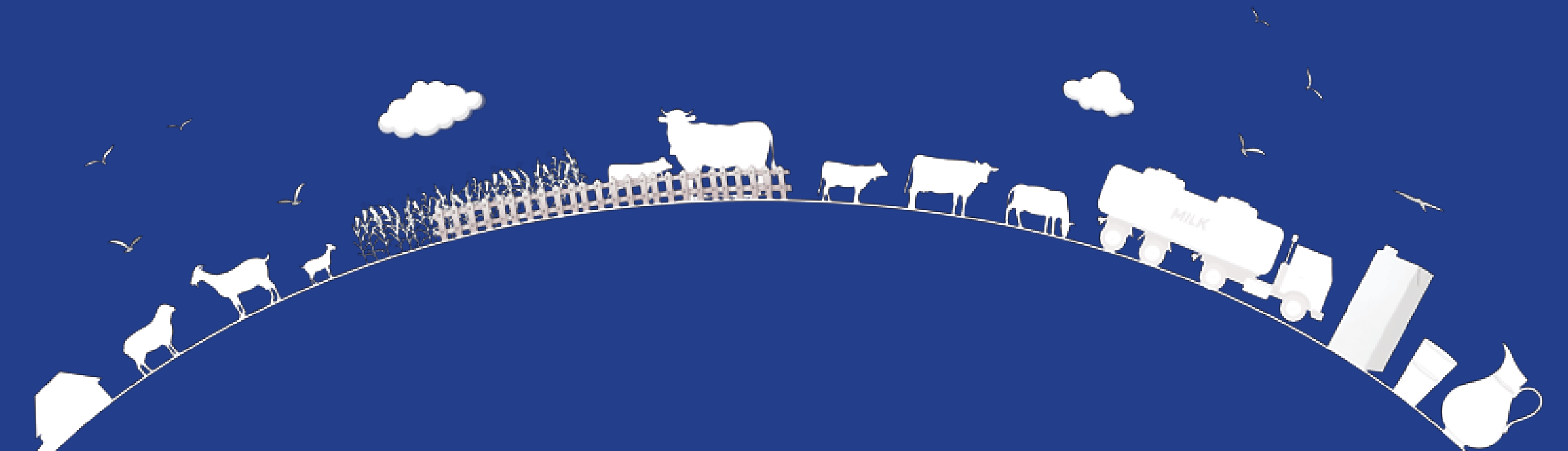


ECONOMIC IMPACT OF DAIRY SECTOR IN PAKISTAN

LESSONS FROM THE PAST TO BUILD A RESILIENT FUTURE

2016, FIRST EDITION

LUMS

'ECONOMIC IMPACT OF DAIRY SECTOR IN PAKISTAN'
LESSONS FROM THE PAST TO BUILD A RESILIENT FUTURE.
2016, FIRST EDITION

Abid A. Burki
Professor of Economics
burki@lums.edu.pk

Mushtaq A. Khan
Associate Professor of Economics
mushtaq@lums.edu.pk

DEPARTMENT OF ECONOMICS
Mushtaq Ahmad Gurmani School of Humanities & Social Sciences
Lahore University of Management Sciences (LUMS)
Lahore, Pakistan

ACKNOWLEDGEMENTS

We wish to acknowledge and express our sincere gratitude to various individuals for valuable discussions, comments and support during the course of this study. We owe our gratitude to Assad Abbas for his enthusiasm, thoughtful criticism, suggestions and comments both on substance and exposition of the material contained in this study. We are also indebted to Osman Bucha, Ahsan Hashmi and Shah Amir for bringing this report to fruition. We appreciate the support from Sehrish Jaffer and Rida Naqvi at various stages of the study.

Our thanks also go to Abubakar Memon for handling the survey data and Tariq Munir and Sananullah for conducting the field survey of the dairy sector. Our special thanks are due to Zunaira Mehmood and Muhammad Husnain Ijaz for providing excellent research assistance on the study. They looked up relevant literature, assembled and compiled data and provided support in computation for the study.

A WORD FROM OUR PARTNER

Tetra Pak Pakistan is pleased to have been invited to partner with Lahore University of Management Sciences for this important publication - a source of invaluable data for the whole dairy industry. In times when society is looking for healthy food, all of us active in the value chain of milk production and distribution, have a responsibility to educate all stakeholders about the tremendous value that dairy industry brings to people. We trust this publication will form an integral and important part of increasing the knowledge about the importance of the dairy industry.

CONTENTS

EXECUTIVE SUMMARY

Introduction:

The livestock sector contributes around 12% to the gross domestic product (GDP) and about 56.3% to agricultural value added. Gross value addition of the livestock sector has increased from Rs.778 billion in 2013-14 to Rs.801 billion in 2014-15, which translates to 3% in the value added of the livestock sector. The livestock sector is dominated by non-corporate smallholder dairy producers who are spread all over Pakistan. They meet major protein and nutrition needs of the country and also earn incomes on a daily or weekly basis.

The demand for livestock and livestock products is increasing at a rapid pace on account of rising population, increased incomes, changes in consumer preferences towards livestock and dairy products and increasing export demand. The rising trend in real prices of livestock and dairy is a reflection of demand overshooting supply, which has provided great incentives to producers and new investors to raise production in this sub-sector. However, there are some key questions that have remained unexplored. This study is an attempt to answer some of these questions.

We raise a number of questions. How realistic is the official data on livestock population, average milk production per animal and milk availability in the country? How can we cope with the seasonal variation in fodder availability for smallholder dairy producers? What are the changing dynamics, the economic outlook and returns for the non-corporate dairy farms? What is total factor productivity (TFP) change in the non-corporate dairy farms and how it is changing the economic outlook and covariates of TFP change? What is the potential of corporate dairy farms in the country especially after the Livestock Development Policy 2007? How can the milk processing industry cope with the challenge of full capacity utilization? How do nutritional deficiencies affect productivity and GDP growth in the country? And, what is the impact of a sales tax on dairy processing industry in terms of overall welfare in the country? These are some of the questions that this study tries to answer.

Dairy Sector Profile: Establishing the Fact Base:

We examine the dairy sector profile by focusing on growth in livestock population, growth in herd size, growth in milk yield per animal, per capita milk consumption, dairy value chain and the role of government policy in dairy sector development.

The first general insight relates to inter-census growth in livestock population. The Pakistan Livestock Census 2006 suggests that livestock supply was overshooting demand: growth in cattle, buffalo and goat population is recorded at 4.5%, 3.5% and 3.1% per annum, respectively. This is much higher than the growth rate of human population at nearly 2%. But, the rising trend in real prices of beef, mutton and fresh milk negates this view.

The share of the livestock sector in growth in agriculture has increased from 25.3% in 1996 to 49.6% in 2006, which is largely due to faster growth in livestock population recorded in the livestock census data.

While the share of subsistence households in livestock sector has declined, the share of commercial dairy farms has gradually increased. The share of commercial dairy farms seems to have further increased in the post-2006 period due to the incentives provided to the corporate dairy sector.

It is generally believed that the official numbers of total milk production in the country and the numbers on average milk yield of dairy animals are far from realistic. Official numbers suggest that average milk yield of cows and buffaloes is 6.14 liters and 7.93 liters, respectively, which is higher than the expectations of the milk processing industry.

We find inconsistency in the inter-census growth in milk yield per animal for some districts of Punjab. More specifically, we find that relative milk yield in Layyah and Mandi Bahauddin districts increased from approximately 5kg per day in 1996 to 15kg per day in 2006, which translates to a 20% increase in yield per year. There are other districts in Punjab province where milk yield has increased from 5% to over 10% per annum, which cannot be justified. These numbers raise some serious questions on the quality of the Pakistan Livestock Census data.

We also take supply side data of milk production and compare it with the demand side data of milk consumption to calculate the disparity between the two. This exercise leads us to conclude that the amount of milk that the Pakistan Census of Livestock (supply side) said is available for human consumption is only 81% of the amount household (demand side) said they consumed. Based on demand side estimates, per capita consumption of milk was 0.26 liters in 2013-14, which was significantly lower than the supply side estimates of 0.32 liters in the same period. This discrepancy may be attributed to measurement errors in the two data sources. This disparity amounts to an estimated shortage of about 7 to 8 billion liters of milk in the system. If the household consumption patterns of 2013-14 persist, the annual household demand for milk in 2015-16 comes to 19.9 billion liters per year, which is much lower than the official numbers.

Regarding the role of government policy, we find that over the past decade, some tangible policy measures have been adopted by the government to promote the dairy sector of Pakistan. The government seems to have realized that focusing solely on smallholder dairying would not suffice and that they have to promote the growth of large commercial dairy and corporate dairy farms to meet the challenges of rising demand for milk in the country. The 2007 policy was instrumental in promoting growth of the corporate dairy farms in the country. However, the start-up infrastructural costs of these farms are serving as a major barrier to entry for the corporate dairy farms.

Economics of Agriculture Related to Dairy Farming:

The quality of feed fed to dairy stock directly affects milk yield. Livestock feed consists mainly of fodder, straws and concentrates. But, despite having access to different types of green fodder, dairy farmers in Pakistan face fodder shortages roughly three times in a year, i.e., from mid-September to end of October; December-January; and the month of May. Seasonal variation in availability of fodder severely affects subsistence and near-subsistence dairy farmers who are unable to purchase fodder in bulk during peak seasons. Our estimates suggest that fodder cost forms a major chunk (38%) of the total input costs incurred by the dairy farms. Therefore, if policy makers are interested in reducing milk production cost to the dairy farms, they must aim at reducing the cost of fodder.

The feeding practices in vogue of the smallholder dairy farms and the outdated technology used by them are putting upward pressure on fodder costs. These farmers use homemade mixtures of ingredients, which comprise of home-grown or locally purchased low quality fodder types and concentrates. However, corporate farms use state-of-the-art technology and high quality fodder for preparing livestock feed. If the average dairy farmer is to increase farm profitability, then the gap between the practices of small and large-scale dairy farms and the issue of fodder shortages need to be dealt with. Vocational training and extension services administered to smallholder dairy producers on animals' feed requirements, high quality indigenous sources of feed and optimal mixtures of ingredients can go a long way towards improving the basic skill set of the target groups. Also, farmers need to be made aware of the different ways in which they can alleviate fodder shortages and reduce fodder costs. They must be trained on how to prepare silage for the consumption of animals during periods of fodder shortage. They also need access to necessary equipment for silage preparation. At the moment, due to lack of demand, there is a missing market for renting-out services for silage making equipment. Private equipment renting-out services may develop on their own when there is enough demand for the equipment in rural areas. In the beginning, medium and large-scale commercial dairy farms may rent out their excess capacity to small farmers while private market players may start providing this equipment in the later stage. However, in the interim period, some tangible efforts need to be made to promote demand for this equipment by providing awareness through training and extension services. The milk processing industry and the provincial governments have an important role to play. Lastly, their crop management skills need to be improved via help sessions and training. If farmers sow fodder crops at intervals within their respective seasons, they will be less vulnerable to variations in fodder availability. Helping the average dairy farmer reduce fodder costs and increase profitability will help increase the aggregate milk supply of the country as farmers will be able to reinvest their profits towards increasing animal productivity.

Understanding Non-Corporate Dairy Farming in Pakistan:

To evaluate the dynamics of non-corporate dairy farms in a rapidly changing environment, we conducted two rounds of a dairy survey of non-corporate dairy farms in 2005 and 2014. Two important insights from these survey rounds are summarized below.

The first general insight is that pure buffalo farms have declined while pure cow farms and mixed farms have increased over the last decade. This is explained by the increasing cost of dairy inputs, which has made buffalos unprofitable due to their low yields and higher maintenance cost. Selling milk to the milk processing industry has been a popular choice 10 years ago, but this pattern has changed since dairy farms who sell milk to milk processing industry has declined by 14 percentage points over the two survey rounds, which should be a matter of concern for the processing industry.

Second, we shed light on changes in return to dairy households. We find that average real return (adjusted for inflation) per dairy farm (excluding cost of family labor) has increased by 145% (from Rs.37,652 in 2005 to Rs.92,161 in 2014) at the rate of 16% per annum. However, including opportunity cost of labor in the total cost, the return increases only by 12.4% in the same period at a rate of 1.4% per annum. Similarly, returns per dairy animal and per 40kg of milk are also impressive, excluding cost of family labor; however, it presents a dismal picture when cost of family labor is also accounted for. We also note that in 2005, returns (excluding cost of family labor) to dairy farms who were selling milk to milk processing industry were 32% more relative to farms who were selling to informal milk collectors. Surprisingly, this picture has changed over time. Now the dairy farms selling milk to the milk processing industry earn 12% less than others. The returns per dairy animal are slightly more than returns on per acre of wheat-coarse rice system, but much lower than return on per acre of sugarcane, wheat-basmati rice and wheat-cotton combinations.

Productivity Growth in Non-Corporate Dairy Farms:

Simply put, total factor productivity change measures the difference between growth in outputs and growth in inputs. To be able to measure the TFP of non-corporate dairy farms, we used two rounds of data of the dairy survey to calculate TFP growth from 2005 to 2014. We apply the Malmquist productivity index to measure productivity change. We also explore the sources of TFP change by decomposing productivity change into its components.

First, we find that productivity of non-corporate dairy farms is declining, on average, at the rate of 1.42% per annum per year. This gives a clear indication that the growth rates of dairy production have fallen short of growth rates of dairy inputs. The findings suggest that despite a slow improvement in use of dairy resources, a sharp inward shift in aggregate production frontier has contributed to an overall productivity regress, implying that the sample dairy farms have failed to innovate.

Second, the disaggregated results show that the aggregate results conceal productivity growth in 282 dairy farms, or 39% of the sample dairy farms, where average productivity growth of 4.9% per year has taken place. By contrast, productivity has declined in 443 dairy farms at an average rate of 4.1% per annum. Failure to innovate is much more common in the entire sample than otherwise.

Third, both subsistence and landless dairy farms have performed better than their counterparts. This is understandable since most subsistence farms employ family labor to collect roughages and grasses to feed their milching animals due to which they have suffered relatively less from rising costs of dairy inputs. Decrease in herd size increases productivity while dairy farms who feed silage to their herd experience higher productivity growth.

Fourth, most best performing districts have a large presence of the milk processing industry, which provides technical support in the form of extension services to the dairy farms; however, the evidence of failure of dairy farms in these districts to innovate is most surprising. Equally surprising is the poor performance of mixed cow and buffalo farms relative to pure cow and pure buffalo farms.

Fifth, animal capital, straws and concentrate and family and hired labor are the most important determinants of raising output in smallholder dairying. However, the estimates of scale elasticity suggest that the sample dairy farms operate under decreasing returns to scale, or on upward sloping portions of their average costs, implying that a proportionate increase in dairy inputs would bring about a less than proportionate increase in value of dairy production. The results also suggest that dairy farms selling milk to informal milk collectors are more efficient than others. Increase in herd size, age of head of farm household and education of head of farm household increase technical efficiency of the dairy farms.

Economics of Modern Dairy Farming – Case Study on Corporate Dairy Farming:

Corporate dairy farms differ from conventional dairy farms in many respects including human resource development, breeding and herd management, capital accumulation, mechanization, fodder and fodder storage. Corporate dairy farms are organized into four departments, viz., maternity and breeding, calf rearing, feed and milking. The maternity department looks after sick and pregnant animals. Detecting animals on heat for insemination is their most important job. The calf rearing department maintains health of the calves until they grow up and are sent to the maternity department for impregnation. The feed department looks after procurement and storage of animal feed. The milking of animals is completely mechanized and goes directly from the cows to the chillers with minimum human exposure. Milk processing units are the main source of demand for the milk produced by the corporate dairy farms; some farms have also set up their own pasteurizing units and distribution networks.

Due to lack of expertise, corporate farms hire experienced foreign managers on internationally competitive salaries. They are making investments on human resource development so that they are able to replace expensive foreign managers with local experts. Significant improvements in dairy farming practices of small scale dairy producers have been achieved through the USAID dairy project, which is likely to have positive spillover effects on corporate dairy farms as well.

Corporate farms require huge initial investments in infrastructure and capital. Additionally, fodder, energy, and labor costs also impose a significant burden upon these farms in the initial years. Most of these farms prefer to use exotic foreign breeds of cattle because their milk yield is higher than local breeds. Some farms use mixed breeds whose yield is higher than local breeds but less than foreign breeds. However, since both foreign and mixed breeds weigh more than local breeds, they need to be fed more which inevitably increases fodder cost. Further, both foreign and mixed breeds are unable to fully adapt to local climatic conditions and are susceptible to local diseases, which is why specialized veterinarians need to be hired for their immunization and medical care. They also need to be kept in temperature controlled sheds which adds to energy costs incurred by the farm. Since the advent of corporate dairy farming is a recent development, skilled foreign human resource is a substantial cost.

However, corporate farms are also trying to reduce operational inefficiencies through human capital and resource development. They are incorporating local personnel into the management teams headed by foreign personnel so that they are able to eventually phase out foreign leadership. They are also engaging in artificial insemination and selective breeding to improve the quality of their herds' offspring, installing better animal housing and water facilities, and trying to lower fodder costs by producing animal feed themselves (backward integration). They are also tagging their herd with transponders to identify them for milking, breeding, and feeding. This helps them separate high yielding animals from low yielding ones, and feed high yielding animals more fodder to increase the quantity and quality of their milk yield. Some farms have also ventured into the retail sector, allowing them to sell their product at a higher price than that offered by milk processing companies. Even so, investing in pasteurizing units is not enough to battle away the market share occupied by popular milk brands, and a lot needs to be invested in marketing and publicity.

More feasible measures that corporate dairy farms can take to lower their production costs are to increase their herd size so that they can benefit from economies of scale by buying fodder in bulk at lower prices during the peak season, and spreading the per unit labor cost of hiring foreign managers and specialized veterinarians. They can also change the composition of their labor force over time to include domestic labor trained by USAID in animal care and artificial insemination to assist the on-site veterinarian. Another way to reduce costs could be to indigenize the feed given to animals by finding a mix of suitable local ingredients that provide approximately the same nourishment for foreign and mixed breeds of cattle as imported ingredients.

These measures may help corporate dairy farms stay afloat and earn profits in the long run. Additionally, as the corporate dairy industry grows, it is likely to become more efficient by sharing expertise. There are, however, no short term solutions and if corporate dairy farms are unable to keep up, the Government will have to re-focus its attention towards rural and small scale dairy farmers who still provide the larger portion of the country's aggregate milk supply.

Structure of Milk Processing Industry:

Due to growth in demand for processed milk and milk products, a number of large scale milk processors are now operating in Pakistan. However, they are not operating at their full capacity due to seasonal nature of milk supply. If the milk processing industry is to thrive in the long run, then an integrated approach needs to be adopted which focuses on both the suppliers of raw milk and innovations in the processing sector itself.

The bulk of raw milk producers are smallholder producers who need support to enhance their productivity and technical efficiency. Farm gate prices, which are considerably lower than the Ultra-High Temperature (UHT) prices, are a primary motivator for these farmers. Increasing awareness amongst these farmers regarding milk quality specification, and providing them with milk testing kits can help increase their bargaining power and motivate them to remain in dairy production and produce larger quantities of milk. Moreover, improving farmers' access to fodder during fodder shortages may also help increase animal productivity. Apart from UHT milk, tea creamers and flavored milk products are also in high demand. Consumers between 15 to 35 years of age are the main stay for demand for UHT milk while tea creamers are popular among urban consumers and lower income groups. These consumption patterns can help milk processing industry shape their marketing strategies in the near future.

Economics of Nutrition: Calcium and Milk:

In this chapter, we focus on the economics of nutrition by exploring the costs of malnutrition on productivity and GDP growth, evaluating the nature and extent of nutritional deficiencies measured by headcount food poverty, measuring and evaluating the magnitude of milk poverty headcount in Pakistan and estimating the impact of malnutrition on school attendance in Pakistan. Our key findings are summarized below.

First, analyzing the cost of malnutrition on productivity and GDP growth the findings are that a one pound increase in birth weight leads to 7% increase in lifetime earnings in the US. Adopting policies that help eliminate birth weight deficit in Pakistan is expected to bring about benefits to the tune of US$11 billion per annum. Protein-energy malnutrition leads to very high productivity losses and a 1% loss in adult height in Pakistan leads to a 0.3% decline in rural wages.

Second, countries with low nutritional indicators suffer huge costs in terms of lost productivity and growth in GDP. Estimates from Pakistan suggest that there is a 3.3% loss in GDP due to iron deficiency alone. In Pakistan, if the nutritional gap in protein energy, iodine deficiency and iron deficiency is eliminated, it has the potential to increase the level of GDP by 4% per annum. These gains may be substantially higher if longer duration childhood cognitive impairment effects are also taken into account.

Third, our estimates suggest that 79% population in Pakistan consumes less than the recommended 2,350 calories per day of which 84% population is from urban and 76% from rural areas. Respectively, 83% and 80% population of Sindh and Balochistan, and 78% and 73% of Punjab and KP is also below the suggested food poverty benchmarks. Moreover, 86% children of 10-14 years consume less than the recommended calories. It implies that Pakistan would need Rs.64 billion per day to bridge this nutritional gap, of which Rs.39 billion would be required for the rural poor.

Fourth, we find that 70% to 75% urban and rural population consumes less milk than the estimated milk poverty line. The highest proportion of population below this benchmark belongs to children in the age-group of 10 to 14 years. There is a deficit of 12.50 million liters per day in the country, which comes to 4.57 billion liters per annum and that is equal to 10% of total milk currently available for human consumption. To bridge the gap in milk consumption would require Rs.275 billion per annum.

Fifth, recent studies have established that better nutrition and child health affects child school performance and post-school productivity. Specific evidence from Pakistan suggests that there is a positive effect of pre-school height-for-age z-score on school enrollment for girls.

Last, the direct relationship between per capita milk calories consumed on school attendance rate is positive. An average household consumes 153 milk calories per capita. Holding all else constant, an increase in per capita daily milk calories by its sample mean of 153.1 increases the probability of school attendance by 0.95 percentage points. Moreover, the probability of school attendance initially increases with per capita milk calories and reaches its maximum point at 770 milk calories per day, which is much higher than the mean calories. By implication, these results suggest that there is a huge gap between the present level of milk calories consumed and the desirable level.

Welfare Analysis of Imposing Sales Tax on Packed Milk:

As part of measures to increase tax to GDP ratio, the Federal Board of Revenue (FBR) is actively exploring ways and means to raise tax revenue. In this context, every year discussions take place between FBR and the milk processing industry. In these parleys, proposals for the imposition of Generalized Sales Tax (GST) on output are contemplated, but the tax is never levied. Presently, a zero rating regime is in place on all direct materials used by the milk processing industry. Refunds are admissible on indirect materials used at the rate of 17%. These materials include fuel, electricity, packing, spare parts, lubricants, etc. But in practice these refunds have never materialized. Over the years, the accumulation of refunds has led to serious problems for some big players. This is because these receivables do not go well with good accounting practices in the eyes of their shareholders.

An even more serious implication of this policy is that it imposes an input tax of 6% on those dairy processing units who are tax compliant. Non-tax compliant units who do not pay their due taxes on indirect materials get undue cost advantages. In this way, when refundable input tax is not refunded, it serves as a distortionary measure whereby tax compliant units are penalized for paying taxes while non-tax compliant units are favored.

In this study, we ask the following question: should FBR impose an output tax on packed milk? If yes, then at what rate? The answer to this question is tricky simply because sales tax is an indirect tax which has far reaching implications on the incidence of the tax on milk consumers and small scale dairy farmers producing milk.

