (7)$$

where π_i, W_{ij} and S_{ij} are defined earlier in (1); Z_{ik} is firm-specific socio-economic variables affecting efficiency; the subscripts i, j, and k refer to jth farmer, ith and kth parameters or variables. The profit function was estimated separately for broiler and layer sample farms because technologies used by these farms are quiet different. The normalised stochastic frontier profit function for broiler farms was specified using functional form (6) and (7) and the variables included were as follows:

π_i = Normalised profit (gross revenue minus variable costs) of jth broiler farm (BDT)

W_{1j} = Normalised wage rate of jth farm

W_{2j} = Normalised feed price of jth farm

W_{3j} = Normalised price of DOCs of jth farm

W_{4j} = Normalised price of veterinary treatment

S_{j1} = Normalised value of house and equipment

S_{j2} = Annual labour (family and annually hired) used (persondays)

S_{j3} = Dummy for access to credit (Yes = 1, No = 0) as a proxy for liquidity

Z_{j1} = Age of the operator (years)

Z_{j2} = Educational level (years)

Z_{j3} = Number of birds in the entire flock

Z_{j4} = Number of batches produced in a year

Z_{j5} = Mean weight at sale (kg)

Z_{j6} = Mean survival rate of broiler (%)

Z_{j7} = Space used/100 birds (m^2)

Z_{j8} = Total number of visits by suppliers of extension and veterinary services

Z_{i9} = Dummy for contractual arrangement with buyer (Yes = 1, No = 0)

Z_{j10} = Dummy for selling broiler at buyer's home/shop (Yes = 1, No = 0)

Gross margin rather than net profit is used as the dependent variable because wages for fixed family labour and rental rate for fixed capital are not farm specific; rather they are constant for a given area.

In case of layer farms, the specification of variables are similar to that of broiler farms except that variable Z_{i5} and Z_{i6} were dropped as irrelevant and a variable called 'number of contacts made by the farm with suppliers of extension and veterinary services' was added. This last variable indicates a demand for extension and veterinary services when they were needed while visits by suppliers of extension/veterinary services might include both visits based on request/demand and regular visits when no specific problems or needs were solved.

The normalised stochastic frontier function was estimated in a single stage using the Frontier 4.1 software (Coelli 1994).

6.2 Results and discussion

6.2.1 Estimation of frontier profit function

The maximum likelihood parameter estimates (MLE) of the normalised stochastic frontier profit function of broiler and layer farmers are shown in Tables 59 and 60, respectively. In case of broiler farms, the variance ratio parameter, γ, is statistically greater than zero and comparatively large (1.00) given the (0,1) interval within which γ lies. The result implies that differences in actual profit from maximum profit between farms mainly arose from differences in farmer practices rather than random variability. On the other hand, γ is small (0.0724) and insignificant in case of layer farms, which implies that differences in actual profit from maximum profit between farms mainly arose from random variability and less from farmers practices. It was not clear why the sources of variation in profit were so glaringly different between broiler and layer farms.

In case of broiler farming, the results show that among the selected price variables only feed price and price of veterinary inputs significantly reduced profit, either because some farms paid higher than its true price (based on value of marginal productivity) or that the marginal value productivity of these inputs were significantly lower than the respective prices. Among the fixed factors, only value of house and equipment significantly increased profit. The non-significance of wage rate and price of DOCs indicate that the sample farms paid true or competitive prices for these inputs. The non-significance of access to credit may indicate either of two things. First, volume of credit rather than access to credit *per se* might be more important but the credit dummy could not adequately capture the effect of volume of credit. Second, non-borrowers did not have liquidity problems which access to credit was supposed to alleviate or that small liquidity differences did not influence the operation of this type of farms as they spent little on purchased feeds and drugs.

In case of layer farms, price of DOCs was the only price variable that significantly affected profit, in this case negatively indicating that the sample farms did not pay true or competitive price for DOCs. Among the fixed factors, annual fixed labour use and value of house and equipment significantly influenced profit.