The final incidence of indirect taxes depends on the relative elasticity of demand and supply curves. If the demand curve is elastic and the supply curve is inelastic then the incidence of sales tax would disproportionately fall on producers or processors. However, if the demand curve is inelastic and the supply curve is elastic then the incidence would fall disproportionately on consumers.

We conduct partial equilibrium analysis to work out the implications of a sales tax on packed milk, especially its incidence on tax revenue, producers, consumers and deadweight loss to the economy. The partial equilibrium analysis is based on information on price elasticity of demand and price elasticity of supply of packed milk, which allows us to map the market demand and supply functions, which in turn are used to compute the implications of the tax on consumers, producers, deadweight loss and potential tax revenue at various tax rates. Our main findings are summarized below.

In general, we find that as sales tax is increased, tax revenue also increases but the gains in revenue only come at the cost of welfare losses to both consumers and dairy farmers.

Our results suggest that sales tax rate and sales tax revenue has a linear relationship. It implies that as sales tax rate increases, tax revenue increases proportionately.

In the long run, sales tax at the rate of 1% would yield tax revenue of Rs.2.16 billion (likewise, sales tax rates of 6% would yield tax revenue of Rs.20 billion). However, this result should be seen in the context of implications on consumers and dairy farmers who supply small quantities of milk to the processing industry. Moreover, it also shields efficiency losses to be incurred by consumers of milk products. We find that the long run revenue loss (i.e., deadweight loss) to society would increase more than proportionately for an additional increase in tax rate.

Every one percentage point increase in tax rate would decrease producer surplus by Rs.0.42 billion and consumer surplus by Rs.1.73 billion. In simple words, as sales tax rate is increased, the tax burden would disproportionally fall on consumers.

The existing net input tax on the dairy sector in 2014 was 6%, which amounts to Rs.6 billion revenue. If the same amount was collected in the form of output tax or sales tax, the effective output/sales tax to be levied on the industry would be approximately 3%. We find that at a sales tax of 3%, the government would earn a total tax revenue of Rs. 6.37 billion. However, the combined loss to producers/processors, consumers and deadweight loss would amount to Rs.6.54 billion, which is higher than the tax revenue collection at 3% sales tax rate.

In the short run, tax revenue collection would be much higher. For instance, a tax rate of 3% would yield tax revenue of Rs.21 billion. However, combined efficiency losses to producers, consumers and deadweight loss would be Rs.21.88 billion, which is higher than the total tax revenue collection. Hence, even in the short run, imposing an output or sales tax instead of an input tax would yield substantial increase in revenues, but it would also incur a higher net cost rather than a gain in revenue.

Our results further reveal that when a sales tax is imposed on tea creamers, ambient white milk, and dairy drinks & beverages, the aggregate change (or fall) in milk supply would be substantial. While lowering output would help processors minimize their losses from new tax, it would also lower dairy farmers' profits. Moreover, farmers would be forced to diversify away from dairy production to maintain their standard of living. Farmers who would fail to do so may suffer adverse consequences of reduced profits and unemployment of their family and hired labor.

Recommendations for the Future

This study has proposed five major recommendations as listed below:

1) The data quality of the Pakistan Census of Livestock is seriously called into question. The Pakistan Bureau of Statistics and the Government of Pakistan must revisit their data collection tools and ensure better monitoring and supervision so that more reliable numbers of the dairy sector are made available. The next round of the Pakistan Livestock Census would be conducted in 2018. The dairy industry and its major stakeholders would eagerly await the outcome of the new livestock census.

2) The government has realized that to meet rising demand for dairy products, the role of large scale and corporate dairy farms has assumed critical importance. However, huge start-up infrastructural costs serve as a major barrier to entry for new players. The government must fine-tune its Livestock Development Policy 2007 to bring it in line with the changing dynamics of this sector.

3) Seasonal variation in fodder availability is a critical challenge for the policy makers in the country because it is responsible for poor quality of feed and rising fodder costs. Serious attempts are warranted to lower the cost of feed. Policy measures that encourage silage making by smallholder dairy producers would be a step in the right direction.

4) The TFP of non-corporate dairy farms is declining at the rate of 1.4% per annum due to slower growth of value of dairy output compared with growth of cost of dairy inputs. Some effective policy measures are warranted to address this critical policy issue. Efforts to enhance the TFP of smallholder dairy farmers would also help the cause of the milk processing industry, which is operating at much below their full capacity.

5) Sales tax policy should be used wisely to create a level playing field for different players in the milk processing industry. The current refund policy imposes an input tax of 6% on tax compliant processing units; however, non-tax compliant units get undue cost advantages, which is a distortion. Imposition of sales tax would have major gains in the short run, but long run gains in tax revenue would be outweighed by welfare losses. Therefore, any such policy has to be used with a great deal of caution.

Chapter 1

INTRODUCTION

Agriculture is a key sector of Pakistan's economy, which contributes 20.9% to GDP i.e. PKR 5,276 billion and provides jobs to 43.5% of population (GoP, 2015). This sector also plays an important role in other sectors of the economy by supplying raw materials, foreign exchange earnings and a market for industrial products. A majority of Pakistanis still live in rural areas and depend directly and indirectly on the agriculture sector for their means of livelihood. Pakistan's GDP growth is directly linked with the performance of its agriculture sector due to the presence of strong backward and forward linkages (GoP, 2015).

The agriculture sector has four sub-sectors namely, crops, livestock, fisheries and forestry. The livestock sector's share in Pakistan's GDP is more than the combined share of crops, fisheries and forestry sectors. It contributes 11.8% to GDP and about 56.3% to agricultural value added (GoP, 2015). Moreover, the gross value addition of the livestock sector has increased from Rs.778.3 billion in 2013-14 to Rs.801.3 billion in 2014-15, which translates to 3% growth in the value added of the livestock sector (GoP, 2015).

Historically, the livestock sector is dominated by smallholder subsistence livestock farmers who are spread across Pakistan and meet their protein and nutrition needs from this sector, and earn cash incomes on a daily or weekly basis. Therefore, the "National Agenda of the Economic Development" of the present government has envisaged the role of poverty alleviation and curbing disparities in incomes for the livestock sector (GoP, 2014).

The demand for livestock and livestock products is increasing at a rapid pace on account of the rising population, increased incomes, changes in consumer preferences towards livestock and dairy products and increasing export demand. Rising trend in real prices of livestock and dairy is a reflection of demand overshooting supply, which has provided great incentives to producers and new investors to raise production in this sub-sector.

However, the economics of agriculture related to non-corporate and corporate dairy sectors is largely unexplored. For example, what are the changing dynamics of non-corporate dairy farms for herd-size, farm-size and mode of selling milk to informal and formal sources? What is the economic outlook of non-corporate dairy farms in terms of returns by herd-size, by mode of selling milk and in comparison with returns to major crops? What is the total factor productivity change in the non-corporate dairy farms and how is it impacting economic outlook of non-corporate dairy sector? What are the covariates of TFP change in the non-corporate dairying?

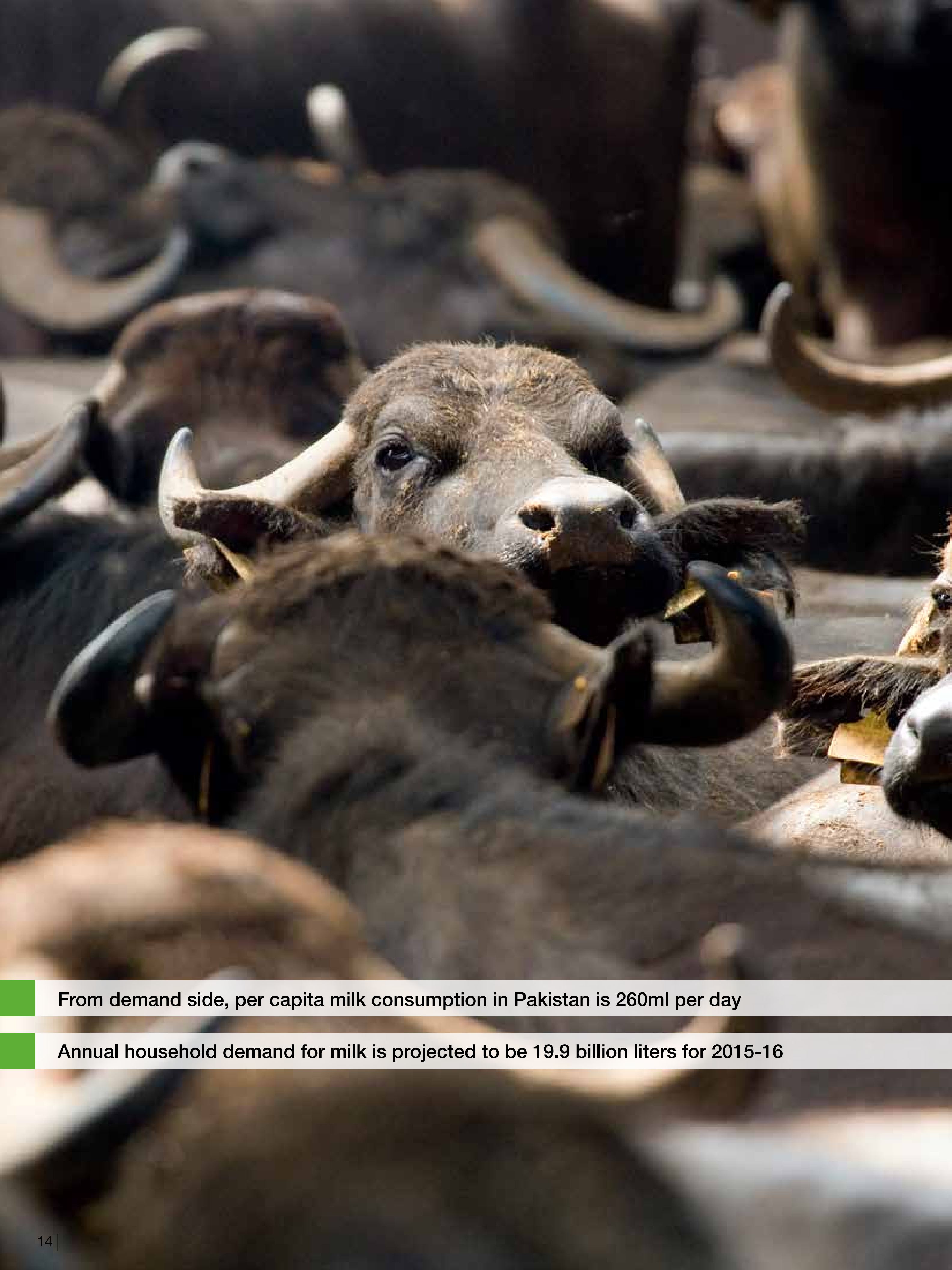
The Livestock Development Policy 2007 was instrumental in attracting big business to establish large-scale corporate dairy farms, however, the farm structure of the corporate dairy sector, its potential for vertical integration and economies of scale and more importantly the challenges faced by this segment are also unclear.

Under nutrition is a condition where a person is not consuming enough calories, proteins, or vitamins and minerals, which can be the cause of stunting and wasting, micronutrient deficiencies, and other diseases. Milk among other things is an important source of calcium and vitamins, which can be effectively used to fight malnutrition. How these nutritional deficiencies affect productivity and GDP growth in the country and what are its other costs to society is largely unclear.

The Federal Board of Revenue (FBR) is trying hard to bring more businesses into the tax net to raise tax to GDP ratio in the country. While a zero rating regime is in place on direct materials consumed by the milk processing industry, refunds claims are admissible at the rate of 17% on indirect materials, viz., fuel, electricity, packing, spare parts, etc. However, accumulation of refunds with the FBR over the past few years has raised the question whether or not the imposition of sales tax on dairy outputs of the processing industry would be a better deal for the dairy processing industry. However, no simulation exercise has been conducted at any level to evaluate and to find out answers to this critical policy issue for the milk processing industry.

This study attempts to answer the questions raised above. Section 2 presents a dairy sector profile on the basis of secondary data. Section 3 deals with the economics of agriculture related to non-corporate dairying where the focus is on feed sources, economic value of fodder consumed by dairy animals and seasonal variations in fodder availability. Section 4 tries to understand the dynamics of non-corporate dairy farming and the economic outlook of the small farms on the basis of primary data collected in 2005 and 2014. Section 5 presents evidence on productivity growth in the non-corporate dairy farms and its sources. Section 6 explores the economics of corporate dairy farms focusing on farm structure and practices and potential for vertical integration and economies of scale. Section 7 provides evidence on the structure of milk processing industry, distribution of liquid dairy products and highlights major challenges faced by the corporate sector. Section 8 reveals the economics

of nutrition while Section 9 investigates the welfare implications of imposing sales tax on milk processing industry in the country. The last section proposes recommendations for the government, milk processing industry and the corporate dairy sector.



From demand side, per capita milk consumption in Pakistan is 260ml per day

Annual household demand for milk is projected to be 19.9 billion liters for 2015-16

Chapter 2

DAIRY SECTOR PROFILE: ESTABLISHING THE FACT BASE

2.1 Introduction

Historically, the livestock sector is dominated by smallholder subsistence livestock farmers who are spread all over Pakistan and meet their protein and nutrition needs from this sector, and earn cash incomes on a daily or weekly basis. The "National Agenda of the Economic Development" of the present government has envisaged the role of poverty alleviation and curbing disparities in incomes for the livestock sector (GoP, 2014). However, it remains to be seen how this agenda is implemented in the years to come.

Due to the rising population, increasing incomes, changing consumer preferences towards livestock and dairy products, and increasing export demand, the demand for the livestock and livestock products is increasing at a rapid pace in Pakistan. The rising trend in real prices of livestock and dairy products is a reflection of the demand overshooting supply, which has provided great incentives to producers and new investors to raise production volumes in this sub-sector.

Before we proceed to study the economics of milk production from different angles, it is important to establish the fact base by examining the current profile of the dairy sector. Hence, the objective of this chapter is to highlight the profile of the dairy sector of Pakistan by examining inter-census growth in herd size, milk volumes and growth in milk yield per animal. We also explore how official supply side estimates of milk availability in the country compare with the demand side estimates to identify discrepancies, if any. Then we move on to present evidence on Pakistan's dairy value chain, which is followed by discussion on the role of government policy in dairy sector development in Pakistan.

2.2 Livestock Population and Growth in Herd Size

The Pakistan Livestock Census 2006 (GoP, 2007) reveals that the share of livestock in agriculture sector growth has increased from 25.3% in 1996 to 49.6% in 2006 (GoP, 2007).[1] Faster growth in the livestock sector is attributed to growth in livestock population and milk yields. Livestock population increased from 91 million in 1986 to 110 million in 1996 and 143 million in 2006 (Table 2.1). Inter-census growth in livestock population was 21% in 1996 and 31% in 2006. The latest inter-census growth of livestock population at 3.1% per year is much higher than the growth in human population in the country. If these trends continue, per capita availability of livestock that was 0.865 in 1996 and 0.896 in 2006 should have reached 0.946 in 2015. In other words, the Pakistan Livestock Census data suggests that holding other things constant, supply was overshooting demand. By contrast, the rising trend in the real prices of dairy and livestock products in the country suggests otherwise. This discrepancy in the numbers in the livestock census is also highlighted in the analysis that follows. Inter-census growth in cattle population was 45% in 2006, which is remarkably higher than the 16% growth in the previous 10 years (see Table 2.1). Similarly, inter-census growth in buffalo and goat population was respectively 35% and 31% in 2006 as compared with 1996. Clearly this growth is much higher than the population growth rate of nearly 2% per annum. Projecting these growth rates for population of cattle, buffaloes and goats for the next 10 years would suggest that their per capita availability is growing rapidly in the country. But, holding all else constant, we find that real prices of beef, mutton and fresh milk have ballooned in the recent years, which tends to negate the view that supply is overshooting demand.

[1] *A primary source of data on the livestock sector is the Pakistan Census of Livestock conducted by the Pakistan Bureau of Statistics after every 10 years.*

Inter-census growth in cattle population was 45% in 2006, which is remarkably higher than 16% growth in the previous 10 years (see Table 2.1). Similarly, inter-census growth in buffalo and goat population was respectively 35% and 31% in 2006 as compared with 1996. Clearly this growth is much higher than the population growth rate of nearly 2% per annum. Projecting these growth rates for population of cattle, buffaloes and goats for the next 10 years would suggest that their per capita availability is growing fast in the country. But, holding all else as constant, we find that real prices of beef, mutton and fresh milk have ballooned in the recent years, which tends to negate the view that supply is overshooting demand.

Table 2.1: Comparative status of livestock population between 1986-1996 & 1996-2006

Type of Animal	Livestock population (in '000)			% change between	
	1986	1996	2006	1986 & 1996	1996 & 2006
Cattle	17,540	20,424	29,559	16	45
Buffaloes	15,705	20,273	27,335	29	35
Sheep	23,286	23,544	26,488	01	13
Goats	29,945	41,169	53,787	37	31
Camels	0.958	0.815	0.921	-15	13
Horses	0.388	0.334	0.344	-14	03
Mules	0.069	0.132	0.156	91	18
Asses	2,998	3,559	4268	19	20
Total Animals	**90,891**	**110,250**	**142,858**	**21**	**30**

Source: Pakistan Economic Survey 2006-2007

The distribution of livestock population by provinces is presented in Table 2.2 where we show that Punjab and Sindh provinces have a dominant share of livestock. It can be seen that 72.4% cattle and 92% buffalo population is found in Punjab and Sindh.

Table 2.2: Livestock population by provinces (in '000)

Location	Cattle	Buffaloes	Sheep	Goats	Camels
Pakistan	29,559	27,335	26,488	53,787	921
Punjab	14,412	17,747	6,362	19,831	199
Sindh	6,925	7,340	3,959	12,572	278
KPK	5,968	1,928	3,363	9,599	64
Balochistan	2,254	320	12,804	11,785	380

Source: Pakistan Livestock Census 2006

A vast majority of dairy households in Pakistan operate under conditions of subsistence (1 to 2 animals) or near subsistence (3 to 4 animals). They consist of small agricultural farmers, tenants or landless laborers who operate mostly in rural areas with the help of family labor and sell much smaller quantities of milk. These smallholders have very high stakes in dairy production because their income from dairying serves as an effective tool of supplementing other income. However, market oriented households keep large herd sizes of cattle and buffaloes, use family and hired labor and operate like a business for commercial supply of milk in rural and urban areas.

A comparison of dairy households across the 1996 and 2006 livestock censuses reveals that the share of subsistence and near-subsistence households owning buffaloes is decreasing and the share of commercial dairy farms owning buffaloes is increasing (Table 2.3). Unlike buffalo farms, the proportion of households owning up to 30 cattle has generally remained unchanged. But, we notice a remarkable increase in the percentage of households owning more than 30 cattle. Also, farms owning more than 50 cattle have increased by 114%, going from 0.14 in 1996 to 0.30 in 2006 (see last row of Table 2.3). We expect this share to have further increased in the post-2006 period due to growth of corporate dairy farms,[2] although no published data is available to substantiate this claim. However, data from industry sources suggests that these incentives have to some extent helped to restructure local dairy industry with the setting up of around 50 corporate dairy farms in Punjab and Sindh provinces with herd-sizes ranging from 100 to 12,000 dairy animals. We provide a detailed analysis of the corporate dairy farming in the country in a separate chapter.

The Pakistan Livestock Census reports impressive growth in milk production in recent decades. Table 2.4 reveals that the highest growth rate is recorded in production of milk by cows showing an

[2] *The government incentives to corporate dairy in the Livestock Development Policy 2007 were instrumental in this growth.*

Table 2.3: Herd Size by Households

Herd Size	Livestock Census 2006		Livestock Census 1996		% change between 2006 & 1996	
	Households owning cattle (%)	Household owning buffaloes (%)	Households owning cattle (%)	Household owning buffaloes (%)	Household owning cattle	Household owning buffaloes
1 – 2	43.11	42.44	42.05	43.47	1.06	-1.03
3 – 4	27.47	27.59	27.48	28.67	-0 .01	-1.08
5 – 6	13.52	13.36	13.85	10.03	-0.33	3.33
7 – 10	10.00	10.43	10.74	9.78	-0.74	0.65
11 – 15	3.35	3.64	3.46	3.32	-0.11	0.32
16 – 20	1.13	1.26	1.18	0.98	-0.05	0.28
21 – 30	0.74	0.74	0.77	0.5	-0.03	0.24
31 – 50	0.39	0.34	0.33	0.18	0.06	0.16
51 or more	0.30	0.20	0.14	0.07	0.16	0.03

Source: Pakistan Livestock Census 2006

increase from 9.36 billion liters in 1996 to 13.33 billion liters in 2006, or a growth rate of 42.4% at an average rate of 4.24% per annum. Milk production by buffaloes also registered an impressive growth of 32.5% since milk production increased from 18.90 billion liters to 25.04 billion liters, or a growth of 32.5% over the ten year period at an average of 3.25% growth per annum. If seen in the light of data on growth in cattle and buffalo population (Table 2.1), it appears that there were no gains in milk yield per animal. Indeed these growth rates are remarkable since they are higher than the population growth rate of the country.

Table 2.4: Milk production per annum between 1986 – 1996 & 1996-2006

Type of Animal	Gross annual production of milk* (billion liters)			% change between	
	1986	1996	2006	1986 & 1996	1996 & 2006
Cows	7.07	9.36	13.33	32.40	42.40
Buffaloes	14.82	18.90	25.04	27.50	32.50
Total	**21.89**	**28.26**	**38.37**	**29.10**	**35.60**
Goats	--	--	0.32	--	--

Source: Pakistan Economic Survey 2006-2007

* *Production of milk is worked out by using average annual lactation length of 250, 305 and 50 days for cows, buffaloes and goats, respectively.*

Together, milk production of cows and buffaloes has increased by 35.6% (see Table 2.4) from 1996 to 2006, at a growth of 3.6% per annum. The census data suggests that due to faster growth in cow milk, the share of cow milk in total milk production has increased (from 33.1% in 1996 to 34.7% in 2006). The share of buffalo milk has decreased from 66.9% in 1996 to 61.71% in 2006. This is consistent with the growth in large cattle farms noted above. Despite the decline in total milk yield from buffaloes over the years, buffaloes still remain the largest contributors toward aggregate milk production.

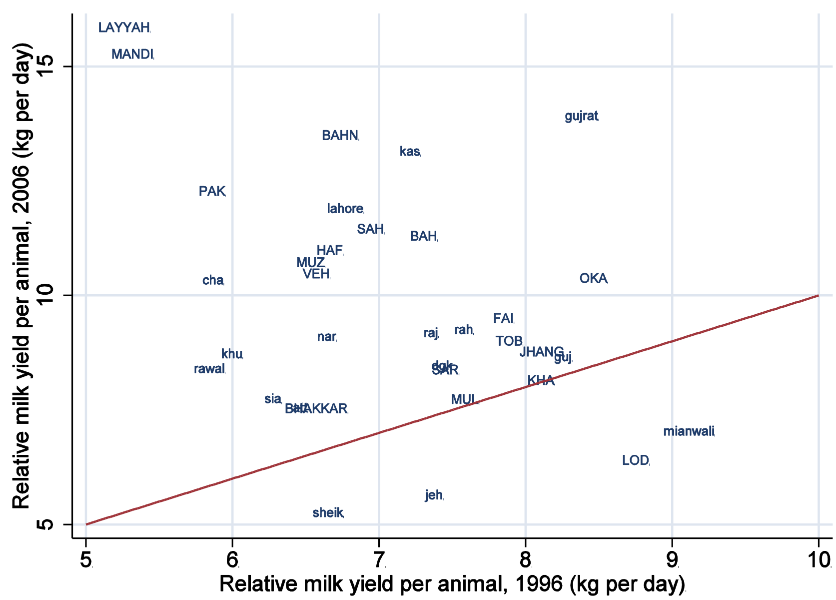
The average milk yield per animal and the gross milk production per day show that animal productivity varies across animal types (see Table 2.5). Buffaloes yield, on average, 7.93 liters of milk per day. Cows have a lower milk yield compared to buffaloes and produce, on average, about 6.14 liters of milk per day. Goats have the lowest milk yield of the three categories. They produce only 1.42 liters of milk daily. Provinces show a similar trend in terms of animal productivity. However, in 2006 average milk yield per animal was highest in Sindh followed by Punjab. Further, it can be inferred that buffaloes contributed 58.01%, cows 37.53%, and goats only 4.45% of total milk production (from cows, buffaloes, and goats) per day.

An inter-census comparison of milk yield per animal across Punjab districts is presented in Figure 2.1. All districts that lie above the 45^{o} line indicate relative improvement in milk yield over the two time periods. Similarly, districts that are placed below the line show a decline in relative milk yield and those

Table 2.5: Average milk yield per animal and total milk production per day							
Administrative Unit	Average milk yield per animal per day (liters)			Production of milk per day (liters)			Total
	Cows	Buffaloes	Goats	Cows	Buffaloes	Goats	
Pakistan	6.14	7.93	1.42	53,093,388	82,061,310	6,293,093	141,447,791
KPK	5.08	7.28	1.33	9,538,051	5,883,543	1,593,859	17,015,453
Punjab	6.31	7.71	1.36	25,580,103	48,046,392	1,098,037	74,724,532
Sindh	6.61	8.90	1.72	14,180,469	27,164,112	2,123,103	43,467,684
Balochistan	6.15	7.61	1.09	3,794,764	967,262.6	1,478,094	6,240,121

Source: Pakistan Livestock Census 2006

located on the line indicate no change in their milk yield per animal over the two time periods. Overall, there is a significant improvement in milk yield per animal in most districts in 2006 over 1996. Relative milk yield has remained unchanged in Multan and Khanewal districts as they lie on the 45° line. Relative milk yield has declined in Mianwali, Lodhran, Jhelum, and Sheikhupura districts. Average milk yield in Jhelum has declined from 7.5 kg to 5.5 kg and from 9kg to 7 kg in Mianwali.



The most remarkable finding in Figure 2.1 is the three-time increase in relative milk yield in Layyah and Mandi Bahauddin going from nearly 5kg per day in 1996 to around 15kg per day. In other words, there was a 200% increase in milk yield in 10 years or 20% increase in per annum, which is hard to believe. Also, there are other districts where relative milk yield per animal has increased in the range of 50% to more than 100%. These numbers coming from the Pakistan Livestock Census 2006 raise serious questions on the quality of the census data. We will verify these numbers by comparing them with our survey data.

2.4 Per Capita Milk Consumption: Is There a Disparity?

Per capita consumption of milk based on supply side estimates is often contested by the dairy industry. There is a general view that the official numbers based on Pakistan Census of Livestock are not realistic. However, there is no concrete evidence to verify this claim. In this section, we contribute to resolve this controversy by taking data from two different sources to calculate milk production (supply side estimate) and compare it with actual data on milk consumption (demand side estimate) by the households.

The supply side estimates are based on milk available for human consumption, taken as 80% of gross annual production, plus imports of dry milk. Data available for human consumption was taken from the Pakistan Economic Survey 2014-15 (GoP, 2015), which is based on inter-census growth rate of Livestock Census 1996 and 2006 (GoP, 2015). A large part of milk available for human consumption is consumed as fresh, boiled and packed milk while the rest is used for commercial dairy products and industrial uses. The Agriculture Statistics of Pakistan 2010-11 notes that 55% of milk available for human consumption is consumed as fresh milk (GoP, 2011, Table 171). Therefore, we work out net milk availability by taking 55% of milk available for human consumption and then adding to it the imported dry milk volumes.

Net availability of milk has increased from 20.764 billion liters in 2011-12 to 22.851 billion liters in 2014-15 (Table 2.6). These numbers are consistent with the numbers reported by the Food and Agriculture Organization (FAO) (see, FAO, 2011) and International Dairy Association because their source of data is also the Pakistan Livestock Census. Per capita fresh milk availability has increased from 115 liters per annum in 2011-12 to 119 liters in 2014-15 or per capita per month milk availability of around 9.97 liters in 2014-15. On a per day basis, milk availability ranges from 0.315 liters (320 grams) to 0.326 liters (340 grams), which is much higher than 290 grams in India and the world average of 285 grams.[3]

To verify the supply side numbers, a natural alternative is the estimation of per capita consumption from the demand side, assuming that supply and demand of milk is equal. Therefore, in the next step we take a demand side route and calculate actual milk consumption from the nationally representative household survey namely, the Household Integrated Economic Survey (HIES) component of the Pakistan Social and Living Standards Measurement Survey (PSLM). HIES survey data is national, provincial and rural-urban representative, which is collected by the Pakistan Bureau of Statistics, Government of Pakistan. The sample size of HIES 2011-12 and HIES 2013-14 rounds was 15,000 and 18,000 households, respectively. The household survey provides detailed information on households' consumption of fresh, boiled milk and milk products consumed by households on a two weeks recall basis. We extract data on household consumption of milk and its equivalent milk products.

Our results suggest that the amount of milk that Census of Livestock (supply side) said is available for human consumption is just 81% the amount that households (demand side) said they consumed. Based on demand side estimates, per capita consumption of fresh milk was 0.24 liters in 2011-12 and 0.26 liters in 2013-14, respectively (Table 2.7), which was significantly lower than the supply side consumption estimates for the same period of 0.315 liters and 0.322 liters, respectively (Table 2.6). This discrepancy in production and consumption data may be attributed to measurement errors in the two data sources. It is not surprising because there are differences in the two data sources in terms of definitions, coverage and methods. However, this is a significant disparity, which needs to be rectified by the relevant quarters for meaningful policy making.

Per capita milk consumption also varies across rural and urban areas as well

Table 2.6: Per capita availability of milk from supply side (million liters)

(million liters)	2011-12	2012-13	2013-14	2014-15
Production	37,383	38,582	39,819	41,098
55% consumed as fresh milk	20,560	21,220	21,900	22,603
Dry milk imported	203.3	212.0	215.9	319.5
Net availability	20,764	21,365	22,116	22,851
Per capita availability (liter/annum)	114.91	116.26	117.63	119.18
Per capita availability (liter/month)	9.58	9.68	9.78	9.97
Per capita availability (liter/day)	0.315	0.318	0.322	0.326

Source: This table is adapted from the Agriculture Statistics of Pakistan (GoP, 2011), Table 171 where this information is reported from 2003-04 to 2010-11 in tonnes. We use the same method to calculate per capita milk availability in liters based on the recent data obtained from the Pakistan Economic Survey 2014-15 (GoP, 2015). Data on dry milk import was taken from the State Bank of Pakistan's website http://sbp.org.pk. One tonne of dry milk is taken as equivalent to 4 tonnes of liquid milk. We multiply values in tonnes with 1000 to convert them into kilograms. These values are then multiplied by 0.96805 to convert milk from kilograms to liters.

Table 2.7: Per capita milk consumption in Pakistan from demand side

	Average per capita consumption per day (liters)	
	2011-12	2012-13
Pakistan	0.24	0.26
Urban	0.23	0.24
Rural	0.25	0.27
Punjab	0.29	0.30
Sindh	0.21	0.24
KPK	0.17	0.18
Balochistan	0.11	0.11

Source: Authors' calculations from PSLM-HIES 2011-12 and 2013-14
Notes: Per capita milk consumption includes consumption of fresh milk, packed milk, butter milk, powdered milk, butter, margarine, cream, cheese, kheer, firni, ice cream, kulfi, curd, yogurt, sweets, e.g., burfi and halwa, etc. Milk products are converted to their milk equivalents by using the conversion scales. Quantities consumed of kheer/firni/ice cream were not reported in the HIES survey. We converted them into quantity by dividing with their price per kg of PKR 200 in 2011-12 and PKR 300 in 2013-14. To make household consumption of milk and milk products nationally representative, we multiplied them with their respective population weights.

[3] *http://timesofindia.indiatimes.com/city/vadodara/Indias-per-capita-milk-availability-above-world-average/articleshow/27301696.cms, accessed on 12th September, 2015.*

as across provinces. As expected, per capita milk consumption is higher in rural than in urban areas. Moreover, per capita consumption of fresh milk is highest in Punjab followed by Sindh, and then KPK and Balochistan.

Table 2.8 works out the disparity between the demand and supply side estimates of milk production. The estimates suggest that the disparity amounts to an estimated shortage of about 7 to 8 billion liters of milk in the system. Demand for milk is growing in Pakistan at an average growth rate of 13.49%. Demand growth is highest in KP (18.8%), followed by Sindh (16.5%) and then in Punjab (13.49%). Assuming that household consumption patterns of 2013-14 would persist in 2015-16, the annual household demand for milk comes to 19.895 billion liters per year. Demand for milk in Punjab and Sindh provinces comes to around 12.532 billion and 4.225 billion liters per year, respectively.

Table 2.8: Disparity between demand and supply side estimates of milk production (million liters)

	Demand side estimates of milk production		Supply side estimates of milk production		Gap between supply side and demand side estimates	
	2011-12	2013-14	2011-12	2013-14	2011-12	2013-14
	(1)	(2)	(3)	(4)	(5)	(6)
Pakistan	12147	15425	20764	22116	8617	6691
Urban	3911	5160	--	--	--	--
Rural	8236	10265	--	--	--	--
Punjab	8005	10016	--	--	--	--
Sindh	2390	3178	--	--	--	--
KPK	1143	1573	--	--	--	--
Balochistan	342	362	--	--	--	--
FATA	267	296	--	--	--	--

Source: These estimates do not include consumption of milk in AJK and FATA. Numbers in columns (1) and (2) are based on PSLM-HIES data by using population weights of the respective regions. Estimates for FATA are based on average per capita consumption in KP, which is multiplied by population estimates obtained from Pakistan Economic Survey for respective years. Columns (3) and (4) report net availability of milk reported in Table 2.6.

2.5 Pakistan's Dairy Value Chain

Currently, the dairy sector of Pakistan is dominated by subsistence farmers. The inchoate milk marketing system is subject to a host of problems. Milk is a highly perishable commodity, which requires a quick and efficient collection system, especially in the hot summer months. This coupled with the rise in urbanization and growth in population has led to the move towards commercialization. Big corporations have entered in the milk processing market as people are gradually moving towards packaged milk and other value added dairy products. The current marketing system comprises of rural, urban, and processed milk marketing chains with various agents and dairy middlemen involved in each chain at every step. In this section, we examine each of these value chains.

2.5.1 Agents Involved in the Value Chain

The milk supply chain involves various agents comprising milk producers, collectors, processors, and finally, the consumers. According to FAO (2011), around 80 percent of the dairy producers are smallholders operating at a subsistence level, 14 percent are medium sized producers and 3 percent are large-scale producers. Due to structural changes and rapid growth in the milk industry, the relative share of these producers is gradually changing. Initially treated as a sideline activity, more people are now investing in the dairy business, encouraged further by the financial institutions that have introduced credit schemes tailored for dairy production and marketing (Younas, 2013).

The milk collectors comprise of middlemen known as dodhis. The rural milk collectors who operate at a small scale are called katcha dodhis and the milk collectors who operate at a medium or large scale are called pacca dodhis. Large milk processing plants either collect milk on their own or use the services of third-party agents who fetch milk from farmers in far off rural areas and then sell them to the processing units. The increased number of players collecting farmer milk has introduced healthy competition, which has helped farmers to focus more on better production techniques and feeding plans (Burki et al. 2004, Burki and Khan, 2011).

2.5.2 Value chains and distribution system

The milk marketing chains fall mainly under three categories, rural, urban and processed. Rural and urban supply chains fall under informal marketing chain and the processed chain is classified as a formal marketing chain. According to FAO (2011), almost 95 percent of the milk is sold through informal chains while the rest is sold through formal chains. The main difference between the two supply chains lies in the handling and storage techniques used.

Rural Marketing Chain:

In the rural supply chain, most of the milk produced is first used for domestic consumption and only surplus milk is sold. The collection and distribution system is based on an interlinked network of collectors known as dodhis who operate individually or in groups. These dodhis enter into contracts with the milk producers, paying them a flat daily fixed price in order to guarantee daily production and also save themselves from seasonal price fluctuations. Especially in summer, as the retail price of milk increases the dodhis benefit from these fixed contracts as the price premiums are not passed on to farmers (FAO, 2011).

The rural milk market involves kacha and pacca dodhis who act as middlemen between milk producers and consumers. The kacha dodhis are village based milk collectors operating at a small scale who collect milk from multiple households in villages. They collect milk from 10-15 smallholders, which is around 80-100 liters (Younas, 2013). This un-pasteurized and un-chilled milk is then delivered to pacca (large scale) dodhis or to the urban milk shops. In some cases these kacha dodhis also provide milk to the processed milk industry, which operates via Hilux or mini-van contractors or through village milk collection centers (VMCs). The katcha dodhis also sell some milk directly to consumers in the village or nearby towns. The scale of their activities depends on the mode of transport that they are relying on, which can be in the form of bicycle, motorbike, bus or train.

The large scale or pacca dodhis operate at a relatively larger scale, collecting around 250 to 1000 liters per day (Shah et al., 2008). They collect milk from kacha dodhis and provide it to urban milk shops and urban consumer households. Most of the raw milk that reaches the milk shops is sold within 1 or 2 hours (Younas, 2013). Before taking the milk to urban milk shops, it is first taken to de-creamers and khoya makers for extraction of cream.

This traditional system of milk marketing has a very limited capacity to grow as it is based on a weak, undeveloped structure. Milk is of a perishable nature and dodhis buy it on the basis of quantity and not quality, putting it at a risk of spoilage. Furthermore, the weak infrastructure, lack of proper roads and cold chains makes it difficult to reach remote milk production areas (FAO, 2011). Moreover, there are hygienic concerns as well because the traditional dodhis usually store milk in non-food grade and dirty containers while transporting them via donkey carts, cycles, motorbikes or trucks.

Urban Marketing Chain:

The urban marketing chain relies on milk production in urban and peri-urban areas supplemented by the supply from rural producers. The peri-urban dairy farmers operate on the outskirts of large cities. In case of urban marketing chain, it is easy to access the consumers and usually there are no middlemen involved, enabling the gawalas to produce as well as sell the milk and get a higher return. According to Burki et al. (2004), gawala or cattle colonies in Karachi and Lahore enter into contracts with milk shops and other milk consumers, supplying them with milk directly on motor bikes, jeeps and pick-ups.

Processed Marketing Chain:

The milk processing industry has penetrated the urban market via introduction of new packaging and milk processing techniques by the private sector. The major products produced by the processing plants in the milk industry through the Ultra-High Temperature (UHT) process are pasteurized milk, tea creamers, ambient while milk, dairy drinks and beverages, among others. The processed milk industry relies on two kinds of supply chains: milk collection through third party suppliers and, self-collection from smallholder dairy producers, large dairy farms and corporate dairy farms. The self-collection system is now gradually replacing the third party supplier system as processing plants want to ensure that the milk is free from any form of adulteration.
The collection criteria depend on a 6% fat content, where price premiums are paid for milk with higher fat content (FAO, 2011). A cold chain is used for bulking and transporting the milk, where milk from Farm Cooling Tanks (FCTs) is transported via refrigerated tanks to the processing plants.

2.6 The Role of Government Policy in Dairy Sector Development

Historically, policy makers in Pakistan have paid little attention to the dairy sector, but much more attention to the development of the crop sector. Here we provide a brief snapshot of the policy environment in the country.[4]

The earliest attempts to improve the state of the dairy sector were made in the First Five-Year Plan (1955–60), which focused on improving breeding centers, hospitals, and dispensaries to curtail the spread of contagious diseases amongst animals (GoP, 1957). It also sought to invest in research on increasing fodder supplies, and starting pilot schemes for artificial insemination of cattle (GoP, 1957). The plan also aimed to remove gujjar (a caste of milkmen) colonies from cities like Lahore to the

[4] *This sub-section draws heavily from Burki et al. (2004).*

outskirts, and recommended pilot milk supply schemes for Karachi and Lahore. Further, it also suggested the testing of milk for purity, the delivery of pasteurized milk in sealed bottles via milk depots, and the concentration of milk production in villages near the cities "where small farmers would specialize in dairying by keeping half a dozen or more cows, produce their own feed and organize themselves into cooperatives for assembling, transporting and even processing of milk" (Burki et al., 2004).

However, this plan proved to be too ambitious, and eventually the government shifted its focus towards other industries: The Second Five-Year Plan (1960–65) was targeted toward the development of the large-scale manufacturing sector (GoP, 1966); and the Third Five-Year Plan (1965–70) focused on agricultural development in the crop sector rather than the dairy industry (Burki et al., 2004).

Despite this shift in focus, the government's milk supply scheme for Karachi was put into action in 1965, when subsidized milk was made available to low-income families and school children (Burki et al., 2004). A similar pilot project was initiated in Lahore in 1967. However, both these projects were eventually abandoned because they failed to receive the support of successive governments (Burki et al., 2004).

There were further developments in the milk processing industry during the sixties and seventies, as a part of the development of the manufacturing sector, 23 milk pasteurization and sterilization plants were set up in Karachi, Lahore, Rawalpindi, and Islamabad (Anjum et al., 1989). These plants used, recombined, and pasteurized skim milk powder[5] before selling it to consumers. However, not only did this recombined milk product had a short shelf life, but it also received a weak response or acceptance from consumers, which ultimately led to the failure of these plants (Anjum et al., 1989). Essentially, "inadequate supplies of fresh milk to milk processing industry proved to be the major hurdle in their success" (Burki et al., 2004).

During the late-seventies and early-eighties, the government provided policy support for the dairy industry in the form of "exemptions of income tax, duty free import of machinery and equipment, and availability of domestic and foreign currency financing" (Burki et al., 2004; GoP, 1990). The success of Packages Limited in producing UHT treated milk captured interest in the late-seventies, encouraging other producers to enter the field (Burki at al., 2004). Tetra Pak Pakistan Limited also started producing "aseptic packaging material for the UHT treated milk" (Burki et al., 2004). Multiple UHT plants were set up in the eighties. However, the demand for processed milk was lower than anticipated by producers in the short run. Consequently, most of the plants were shut down, or did not begin their operations (Burki et al., 2004).

Other than making claims, successive governments in the period of nineties did not initiate any tangible policy for the improvement of the dairy sector. However, with the dawn of the new millennium, a number of projects were initiated to strengthen the livestock and dairy sector. These included efforts to eradicate rudder pest disease, and to enhance vaccine production against newly emerging trans-boundary animal diseases (GoP, 2009).[6] In 2005, the government initiated a 5-year long project called the Milk Collection, Processing, Dairy Production and Development Program. The aim of this project was to encourage rural subsistence dairy farmers to enter the milk marketing chain. It provided 15,000 to 20,000 additional breeding animals of better genetic potential in the hope that their offspring would produce higher milk yields (GoP, 2008). Another project (known as the Prime Minister's Special Initiative for Livestock) was launched in the same year to enhance livestock productivity through the provision of subsidized livestock production and extension services at farmer's doorsteps (GoP, 2009). The government also took steps to establish and improve animal quarantine facilities, improve reproductive efficiency of cattle and buffaloes, and prevent and control the spread of avian influenza amongst animals (GoP, 2008; GoP, 2009).

By 2007, the government had realized that focusing on small-holders alone would not suffice, and that to meet the excess demand for milk they would have to promote the growth of large-holders in the dairy industry. So, in an attempt to protect and develop the local dairy industry, the Government of Pakistan introduced a Livestock Development Policy in 2007, which encouraged the establishment of large corporate dairy farms. This policy had the aim to help re-structure the dairy industry, which until then had consisted primarily of small-scale dairy farmers. The incentives offered by the government included exemption of taxes and duties on import of modern equipment for these dairy farms, exemption of tax on dividends, availability of liberal credit and the provision of government land for lease (Afzal, 2008). Up to 100% foreign equity was also allowed to encourage foreign investment in this sector. The government also allowed import of high yielding animals, semen and embryos for cross-breeding (GoP, 2008). Local centers for embryo transfer and semen production were also established, and it was estimated that these centers would produce 5000 embryo per year

[5] Supplies of skim milk powder were obtained through the patronage of the World Food Program.

[6] This project, also known as the "Strengthening of Livestock Services Project" (SLSP) received funding from the European Union.

for farm use (GoP, 2008). Following the introduction of this policy, the private sector has invested heavily in milk processing equipment and many corporate groups invested in dairy farming.[7] The government continued to allow import of exotic animals, high quality feed, and dairy equipment in the following years (GoP, 2014).[8] And it is continuing to take steps to diagnose and control foot and mouth disease prevalent amongst livestock (GoP, 2015).[9] But, the start-up infrastructure costs for such large scale projects are extremely high. In fact, huge losses are reported in the financial statements of these dairy businesses, suggesting that the long run feasibility of these projects remains to be assessed.

2.7 Conclusions

In this chapter, we focus on the dairy sector profile by examining growth in livestock population and growth in herd size, growth in milk yield per animal, disparity in per capita milk consumption from the supply and demand sides, dairy value chain and the role of government policy in dairy sector development. The following conclusions emerge from this chapter. One, the inter-census growth in livestock population is much higher than the growth rate of human population, but the rising trend in real prices of beef, mutton and fresh milk tends to negate this view. Two, despite growth in livestock population there was no gain in milk yield per animal. Average milk yield for cows and buffaloes comes to 6.14 liters and 7.93 liters, respectively, which is higher than the expectations of the milk processing industry. Growth in milk yield in some districts of Punjab in 2006 versus 1996 suggest that milk yield has increased by 20% per annum, which is hard to believe and raises serious questions on the quality of the Pakistan Livestock Census data. Three, we find that per capita consumption estimated from production data overstates consumption by about 33% as compared with the data from household survey. The discrepancy between supply and demand leads us to conclude that around 7 to 8 billion liters of milk could not be accounted for in the system. Finally, the analysis shows that over the past 10 years some tangible policy measures have been adopted by the government to strengthen the livestock and dairy sector.

---

[7] JK Dairies, Sapphire Dairies, and Al-Tahur Dairy Farm were the initial leaders.

[8] From July 2013 to March 2014, approximately 389.7 thousand doses of semen and 7,186 exotic dairy cows were imported (GoP, 2014).

[9] Initiatives for animal immunization against prevalent diseases, and efforts at improving animal reproductive efficiency, etc have been targeted toward both small and large scale dairy producers, and have been or are being implemented over the course of years.

Fodder contributes from 38% to 48% in cost of a subsistence dairy farm operations

Gross value of fodder consumed by dairy animals in Pakistan for 2014-15 is Rs. 55.4 billion

Chapter 3

ECONOMICS OF AGRICULTURE RELATED TO DAIRY FARMING

3.1 Introduction

Pakistan's economy is heavily dependent on livestock, which contributes significantly to the nation's gross domestic product.[10] Subsistence dairy farmers, who supply the bulk of the country's milk supply, are also dependent upon their livestock for their livelihoods. Unfortunately, however, there are significant differences in the feed sources, practices, and technology used by small scale subsistence and corporate dairy farms which have a direct impact on animal productivity. In order to increase animal productivity (or milk yield per animal) whilst reducing fodder costs incurred by dairy farms, efforts must be made to provide farmers with vocational training to understand animal-specific requirements, alleviate fodder shortages, and reduce per-liter milk production costs.