Table 59. *Maximum likelihood estimates of parameters of the normalised stochastic frontier profit function and inefficiency model of broiler farms.*

Profit function variables	Coefficient	Inefficiency variables	Coefficient
Constant	13.5100***	Constant	7.6181***
	(0.2545)		(0.9675)
Normalised wage rate (lnX_1)	0.0271	Age of the operator (LnZ_1)	0.0218
	(0.0454)		(0.0282)
Normalised feed price (lnX_2)	–0.1803*	Educational level of operator (lnZ_2)	0.0046*
	(0.1025)		(0.0028)
Normalised price of veterinary treatment (lnX_3)	0.0175**	Number of birds in the entire flock (lnZ_3)	–0.8866***
	(0.0099)		(0.0327)
Normalised price of DOCs (X_6)	–0.0255	Number of batches produced in a year (lnZ_4)	–0.1178**
	(0.0895)		(0.0513)
Annual fixed labour (X_5)	0.0132	Mean weight at sale (lnZ_5)	–0.4177**
	(0.0239)		(0.1073)
Normalised value of house and equipment (X_4)	0.0486**	Mean survival rate of broiler (lnZ_6)	0.3243*
	(0.0191)		(0.2145)
Dummy for access to credit (X_7)	0.0377	Space used/100 birds (lnZ_7)	–0.738***
	(0.0205)		(0.0146)
		Number of visits by suppliers of extension and veterinary services (lnZ_7)	–0.0091***
			(0.0016)
		Dummy for contractual arrangement with buyer (lnZ_8)	0.0318
			0.0361
		Dummy for selling broiler in buyer's home/ shop (lnZ_9)	–0.0236
			0.0262

Variance (σ^2) = 0.0082***(0.0009); $\gamma = (\sigma_u^2/\sigma_v^2)$ = 1.0000***(0.1795).
Log-likelihood function = 107.74; Test statistic λ = 259.24***
***, ** and * show statistical significance at 1, 5 and 10% level, respectively. Figures in parentheses are standard errors of estimates. Log-likelihood ratio test for the null hypothesis that the inefficiency effects are not present, H_0: $\lambda = \delta_0 = \ldots = \delta_9 = 0$. Test statistic $\lambda = -2\ \ln(L(w)/L(q))$, where L(w) and L(q) are the values of the likelihood function under the null and alternate hypothesis H_0 and H_1, respectively. This statistic has a mixed χ^2 distribution (Coelli 1994).
Source: Field survey and authors' estimates.

6.2.2 Determinants of inefficiency

The mean economic efficiency of the broiler farms was 30%, which means that they were making a profit loss of 70% due to inefficiency. The mean economic efficiency of sample layer farms was 82%, which means they were making less profit loss (18%) than the broiler farms due to inefficiency (Table 61).

Only 13% of the broiler farms achieved over 50% efficiency while over 50% of the layer farms achieved 90–96% efficiency. The reason could be that layer birds are reared for a relatively longer period of time (18 months) and farmers get enough time to adjust production practices through trial and error. On the other hand, broiler is reared for 40 to 42 days and within such short time farmers have less flexibility to adjust farm practices efficiently. Also sale weight for broiler is a key factor but layer farms sell eggs without weighing; so egg size within a reasonable limit can vary without affecting price.

Average economic efficiency of both broiler and layer farms increased with farm size. The differences for broiler farms were significant but for layer farms the difference between small and large farms was significant but the difference between medium and large farms was not

pronounced (Figure 3). Most likely, differences in both technical performance (e.g. egg and meat production, feed conversion ratio), use of fixed resources and input and output prices contributed to these differences (see below).

Table 60. *Maximum likelihood estimates of parameters of the normalised stochastic frontier profit function and inefficiency model of layer farms*

Profit function variables	Coefficient	Inefficiency variables	Coefficient
Constant	–0.5748 (4.9616)	Constant	0.0764 (3.3686)
Normalised wage rate ($\ln X_1$)	0.0226 (0.6670)	Age of the operator ($\ln Z_1$)	0.2399 (0.9985)
Normalised feed price ($\ln X_2$)	0.2847 (0.2261)	Educational level of the operator ($\ln Z_2$)	0.1539 (0.1156)
Normalised price of veterinary services ($\ln X_3$)	–0.0402 (0.0486)	Number of birds in the entire flock ($\ln Z_3$)	–0.3354*** (0.1108)
Normalised value of house and equipment (X_4)	0.5028** (0.2935)	Number of batch produced in a year ($\ln Z_4$)	0.46063*** (0.1152)
Annual labour used (X_5)	0.1549** (0.0875)	Space used/100 birds ($\ln Z_5$)	0.1833** (0.0753)
Normalised price of DOCs (X_6)	–0.6975** (0.3520)	Number of visit by suppliers of extension and veterinary services ($\ln Z_6$)	0.0435 (0.2049)
Dummy for access to credit (X_7)	0.0867 (0.1334)	Total no. of visits by the farmer to suppliers of extension and veterinary services ($\ln Z_7$)	–0.0099 (0.0225)
Land holdings (X_8)	–0.0213 (0.0981)	Dummy for contractual arrangement with buyer (Z_8)	–0.1976 (1.2130)
		Dummy for selling eggs at buyer's home/ shop (Z_9)	0.0410 (0.6539)