The remainder of this chapter is divided into four sections, which explore these topics in detail. Section 3.2 discusses the feed sources, practices, and technology used by the corporate and non-corporate dairy farms. Section 3.3 reports the economic value of fodder consumed and its share in total input cost for dairy farm operations. Section 3.4 analyzes seasonal variations in fodder availability, its repercussions on farmers, and how farmers can help alleviate these shortages. Finally, Section 3.5 concludes our arguments in this chapter.

3.2 Feed Sources, Practices, and Technology

Preparing feed for dairy animals requires special care and attention because the quality of feed given to the animals affects milk yield. Animals that are underfed or undernourished are likely to produce lower milk yield. Moreover, the quality of milk is also affected.

Even though feed ingredients vary from one farm to the other, it consists primarily of fodder, straws, and concentrates. Dairy farmers have access to different types of fodder (termed as Rabi fodder and Kharif fodder) and grasses like Mott grass and Sudan grass, etc.[11] These fodders are referred to as 'green fodder', and they form one of the basic ingredients of animal feed. The major content of fodder comes from maize (which has the highest dry content), barseem and lucern. Some farmers also include wheat straw, rice straw, and sugarcane tops in their herds' diet. Concentrates like cotton seed cake, cotton seed, wheat flour, wheat dalia, gram flour and molasses are also fed to the animals along with fodder. Animals are also sometimes taken to open fields for grazing.

The type of feed given to the animals varies depending upon a number of factors, including the type of dairy farm. For instance, rural subsistence farmers feed their animals on "grasses and herbs, with forages gathered from uncultivated lands, crop residues and low quality roughages" (Burki et al., 2004). Semi-subsistence and commercial dairy farmers use crop residues, agro-industrial byproducts, and green fodder (depending on its economical availability) to feed their animals (Jong, 2013). Peri-urban farmers use green fodder supplemented by concentrates (Jong, 2013) while large corporate dairy farms use healthy green fodder, and prepare corn silage to provide their animals with carbohydrates, lipids and proteins. They also use sources such as maize, barseem, sorghum grains and wheat bran to cater to the animals' mineral and vitamin requirements.

Animal feed also varies based on the weight of the animal and whether it has been impregnated or is in lactation. Typically, an adult cow is fed one-third

[10] Recent figures show that the contribution of livestock amounts to 11.8% of national GDP and 56.3% of Agricultural GDP (GoP, 2015).
[11] A formal categorization of these fodders divides them into three types: perennial or evergreen fodder, fodder grown in summer, and fodder grown in winter. Perennial fodders include lucern, Mott grass, and Sudan grass. Fodders sown in summer include maize, sorghum, and millet. And fodders planted in winter include barseem, oats, and rye grass. (Javed and Khan, n.d.)

of its total body weight, and for young calves, the feed requirement is equal to one-tenth of their total body weight (Awais and Choudhry, 2015). Also, during pregnancy, it is optimal to feed the animal 2kg of concentrate each day along with good quality fodder and to restrict straw in its diet (Pasha, n.d.). Similarly, 21 days prior to calving, the animal should be fed grain and good quality forage, but added fat should be limited and calcium should be restricted (Pasha, n.d.). After 21 days of calving, the animal feed should not include high levels of starch but should maintain a healthy level of fiber, amongst other things (Pasha, n.d.).

Most small-scale or subsistence farmers use homemade mixtures of ingredients, which comprise of home-grown or locally purchased low quality fodders and concentrates (Jong, 2013). Since the use of cutter machines is limited, most of the farmers mix the feed manually. In comparison, the corporate dairy farms pay meticulous attention to the content of fodder, and they often import some ingredients. For instance, Nishat Dairy use total mixed ration (TMR) feed where the green fodder is locally procured, and minerals are imported from Spain, Turkey, and USA (Saigol and Farooqui, 2015). Further, unlike traditional farms, the corporate dairy farms use mixer wagons to prepare balanced rations for their herd.

The differences in the feeding practices of subsistence, commercial and corporate dairy farms are alarming, which needs to be overcome through media campaigns and extension services. In this regard, vocational training may be administered on animal requirements, availability of high quality indigenous sources of feed and optimal mixtures of ingredients. They also need to be trained how to prepare silage from maize, sugarcane tops, oats, and Mott grass, etc. (Pasha, n.d.). Further, they need to be provided access to fodder reapers, and mixer wagons to save time and for more efficient production of feed.

Farmers will need support to build infrastructure and acquire equipment such as mowers, rakes, bales, and press for making silage. When there is enough demand for this equipment, a private market may emerge for equipment renting. However, in the interim period, efforts need to be made to promote demand for this equipment by providing awareness through training and extension services. In the first phase, large commercial dairy farmers may take the lead and offer this equipment on rent to smaller players. In the second and final phase, private players may provide this equipment on rent. The provincial governments may want to intervene to create this missing market by providing incentives.

3.3 Economic Value of Fodder Consumed by Dairy Animals and its Cost Share in Dairy Operations

The gross economic value of fodder consumed by dairy animals has been computed using data from the Agriculture Statistics of Pakistan and the Pakistan Economic Survey series for several years, and is given in Table 3.1.

Column 6 of the table reports the gross value of fodder crops for dairy animals and other livestock. In order to separate out the gross value of fodder consumed by dairy animals from these figures, weights were assigned to milking cows, buffaloes, sheep, and goats, as well as dry buffaloes and other animals including camels, horses and mules. These weights were then used to adjust their individual fodder consumptions. Next, these weighted fodder consumptions were added, first for only dairy animals, and then for all animals. The ratio of the weighted fodder consumption of dairy animals to all animals was then taken and multiplied with the gross value of fodder crops to obtain the gross value of fodder for dairy animals.

Table 3.1 shows that the area cultivated by fodder crops has declined over the years from approximately 2.5 million hectares in 2006 to 2.2 million hectares in 2014. Consequently, total fodder production has also fallen from 56.6 million tons in 2006 to 49 million tons in 2014. In spite of this, the gross value of fodder crops has almost doubled over the years; and with it, the total economic value of fodder consumed by dairy animals has also risen consistently and almost doubled between 2006 and 2014.

An increase in the value of fodder consumed by dairy animals along with a decrease in aggregate fodder production indicates that fodder prices must have risen. This is likely to have an adverse impact on dairy farmers who purchase fodder for their animals. This is because with a fixed income (in the short run), farmers may not be able to afford the same quantity of fodder as they could before. Growth in the livestock population can further exacerbate this problem: if farmers are unable to procure a higher quantity of feed for their growing herd, they may be unable to meet animal-specific feed requirements resulting in lower milk yields and productivity.

Table 3.1: Total value or cost of fodder consumed by dairy animals

Year	Total cropped area (million hectares)	Gross value of all crops (Rs. million)	Fodder cropped area (million hectares)	Total fodder production (million tons)	Gross value of fodder crops (Rs. million)	Gross value of fodder for dairy animals (Rs. million)
2006-07	23.560	870,990	2.501	56.589	66,641	27,281
2007-08	23.850	1,097,991	2.460	55.057	73,919	30,280
2008-09	24.120	1,460,713	2.370	53.616	85,351	34,985
2009-10	23.870	1,604,816	2.312	51.925	93,005	38,862
2010-11	22.720	2,309,517	2.236	49.235	102,289	41,979
2011-12	22.500	1,966,610	2.197	48.376	100,537	42,172
2012-13	22.560	2,192,553	2.211	48.697	104,598	43,895
2013-14	22.730	2,625,223	2.224	48.967	129,723	54,459
2014-15	22.730	2,720,514	2.226	49.015	132,108	55,481

Sources: Authors' calculations from Agriculture Statistics of Pakistan (GoP, 2011) and Pakistan Economic Survey (GoP, 2015).
Note: All values are reported in terms of current prices. Values for area cultivated with fodder crops, and total production and value of fodder crops were not available for the years 2011 to 2014. The missing figures for area cultivated with fodder crops were computed by first calculating the ratio of fodder cropped area to total cropped area for the available years, and then using moving averages to determine this ratio for the remaining years. These ratios were then used along with the respective years' total cropped area to calculate the area cultivated by fodder crops for the years with missing data. Similarly, missing values for total fodder production were filled in by computing the fodder production per unit of area for the respective previous year and multiplying it with the respective current year's fodder cropped area. Finally, missing values for the gross value of fodder crops were calculated by computing the ratio of gross value of fodder to the gross value all crops for the available years, and then using moving averages to determine this ratio for the remaining years. These ratios were then used alongside the respective years' gross value of all crops to calculate the gross value of fodder for the years with missing data.

Fodder costs impose a heavy burden on farmers (Table 3.2). For non-corporate dairy farms, cost share of fodder in dairy farm operations is as high as 47.55% when family labor is excluded, and is equal to 37.89% when family labor is included in total cost. These figures show that fodder has the highest share in total cost regardless of whether family labor is included or excluded from the calculations. However, since family labor plays an important role in the care and upkeep of the animals, figures which include family labor are perhaps a more accurate reflection of the true economic burden imposed by fodder costs on an average dairy farmer. Share of fodder costs are likely to be much higher for corporate dairy farms because they have access to higher quality and quantity of fodder compared to the subsistence farmers. However, fodder costs per animal are relatively lower for corporate farms compared with non-corporate dairy farms due to economies of scale.

Table 3.2: Cost share of inputs used in dairy farm operations

Variable	Share of input in total cost (%)	
	Excluding family labor	Including family labor
Cost of shed and structure capital	9.38	7.09
Cost of animal capital	18.99	14.69
Cost of fodder	47.55	37.89
Cost of straws and concentrate	22.52	17.71
Cost of hired labor	1.56	1.43
Cost of family labor	-	21.18

Note: Authors' calculations based on LUMS Survey of Dairy Households in Rural Punjab, 2014.

Further, seasonal variations in fodder availability also exert an upward pressure on fodder prices, making it difficult for small-scale farmers to cope with rising fodder costs. This aspect is explored in more detail in the following sub-section.

3.4 Seasonal Variations in Fodder Availability and Prices

One of the ways in which traditional and small-scale farms differ from the commercial or corporate dairy farms is in terms of fodder storage facilities. In spite of the availability of many different types of fodder, small-scale farmers succumb to fodder shortages roughly three times during the year: from mid-September till the end of October, through most of December and January, and throughout May (Javed and Khan, n.d.). Unfortunately, these seasonal variations in fodder availability force fodder prices to increase during lean seasons, thereby, imposing a heavy economic burden on farmers. Farmers are forced to pay higher prices for the same quantity of fodder for their animals. If they are unable to procure the optimal quantity of high quality fodder for their herd due to budgetary constraints, it is likely that animal productivity or milk yield may decline. Unless measures are taken to help farmers improve fodder storage facilities and equipment, rising fodder costs and lack of access to good quality fodder may have an adverse impact on their incomes.

The major content of fodder comes from maize, barseem, and lucern. Lucern is a perennial fodder, which can be utilized all year round that can help alleviate variations in fodder availability.[12] Even so, animals have specific feed requirements that need to be met. For instance, animals should be fed approximately 26-28% dry matter in their feed (Awais and Choudhry, 2015). This requirement can be fulfilled by including maize in their feed. However, maize, which has the highest dry content, is only available in spring and autumn. Farms without proper storage facilities are unable to procure maize in bulk at low prices during its peak season because they do not have the infrastructural capacity to store it. This difficulty can easily be overcome in two ways.

Firstly, maize can be fed to the animals directly during its peak season, and maize stocks can also be conserved by farmers in the form of silage for later use. Silage requires less storage space than maize stocks, enabling farmers with smaller storage facilities to buy maize in bulk. Further, silage preparation can also help reduce fodder costs for farmers since maize stock is relatively cheaper to obtain than corn or maize grains.[13]

Secondly, instead of planting the maize crop all at once, farmers that produce their own fodder should plant it at intervals so that they have access to more supplies of maize towards the end of the season to prepare silage. If stored properly, the availability of maize during the autumn and the spring season can especially help farmers to curb fodder shortages in the mid-September to October period, as well as during the month of May.

Farmers can also use the latter strategy to prolong the provision of other crops during their seasons by sowing them at intervals as well. This may prove beneficial, since animals have other feed requirements as well. The intake of Kharif and Rabi fodders, for instance, helps animals maintain the optimal level of body heat in different seasons.[14]

Essentially, better crop management and fodder storage can help farmers reduce fodder costs significantly.[15] Firstly, farmers should be made aware of the possible measures they can take to alleviate fodder shortages. Secondly, they need to be provided loans to build infrastructure for the storage of fodder. They also need access to equipment such as mowers, rakes, bales, and press for silage preparation. Lastly, they need training on how to conserve maize, sugarcane tops, oats, and Mott grass in the form of silage for the future consumption of animals. Since the share of fodder costs in total input cost is high, measures to reduce fodder cost will significantly reduce per liter milk production costs as well.

3.5 Conclusion

In sum seasonal variations in fodder availability affect subsistence and small-scale farmers the most as they are unable to purchase fodder in bulk at low prices during their peak seasons due to lack of fodder storage facilities. Estimates from recent data show that fodder costs form a major chunk (37.89%) of the total input costs incurred by dairy farm operations. Therefore, it is essential to reduce these costs in order to decrease per liter milk production costs for the farmers.

The gap between the practices of small and large-scale dairy farms, and the issue of fodder shortages need to be resolved if the average dairy farmer are to increase farm profitability. Farmers need to be made aware of the different ways in which they can alleviate fodder shortages and reduce fodder costs. They need to be trained how to prepare

[12] Other perennial fodders like Mott grass and Sudan grass can also help bridge fodder shortages faced by farmers.

[13] Farmers sometimes produce more maize crop than they require. When this happens and the maize is harvested, farmers extract the grains from the excess crop and either sell off the maize stocks or stems at a very low cost or give it to other farmers for free. Even if the maize stocks are obtained for free, the farmer might still incur collection and transportation charges; however, these costs are usually nominal.

[14] Summer-time or Kharif fodders contain less protein which helps animals counter the adverse effects of high temperatures; similarly, winter-time or Rabi fodders have a higher protein content which helps animals endure cold climates (Javed and Khan, n.d.).

[15] For instance, assume that maize prices increase by 5% during its lean season. If farmers purchase maize in bulk and then convert it to silage, they would not have to pay the additional 5% because they would not need to purchase it during the lean season. If all the farmers in the country purchase maize for their animals during the peak season only, aggregate fodder savings would have amounted to as much as Rs.2,774 million (5% of Rs.55,481 million) in 2014 (see Table 3.1).

silage for the consumption of animals during periods of fodder shortage. They also need access to necessary equipment for silage preparation. Due to lack of demand, there is missing market for renting-out services for silage making equipment. Private equipment renting-out services may develop on their own when there is enough demand for the equipment in rural areas. In the interim period, some tangible efforts needs to be made to promote demand for this equipment by providing awareness through training and extension services. If farmers sow fodder crops at intervals within their respective seasons, they will be less vulnerable to variations in fodder availability.

From 2005 to 2014, pure buffalo farms have declined from 62% to 27%

In the same period, mixed (cows & buffaloes) farms have gone up from 22% to 52%

Farmers selling milk directly to milk processors have gone down from 46% to 32% in the last 10 years

Chapter 4

UNDERSTANDING NON-CORPORATE DAIRY FARMING IN PAKISTAN

4.1 Introduction

Fresh milk being a highly perishable item demands prompt and efficient collection from milk producers to consumers and manufacturers of milk. Until early 1990s, traditional rural milk collectors, known as dodhis, were the only players playing the role of middlemen between millions of subsistence and commercial dairy farmers and consumers. Long distances, poor transportation networks and absence of storage facilities prevented effective access to dairy farms located in far off places leading to market failures. As a result, the nominal price of fresh milk stagnated. For example, the price of fresh milk which was Rs.3.03 in 1976-77 increased to only Rs.7.71 in 1990-91; in real terms, the price fell from Rs.13.42 in 1976-77 to Rs.11.88 in 1994-95 prices (Burki et al, 2004).

With burgeoning urbanization, income growth, and cities growing in size, the demand for urban milk has rapidly increased, which, in turn, has promoted large scale commercial dairy production of farmer milk.[16] The milk processing industry has gradually built up fresh milk supply chain network by working directly with smallholder commercial dairy producers in rural Punjab and Sindh for collection of surplus dairy milk. Rural milk supply chain runs through two independent but competing networks of milk collectors serving markets for open gawala milk and processed milk. The supply chain for fresh gawala milk consists of a dense but labor-intensive network of small, medium and large-scale dairy marketers known as dodhis who serve as middlemen between milk producers and milk users including de-creamers and khoya makers, sweet manufacturers and halwais, confectioners, milk shops and consumers. However, the milk processing industry operates through transport contractors, village milk collecting agents, village milk collection centers, chilling units, among others.

To conduct an in-depth analysis of the dairy sector, a first round of LUMS Survey of Dairy Households in Rural Punjab was conducted by the authors in 2005. This survey provided basic information about the production systems and technical efficiency of the dairy farms. The sample was drawn from both the districts where industry had and had not established the milk collection network. The efficiency of the dairy farms in milk collection districts was found to be much better than others. While the dairy sector has experienced marked changes over the last decade, no systematic evidence has been gathered ever since to explore the dynamics of change.

Hence this chapter tries to understand the changing dynamics of the non-corporate dairy sector by focusing on the economic outlook of these dairy farms. First, we present details on the dairy sector survey explaining survey design, survey rounds, distribution of sample respondents and details on the survey questionnaire used to collect data. Second, we present changing distribution of the dairy farms to highlight some important trends. Third, we calculate rate of return to dairy farms in 2005 and 2014 to see the emerging patterns. More specifically, we provide evidence on returns by herd size, by mode of selling milk to informal versus formal milk collecting agents and compare returns to the dairy sector with returns to major crops.

4.2 LUMS Survey of Dairy Households in Rural Punjab

The Census of Livestock is a primary source of data on the livestock and dairy sector in the country, which is conducted after a gap of 10 years by the Pakistan Bureau of Statistics (PBS), Statistics Division, Government of Pakistan. The last three censuses were conducted in 1986, 1996 and 2006 while the next census is due in 2016. The census provides data on livestock composition and the livestock units. The other important source of data on the livestock

[16] *Burki et al. (2004) have documented the characteristics of three milk production systems, viz., rural milk production, city and peri-urban milk production and commercial dairy farming and have also highlighted the future potential of this sector.*

sector is the cross-section household survey known as the Pakistan Social and Living Standards Measurement Survey (PSLM) also conducted by PBS. This survey contains a separate module on the livestock and dairy. However, the two surveys do not provide information on commercial dairy producers since it is beyond their scope. Particularly, the two PBS surveys do not cover information on milk collection agents in rural areas of the sort required to conduct detailed analysis on the economics of milk production and the role of milk processing industry. With this objective in mind, we designed a survey of smallholder dairy producers in rural Punjab to get detailed information on the profile of commercial dairy producers. The name of the survey is LUMS Survey of Dairy Households in Rural Punjab. Here we describe the survey design, and present a picture of returns to family dairy farms.

4.2.1 Survey Design

Punjab is the most populous of the four provinces producing nearly 70% of total fresh milk in the country. While dairy farms are evenly spread out in Punjab, surplus milk is available in districts located in Southern Punjab due to which milk processing plants collect most of the milk from these districts. A representative sample of dairy farms was drawn from rural Punjab to conduct the analysis. The target respondents owned at least one milching animal (buffalo or cow), sold milk for at least 6 months, and did not share ownership of farm resources with other households during the calendar year of the survey.

Cluster sampling method was used as a probability sampling plan where sampled area (rural Punjab) was divided into sections based on agro-climatic (crop) zones, mouzas/villages and target groups. Districts in Punjab have significant differences in climate (arid vs. non-arid), soil conditions, temperature, rainfall, and water availability due to which dairy production significantly varies. To allow for different environmental production conditions, we followed Pinckney (1989) and classified districts into five agro-climatic (or crop) zones consisting of (1) wheat-rice, (2) wheat-mix, (3) wheat-cotton, (4) low intensity barani, and (5) barani (rainfed).

In stage 1, we randomly selected 10 districts (two districts from each agro-climatic zone) from 34 districts of Punjab. The sample districts were Hafizabad and Narowal in wheat-rice zone, Sargodha and Okara districts in mixed-cropping zone, Pakpattan and Khanewal districts in wheat-cotton zone, Muzaffargarh and Layyah in low-intensity zone, and Jhelum and Attock in barani zone. In stage 2, mouza/village was used as the basic geographical unit due to its convenient and divisible nature.[17] Four mouzas/villages were randomly drawn from each selected district based on the list of mouzas/villages obtained from Pakistan Mouza Statistics 1998 (GoP, 1999). Out of the 40 mouzas/villages sampled, 26 had at least one industry player involved in milk collection in 2005 survey round. In stage 3, a census of each village was conducted for listing of commercial dairy farmers. On the basis of these lists, 20 dairy farms were randomly selected from each village with equal probability. Five replacement dairy households were selected from each village for non-response from selected dairy households. Of the 800 dairy households sampled, 160 dairy households were drawn from each agro-climatic zone, 10 districts and 40 villages.

4.2.2 Survey Rounds

Two survey rounds were conducted. Round 1 of the survey was conducted in 2006 to collect data for the calendar year 2005 while Round 2 was conducted in 2015 to collect information for the calendar year 2014.[18] Round 1 was conducted from January to April 2006 while Round 2 survey was conducted from January to May 2015. In Round 1, all 800 dairy farms were interviewed, but when they were approached after a gap of 9 years for Round 2 survey, only 725 dairy households could be found and surveyed with an attrition rate of 9.4%, which is quite standard in such surveys. For all practical purposes, we use data of only those dairy households who were surveyed in both survey rounds, which leaves us with a balanced panel of 725 dairy households.

4.2.3 Distribution of Sample Respondents

The list of sample villages covered in the survey is presented in Table 4.1 while Table 4.2 shows the distribution of working sample by districts. The number of dairy farms covered range from lowest of 131 in barani region (Jhelum and Attock districts) to highest of 154 in rice-wheat region (Narowal and Hafizabad districts). The number of respondents range from 64 in Jhelum district to 79 in Okara district.

[17] Mouza is the smallest administrative unit under the revenue department which may consist of one big village or few small villages. Punjab province has 23385 mouzas with an average of 600 mouzas in each district.

[18] The survey was carried out by a three-member team of professional enumerators who had 14 to 16 years of schooling in humanities and social sciences and had vast experience of conducting village level surveys. They belonged to rural Punjab and therefore had the added advantage of understanding all local dialects of the Punjabi language spoken in the sampled area. The enumerators were given a one-day orientation session to ascertain that they clearly understand the questions and the procedure of conducting the sample survey. Pre-testing of the survey questionnaire was done in second week of December 2005 after which the questionnaire was revised. A second orientation session of two-hour duration was conducted with the enumerators in third week of December 2005 to provide further clarifications on survey questions in the light of initial feedbacks from pre-testing of the questionnaire. The respondents were interviewed during January 2006 to April 2006.