Variance (σ^2) = 0.1831* (0.1180); $\gamma = (\sigma_u^2/\sigma_v^2)$= 0.0724 (0.6105)
Log-likelihood function = 70.19; Test statistic λ = 26.67**
***, ** and * show statistical significance at 1, 5 and 10% level, respectively.
Figures in parentheses are standard errors of estimates.
Source: Field survey and authors' estimates.

Table 61. *Descriptive statistics for farm specific economic efficiency for broiler and layer farms.*

Descriptive statistics	Broiler farms	Layer farms
Number of farms	110	122
Minimum efficiency (%)	04	28
Maximum efficiency (%)	100	100
Mean efficiency (%)	30	82
Standard deviation	6	4
Variance	34	18
Skewness	148	–114
Kurtosis	254	39

Source: Field survey.

To quantify determinants of efficiency or inefficiency of poultry farms, socio-economic variables as well as indicators of management factors were included in the stochastic frontier profit function. The coefficients of the inefficiency factors are presented in Tables 59 and 60. Also characteristics of broiler and layer farms are presented in Tables 62 and 63.

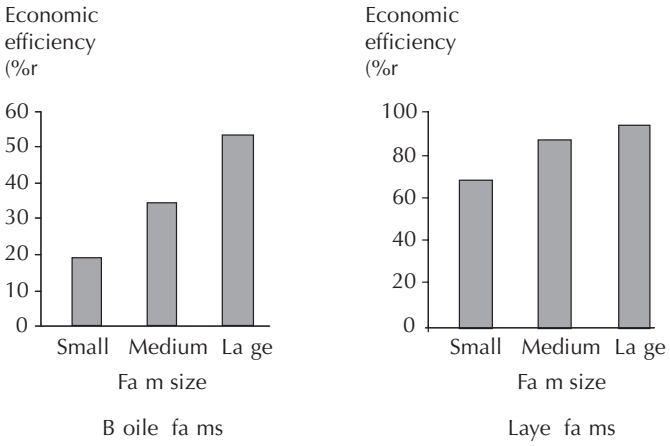


Figure 3. *Economic efficiency of poultry farms by farm size.*

Table 62. *Selected characteristics of sample broiler farms by size of farm.*

Variable/characteristics	Farm size			
	Small	Medium	Large	All farms
Economic efficiency (%)	19	34	53	30
Educational level in years	9	8	12	9
Total land holdings (ha)	0.57	0.99	1.21	0.82
No. of batches/year for broiler	2	2	3	2
No. of birds in the entire flock	1,687	3,150	5,133	2,797
Mean batch size (no. of birds/batch)	742	1,364	2,066	1,187
Mean survival rate of broiler (%)	94	95	95	94
No. of days to complete a batch	40.8	40.9	42.2	40.6
Mean weight at sale (Kg)	1.52	1.56	1.61	1.56
Cost of DOCs (BDT*/100 broilers)	1,575	1,605	1,479	1,565
Transport cost of DOCs (BDT/100 broilers)	18	14	12	16
Total mixed feed cost (BDT/100 broilers)	3,073	3,057	2,907	3,071
Transport cost for feed (BDT/100 broilers)	43	60	39	48
Total veterinary cost (BDT/100 broilers)	251	215	243	238
Total labour cost (BDT/100 broilers)	348	328	381	367
Total cost (BDT/100 broilers)	5,504	5,429	5,351	5,469
Total no. of visits by suppliers of extension and veterinary services	6.2	6.1	9.3	6.7
Total no. of visits to extension and veterinary service suppliers by farmers	6.0	6.5	7.5	6.5

* In 2004, US$ 1 = BDT 59.513.

Source: Field survey.

In case of broiler farms, out of 10 socio-economic variables 7 were found to, statistically, significantly affect farm specific economic efficiency. The results show that there is scale effect on economic efficiency of broiler farms as economic inefficiency reduced with the increase of scale of farming (number of birds in the flock). Other factors significantly reducing inefficiency were number of batches produced in a year, mean weight at sale, space used/bird and number of extension contacts. Larger farms achieved higher efficiency not only due to better cost economy but due to better technical performance of the flock (Table 62). The small- and medium-scale

farmers managed two batches of broiler at a time while the large farmer managed three batches simultaneously. Mean age and mean weight of broiler at sale increased with the increase of scale of farming (ranged from 1.52 kg in small farms to 1.61 kg in large farms). Moreover, the large farms achieved economies of scale for costs of DOCs, feed and labour. Mean survival rate of broiler and education of the farm owner increased inefficiency. The reasons could be that higher survival means lower space/bird, which may hamper growth. In case of education, the type of education referred to here is of a general nature, which may not significantly help technical management of the firm. In general, it appears that technical performance was highly variable across farms, which caused low average efficiency.

Table 63. *Selected characteristics of sample layer farms by size of farm.*

Variable/characteristics	Farm size			
	Small	Medium	Large	All farms
Economic efficiency (%)	70	89	96	82
Age of the respondent	32	3	33	33
Educational level of respondent (years)	10	10	13	11
Total land holdings (ha)	1.11	2.29	2.71	1.88
Number of batches/year	1	1	2	1
Total number of layer birds	488	1,245	4,059	1,511
Cost of DOC (BDT*/100 layers)	2,662	2,696	2,518	2,645
Mean transport cost for DOC (BDT/100 birds)	33	27	20	28
Total annual feed cost (BDT/100 layer birds)	19,312	16,158	19,574	18,195
Annual transport cost for feed (BDT/100 birds)	1,002	887	533	862
Total annual veterinary cost (BDT/100 layer birds)	1,110	1,278	1,021	1,153
Total annual labour cost (BDT/100 layers)	6,481	3,980	3,706	4,769
Total annual cost (BDT/100 layers)	3,4478	28,317	31,626	31,612
Total no. of visits by suppliers of extension and veterinary services	5.2	6.8	9.4	6.76
Total no. of visits to extension and vet service suppliers by farmers	4.5	6.8	9.4	6.3

* In 2004, US$ 1 = BDT 59.513.

Source: Field survey.

In case of layer farming, 3 socio-economic variables were found to be significant out of a total of 10 variables. The results show that similar to broiler farms, there was scale effect on economic efficiency of the layer farms as economic efficiency was found to increase with the increase of scale of farming (number of birds in the flock). Larger farms achieved cost economy on all major cost items (Table 63). Feed cost, veterinary cost and transport cost/100 layer birds reduced with the increase of scale of farming from small to large. Number of batches produced simultaneously and space used/bird increased inefficiency. The reasons could be that efforts were distributed thinly between batches resulting in poor technical performance; on the other hand, perhaps space was not optimally used/100 birds to produce enough eggs.

Sales point (farm gate or delivery to buyer's shop) and marketing arrangements (contractual arrangement or open negotiation) did not have any significant effect on economic efficiency of either broiler or layer farms. This may imply that net transactions costs/unit output were not significantly different between market locations and marking arrangements for either commodity.

7 Summary and conclusions

The overall objective of this study was to identify policy options for assisting small-scale operators to develop economically viable and ecologically sustainable production enterprises for participating in the rapidly expanding urban and rural markets for milk, poultry and eggs. For analysis of dairy enterprises, a stratified sample of 120 farms with crossbred dairy cows (CBC farms) and 40 farms with local cows (LBC farms) from two *thanas* in each of Manikgonj, Pabna and Shirajgonj districts were studied. For analysis of poultry enterprises, a stratified sample of 120 layer and 120 broiler farms were selected from Gazipur and Kishoreganj districts. Data were collected on a recall basis in two rounds covering a period of six months in each round, thus the actual sample size for analysis was doubled.

7.1 Summary on dairy farms

7.1.1 Characteristics of dairy farms

The small, medium and large CBC farms had an average of 1.17, 1.05 and 1.5 ha of land, respectively; the corresponding figures for LBC farms are 1.0, 2.27 and 1.34 ha, respectively. This indicates that privately-owned land size did not have direct relationship with dairy herd size as some farms owned a small amount of grazing land or had access to common grazing land. Livestock share of annual income was 37% for CBC farms and 32% for LBC farms. In general, livestock share of total income increased with farm size and the shares varied more widely across farm sizes for LBC farms than for CBC farms.