Table 4.1: List of sample Mouzas by districts

District	Mouza/village
Narowal	Mahyanwala; Bhelowalee; Deblywala; Kakkay
Hafizabad	Tahili Goraya; Saroopwala; Kot Alam; Kot Gazi
Sargodha	Bhakhi; Verowal; Chak-7-Alif; 77-Janobi
Okara	14-GB; 23-D; Vinaik; C-9/1-R
Pakpattan	Dhawana; 70-D; 66-EB; 35-EB
Khanewal	27-10R Chak; 83-85 Chak; Baati Bangla; 3-Kassi Jadeed
Muzafargarh	Aludhaywali; Bannywala; Pati Khar; Bait Budhra
Layyah	121-TDA; Bhagul; 341-TDA; Kacha Ahsan
Jhelum	Chak Mahmand; Hatia Dhamial; Khurd; Hiranpur
Attock	Kasran; Mathyan; Attock Khurd; Gee Kasran

Source: LUMS Survey of Dairy Households in Rural Punjab, 2005 & 2014

Table 4.2: Distribution of sample respondents by districts

Agro climate Zone/ District	Sample size by district	Sample size by agro-climatic zone
Rice-wheat:		154
Narowal	77	
Hafizabad	77	
Mix cropping:		150
Sargodha	71	
Okara	79	
Cotton-Wheat:		146
Pakpattan	74	
Khanewal	72	
Low Intensity Barani:		144
Muzaffarghar	66	
Layyah	78	
Barani:		131
Jhelum	64	
Attock	67	
Total	725	725

Source: LUMS Survey of Dairy Households in Rural Punjab, 2005 & 2014

4.2.4 Survey Questionnaire

A 26-page survey questionnaire was developed, which was appended by the World Health Organization (WHO's) self-reporting questionnaire-20 (or SRQ-20)[19] to measure prevalence of depression in the dairy farmers. The survey questionnaire was administered to collect information on various attributes of commercial dairy farms. The information was collected on household head, personal characteristics of household members, dairy production, marketing of milk, information on dairy animals and livestock, cost of dairy production, dairy sector environment, socioeconomic development of villages, land ownership profile of the household, information on crop sector, farm structures and machinery, loans and credit, profile of casual and permanent labor, wheat marketing by producers, and a module on WHO's SRQ-20. This information was obtained, by the enumerators in face-to-face interviews conducted on their respective farms. The interviews were administered on those household members who were directly involved in management and decision-making of farming activities. In most cases the respondents were household heads themselves.

4.3 Changing Dynamics of Non-Corporate Dairy Farms

The changing dynamics of smallholder non-corporate dairy farms is evaluated by using the data on commercial dairy producers in Punjab obtained from the LUMS Survey of Dairy Households in Rural Punjab. The data pertains to 725 smallholder dairy households who were surveyed both in 2005 and 2014 with an attrition rate of 9.4%.

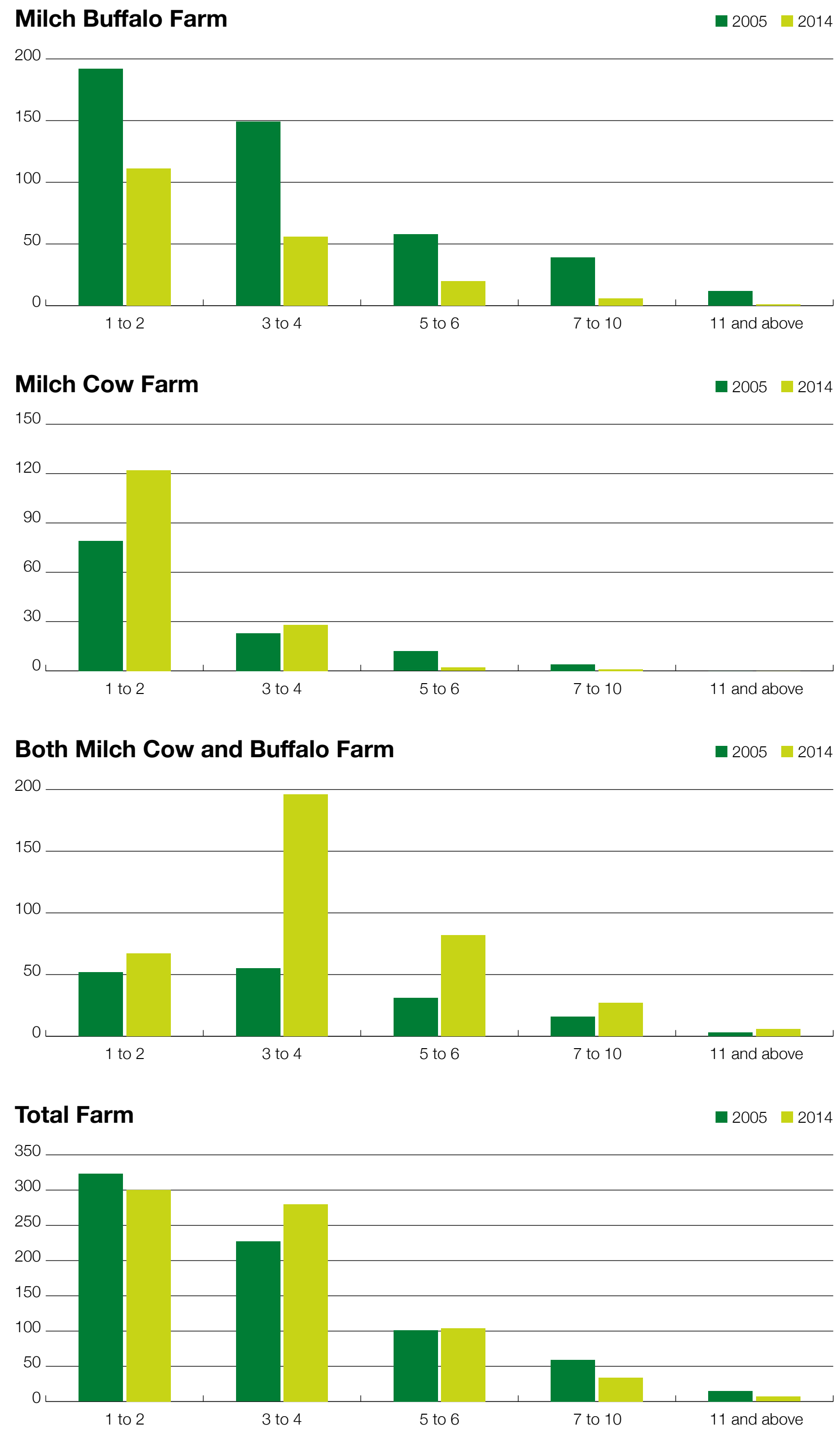
[19] *A user's guide to the World Health Organization's Self Reporting Questionnaire is available at http://apps.who.int/iris/bitstream/10665/61113/1/WHO_MNH_PSF_94.8.pdf. Accessed on 23rd April 2016.*

4.3.1 Change in distribution of dairy farms by herd size and by farm type

A distribution of sample dairy households in 2005 and 2014 is presented in Figure 4.1 and Table 4.3 by herd size and by farm type. We define herd size of 1 – 2 as subsistence, 3 – 4 as near subsistence, 5 – 10 as small, and 11 – 20 as medium farms. More than 41% of the sample dairy farms in 2014 were subsistence farms (herd size of 1 – 2), down from 45% in 2005. The second largest category were near subsistence farms (herd size of 3 – 4), which increased from 31% in 2005 to 39% in 2014. The rest of the dairy farms in the sample maintained more than 4 dairy animals and their proportion has decreased from 24% to 20% in the same period.[20]

There is convincing evidence from the survey that pure buffalo farms have declined whereas pure cow farms as well as mixed farms (both cows and buffaloes) have increased in the study period (Table 4.3). The last row of the table reveals that the proportion of pure buffalo farms have decreased from 62% in 2005 to only 27% in 2014 and pure cow farms have increased from 16% to 21% in the same period; at the same time, the number of mixed farms has increased from 22% in 2005 to 52% in 2014. Increase in the number of cow and mixed dairy farms was most pronounced in subsistence and near subsistence categories where the proportion of subsistence cow farms have increased from 79 farms in 2005 to 122 farms in 2014. However, the most dramatic increase was found in the number of mixed farms in near subsistence category going up from 55 farms in 2005 to 196 farms in 2014. The herd size in sample dairy farms has also changed, but these changes are not remarkable. For example, the number

Figure 4.1: Distribution of dairy households by herd-size and farm type



[20] *The distribution of the sample survey does not match with the national distribution of the Pakistan Livestock Census because our focus is only on commercial dairy households while the Pakistan livestock census includes both commercial and non-commercial dairy farms.*

of subsistence farms has declined by 7% 2014 over 2005 while the number of near subsistence farms has increased by 23% in the same period.

4.3.2 Change in distribution of dairy farms by size of landholding

Table 4.4 presents changes in distribution of dairy households by farm size where we note change in the landholding profile of sample dairy farms over the two survey rounds. More specifically, the numbers of dairy farms owned by landless households and those who own up to 12.5 acres of land have increased while the numbers of dairy farms owned by those owning more than 12 acres of land have decreased. Nearly 75% of the sample dairy farms are landless or they own small landholdings and the rest of them own more than 12.5 acres (Table 4.4).

4.3.3 Change in distribution of dairy farms by mode of selling milk: formal vs. informal

Table 4.5 presents distribution of dairy farms by mode of selling milk to formal and informal milk collectors. Informal sources include dodhis, transporters, contractors, village and city milk shops, and neighbors. Formal sources include village milk collecting agents, milk collection centers and chilling units of milk processing industry.

It reveals that selling to milk processing industry that was a popular option in 2005 has lost appeal. Most of the farms have already switched to informal milk collecting agents. We show that the dairy farms who were selling milk to processing industry has gone down from 330 farms (46% of total) in 2005 to only 233 farms (32% of total) in 2014 or a decrease of 29%. The new pattern prevails in all districts where the industry was involved in collection milk from the

Table 4.3: Change in distribution of dairy households by herd size and by farm type (numbers, %)

Herd Size (2005)	Milch buffalo farm	Milch cow farm	Both milch cow and buffalo farm	Total farms
1 to 2	192	79	52	323
3 to 4	149	23	55	227
5 to 6	58	12	31	101
7 to 10	39	4	16	59
11 and more	12	0	3	15
Total	**450 (62.07%)**	**118 (16.28%)**	**157 (21.66%)**	**725 (100%)**
Herd Size (2014)	**Milch buffalo farm**	**Milch cow farm**	**Both milch cow and buffalo farm**	**Total farms**
1 to 2	111	122	67	300
3 to 4	56	28	196	280
5 to 6	20	2	82	104
7 to 10	6	1	27	34
11 and more	1	0	6	7
Total	**194 (26.76%)**	**153 (21.10%)**	**378 (52.14%)**	**725 (100%)**

Source: LUMS Survey of Dairy Households in Rural Punjab, 2005 & 2014

Table 4.4: Change in distribution of respondents by farm size

Farm Size (2005)	Frequency	(%)
Landless	118	16.28
Under 5 acres	186	25.66
5 - < 12.5	235	32.41
12.5 - < 25	111	15.31
25 acres or more	75	10.34
Total	**725**	**100**
Farm Size (2014)	**Frequency**	**(%)**
Landless	124	17.10
Under 5 acres	203	28.00
5 - < 12.5	241	33.24
12.5 - < 25	99	13.66
25 acres or more	58	8.00
Total	**725**	**100**

Source: LUMS Survey of Dairy Households in Rural Punjab, 2005 & 2014 dairy farms including Pakpattan and Okara districts where in 2005 there was almost a complete capture of the rural milk market by the milk processing industry. Needless to say that the milk processing industry was not present in three of the sampled districts, namely Narowal, Jhelum and Attock in both time periods and excluding them from this analysis presents even a bleaker picture.

Table 4.5: Change in distribution of sample dairy farms by mode of selling milk

District (2005)	Sell milk to dodhi/IFS	Sell milk to milk- processors
Attock	67	0
Hafizabad	24	53
Jhelum	64	0
Khanewal	22	50
Layyah	43	35
Muzaffargarh	38	28
Narowal	77	0
Okara	6	73
Pakpattan	3	71
Sargodha	51	20
Total (%)	**395 (54.50%)**	**330 (45.50%)**
District (2014)	**Sell milk to dodhi/IFS**	**Sell milk to milk- processors**
Attock	67	0
Hafizabad	46	31
Jhelum	64	0
Khanewal	31	41
Layyah	56	22
Muzaffargarh	39	27
Narowal	77	0
Okara	26	53
Pakpattan	32	42
Sargodha	55	16
Total (%)	**492 (67.86%)**	**233 (32.14%)**

Source: LUMS Survey of Dairy Households in Rural Punjab, 2005 & 2014

4.4 Economic Outlook of Non-corporate Dairy: Costs and Returns to Dairy Farms

In a conventional setting of the theory of the firm, profitability is generally calculated by the simple rule

$\pi = TR - TC$

where π is for profit, TR is for total revenue, and TC is for total cost. However, in the case of family farms like those in our survey, family labor and own land is fully committed to farm production. In this case, returns to family farms are defined as

$RFF = TR - TVC - R$

where RFF depicts returns to family farms, TR is total revenue, TVC is total variable cost and is opportunity cost on fixed capital, e.g., animal capital, machinery, shed and structures. It is pertinent to note that family farms do not maximize profits in the conventional sense, but they do maximize RFF and compare it with transfer earnings (TE) (i.e., the minimum acceptable returns to family farms). As long as RFF > TE, the family farms continue their operations; they only quit when their transfer earnings fall below RFF.

How do returns to family dairy farms compare in our sample? We calculate total revenue and total cost of dairy producers in our sample survey. First, we calculate cost of production of milk on each dairy farm by summing up cost of five inputs used by the dairy producers. Cost of shed and structure capital is worked out by taking the opportunity cost; cost of animal capital is the user cost worked out on the basis of the total remaining life-span of the dairy animals. Costs of fodders, straw and concentrate and hired labor are the actual out of pocket costs reported by the dairy farms. Our calculation of revenue from milk and farm yard manure is based on the actual sale price reported in the survey, or based on the prevailing market prices in the area. The value of capital gain on milch animals was determined on the basis of reported price for the beginning and the end of the year. All the values were converted into 2014-15 real prices by using corresponding consumer price index (CPI) obtained from the Pakistan Economic Survey 2014-15 (GoP, 2015).

Table 4.6 reports average returns to dairy households in 2005 and 2014. After paying for cost of shed and structure capital, animal cost, fodders, straw and concentrate and hired labor, average real returns per dairy farm increased by 145% (i.e., from Rs.37,652 in 2005 to

Table 4.6: Returns to dairy households in 2005 and 2014 (In PKR)

2005	Per dairy farm	Per dairy animal	Per 40kg of milk	Percent of revenue	Percent of cost
Total cost	**255,960**	**70,562**	**1,869**	**87.18**	**100.00**
Cost of shed & structure capital	13,774	4,328	117	4.69	5.38
Cost of animal capital	38,505	10,360	277	13.11	15.04
Cost of fodders	135,585	37,571	1,000	46.18	52.97
Cost of straws & concentrate	67,610	18,243	474	23.03	26.41
Cost of hired labor	485	58	2	0.17	0.19
Total revenue	**293,612**	**79,865**	**2,041**	**100.00**	**114.71**
Revenue from milk	224,842	61,922	1,555	76.58	87.84
Revenue from farm yard manure	3,495	930	25	1.19	1.37
Revenue from capital gain on milch animals	65,275	17,012	460	22.23	25.50
Total returns	**37,652**	**9,303**	**172**	**12.82**	**14.71**
2014	**Per dairy farm**	**Per dairy animal**	**Per 40kg of milk**	**Percent of revenue**	**Percent of cost**
Total cost	**235,929**	**65,388**	**2,027**	**71.91**	**100.00**
Cost of shed & structure capital	17,408	5,726	181	5.31	7.38
Cost of animal capital	39,340	11,131	338	11.99	16.67
Cost of fodders	116,071	32,627	1,036	35.38	49.20
Cost of straws & concentrate	54,690	14,480	432	16.67	23.18
Cost of hired labor	8,420	1,424	40	2.57	3.57
Total revenue	**328,090**	**92,947**	**2,729**	**100.00**	**139.06**
Revenue from milk	244,105	69,079	2,004	74.40	103.47
Revenue from farm yard manure	3,869	1,107	35	1.18	1.64
Revenue from capital gain on milch animals	80,117	22,762	690	24.42	33.96
Total returns	**92,161**	**27,559**	**702**	**28.09**	**39.06**

Source: LUMS Survey of Dairy Households in Rural Punjab, 2005 & 2014
Note: The numbers for 2005 are converted into 2014-15 prices by using CPI.

Rs.92,161 in 2014) at the rate of 16% per year. The increase in rate of return may be attributed to a 12% increase in total revenue in 2014 over 2005 and an 8% decrease in real cost, both in 2014-15 prices.

However, when we include cost of family labor (i.e., Rs.14,638 and Rs.57,337 in 2005 and 2014, respectively), the returns decline to only 12.4% (i.e., Rs.23,499 and Rs.26,404 in 2014 and 2005, respectively) at a rate of 1.4% per annum.

Likewise, real returns per dairy animal increased by 196% going from Rs.9,303 in 2005 to Rs.27,559 in 2014 or a 22% increase per annum. Real returns per 40kg of milk increased by 308% in 2014 over 2005 (or 34% per annum) going from only Rs.172 per 40kg in 2005 to Rs.702 per 40kg in 2014. As a percent of total revenue, real returns increased from 13% in 2005 to 28% in 2014; as a percent of total cost, real returns increased 17% in 2005 to 39% in 2014. Table 4.7 suggests that returns to dairy farms have witnessed marked changes overtime and that returns to farms vary by herd size. It is well known that subsistence dairy farms (1 – 2 animals) are largely managed by females with family labor and where animals are fed by grazing, grasses and roughages. However, the involvement of men

Table 4.7: Returns to dairy farms by herd size

Revenue/Cost	Herd Size				
2005 survey	**1 to 2**	**3 to 4**	**5 to 6**	**7 to 10**	**11 and more**
Revenue per milch cow/buffalo	79,887	77,263	81,431	83,932	91,744
Cost per milch cow/buffalo	72,111	67,086	71,777	71,281	79,506
Returns per milch cow/buffalo	7,776	10,176	9,654	12,651	12,238
%age Returns	9.73%	13.17%	11.86%	15.07%	13.34%
2014 survey	**1 to 2**	**3 to 4**	**5 to 6**	**7 to 10**	**11 and more**
Revenue per milch cow/buffalo	92356	89909	96302	103682	129618
Cost per milch cow/buffalo	58819	66606	74620	80128	86190
Returns per milch cow/buffalo	33536	23303	21682	23554	43428
%age Returns	36.31%	25.92%	22.51%	22.72%	33.50%
Increase/decrease in 2014	**331.3%**	**129.0%**	**124.6%**	**86.1%**	**254.9%**

Source: LUMS Survey of Dairy Households in Rural Punjab, 2005 & 2014
Note: The numbers for 2005 are converted into 2014-15 prices by using CPI.

becomes dominant with increase in farm size. The highest increase in real return per animal is recorded for subsistence households (331%), followed by relatively large farms (11 animals and more) where increase in real return was 255%. The returns to herd sizes 3 – 4 and 5 – 6 have been similar while the lowest increase in return is recorded for herd sizes 7 – 10 animals. The returns to dairy farms follow a U-shaped pattern where the returns first decrease reach to the minimum level and then increase.

Table 4.8: Returns to dairy farms by mode of selling milk

2005		
Revenue/Cost	**Sell to dodhi/IFS**	**Sell to processors**
Revenue per milch cow/buffalo	77,556.52	83,269.10
Cost per milch cow/buffalo	69,201.23	72,246.10
Returns per milch cow/buffalo	8,355.30	11,023.00
%age Returns	11%	13%
2014		
Revenue/Cost	**Sell to dodhi/IFS**	**Sell to processors**
Revenue per milch cow/buffalo	92,409.72	94,674.04
Cost per milch cow/buffalo	63,619.16	69,035.50
Returns per milch cow/buffalo	28,790.56	25,638.54
%age Returns	31%	27%

Source: LUMS Survey of Dairy Households in Rural Punjab, 2005 & 2014
Note: The numbers for 2005 are converted into 2014-15 prices by using CPI.

Table 4.8 presents returns to dairy farms by mode of selling milk. In 2005, farmers earned 32% more returns by selling milk to milk processors as compared with dodhis and other agents operating in the informal sector.[21] Over the years, this equation has drastically changed in favor of milk agents operating in the informal sector. In 2014, the returns to dairy households selling milk to processors are 12.3% less than others, i.e., Rs.25, 638 versus Rs.28, 791. We noted above that average return per animal in the entire sample is Rs.27, 599 (Table 4.8). However, its distribution significantly varies by mode of selling milk, viz., the average return to dairy households that sell milk to dodhis is Rs.23, 046; the average return to those who sell milk to processors is Rs.25, 638; and the average return to those who sell milk to other agents is Rs.36, 233. In other words, the return offered by other agents (e.g., milk transporters, village shopkeepers, city shops and neighbors) are 41% more than processing units and 57% more than dodhis.

4.5 Conclusions

This chapter was an attempt to evaluate the dynamics of the smallholder dairy producers in a changing environment and to explore their total factor

[21] They include milk transporters, village shopkeepers, neighbors, and city shops.

productivity change and technical inefficiency over time.

The first general insight of this chapter, on the basis of evidence from two rounds of dairy survey in 2005 and 2014, is that pure buffalo farms have declined while pure cow farms and mixed farms have increased over the last one decade. This may be explained by the increasing cost of dairy inputs overtime, which has made buffalos unprofitable due to their low yields and higher maintenance cost. Selling milk to milk processing industry has been a popular choice 10 years ago, but this pattern has changed since dairy farms who sell milk to milk processing industry has declined by 14 percentage points over the two survey rounds, which should be a matter of concern for the processing industry.

Second, the chapter sheds light on changes in return to dairy households. The findings suggest that average real return per dairy farm (excluding cost of family labor) has increased by 145% (from Rs.37, 652 in 2005 to Rs.92, 161 in 2014) at the rate of 16% per annum. However, including opportunity cost of labor in the total cost, the return increases only by 12.4% in the same period at a rate of 1.4% per annum. Similarly, returns per dairy animal and per 40kg of milk are also impressive, excluding cost of family labor, however, it presents a dismal picture when cost of family labor is also accounted for. We also note that in 2005, returns (excluding cost of family labor) to dairy farms who were selling milk to milk processing industry were 32% more relative to farms who were selling to informal milk collectors. Surprisingly, this picture has changed over time. Now the dairy farms selling milk to milk processing industry earn 12% less than others. The returns per dairy animal are slightly more than returns on per acre of wheat-coarse rice system, but much lower than return on per acre of sugarcane, wheat-basmati rice and wheat-cotton combinations.

Table 4.9: Break-up of cost and revenue of some major crops in 2014 (In PKR)

Cost/Profitability/ Returns	Wheat	Cotton	Sugar Cane	Basmati Rice	Coarse Rice
Ploughing	2,813	3,677	3,081	3,379	3,019
Seed	731	617	8,828	258	231
Farm yard manure	527	120	174	53	0
Fertilizer	4,860	5,298	5,662	5,182	6,773
Pesticide and weedicide	895	6,428	993	1,270	1,330
Irrigation	1,853	1,488	2,568	5,718	5,807
Harvesting and threshing	560	116	0	163	0
Interest on loans	448	249	2,376	1,117	6,449
Depreciation cost on machinery & structures	8,192	10,154	30,065	14,688	32,873
Hired labor	1,037	1,143	2,925	1,359	1,370
Rental cost	14,647	12,880	34,299	16,801	17,917
Family labor	2,890	3,132	3,658	2,555	2,149
Value of production	54,874	57,258	123,623	52,502	49,796
Total cost	39,453	45,303	94,628	52,542	77,917
Total cost (minus family labor and rental cost)	21,916	29,292	56,671	33,186	57,851
Profitability	15,421	11,956	28,994	-40	-28,121
Returns (minus family labor and rental cost)	32,958	27,967	66,951	19,316	-8,056
%age Profitability	28%	21%	23%	0%	-56%
%age Return	60%	49%	54%	37%	-16%

Source: LUMS Dairy Survey of Households in Rural Punjab, 2014

Table 4.10: Comparison of returns on dairy and major crops, 2014 (in PKR)

	Per dairy animal	Per acre of sugarcane	Per acre of wheat and basmati rice	Per acre of wheat and coarse rice	Wheat and cotton
Total running cost	65,388.35	56,671.19	55,101.81	79,766.95	51,207.44
Total revenue	92,947.51	123,622.60	107,375.94	104,669.73	112,132.47
Total returns	27,559.16	66,951.41	52,274.13	24,902.78	60,925.03
%age Returns	30%	54%	49%	24%	54%

Source: LUMS Survey of Dairy Households in Rural Punjab, 2014

There is an overall productivity decline of 1.4% per year

Failure to innovate is the most common reason for overall productivity decline

Chapter 5

PRODUCTIVITY GROWTH IN NON-CORPORATE DAIRY FARMS

5.1 Introduction

The dairy sector of Pakistan has witnessed dramatic changes over the last two and a half decades. During this period, there was a substantial increase in the demand for fresh and packed milk owing to urbanization and growth in real incomes of urban consumers. Until 1990s, while fresh milk prices remained stagnant largely due to market failures in rural milk markets, there was reversal in this trend afterwards. Partly this was due to the interventions of the milk processing industry in the rural milk market where they have established a large milk collection network, which has opened the doors for increasing competition among the industry players for purchase of milk. The milk processing industry has seen a remarkable growth as revealed by the growing number of UHT and pasteurized milk processing units. At the same time, traditional milk collectors who function in the informal sector have also become stronger. More importantly, there has been an increased but healthy competition between formal and informal milk collection networks leading to higher farm-gate prices of milk.

Initial evidence suggests that the vast and growing milk collection network of the milk processing industry that operates only in milk surplus districts of Punjab, has made a positive impact on the incentive structure to the smallholder dairy producers.[22] For example, Burki and Khan (2011) have shown, on the basis of survey data of 800 smallholder dairy farms in rural Punjab, that technical inefficiency of the dairy farms is significantly reduced when: (1) they have larger herd-sizes, (2) they are experienced farmers, (3) they sell milk to the milk processing industry, and (4) the dairy farms are located in remote rural villages. Moreover, increase in number of industry players buying farmer milk in a village promotes price competition leading to decreased technical inefficiency of the dairy farms.

Over the last decade, the informal milk collecting agents have also become powerful. They transport surplus milk from rural to urban areas and metropolitan centers. Billions of rupees are being injected annually into the participating villages and towns by formal and informal milk collecting agents. Due to rising competition, retail price of fresh milk has gone up from Rs.21.28 in 2004-05 to Rs.69.86 in 2013-14, which translates to roughly 40% increase in real terms in 2007-08 prices (GoP, 2014). Side by side, the prices of major dairy inputs have also witnessed substantial increase in the same period. Even though growth rates of both dairy outputs and dairy inputs have been positive over the last decade, it is not clear whether output growth rate has exceeded growth rate of all dairy inputs. Therefore, the direction, magnitude and sources of productivity change in the dairy sector are unclear.

This chapter is an attempt to measure total factor productivity and its components for a group of 725 smallholder dairy producers for the last one decade, using the non-parametric Malmquist productivity index. We evaluate productivity change and its components from different angels and also comment on the determinants of productivity change. We also explore the stochastic production frontier and technical inefficiency effects model on the same data and provide evidence on input-output elasticity and comment on the determinants of technical inefficiency.

5.2 Total Factor Productivity Change in Non-Corporate Dairy Farms

Indeed competition for farmer milk in Pakistan has consistently led to increase in farm-gate prices of milk over time.[23]

[22] Favorable production conditions were created for the dairy producers with the setting up of modern milk storage facilities, access to chillers in remote rural areas, better and dependable transportation networks, regular payment schedules to small dairy producers, buyer-side competition, technical support and farmer extension services.

[23] However, there was a vast variation in milk prices across regions depending upon the pressures of demand and supply of milk.

Likewise, prices of key dairy inputs have also increased over time, varying across regions. By definition, total factor productivity change is measured by the differential in dairy output growth rate with dairy input growth rate. In theory, we expect increased competition should enhance productivity of the dairy farms after an initial adjustment phase. However, few studies have provided estimates of productivity change mainly due to non-availability of relevant data.[24]

We explore productivity change for a group of commercial smallholder dairy producers in Punjab over the last decade by employing the non-parametric Malmquist productivity index on the survey of smallholder dairy producers for rural Punjab for 2005 and 2014. Appendix – 1 outlines the methodology for the Malmquist productivity index, describes data and the construction of variables. The Malmquist index constructs a best-practice frontier on the basis of the survey data and compares individual dairy farms to that frontier.[25] We calculate the Malmquist productivity indexes as TFP change, technical efficiency change, efficiency change, pure efficiency change and scale change for each of the 725 farms in the sample.

Table 5.1: Geometric means of the Malmquist productivity change index and its components

Index name	Number of dairy farms	Productivity change	Standard deviation
Aggregated results			
Total factor productivity change (TFPCH)	725	0.872	0.558
Technical efficiency change (TECHCH)	725	0.866	0.150
Efficiency change (EFFCH)	725	1.008	0.564
Pure efficiency change (PECH)	725	0.946	0.533
Scale efficiency change (SECH)	725	1.065	0.161
Disaggregated results			
Total factor productivity change (TFPCH) < 1	443	0.634	0.188
Total factor productivity change (TFPCH) ≥ 1	282	1.440	0.553
Technical efficiency change (TECHCH) < 1	582	0.816	0.104
Technical efficiency change (TECHCH) ≥ 1	143	1.102	0.078
Efficiency change (EFFCH) < 1	375	0.707	0.180
Efficiency change (EFFCH) ≥ 1	350	1.473	0.535
Pure efficiency change (PECH) < 1	416	0.688	0.182
Pure efficiency change (PECH) ≥ 1	309	1.452	0.504
Scale efficiency change (SECH) < 1	220	0.919	0.071
Scale efficiency change (SECH) ≥ 1	505	1.136	0.141

Source: LUMS Survey of Dairy Households in Rural Punjab, 2015 & 2014

A summary description of the average performance of the dairy farms is presented in Table 5.1. Note that an index value of 1 implies no change in productivity, the value of less than 1 means deterioration in performance (or productivity regress) and the value of greater than 1 indicates growth or improvement in the performance. To get average increase or decrease over the study period, we subtract 1 from the reported number in the tables. Growth or regress in productivity per annum is obtained by dividing this number by 9.

[24] Avila and Evenson (2010) is perhaps the only study that has used cross-country data obtained from FAOSTAT to calculate TFP growth in both agriculture and livestock sectors during 2001-2001. Their estimates suggest that TFP growth in the livestock sector of Pakistan has increased by 1.17% per annum during 1961-1980, and 3.98% per annum during 1981-2001. However, no results are reported for TFP change in the dairy sector. Fuglie (2012) has extended TFP estimates to 2011, but they have not separated TFP change of the livestock sector from the agriculture sector. Their findings suggest that TFP growth in the agriculture sector of Pakistan has increased by 1.93% per annum during 1961-1970, 0.14% during 1971-1980, 3.21% during 1981-1990, 1.22% during 1991-2000 and 0.83% per annum during 2002-2011. More recently, Burki et al. (2016) has also estimated TFP growth in agriculture and livestock sector by using Pakistan KLEMS database. They show that TFP has increased at the rate of 2.89 percent per annum from 1980 to 2010. They note that TFP growth has played more important role than factor accumulation in growth of output. However, they have not estimated TFP growth in the dairy sector alone. To the best of our knowledge no other study has provided productivity change for the dairy sector of Pakistan.

[25] Following Fare et al. (1994), we use DEA-like linear programming methods to measure the distance functions by assuming constant returns to scale technology. Grifell-Tatje and Lovell (1995) have illustrated that the Malmquist index does not correctly measure TFP change under variable returns to scale technology. Hence we impose constant returns to scale technology to estimate output distance functions. We compute the TFP index of each farm by using DEAP computer program of Tim Coelli (Coelli, 1996).

Looking at the full sample results, we find that on average productivity (TFPCH) of the sample dairy farms as a whole cumulates to a 2014 value of 0.872, implying that on average they were 12.8% less productive in 2014 than they were in 2005. In other words, there was mean productivity decline of 1.42% per year from 2005 to 2014. Virtually all of productivity decline at an aggregate level is attributable to technical regress (TECHCH) on the benchmark technology, implying an inward shift of the frontier itself. Overall technical change index cumulates to 0.866 in 2014, implying a decline in technical change index at a mean rate of 1.49% per year. However, efficiency change (EFFCH) index has improved at a very slow rate, which cumulates to 1.008 in 2014, implying improvement in resource use efficiency of 0.8% in 2014 over 2005. The growth in efficiency change index is jointly explained by pure efficiency change (PECH) and scale change (SECH). Pure efficiency change cumulates to 0.946 in 2014, implying a divergence of 5.4% from the frontier technology. It indicates that the dairy farms were not good at converging toward the best practice frontier. The scale change (SECH) index cumulates to 1.065 in 2014, which implies convergence of the dairy farms toward optimal scale, but at a slow rate of 0.72% per year.

A closer look at the disaggregated results shows that the aggregate productivity numbers mask remarkable growth in productivity in 282 dairy farms or 39% of the total sample where TFPCH index cumulates to 1.44 (or 44% productivity growth), implying a mean rate of productivity growth of 4.9% per year on these farms. By contrast, 443 or 61% of the dairy farms were such where productivity change in 2014 cumulates to 0.634, indicating that these farms were 37% less productive in 2014 than in 2005 with an average annual decline of 4.1%.

Disaggregated results for technical efficiency change suggest that failure to innovate is much more common in the sample than otherwise since 80.3% (or 582 farms) of the farms experienced technical regress of 18% from the benchmark technology, while the rest of the farms experienced technical progress of 10.2%. However, there is somewhat equal split between dairy farms that succeeded in improving resource use efficiency versus those who were not so successful whereas improvement in efficiency change (47.3%) far exceeds efficiency decline (29.3%). A similar pattern is observed in pure efficiency change and scale change measures.

5.2.1 Correlates of productivity change

Pearson's correlation coefficients between TFP change and its components, based on estimates of 725 dairy farms, are presented in Table 5.2. While TFP change is positively and significantly correlated with technical efficiency change, efficiency change and pure efficiency change, it is confirmed that technical efficiency change had a much smaller influence on TFPCH. Moreover, change in scale efficiency (SECH) is not significantly correlated with productivity change.

Table 5.3 reports correlates of productivity with various output and input mixes. In output mixes, we find that increase in the value of milk per unit of farmyard manure leads to productivity growth, while increase in the value of milk per unit of capital gain, and increase in the value of farmyard manure per unit of capital gain both lead to productivity regress. Turning to various input mixes, our results suggest that productivity change has been positively and significantly correlated with most input combinations. For example, productivity change is animal capital using relative to both fodder and straw & concentrate.

Table 5.2: Pearson's correlation between productivity change and its components

	Technical efficiency change (TECHCH)	Efficiency change (EFFCH)	Pure efficiency change (PECH)	Scale efficiency change (SECH)
TFP change (TFPCH)	0.398*** [0.000]	0.926*** [0.000]	0.926*** [0.000]	-0.007 [0.839]

Note: Numbers in brackets are p-values.

Table 5.3: Pearson's correlation between TFP change and changes in production processes	
Output and input mixes	**Correlation coefficient**
Output mixes	
Value of milk/Value of farmyard manure	0.1796*** [0.000]
Value of milk/value of capital gain	-0.0195*** [0.000]
Value of farmyard manure/value of capital gain	-0.1601*** [0.000]
Input mixes	
Cost of shed & structure capital/cost of animal capital	-0.1866*** [0.000]
Cost of shed & structure capital/cost of fodder	0.1384*** [0.000]
Cost of shed & structure capital/cost of straw & concentrate	0.0063 [0.865]
Cost of shed & structure capital/cost of hired labor	-0.1514*** [0.000]
Cost of shed & structure capital/cost of family labor	-0.1471*** [0.000]
Cost of animal capital /cost of fodder	0.2170*** [0.000]
Cost of animal capital /cost of straw & concentrate	0.2939*** [0.000]
Cost of animal capital/cost of hired labor	-0.0374 [0.314]
Cost of animal capital/cost of family labor	-0.0570** [0.027]
Cost of fodder/cost of straws & concentrate	0.0184 [0.620]
Cost of fodder/cost of hired labor	-0.0837** [0.024]
Cost of fodder/cost of family labor	-0.1294*** [0.000]
Cost of straw & concentrate/cost of hired labor	-0.0559 [0.133]
Cost of straws & concentrate/cost of family labor	-0.1029*** [0.006]

Note: Numbers in brackets are p-values.

Likewise, it is shed & structure capital using relative to fodder. However, productivity change has been shed & structure capital saving relative to animal capital as well as family labor; animal capital saving relative to family labor; fodder saving relative to both family and hired labor; and straw & capital saving relative to family labor. These results imply that the dairy farms may increase their productivity by increasing use of animal capital and straw & concentrate, and decreasing the use of fodder and labor.

Productivity Change by Size of Landholding

The results by herd-size show that subsistence farms (1 to 2 herd size) have relatively performed well since their cumulative productivity (0.904) is much higher than the mean of the full sample (Table 5.4). Virtually, the entire productivity decline is attributable to technology regress leading to inward shift in the frontier in 2014 compared with 2005. Except herd-size 5 to 6, all other dairy farms who own more than 2 dairy animals have experienced a greater decline in productivity than the overall average. While these dairy farms have improved upon resource use efficiency, their productivity decline is credited to failure to innovate.

Productivity Change by Size of Landholding

A similar picture evolves when we evaluate productivity change by size of landholding. Productivity change of landless dairy farms cumulates to 1.013, implying productivity improvement of 1.3% in 2014 over 2005 (Table 5.5). Technical change of landless dairy farms cumulates to 0.930, implying inward shift of 7% in the production possibility frontier from the benchmark. However,

Table 5.4: Geometric means of productivity change and its components by Herd size

Herd Size	TFP change (TFPCH)	Technical efficiency change (TECHCH)	Efficiency change (EFFCH)	Pure efficiency change (PECH)	Scale efficiency change (SECH)
1 to 2	0.904	0.909	0.994	0.953	1.044
3 to 4	0.846	0.851	0.993	0.919	1.080
5 to 6	0.898	0.831	1.080	0.985	1.097
7 to 10	0.788	0.773	1.019	0.996	1.024
11 or more	0.734	0.686	1.070	0.942	1.136
Full sample	**0.872**	**0.866**	**1.008**	**0.946**	**1.065**

Table 5.5: Geometric means of productivity change and its components by size of landholding

Farm Size	TFP change (TFPCH)	Technical efficiency change (TECHCH)	Efficiency change (EFFCH)	Pure efficiency change (PECH)	Scale efficiency change (SECH)
Landless	1.013	0.930	1.090	1.072	1.016
Under 5 acres	0.905	0.884	1.024	0.985	1.039
5 - < 12.5	0.821	0.855	0.961	0.880	1.092
12.5 - < 25	0.835	0.826	1.011	0.917	1.103
25 acres or more	0.770	0.787	0.978	0.891	1.098
Full sample	**0.872**	**0.866**	**1.008**	**0.946**	**1.065**

Table 5.6: Geometric means of productivity change and its components by districts

District	TFP change (TFPCH)	Technical efficiency change (TECHCH)	Efficiency change (EFFCH)	Pure efficiency change (PECH)	Scale efficiency change (SECH)
Khanewal	0.944	0.867	1.089	1.044	1.044
Pakpattan	0.908	0.823	1.102	1.018	1.083
Sargodha	0.899	0.851	1.056	0.971	1.088
Narowal	0.893	0.851	1.050	0.987	1.063
Okara	0.892	0.809	1.103	1.044	1.056
Attock	0.874	0.912	0.958	0.910	1.053
Jhelum	0.851	0.908	0.937	0.903	1.038
Layyah	0.847	0.867	0.977	0.898	1.088
Hafizabad	0.841	0.895	0.940	0.882	1.066
Muzaffargarh	0.774	0.895	0.865	0.807	1.072
Full sample	**0.872**	**0.866**	**1.008**	**0.946**	**1.065**

there was a larger gain in productivity due to improvement in efficiency change by 9%. Pure efficiency change of landless farms cumulates to 1.072, which indicates convergence toward the frontier, and scale efficiency change cumulates to 1.016, indicating a slower rate of convergence toward optimal production scale. Land owners as a group have poorly performed with a productivity regress ranging from a low of 9.5% for farms under 5 acres to a high of nearly 23% for farms with more than 25 acres; this decline is largely due to failure of the dairy farms to innovate.

Productivity Change by Districts:

A summary of productivity change index by districts reveals that Khanewal, Pakpattan, Sargodha, Narowal and Okara are five best performing districts where TFPCH index cumulates to more than the sample mean (Table 5.6). Muzaffargarh is the least performing district which experienced a productivity decline of 22.6% in 2014 over 2005 at a mean annual rate of 2.51%. The best performing districts gradually improved their resource use efficiency ranging from a high of 10.3% and 10.2% in Okara and Pakpattan, respectively to a low of 5% growth in Narowal district.

Productivity Change in Cow, Buffalo and Mixed Farms

We also study variation in TFP change across buffalo, cow and mixed farms by studying cumulative productivity change and its components by farm type. The results suggest that the productivity change index for buffalo farms cumulates to 0.877 in 2014, implying that these farms were 12.3% less productive than their 2005 level (Table 5.7). This decline is attributable to technical regress on the benchmark technology of production. Pure cow farms have performed relatively better than pure buffalo farms where the productivity change index cumulates to 0.899 with a large part of the decline taking place due to technical regress of 0.911, and virtually no growth in efficiency of resource use at 0.987. Mixed cow & buffalo farms as a whole have performed poorly with productivity change index of 0.859, which is largely explained by their failure to achieve technical progress, while they experienced a very slow improvement in resource use efficiency.

Table 5.7: Geometric means of productivity change and its components by farm types

Farm type	TFP change (TFPCH)	Technical efficiency change (TECHCH)	Efficiency change (EFFCH)	Pure efficiency change (PECH)	Scale efficiency change (SECH)
Milch buffalo farm	0.877	0.863	1.016	0.964	1.054
Milk cow farm	0.899	0.911	0.987	0.943	1.046
Mixed cow & buffalo farms	0.859	0.849	1.012	0.938	1.079
Full sample	0.872	0.866	1.008	0.946	1.065
11 or more	0.734	0.686	1.070	0.942	1.136
Full sample	**0.872**	**0.866**	**1.008**	**0.946**	**1.065**

5.3 Input Elasticity and Technical Inefficiency in Non-Corporate Dairy Farms

Next, we turn to investigate the determinants of technical inefficiency in smallholder dairy farms by using the stochastic frontier technical inefficiency effects model. For detailed methodology and estimation results, see Appendix – 2.

Our estimates suggest that animal capital, straw & concentrate and family & hired labor continue to be the most important determinants of raising output in non-corporate dairy farms while fodder and shed & structure capital do not significantly increase dairy output. Every 1-percent increase in the value of animal capital results in about 0.77 percent increase in dairy output. Similarly, a 1-percent increase in straw & concentrates leads to 0.7% increase in dairy output. The elasticity of family & hired labor suggests that a 1-percent increase in labor leads to 0.04% increase in dairy output.

We also find that the returns to scale at the point of approximation are less than one (0.85) or decreasing returns to scale. A proportionate increase in inputs brings about a less than proportionate growth in dairy output. In other words, the dairy farms in our sample operate on increasing cost portion of their average cost curves.

The estimated mean technical efficiency of the dairy farms in the sample ranges from 65% to 66%, which implies that on average the dairy farms in the sample could have produced 34% to 35% more output had they been fully technically efficient by being on the frontier.

We find that dairy farms selling milk to informal milk collectors are more efficient since their technical inefficiency decreases (in the study period) than those who sell milk directly to milk processing industry. Moreover, increase in herd size decreases technical inefficiency of the dairy farms. Older and experienced farmers are less inefficient than the younger ones. Farmers suffering from severe depression are technically more inefficient than the excluded category of farms. Increase in years of education of the head of the household also decreases technical inefficiency of the dairy farms in the sample. Farmers from Attock district are technically most efficient as compared with the farmers from other districts in the sample. Moreover, farmers from Layyah district are also quite efficient.

5.4 Conclusions

In this chapter, we apply the Malmquist productivity index to measure productivity change for smallholder dairy farms by using two rounds of survey data for the period 2005 and 2014. We also isolate the role of productivity change by its components. First, we find overall productivity decline of 12.8% or 1.42% per year, on average. It gives a clear indication that the growth rates of dairy production have fallen short of growth rates of dairy inputs. As a result, despite a slow improvement in resource use efficiency, a sharp inward shift in frontier function has contributed to an overall productivity regress, implying that the sample dairy farms have failed to innovate. Simple correlation of TFP change confirms that technical efficiency change had a much smaller influence on total factor productivity growth relative to efficiency change, which had the most impact.