The sample CBC farms reared a mixture of crossbred and local cows or solely crossbred cow. Apart from cows, other types of animals, e.g. followers, bulls, oxen for draft were also kept. About 63% of the cows in the sample CBC farms were crossbred and 37% local. Larger dairy farms had a slightly larger proportion of crossbred cows in their dairy herds. Among the crossbreds, about one half are Frisian crosses with local zebus; the others are Jersey, Sahiwal and Red Sindhi crosses. These breeds differ in size (body weight), feed needs and milk yield. The proportion of dairy animals in the herd was 45% for CBC and 56% for LBC farms.

About 70% of the dairy cows of CBC farms were bred on own farm while 30% were purchased. About 76% of the cows of LBC farms were bred on own farm while 24% were purchased. Among CBC farms, medium farms purchased a lower proportion of their cows compared to small and large farms. Among LBC farms, share of purchased cows decreased with farm size. About three-quarter of CBC farms and over half of the LBC farms purchased at least one cow in their herds. Among CBC farms who purchased cows, 58% did so from local markets, 39% from other farmers and 3% from government farms. A higher proportion of medium size farmers depended on local markets for stock. Among the LBC farms who purchased cows, 77% did so from local markets and 23% from other farmers. Market dependence was about the same for all sizes of farms. Although there is no government or private farm engaged in stock breeding, farmers apparently can get breeding stock from each other, sometimes exchanged through the market. Extension and veterinary services contacts increased with the increase of scale of dairy farming

On average, crossbred cows produced twice as much milk/cow per day than local cows, and local cows on CBC farms produced about a litre more milk/cow per day than those on LBC farms.

Among the crossbreds, Jersey and Frisian produced more milk than Sahiwal and Red Sindhi, and Red Sindhi gave the lowest yield. This pattern was observed for all sizes of farms. On CBC farms, yield difference across farm sizes for different breeds were not significant but on LBC farms, yield was significantly lower for small farms.

Only the large CBC farms and the medium LBC farms used a small amount of land, 0.016 and 0.034 ha, respectively, exclusively for livestock feeding. In case of CBC farms, 64% practice stall feeding and 36% practice a mixture of grazing and stall feeding. Proportion of CBC farms practicing stall feeding increased as farm size decreased, perhaps because smaller dairy farms had more land constraint to practice grazing. Among LBC farms, 48% practised stall feeding and 52% practised a mixture of stall feeding and grazing. A higher proportion of medium farms practised stall feeding than small farms.

Among the roughages, paddy straw and green grass were principal sources while among concentrates rice bran, wheat bran, pulse bran and oil cakes were the principal sources for both CBC and LBC farms though CBC farms used more concentrate feed/cow than LBC farms. CBC farms purchased 49% of paddy straw, the main dry roughage, and 25% of green grass, the remainder were produced on-farm. In case of LBC farms, 44% of paddy straw and 11% of green grass were purchased. A small amount of green grass was purchased in cut-and-carry form, most of the green grass was actually purchased as grazing right in the *bathans* (common grazing land). Farmers paid a fee/season on the basis of the number of cows grazed. Dependence on purchased roughages varied across feed types and sizes of farms depending on availability of own feed in relation to the herd size. Over 85% of all types of grain-based concentrate feeds and 100% of minerals, molasses and mixes were purchased, the remainder were produced on-farm. The medium and large farms purchased higher quantity at a time than the small farms. In case of CBC farms, the quantity of concentrate feed purchased per order increased as the farm size increased. In case of CBC farms, prices of rice straw, green grass and wheat bran were found to decrease as farm size increased, an indication of cost economy due to purchase of larger volumes. In case of LBC farms, the small farms paid less price for rice straw, green grass, rice bran, wheat bran and pulse bran than the medium and large farms perhaps because small farms purchased feeds of lower quality.

It was found that regardless of breed type reared, the distance of feed market and milk sale outlet increased with the increase of scale of dairy farming. Overall, Milk Vita, the milk producers' co-operative, was the principal buyer for both morning and evening milk of both CBC and LBC farms. However, the proportion of farms selling milk to Milk Vita increased with farm size for both CBC and LBC farms. Among the CBC farms, the proportion of farms selling to traders decreased with farm size and sale to the other types of buyers was the same for all sizes. Among the LBC farms, a higher proportion of small farms sold to local processors etc. but a lower proportion sold to traders compared to medium and large farms. This implies that the formal milk marketing outlet is more used by the larger farmers perhaps because they supply larger volumes of more uniform quality.