Second, evidence on various combinations of output and input mixes suggests that dairy farms may increase

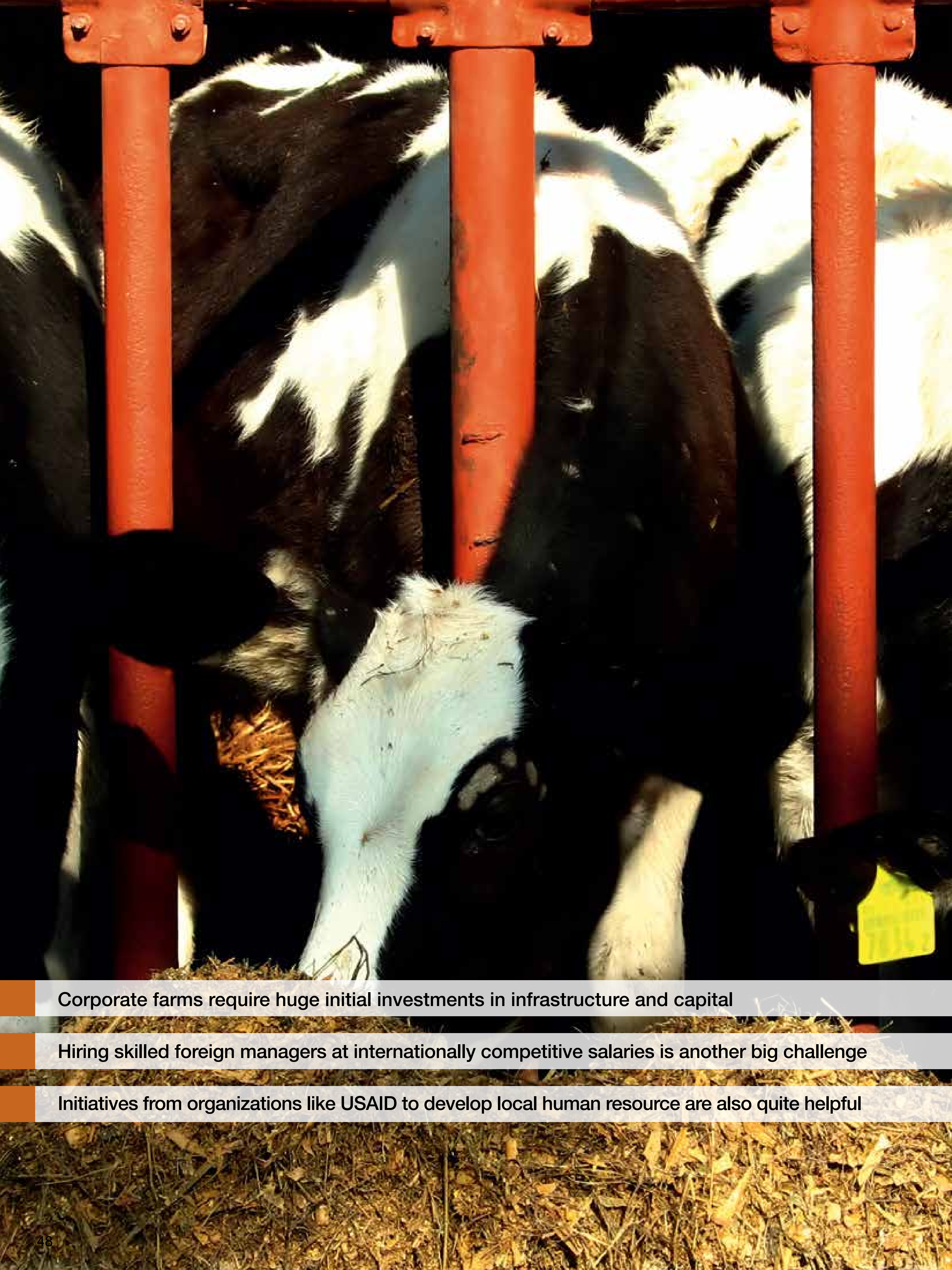
productivity by increasing the value of milk produced and by increasing their use of animal capital and straw & concentrate, and decreasing their use of fodder and labor.

Third, the aggregate results on productivity change conceal productivity growth of 44% in 39% of the farms where failure to innovate is much more common since 80% of the farms experienced an inward shift in the production technology. There was somewhat equal split between those who successfully improved resource allocation by moving closer to the frontier and those who could not.

Fourth, both subsistence and landless dairy farms have performed better than their counterparts. This is understandable since most subsistence farms employ family labor to collect roughages and grasses to feed their milching animals due to which they have suffered relatively less from rising costs of dairy inputs. A second-stage regression of TFP change on its determinants reveals that decrease in herd size increases productivity. Also, dairy farms who feed silage to their herd experience higher productivity growth.

Fifth, most best performing districts have a large presence of milk processing industry, which provides technical support in the form of extension services to the dairy farms, however, the evidence of large technical efficiency regress there is most surprising. Equally surprising is the poor performance of mixed cow and buffalo farms relative to pure cow and pure buffalo farms.

Sixth, animal capital, straw and concentrate and family and hired labor are most important determinants of raising output in smallholder dairying. However, the estimates of scale elasticity suggest that the sample dairy farms operate under decreasing returns to scale, or on upward sloping portions of their average costs, implying that a proportionate increase in dairy inputs would bring about a less than proportionate increase in value of dairy production. The results also suggest that dairy farms selling milk to informal milk collectors are more efficient than others. Increase in herd size, age of head of farm household and education of head of farm household increase technical efficiency of the dairy farms.



Corporate farms require huge initial investments in infrastructure and capital

Hiring skilled foreign managers at internationally competitive salaries is another big challenge

Initiatives from organizations like USAID to develop local human resource are also quite helpful

Chapter 6

ECONOMICS OF CORPORATE DAIRY FARMING

6.1 Introduction

Livestock is an important sub-sector of agriculture, which contributes 52.2% of the value addition in the agriculture sector, and approximately 11% of in gross domestic product (GoP, 2008). Net foreign exchange earnings from livestock constitute more than 8.5% of the total exports (Afzal, 2008). It is also an "important source of raw material particularly for leather, carpet and woolen cloth industries" (Afzal, 2008).

Approximately 30 to 35 million people in the rural areas of Pakistan are engaged in livestock rearing, and derive 30 - 40% of their income from this sector (Burki et al., 2004). Within this sector, milk is the largest and most important commodity (Burki et al., 2004).

In fact, Pakistan is producing 47 billion liters of milk annually, making it the third largest milk producing country of the world (Haq, 2014). Even so, the demand for raw milk for processing is increasing at an annual rate of 20% (Afzal, 2008), and Pakistan's milk production per animal is low compared to other countries (Khan et al., 2013). One animal in Pakistan produces milk equal to only one-third of the milk produced by a dairy animal in New Zealand, one-sixth of the milk produced by an animal in Germany, and one-seventh of the milk produced by an animal in United States of America (Garcia et al., 2003). Milk supply is also low during summer months because yield per animal drops due to high temperatures (Patel and Raza, 2015). This means that the supply of milk produced in Pakistan is nowhere close to the quantity demanded by its people.

This excess demand for milk by local population has been met by importing powdered milk (Patel and Raza, 2015). However, doing so has not only increased competition in the dairy sector and driven down the prices that local producers get for their product (Patel and Raza, 2015), but has also created a pressure on our country's net foreign exchange earnings from livestock. So, in an attempt to protect the local dairy industry, the Government of Pakistan introduced a Livestock Development Policy in 2007, which encourages the establishment of large corporate dairy farms. This policy has helped to restructure the dairy industry, which until then had consisted primarily of small-scale dairy farmers.[26] The incentives offered by the government attracted some corporate groups to invest in the dairy farming sector (Afzal, 2008). But huge losses were reported in the financial statements of these dairy farms posing a question on the feasibility of these farms in the short to long run.

This chapter explores multiple facets of the dairy industry by comparing conventional dairy farming methods to the practices of the corporate dairy farms. We begin with an overview of the composition of the dairy industry and discuss the farming structure of conventional and corporate dairy farms; it also examines how these two differ in terms of breeding and herd management, human resource development, capital accumulation and mechanization, fodder, and fodder storage. This is followed by discussion on the potential for vertical integration and knowledge economies in the dairy sector.

[26] A total of 8.42 million families raise 26.79 million cattle and buffaloes for milk production in the country (Agricultural Census Organization, 2006). Most of these milch animals (65.3%) are with families who keep one to six milking animals. These smallholders constitute 91.4 % of the families raising cattle and buffaloes.

6.2 Farm Structure and Practices

The dairy industry of Pakistan is dominated by rural market-oriented small holdings (Burki et al., 2004; Afzal, 2008).[27] Out of the 8.42 million families raising livestock for milk production 91.4% are small holders (Afzal, 2008). In comparison, only 0.3% of these households are engaged in large-scale dairy farming[28] with a herd size larger than thirty milking animals per farm (Afzal, 2008).

The Livestock Development Policy, introduced by the Government of Pakistan in 2007, radically altered the composition of the dairy industry by encouraging the establishment of large corporate dairy farms in the country. The incentives offered by the government included exemption of import duties on modern farming equipment, exemption of tax on dividends, provision of government land for lease for up to 99 years, and the availability of liberal credit (Afzal, 2007). This encouraged many successful conglomerates to invest in dairy farming. JK Dairies, Sapphire Dairies, and Al-Tahur Dairy Farm were the initial leaders (Afzal, 2008). But huge losses were reported in the initial financial statements of these businesses. It is important to note, however, that these losses seemed imminent given that corporate dairy farms operate on a much larger scale than the conventional farming systems that are so popular in Pakistan – the initial capital investment on corporate dairy farms is extremely high.

Corporate dairy farms and conventional dairy farms differ on multiple dimensions including human resource development, breeding and herd management, capital accumulation, mechanization, fodder, and fodder storage. The remainder of this section discusses these elements in detail.

6.2.1 Corporate Farm Structure

The functioning of the corporate dairy farms can be broken down into four major departments: maternity and breeding, calf rearing, feed, and milking. The maternity department is responsible for breeding, and managing the sick and pregnant animals. Their most important job is to detect when an animal 'goes into heat' so that the animal can be inseminated with imported semen. The cost of importing semen is high, and inefficiency costs can arise if the animal's 'heat' is not detected at the right time. Since the pregnancy of an animal can be tested only after 35 days, the entire process needs to be repeated if the animal is not successfully impregnated.[29] In the meantime, the animals need to be fed and vaccinated so that the milk yield upon impregnation is high.

The calf rearing department feeds calves and maintains their health until they are grown up to be sent to the maternity department for impregnation. Calves are normally kept till the age of 14 months. However, if their diet is not taken care of, the standard weight and size for an adult cow is achieved much later than the optimum fourteen months. This causes an increase in the upkeep cost as calves that have not reached adulthood cannot be sent to the maternity department for insemination. Further, if insemination is inefficient, there will not be enough cows to replace the older cows,[30] and cows will have to be imported in order to maintain the milk supply. This further increase the costs associated with animal breeding.

The feed department is responsible for the procurement and storage of animal feed. The ingredients that make up the feed vary from one farm to the other. But typically the feed consists of three main elements: fodder, straw, and concentrate. The major content of fodder comes from maize. Since maize has the highest dry content, less feed is sufficient for the animals. However, feed procurement costs also vary across farms. High quality maize is produced only in the spring season, and it is during this peak season that its price is low. Farms with efficient feed storage facilities that prevent maize from losing its dry content are able to keep feed procurement costs low by purchasing it in bulk during this season. However, farms without proper storage bunkers are forced to buy fodder from private vendors. This makes feed procurement costly as vendors sell maize at higher prices during off season. Additionally, if the quality of the fodder is not good, more needs to be fed to the animals to fill their stomach. Further, animal feeding is differentiated based on milk yield. High yielding cows are given more feed compared to those that have lower yields. The high yielding cows are usually the younger ones and their impregnation is a top priority.

The milking department is also known as the 'milking parlor'. This department is completely mechanized and the milk from the cows goes directly into the chillers. Since corporate dairy farms

[27] There are four main types of farming systems currently prevalent in Pakistan: rural subsistence holdings, rural market-oriented small-holdings, rural commercial farms, and peri-urban/urban commercial dairy farms (Food and Agriculture Organization, 1987). Rural market oriented small-holdings aim to produce a greater quantity of milk than the amount required by the family. The excess milk is then sold in nearby markets. These farms usually keep less than six animals, of which two to three are milking animals. The milking animals are fed seasonal green fodder, straw, and concentrate, whereas the other animals are fed by grazing. Calves are retained during lactation, then the males are disposed of, and females are kept as replacements.

[28] Rural and urban commercial dairy farms normally raise a herd size greater than 30 animals. Whilst rural commercial farming has been gaining popularity in recent years, the total milk supplied by rural and urban commercial dairy farms is small in comparison to the aggregate quantity of milk produced by rural market-oriented holdings in the country.

[29] Inefficiencies in insemination vary from 1 out of 5 positive pregnancies to 1 out of 40.

[30] Cows normally have only 4 to 5 high yielding cycles.

produce large quantities of milk, they have proper storage chillers to store the milk and ensure minimum human exposure. Apart from maintaining milk hygiene, this also reduces the procurement costs for milk buyers, and allows corporate dairy farms to bargain higher prices for their milk compared to conventional dairy farms. While most corporate dairy farms sell their milk to milk processing corporations, some farms also have their own pasteurizing units and distribution networks.

Since all these departments are interlinked, a setback in one department impedes the progress of other departments as well. The management of these different but intertwined units within a corporate dairy farm is crucial to its long run success, and that is why corporate farms invest heavily in human capital accumulation and development.

6.2.2 Resource Training and Development

The corporate dairy industry is still in its initial stages of development and there is much to be gained by striving to acquire knowledge economies. The more this industry grows, the more efficient and productive it is likely to become through the development and sharing of expertise across farms. In the short run, however, this industry is likely to face obstacles in its initial years. So, corporate dairy farms hire foreign managers who have prior experience in handling such large scale dairy ventures to manage their operations. Most specialists hired to run such farms have specializations in the field of dairy and agriculture studies (Saigol and Farooqui, 2015). However, since these foreign personnel are hired at internationally competitive salaries, it is not feasible to contract their labor in the long run (Saigol and Farooqui, 2015). Therefore, corporate dairy farms invest in human capital development by incorporating local personnel into their management teams. For instance, while Nishat Dairy has filled its higher management positions with British experts, it has also hired 200 local employees as part of its labor participatory force so that they can observe these foreign specialists and over time, incorporate their working styles into their own vocational ethic (Saigol and Farooqui, 2015).

Some farms have even re-structured their labor composition to reduce operational inefficiencies arising from lack of skill and coordination between different departments within the farm. For example, when Makhdoom Farm was initially set up in Rahim Yar Khan, its labor force consisted of two skilled farm managers with prior experience in handling imported cattle, unskilled labor, and part-time workers from the village. But when Makhdoom Farm launched its modernization process in 2001, it altered its labor force by laying off its part-time workers. Instead, it focused on its permanent staff, and provided them with informal on-the-job training (Awais and Choudhry, 2015). As a result, the overall labor force has been down-sized and the existing workers are now semi-skilled (Awais and Choudhry, 2015). These efforts at human resource development have allowed Makhdoom Farm to reduce the number of skilled professional farm managers to one (Awais and Choudhry, 2015). Consequently, labor costs and labor inefficiencies have declined.

It is important to note, however, that while corporate dairy farms have been undertaking measures to improve their human capital resources, organizations like USAID have invested in resource development for small-scale dairy farmers in Pakistan as well. The Dairy Project implemented by USAID in 2013 specifically targeted low-income, small-scale dairy farmers in Punjab. They conducted awareness campaigns to instruct local farmers on the best dairy farming practices, and trained “16,000 small dairy farmers, farm managers, artificial insemination technicians, and female livestock extension workers on improved farming and breeding interventions” (USAID, 2013a). In particular, they trained 1,296 unemployed rural youth in artificial insemination (AI) techniques. These AIs are now earning up to Rs. 4,000 per month and “providing breed improvement services to farmers in over 7,000 villages in Punjab” (USAID, 2013a).

This human capital development by USAID has had both a positive impact on small-scale dairy farmers, and is likely to have positive spillover effects on corporate dairy farms as well. Corporate dairy farms normally employ a full-time doctor who lives on the farm to take care of animal immunization, insemination, and health. Depending on the herd size, they may need to employ multiple veterinarians to cater to the needs of the animals, especially since their herds largely consist of imported breeds. But they may be able to cut down labor costs by hiring trained part-time local veterinarians as assistants or helpers for the full-time specialist. Therefore, not only does human resource development in the dairy sector reduce operational inefficiencies, but it also reduces labor costs incurred by farms in the long run.

6.2.3 Breeding Practices and Herd Management

Hiring foreign managers and veterinarians, and training local personnel has proved beneficial for corporate dairy farms because they tend to import high-yielding foreign animal breeds for impregnation and milking. The import of foreign animal breeds for milk production was a feasible option for corporate dairy farms because of the government’s willingness to facilitate these ventures. Initially, the government allowed the import of diary animals from Australia only. But later, it also allowed the import of animals from Europe. This resulted in the import of Holstein Friesian, a breed of cattle known today as the world's highest-producing dairy animal. Holstein Friesian has an average yield of 35 liters of milk per day. Similarly, another imported exotic breed that made its way into Pakistan is the Jersey Cow which has an average yield of 18 to 22 liters of milk daily. In comparison, local breeds like the Nili Ravi[31] (buffalo) and the Sahiwal Cow have an average yield of 9 to 10 liters per day and 14 to 16 liters per day, respectively.

While these exotic foreign breeds have higher milk yields compared to local animals, they require extra care and help in acclimatizing to the local environment. These animals need to be kept in temperature controlled environments of roughly 30-35^{0}C (Saigol and Farooqui, 2015), and they are also susceptible to several local diseases like the foot and mouth disease, the black quarter disease, and the tick-borne disease (Khan et al., 2013). Since it is costly to raise these animals, some corporate dairy farms opt to work with a crossbred herd, which is relatively immune to local epidemics, produces more milk, has a smaller calving interval, matures at an early age, and has a longer lactation period compared to local breeds.

Then there also some farms, like the Makhdoom Farm, which prefer to use local breeds rather than crossbred animals (Awais and Choudhry, 2015). The Makhdoom Farm initially worked with 100 mixed breed cattle. But in 2001, it decided to replace its entire herd with a local breed known as the Sahiwal Cow. It also increased its herd size from 100 to 160 animals. There are several differences between the two breeds which helped the Makhdoom Farm lower its feed, labor, and vaccination costs, and acquire higher prices for its milk.

Firstly, mixed breed cows almost always damage their hooves when they are sent out to graze. They calve and milk late, are unable to conceive in hot temperatures, and require help during birthing. Even though mixed breeds do contain some characteristics of the local breeds, they are still unable to adapt to the climatic conditions of the country, and special cooling units have to be fitted into their stalls. In comparison, Sahiwal cows have the ability to produce adequate milk under subsistence setups, do not require temperature controlled sheds, and do not require help in birthing.

Secondly, while the feed content requirements remain the same for crossbred and Sahiwal cows, mixed breed cows require more feed than the Sahiwal cows because they weigh more.[32] The general norm is to feed an adult cow approximately one-third of its total body weight. A mixed breed cow, on average, weighs around 700 kilograms whereas a Sahiwal cow weighs only 450 kilograms. For young calves, the feed requirement is equal to one-tenth of their total body weight. The birth weight of a mixed breed calf is approximately 45 to 55 kilograms, while that of the Sahiwal cow is 23 to 27 kilograms. As a result, raising a Sahiwal cow considerably lowers fodder costs for the farm.

Thirdly, while mixed breed cows yield up to 24 liters of milk daily, the medical expenses to maintain their health are very high. They are vulnerable to several diseases including the protozoan parasitic disease, and need to be regularly de-wormed for protection against stomach parasites. Butalux medicine is an absolute essential without which mixed breed calves can die, and Imizol also need to be administered from time to time. Medical costs for Sahiwal cows, on the other hand, are comparatively low: the Sahiwal cows have an inherent tendency to keep shuddering their skin, and this acts as a natural combatant to ticks and parasites. This breed also requires de-worming but not as often as the mixed breed cows. Further, the vaccinations given to Sahiwal cows are comparatively cheap, costing only Rs.2,500 for 60 animals at a time.

Fourthly, mixed breeds have uneven teats, which make it difficult for the milk to be collected through automated milking systems. Since the Makhdoom Farm still employs manual labor for milking, this is a concern they have expressed for the long run. Although this problem can arise with manual milking too as employees at times do not bother expending the extra energy and time to collect all of the milk from the cow.

Fifthly, mixed breed cows have only a 30% chance of a female offspring, whereas the Sahiwal cow has a 50% chance. Since Makhdoom farm is a semi-modern farm, which has shifted to the use of tractors rather than using draught animals, the excess males not used for breeding need to be sold. However, selling these animals for meat is not feasible since they have to wait till the male matures for it to be sold off, and it is too costly to keep and feed these animals until then. Since Sahiwal cows have a higher chance of producing a female offspring, the potential costs of raising male animals is lower.

Sixthly, while mixed breed cows produce more milk per day compared to Sahiwal

[31] Milking animals used by conventional farms are predominantly buffaloes. But buffaloes are bred for their physical power rather than their milk productivity, so they are not as productive as cows. Also, buffaloes fully mature at the age of 24 to 30 months whereas cows require only 15 to 18 months to attain maturity. Cows also have a larger lactation period with a dry period of 2 months, whereas buffaloes have a dry period of 4 months.

[32] The feed given to both breeds comprises of silage, green fodder and concentrate. The cows are both fed in their stalls and are allowed to graze freely from morning to late afternoon on specially prepared lands. The total feed, for both adults and young must comprise of 26-28% dry matter, while the remaining is to be given in terms of water.

cows, the milk from Sahiwal cows has more fat content compared to the mixed breed.[33] This means that the milk from Sahiwal sells for a higher price as it is considered higher quality milk.

Lastly, the milk produced by cow breeds of North America and Europe contains a milk protein called A1 beta-casein; the consumption of this type of milk has been associated with heart diseases and Type 1 diabetes (Woodford, 2009). The Sahiwal breed produces A2 milk, which has not been linked with any such health problem and is considered healthy (Awais and Choudhry, 2015).

Corporate dairy farms also use artificial insemination and selective breeding to improve the quality of their herd's offspring. Before the advent of corporate dairy farming in Pakistan, the overall conception rate in the field was only 29% (Anzar et al., 2003). According to the CEO of Dada Dairies, the initial conception rate for their farm was only 20% (Riaz and Toor, 2015). But investments in insemination and advanced machinery which detects pregnancy in cattle have helped them increase their conception rate up to 49% (Riaz and Toor, 2015). This increase in conception rate was seen to be correlated with a reduction in loss initially, and then an increase in profits for the last year. The management also initiated artificial insemination programs with the Sahiwal cows but their coverage was on a very limited scale at approximately 2% (Awais and Choudhry, 2015). Similarly, corporate farms also focus on developing the best breeds by carefully testing semen, ovulation period, genetics and abnormalities. In fact, the management of the Makhdoom Farm also paid considerable attention to selective breeding practices, allowing only the best animals to be mated to produce high quality offspring (Awais and Choudhry, 2015). This practice also helped them resolve the issue of uneven teats amongst their herd (Awais and Choudhry, 2015). They claim that they have been able to make the teats equal in almost 60% of their stock of Sahiwal cows through selective breeding (Awais and Choudhry, 2015). On the other hand, Nishat Dairy, which raises Friesian herds, expressed its unwillingness to experiment with a cross-breed of the Friesian and Sahiwal cows (Saigol and Farooqui, 2015). This is because while selective breeding helps improve the quality of animal offspring and increases milk yield, advancements in selective breeding require investment in R&D which is costly.

6.2.4 Farm Mechanization and Infrastructure

Corporate dairy farms structure their land in a way that they are able to ensure good quality housing and water facilities for their herds. Animals are housed using 'free' stalls in which cows are allowed to move freely, and are only restricted during milking. The shed has an adequate supply of drinking water and fodder, and the flooring is made out of rubber or sand. Electric fencing systems are also used to prevent cows from getting lost, attacked by dogs, or stolen. The handling of manure is more systematized and frequent in order to prevent diseases and insect infestations. Fans and cooling systems are installed to control the temperature inside the shed. Disinfectants are used liberally, and the animals are washed with clean water to maintain animal and, thereby, milk hygiene. There is a system of automatic suction pumps through which cows are milked and the milking parlors[34] are mechanized, and allow for automatic and efficient milking alongside cleansing and drying of the teats and udders. Cows are tagged with transponders to identify them for milking, breeding, and feeding. The collected fresh milk is then sent to a buffer tank for cooling. Since cooling helps avoid the formation of bacteria in fresh milk, corporate farms use more sophisticated cooling mechanisms in the form of immersion coolers and heat exchangers. The milk is then automatically filtered before pumping it into the storage tanks where it is kept at a temperature of 4^0C until it is delivered to the milk processing companies.