Share of major cost items—feeds and labour—show similar pattern across farm sizes for CBC farms, indicating that management regime for CBCs were similar, but larger LBC farms spent a higher share of cost on concentrate feeds compared to smaller farms. Gross margin/litre of milk decreased and then increased as farm size increased, and net profit generally increased as farm size increased. Also net profit increased at a faster rate as farm size increased due to higher milk yield and higher milk prices but lower/unit cost as farm size increased.

7.1.2 Profit efficiency of dairy farms

Analysis of stochastic frontier profit function and inefficiency model was fitted to LBC and CBC farms. In case of CBC farms, the results show that among the selected variables price of dry roughage, price of veterinary treatment, value of herd and access to credit significantly influence profit. Price of dry roughage and veterinary treatment significantly reduced profit indicating that all farmers did not pay price consistent with the value of marginal productivity for these inputs and services. On the other hand, the fixed factors like value of total herd and access to credit (a proxy for financial capital) significantly increased profit of this type of dairy farms indicating that larger scale and liquidity enhanced profit. In case of LBC farms, the negative effect of wage rate on profit indicate that all farms did not pay hired labour according to its value of marginal productivity, and positive effects of price of green roughage indicates that its value of marginal productivity might be higher than its price. The positive effects of fixed factors like total herd value and annual fixed labour indicate that there was economy of larger scale.

The mean economic efficiency of CBC and LBC farms was 44 and 55%, respectively, and inefficiency decreased as farm size increased. It means that there is ample scope to raise farm profitability by improving economic efficiency and minimising profit loss of 56 and 45%, respectively, of CBC and LBC farms. Among the factors affecting inefficiency, it was found that demand-driven extension contact by the farmer, possession of pasture land and proportion of crossbred cows in the total dairy herd reduced inefficiency of CBC farms. The result implies that better quality animals in a herd supported by adequate good quality feed and extension advice to deal with production constraining problems reduce inefficiency. In case of LBC farms, education, dairy herd size and pasture land reduced inefficiency.

7.1.3 Conclusions and recommendations

The results of this analysis show that breeds, management practices, economy in feed purchases, choice of market outlets when prices are different, access to credit for liquidity and to extension contact at times of real need to solve a production constraint are significant variables affecting profitability and efficiency of dairy farms. Policy interventions that facilitate to ease constraints in each of these areas and targeting those policies to smaller farms who face these constraints more than the larger farms may contribute to increasing overall efficiency of the dairy sector. Policies towards infrastructure, pollution, access to capital and credit, and rural organisation may affect the comparative advantage of smallholders vs. large enterprises and may determine if large-scale producers will capture the growing market and drive out the small-scale producers making them remain poor as before.

Demand for dairy products has been increasing rapidly in the country driven by growth in income, population and urbanisation. However, domestic milk production has been failing to keep pace while import, though decreased in recent years, still remains high. High import dependence has also contributed to shape the domestic processing and marketing industry in a way that is not serving the interests of smallholder producers because such industries do not normally create the infrastructure necessary to collect milk from large number of small producers scattered throughout the country. Although dairy has the potential to be an important component of smallholder mixed farming and income generation, dairy development efforts through cross-breeding, milk collection and processing for urban markets are limited to a tiny part of the country and to medium to large

farms. Furthermore, government policies to support production primarily consist of subsidies to these larger farmers, which may not be socially desirable, and is unsustainable. On the other hand, carefully-designed policy reform and strategies may allow the large numbers of poor smallholders and landless with 1–2 local cows, who produce 70–80% of the milk in the country, to participate in the expanding milk market alongside larger farms. This strategy will result in increased aggregate output to meet increased consumer demand for dairy products but, most importantly, reduce poverty and malnutrition among smallholders in the country. The problem is to identify, develop and test appropriate marketing and processing arrangements to improve smallholder access to urban markets at competitive cost levels. Appropriate technology and services (e.g. breed and breeding services, feed and health inputs) for improving productivity, but specifically targeting smallholder needs, will also be required to bolster the competitiveness of smallholder producers.

In order to pursue a balanced dairy development strategy in which farms of various sizes and resource endowments may have the opportunity to compete on a fair basis, it is important to make livestock assets accessible to them, especially the poor, to be followed up by technical assistance—health, AI, feeds, credit and market outlet. In the dairy milk sheds where this study was conducted, producers have asymmetric access to health and AI services from DLS and other providers, e.g. Milk Vita, BRAC and Grameen Motsho Foundation. There are also differences in costs of these services from different providers, some subsidised while others are not so. Therefore, institutional options for inputs and service delivery, and the social costs and benefits of these options for supporting smallholder dairy need to be developed, rationalised and assessed.

Formal milk market opportunities are limited to few milk sheds in specific areas of the country. Market targeted to high income consumers through processed milk has several limitations as a strategy to involve the poor. Formal milk market has played a minor role so far in most developing countries in promoting dairy development as informal market still remains the primary source of milk in both rural and urban areas. This is true even for India in spite of the success and contribution of National Dairy Development Board's successes with respect to production, processing and marketing infrastructure development. The issue is how to make the informal market respond to consumer requirements for quality and food safety, and how scattered smallholder producers can be linked with markets at different levels. This can be promoted by two parallel policy and institutional arrangements. The formal market segment can be promoted by vertical integration of small producers with dairy processors, through contract farming or participatory producer co-operatives in order to make access to inputs and services that are more economic and cost-effective for small producers. The informal market can be promoted by providing simple technology options for milk preservation to enable transportation over long distances, technology for testing quality assurance, and supporting facilities, e.g. credit and training for informal traders to operate more efficiently to serve the needs of the consumer.

Feed typically account for 50–70% of total cost of production of milk and availability of good quality feed remains a major constraint. Increased smallholder participation and competitiveness in the market will depend a great deal on the ability of the research and extension system to provide greater number of feed supply options, improve feed use efficiency and reduce the share of feed in total cost. Given that most poor still raise local cows with low feed, what they need is a feed package that will increase their milk yield from 1–2 litres/cow per day by an additional half or one litre. Such a feed package should be made widely accessible so that the aggregate effect on output and poverty alleviation will be large, though at the individual cow and farm level, the impact

may be small. Given the country's land scarcity and the limited opportunity to produce feeds domestically through crop diversification, e.g. moving into maize, options other than dependence on imports need to be seriously investigated.

For quite sometime, bull:cow ratio in the country has been very unfavourable for a healthy fertility rate. Therefore, an extensive AI service may be highly beneficial for poor dairy farmers raising low producing local cows but they may not necessarily need exotic blood. The choice of breed for dairy development remains a major problem to be resolved. If poor farmers throughout the country are to be given an opportunity to get involved in dairy development rather than in a few high potential milk sheds as presently practised, then two concurrent actions will be needed. A long-term breed improvement policy and research programme need to be developed and implemented while at the same time quality of breeding services need to be improved and the current chaotic AI service provision by various providers need to be streamlined in a way that will be complementary to the long-term strategy. The long-term strategy should be based on a detailed assessment of the genetic characteristics and adaptability of the local and various crossbreds, efficiency and impact of past AI and other breeding services, their constraints, and current and future demand of producers of all categories and other stakeholders in the dairy sector for improved breeds.

7.2 Summary on poultry farms

7.2.1 General characteristics of poultry farms

Both Gazipur and Kishoreganj districts experienced rapid growth in commercial poultry production during the 1990s. Commercial poultry was started by small-scale crop–livestock farmers in order to diversify income but large mixed farmers and independent investors also entered this business. Initial capital investment/100 birds was higher in large farms compared to the small farms. Most small mixed farms started with commercial broiler instead of layer farming perhaps because of lower investment and skill requirement and quick returns from broiler. However, larger landholders apparently entered the poultry business sooner than small landholders and more through layer than broiler because urban demand for eggs grew faster and sooner than demand for broiler.

Technical performance in egg production was measured in terms of age and weight at first laying, length of laying period, egg production/hen per laying period and culling age. Technical performance in broiler production was measured in terms of age and weight at sale, feed conversion ratio and survival rate. In both cases, larger farms showed better technical performance in terms of the key indicators.

Shortage in the supply of DOCs was a major constraint as few hatcheries supply the market. Three-quarter of layer farms and about one-third of broiler farms had to pay in advance for DOCs and yet had to wait for several weeks for delivery. Large farms had to wait for a longer period perhaps because of larger number of chicks required/batch. Feed costs of broiler farms did not differ significantly between sizes of farms and between the two districts. Most layer farms bought feed ingredients and mixed those themselves, and prices of ingredients apparently did not differ significantly indicating that the feed market was fairly competitive. Local drug stores appeared as the major provider of vaccination service for the large breeder farm through contract agreement. The government veterinary service plays a minor role in the provision of veterinary services to the commercial poultry sector. Access to formal credit was more biased towards larger farms as few

small farms borrowed and they did so from a variety of sources including private money lenders who usually charged higher interest rates.

Most farmers sold output at the farm gate to traders coming to buy and in case of contract growing, output was delivered to the contracting farm. Prices were apparently very competitive. For broiler farms, average net return/100 eggs increased with farm size because larger farms were able to economise on costs of DOCs, feeds and veterinary costs due to larger volume of purchase. In case of layer farms, average net return/100 birds did not differ significantly between sizes of farms.

7.2.2 Profit efficiency of poultry farms

Results of the stochastic frontier profit functions show that mean economic efficiency of broiler and layer farms was 30 and 82%, respectively. Average economic efficiency of both broiler and layer farms increased with farm size. In case of broiler farms, feed price and price of veterinary inputs significantly reduced profit, either because some farms paid higher than optimal price or that the marginal value product of these inputs were significantly lower than the respective prices. In case of layer farms, price of DOCs significantly affected profit negatively indicating that the sample farms did not pay competitive price for DOCs.

In case of broiler farms, the number of batches produced in a year, mean weight at sale, space used/bird and number of extension contacts significantly reduced inefficiency. Larger farms achieved higher efficiency not only due to better cost economy in purchasing feeds, DOCs and veterinary services but also due to better technical performance of the flock. Extension contacts might have contributed to better technical performance.

In case of layer farms, cost economy especially for feeds, veterinary services and DOCs transportation significantly enhanced the efficiency of larger farms. However, two factors—number of batches produced simultaneously and space used/bird—increased inefficiency. The reasons could be that efforts were distributed thinly between batches resulting in poor technical performance; on the other hand, perhaps space was not optimally used/100 birds to produce enough eggs.

Marketing arrangements for outputs and inputs, e.g. contract farming and direct selling to traders, and access to credit did not significantly influence profit efficiency as perhaps the effects of these factors have been captured by other factors representing either technical performance or cost economy.

7.2.3 Conclusions and recommendations

The effect of economies of scale in poultry farming in the study areas is evident in the rising average size of both broiler and layer farms over time. Smallholder farms are either scaling up to benefit from scale economies or if they are inefficient, dropping out. Therefore, improving efficiency of small-scale operations is essential for their continued participation in the expanding market. Given very low efficiency in broiler production, better use of existing technology to improve technical performance and management may provide substantial opportunities to improve profitability of the broiler farms in general and small-scale farms in particular. Profit loss was less in case of medium and large farms, which had more extension contacts and exhibited better technical performance. Therefore, targeting extension programmes and input services to the needs of smallholders may

have a high payoff. Overall efficiency of layer farms could be further improved by enhancing the efficiency of smaller farms which achieved only 70% efficiency compared to about 96% by large farms.

Private sector investment in commercial hatchery in the country is highly insufficient to satisfy the needs of commercial poultry sector for DOCs; so waiting time for supplies are pretty long even after advance payments. The reason for this apparent anomaly in an otherwise profitable business is unclear. Therefore, this needs to be investigated and appropriate policy incentive to encourage investment in this activity needs to be identified.

The feed and output markets are apparently very competitive. Farm gate sale of output by a vast majority of both layer and broiler farms may indicate that other marketing options are possibly not considered due to high transaction costs of individual marketing operations due to low volume of output. Contract broiler farms did not do better than independent broiler farms. However, the analysis with respect to contract farming was not exhaustive due to data limitations as detailed data collection on various aspects of contract farming arrangements including risk and cost sharing were not envisaged during the design of this study. Further exploration of the contract farming issues and other institutional arrangements for input and output marketing is therefore warranted to judge the real constraints and prospects of small-scale operations.

Asymmetric access to formal sector credit is disadvantageous for small-scale operators both for starting business and for running existing operations. Vaccination services provided by private drug stores may be an encouraging sign given the poor delivery of public sector veterinary services to the commercial poultry sector in general and smallholders in particular but the quality of personnel in private vaccination and other veterinary service delivery may need to be monitored and improved in order to ensure high technical performance (e.g. low mortality) of the farms, without which profit efficiency is bound to suffer.

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