Nishat Dairy has constructed around 15 similar animal sheds to cater to their Friesian herd (Saigol and Farooqui, 2015). It also uses identification tags with electronic readers to record the amount of milk given by each animal and the time at which milk was given. Using identification tags is a popular process in U.S.A and Australia as it allows farmers to separate high yielding animals from low yielding ones in the herd. Makhdoom Farm, however, is not fully automated yet. It has repaired the housing facilities and improved the drainage of dung and urine systems for the cows (Awais and Choudhry, 2015). Animal sheds are cleaned daily using disinfectants, and larger open compounds with sheds on one side were constructed for the cows in which they are allowed to roam freely and drink as much water as they want (Awais and Choudhry, 2015). Previously, water was taken from an un-cemented (kacha) canal flowing nearby (Awais and Choudhry, 2015). But water quantity from the canal fluctuated and the water was not always clean. So, to ensure a more consistent supply of clean water, the farm management constructed small cemented canals which brought in water from a tube well close by. Since the cows now have plenty of clean drinking water, their milk production has

[33] The milk from mixed breed cows has only 3.4-4% fat content, whereas the milk from Sahiwal cows has 4.5-5% fat content.

[34] Firms such as ProFarm, DeLaval and Altaf & Co provide specialized services to corporate dairy farms whether it is related to farm equipment, breeding (artificial insemination), herd management, farm management softwares, or feeding solutions. Corporate farms use GEA Farm Technology which combines the best of herringbone and parallel stalls in an economical milk parlor that can milk 60 cows in six minutes. Likewise, DeLaval technology is used to especially milk pregnant, injured and ill cows. It can milk 32 cows at a time and one cow in 5 minutes.

increased (Awais and Choudhry, 2015). Labor efficiency has also increased because now the workers do not have to spend time cleaning and bedding individual stalls (Awais and Choudhry, 2015).

In comparison, conventional small-scale farms engage manual labor to manage their herds.[35] Cows are usually tied up, and this leads to improper digestive balances. To feed the animals, farmers rely on fodder, which is seasonal in nature, but they cannot afford to purchase a chuffing machine (like modern farms) to chop down the fodder. So, normally, a group of small farmers join together to invest in the machine (Jalil, 2008). Milking is done manually which often creates unwarranted time lags between demand and supply of milk. There is lack of fresh and clean water for the animals, which can be detrimental for their health. Small-scale farmers do not consult veterinarians as regularly and choose to rely on their traditional knowledge regarding animal disease. Their knowledge of the impact of excessive antibiotic use on milk quality is limited. While such farms have a lower up-keep cost compared to corporate farms, their milk production is restricted and the quality of milk is low. However, rural dairy farming practices have benefitted greatly in recent years from the awareness campaigns conducted by USAID in 2013. Estimates from a study on rural farmers in Jhang revealed that farmers who adopted modern techniques have almost doubled their income from Rs.21,500, on average, to Rs.40,000 per month (USAID, 2013b).

6.2.5 Fodder and Fodder Storage Practices

Rural and corporate farm practices also differ in the quality and content of fodder provided to the animals. Most small scale dairy farms provide basic and low cost fodder to their indigenous breeds. Animals are either stall-feeding, or allowed to graze freely. Rural farmers usually "feed their animals on grasses and herbs, with forages gathered from uncultivated lands, crop residues and low quality roughages" (Burki et al., 2004). The amount of concentrate and high quality green fodder fed to these animals is often small (Burki et al., 2004). In comparison, corporate dairy farms provide their animals with expensive, well-concocted feed. They import grass varieties like Mott grass, Sudan grass, and Rhodes grass for both local and exotic animals. Healthy green fodder is often purchased, and corn silage is prepared to provide animals with carbohydrates, lipids and proteins. To meet the animals' mineral and vitamin requirements, large farms often use both conventional and unconventional feed sources such as maize, barseem, sorghum grains and wheat bran. While the ingredients of animal feed may vary from one farm to the other, all corporate farms pay meticulous attention to the content of fodder. For instance, Nishat Dairy produces its own fodder, which is composed of a mixture of 15-20 ingredients. These include the use of a Total Mixed Ration (TMR) feed where the green fodder is locally procured, but important minerals are imported from Spain, Turkey, and U.S.A. (Saigol and Farooqui, 2015). Unlike traditional farms, these farms also use mixer wagons to prepare balanced rations. Animals with higher yield are fed more compared to those with lower yields.

Even though the quality of fodder provided to animals is inextricably linked with their milk yield and quality, feed procurement costs are high for corporate farms. For example, as mentioned above, good quality maize is produced only in the spring season. During this peak production time, the price of maize is also low. Farms with efficient storage facilities can benefit from this by buying maize in bulk during the spring season and storing it for use throughout the year. But farms without proper storage bunkers are forced to buy fodder from private vendors who sell maize at higher prices during the off season. Additionally, feed requirements of animals vary by breed because animal weight differs across breeds.[36] Since corporate farms use imported/exotic or mixed breed cattle, their fodder costs per animal are considerably higher compared to traditional farms. According to the management team of Nishat Dairy, the most important cost in running a dairy farm is its feed. That is, 60-65% of a farm's revenue is utilized to procure animal feed (Saigol and Farooqui, 2015) and if a farm is in its rudimentary or initial stage of functioning, such feeds can consume up to 70% of farm revenue (Saigol and Farooqui, 2015). To reduce these feed procurement costs, some farms have engaged in backward integration by producing their own fodder but this does not always prove fruitful. For example, the Makhdoom farm is now producing its feed itself but growing the feed themselves has neither had any impact on their feed procurement costs nor their profits (Awais and Choudhry, 2015).

6.3 Potential for Vertical Integration and Economies of Scale

Corporate farms have the expertise, skill, financial resources and knowledge to engage in vertical integration, and are more capable of working in synergy with other industries. They have developed linkages with the fertilizer industry, the marketing and processing industry, the transport industry, the storage and distribution industry, silage producing firms, the meat industry, and the leather

[35] The work is divided amongst the family members and almost nothing is spent on labor. Men usually carry out physically demanding tasks such as constructing sheds, bringing fodder to the farm, herding, and marketing, whereas women are usually responsible for the feeding and milking of the cattle.
[36] For example, as mentioned before, a mixed breed cow, on average, weighs around 700 kilograms whereas a Sahiwal cow weighs only 450 kilograms.

industry. However, the more popular forms of vertical integration adopted by these farms are the backward integration into fodder production, and the forward integration into the retail sector.[37]

One of the major inputs and the highest proportion of the costs of a farm is animal feed. There are two major parts of the feed. One is the nutrients that are imported, and the other is the fodder which is used to fill the stomach of the animals. Some farms purchase imported nutrients from local vendors whereas larger farms get the supply directly from international exporters. Local production units can be established to manufacture this nutrient mix at lower costs. However, this nutrient mix is only about 15 percent of total cost of feed, while the more important portion is fodder that can be purchased from local suppliers. This is a costly option as maize is a seasonal crop grown only in the spring season and it is during this peak season that its price is at its lowest. Local vendors tend to sell maize at higher prices during off season, but farms with efficient storage units can purchase maize in bulk during peak season when its prices are low and store it for use throughout the year. Farms without proper storage bunkers that keep maize from losing its dry content can reduce feed procurement costs by engaging in backward integration. In fact, Dada Dairies has reduced the cost of obtaining maize by 40% by cultivating the crop itself (Riaz and Toor, 2015). On the other hand, backward integration did not have the anticipated effect on Makhdoom farm, which was unable to reduce its feed procurement costs by producing its own feed (Awais and Choudhry, 2015). Thus, the potential for backward integration exists, but its benefits differ from one farm to the other.

Similarly, corporate farms can engage in forward integration by entering the retail market. Entering the retail market can be beneficial for corporate farms, as it allows them to sell their product at a higher price in the market than that offered by milk processing companies. However, this possibility is not feasible for two reasons. Firstly, it is costly to construct and run pasteurizing plants. Secondly, entering the retail sector with the hope of capturing the market share of well-established milk processing companies requires a lot of marketing and publicity, as well as a great deal of investments in distribution infrastructure. This imposes a significant barrier to entry in the retail sector – one which many corporate farms are unlikely to traverse. However, a few farms like Sharif Dairies[38], Everfresh Farms, and Al-Tahur Dairies have chosen to venture into the retail sector, and are earning huge profits. Infinita Dairies and Dada Dairies have also voiced their intention of entering the retail business eventually.

Also, considering that the corporate dairy industry is still in its initial stages of development, there is much to be gained by striving to acquire knowledge economies. That is, the more this industry grows, the more efficient and productive it is likely to become through the development and sharing of expertise across farms. In the short run, however, this industry is likely to face obstacles in its initial years, but will become more efficient with time and experience. Smaller corporate farms are at an advantage in this regard, since they have lower initial start-up costs and, hence, suffer smaller losses in these 'early stages of learning'.

Economies of scale are another potential source of improved profits for these farms. With larger herd sizes, farms are better able to maintain a consistent daily supply of milk as a short term reduction in milking animals will not have a substantially large percentage effect on total milk production. A higher output entails that these farms will have to buy fodder and procure them in bulk and, consequently, they can bargain with vendors to procure these materials at lower costs. The labor costs of hiring specialized veterinarians will also be more dispersed across a larger herd. Further, the existence of such large scale dairy farms compels allied industries to develop their expertise. Thus, corporate farms can reduce operational inefficiencies by outsourcing the work of its inefficient departments to these firms. Consequently, large efficiency gains await this sector in the long run.

6.4 Challenges Faced by Modern Dairy Farms

While conventional farms are able to operate on lower costs, corporate farms have been able to push down per liter milk production costs by engaging in better management practices. These practices include training and resource development to reduce operational inefficiencies arising from lack of skill and coordination between departments, selective breeding and insemination, installation of better animal housing and water facilities, meticulous preparation of fodder, and farm mechanization to milk the animals and improve the quality and hygiene of their milk product. As corporate farms are not constrained by location, they are able to locate near cities where they have better access to communication and transportation infrastructure, and are better situated to cater to urban milk demand. This makes corporate farms a natural place

[37] In comparison, rural and urban small-scale farmers have not developed any strong forward linkages with other industries. For instance, farmers in peri-urban and rural areas simply sell off their non-lactating animals to the butcher, instead of auctioning them off. Since rural farmers normally do not engage in artificial insemination, they keep their male cattle for mating and as draught animals. This imposes a huge burden on the farmer in terms of feeding these excess animals. 'Dhodhis' and milk shop collectors mostly acquire the milk from these farms at a lower price and prevent these farms from developing their own processing, transport or marketing links with industries directly.

[38] The milk products Anhaar and Milkville are initiatives of Sharif Dairies and Everfresh Farms, respectively.

to buy milk from. Processing firms prefer buying from them to save the hassle of collecting milk from distant villages. Having created a well-functioning supply chain, many corporate farms have started selling their milk directly in the market. Unlike milk processing companies, their milk is pasteurized and not UHT-treated, and has a shorter shelf life. In the market, however, both UHT and pasteurized milk sell for roughly the same price. Consequently, farms with their own pasteurized brands are beginning to capture the market share that UHT milk processors previously enjoyed.

Even so, the key challenge faced by corporate dairy farms is lowering per liter milk production costs. But this is a difficult task considering that corporate farms require huge initial capital investments. They hire skilled foreign managers at internationally competitive salaries to handle their exotic animals, which imposes huge burden on labor costs at least in the short run. Imported animals need time to adapt to local environment, have difficulty in conceiving in hot temperatures, need help in birthing and are susceptible to local diseases. As a result, corporate farms need to create temperature controlled sheds for these animals, and hire specialized veterinarians to care for their health. They also spend copious amounts of money on vaccinations for these animals. Since the milk yield of foreign and mixed breeds is higher than local breeds, they have to construct milking parlors and use automatic milking systems to milk all the animals. A cold chain infrastructure is also needed to facilitate storage and transportation of the collected milk. Farms need mixer wagons to balance the rations for animal feed. As a result capital investments are high, and it takes firms years to break even, let alone make profits.

Selective breeding to produce higher quality offspring from existing animal herds requires investment in R&D which is costly. Feed procurement costs need to be cut down if per liter milk production costs are to fall. But feed content affects animal productivity and milk quality. If the feed is not concocted properly, the milk that the animal produces does not have the required content which come under the incentive contract of milk processors. For instance, Nestle has set a basic price for purchasing milk from corporate farms, and offers an increment in price based on the total solid content, total platelet count, and Afla-toxin levels. If the total platelet count and Afla-toxin levels are high, dairy farms are given lower prices for their milk.[39] Since the quality of fodder has a direct impact on milk quality, corporate farms that do not invest in the quality and content of fodder are unable to benefit from these incentives. However, in order to cut down fodder costs, farms can engage in backward integration by cultivating maize themselves for use as feed. Another way to reduce the cost of fodder would be to indigenize the feed (Saigol and Farooqui, 2015). Finding suitable Total Mixed Ration feeds through the blending of local ingredients would decrease fodder costs and increase farm sustainability (Saigol and Farooqui, 2015). Finally, it is not feasible for corporate farmers to engage in forward integration and set up their own pasteurizing units as investing in pasteurizing units is not enough to battle away the market share occupied by popular milk brands. A lot needs to be invested in marketing and publicity for their pasteurized product to survive on the market, and this creates a significant barrier to entry for these farms. If corporate farms continue to run into losses, the government of Pakistan will have no option but to divert its attention to small-scale farmers where the large part of the country's milk production comes from.

6.5 Conclusions

This chapter presents multiple facets of the dairy industry by comparing conventional dairy practices with the corporate dairy farming. Corporate dairy farms differ with conventional dairy farms in many respects including human resource development, breeding and herd management, capital accumulation, mechanization, fodder and fodder storage. The corporate dairy farms are organized into four departments, viz., maternity and breeding, calf rearing, feed and milking. The maternity department looks after sick and pregnant animals. Detecting animals on heat for insemination is their most important job. Calf rearing department maintains health of the calves until they grow up and are sent to the maternity department for impregnation. The feed department looks after procurement and storage of animal feed. The milking of animals is completely mechanized and goes directly from the cows to the chillers with minimum human exposure. Milk processing units are the main source of demand for the milk produced by the corporate dairy farms; some farms have also set up their own pasteurizing units and distribution networks.

The corporate dairy farms often lack expertise since they are in their initial phases of development. Therefore, they hire experienced foreign managers, who specialize in the field of dairy, but on internationally competitive salaries. They are making investments on human resource development so that they are able to replace expensive foreign managers with local experts. Significant improvements in dairy farming practices of small scale dairy producers have been achieved through the USAID dairy project, which is likely to have positive spillover effects on corporate dairy farms as well.

[39] *The total platelet count is a test for the bacteria count inside the chiller. Similarly, Afla-toxin is also a harmful content.*

Corporate farms require huge initial investments in infrastructure and capital. Additionally fodder, energy, and labor costs also impose a significant burden upon these farms in the initial years. Most of these farms prefer to use exotic foreign breeds of cattle because their milk yield is higher than local breeds. Some farms use mixed breeds whose yield is higher than local breeds but less than foreign breeds. However, since both foreign and mixed breeds weigh more than local breeds, they need to be fed more which inevitably increases fodder cost. Further, both foreign and mixed breeds are unable to fully adapt to local climatic conditions and are susceptible to local diseases, which is why specialized veterinarians need to be hired for their immunization and medical care. They also need to be kept in temperature controlled sheds which adds to energy costs incurred by the farm. Since the advent of corporate dairy farming in Pakistan is a recent development, skilled foreign personnel are hired by corporate farms at internationally competitive wages to head their operation, which poses a substantial cost.

However, corporate farms are also trying to reduce operational inefficiencies through human capital and resource development. They are incorporating local personnel into the management teams headed by foreign personnel so that they are able to eventually phase out foreign leadership. They are also engaging in artificial insemination and selective breeding to improve the quality of their herds' offspring, installing better animal housing and water facilities, and trying to lower fodder costs by producing animal feed themselves (backward integration). They are also tagging their herd with transponders to identify them for milking, breeding, and feeding. This helps them separate high yielding animals from low yielding ones, and feed high yielding animals more fodder to increase the quantity and quality of their milk yield. Some farms have also ventured into the retail sector, allowing them to sell their product at a higher price than that offered by milk processing companies. Even so, investing in pasteurizing units is not enough to battle away the market share occupied by popular milk brands, and a lot needs to be invested in marketing and publicity.

More feasible measures that corporate dairy farms can take to lower their production costs is to increase their herd size so that they can benefit from economies of scale by buying fodder in bulk for lower prices during the peak season, and spreading the per unit labor cost of hiring foreign managers and specialized veterinarians. They can also change the composition of their labor force over time to include domestic labor trained by USAID in animal care and artificial insemination to assist the on-site veterinarian. Another way to reduce costs could be to indigenize the feed given to animals by finding a mix of suitable local ingredients that provide approximately the same nourishment for foreign and mixed breeds of cattle as imported ingredients.

These measures may help corporate dairy farms stay afloat and earn profits in the long run. Additionally, as the corporate dairy industry grows, it is likely to become more efficient by sharing expertise. But there are no short term solutions and if corporate dairy farms are unable to keep up, the government will have to re-focus its attention towards rural and small scale dairy farmers who still provide a larger portion of the country's aggregate milk supply.

From 2005-15, on average farm gate price of raw milk has gone up from Rs. 15.4 to Rs. 44.1

Total UHT milk production has gone up from 0.46 to 1.18 billion liters, over the last decade

General stores contribute for about 80% of branded liquid dairy products

Chapter 7

STRUCTURE OF MILK PROCESSING INDUSTRY AND DISTRIBUTION OF DAIRY PRODUCTS

7.1 Introduction

With a slow start in the beginning, the milk processing industry has come of age in recent years. Now there are several large scale and small scale milk processing plants are operating in the country. Likewise, consumer demand for processed milk and milk products has gradually picked up in recent times. The demand for milk is gradually shifting from fresh or loose milk towards processed milk and milk products (Fakhar and Walker, 2006). Even though 47% of consumers in Pakistan still use fresh milk exclusively (of which 63% are from rural areas) (Nielsen Pakistan, 2016A), most urban consumers are not satisfied with the milk quality delivered by dodhis and middlemen. This is because the chain of delivery for fresh milk is multi-layered and unreliable in terms of quality. However, milk processors have tried to circumvent this problem by establishing milk collection centers which test the milk for purity (Jong, 2013). These quality checks have helped entrench a positive consumer perception of the hygiene standards of the milk processing sector, thereby increasing demand for processed milk products. In this chapter, we examine the structure of milk processing industry in Pakistan and evaluate distribution network of liquid dairy products.

Section 7.2 provides an overview of the milk processing industry and discusses current large scale milk processors in Pakistan, farm gate and UHT milk prices, and capacity utilization of milk processing plants. Section 7.3 analyzes consumer preferences and distribution of liquid dairy products. Finally, Section 7.4 concludes the chapter.

7.2 The Milk Processing Industry

Efforts to increase the production of processed milk in Pakistan date back to the sixties and the seventies when 23 milk pasteurization and sterilization plants were set up in major cities of the country (Anjum et al., 1989). These plants used, recombined, and pasteurized skim milk powder before selling it to consumers (Burki et al., 2004). Unfortunately, this recombined milk product received a weak response from consumers; and inadequate supplies of fresh milk for processing forced these plants to run into deficits (Anjum et al., 1989; Burki et al., 2004).

In the late seventies, UHT treated milk gained popularity with the success of Packages Limited (Burki et al., 2004). Tetra Pak Pakistan Limited also contributed to the introduction of this product by producing aseptic packaging material for it (Burki et al., 2004). This attracted other players into the field. Consequently, multiple UHT plants were set up in the eighties, increasing productive capacity for processed milk in the country. Even so, a tangible shift in consumer preferences emerged only in the long run.

7.2.1 Number of Processors

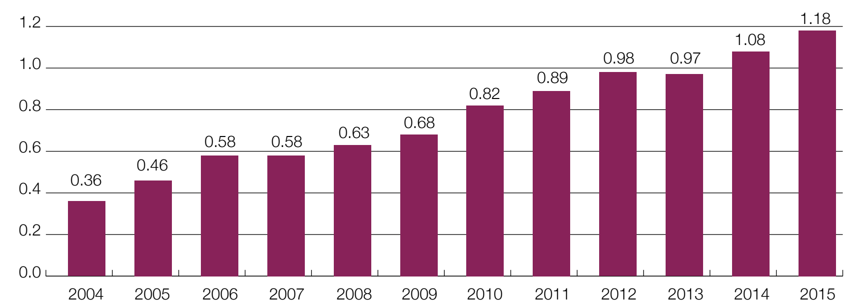
Processed milk production has gained momentum in recent years. Currently, a number of large scale dairy processing plants are operating in Pakistan. These include Nestle, Engro Foods, Chaudhry Dairies, Nirala, Halla, Noon Milac, Dairy Bell, Dairy Crest, Premier Haleeb, Prime, K&K, and Pak Army (Jong, 2013). Even though the share of milk processors in aggregate milk production is still small, a recent study by USAID suggests that the total estimated installed processing capacity is 2.42 billion liters per year (Jong, 2013). However, the industry is running at an average of only 50% of its production capacity when adjusted for peak and lean periods (Jong, 2013). This corresponds with the most recent figures of UHT milk production. Figure 7.1 below shows that total UHT milk production has increased steadily over the years from about 0.36 billion liters in 2004 to 1.18 billion liters in 2015.

This rise in UHT milk production can perhaps be attributed to dynamic adjustments of market demand and supply for processed milk. Over the years, consumer demand (especially in urban areas) has shifted from fresh or loose milk towards processed milk (Fakhar and Walker, 2006). This is because the chain of delivery for fresh milk is multi-layered and unreliable in terms of quality. Fresh milk is delivered to consumers by 'dodhis' or 'middlemen'. Dodhis purchase milk from dairy farmers and sell it to other economic agents like shopkeepers, khoya makers, confectioners/bakers, etc. who then sell fresh milk and milk products to the consumers (Jong, 2013). However, there are no quality control checks upon these middlemen who often adulterate fresh milk obtained by dairy farms by adding water and other ingredients to increase the volume, thickness and color of the milk in order to obtain higher prices from consumers. To circumvent this problem, milk processing companies have established milk collection centers in milk production areas with basic infrastructure in the form of chillers and refrigerated carriers (Jong, 2013). They also test the milk for purity (Jong, 2013). From the supply perspective, this enhanced access to sources of raw milk has in turn helped milk processors increase UHT milk production to match the rise in consumer demand.

7.2.2 Farm Gate and UHT Milk Price

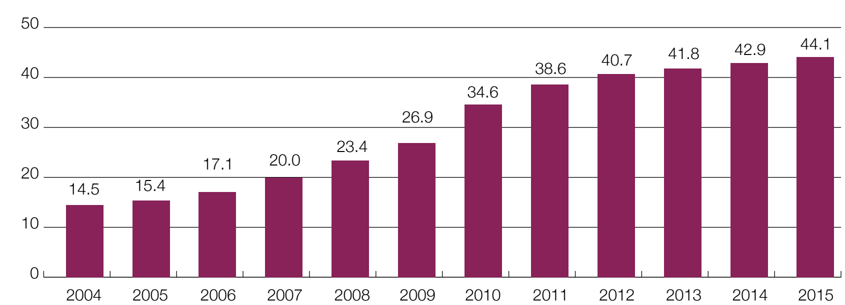
Farm gate prices for raw milk have also risen over the years (see Figure 7.2) from Rs.14.5 per liter in 2004 to Rs.44.1 per liter in 2015. When the collection and supply of fresh milk to consumers was dominated by dodhis, they were able to bargain with dairy farmers and offer them lower prices for their milk to obtain a higher profit margin for themselves. But the establishment of milk collection centers provides rural farmers the option of selling milk at village milk collection centers in order to try and obtain better farm gate prices (Jong, 2013).

Figure 7.1: Total UHT Milk Production in billion liters



Source: Various Market Sources

Figure 7.2: Farm gate price for raw milk in Rupees per liter



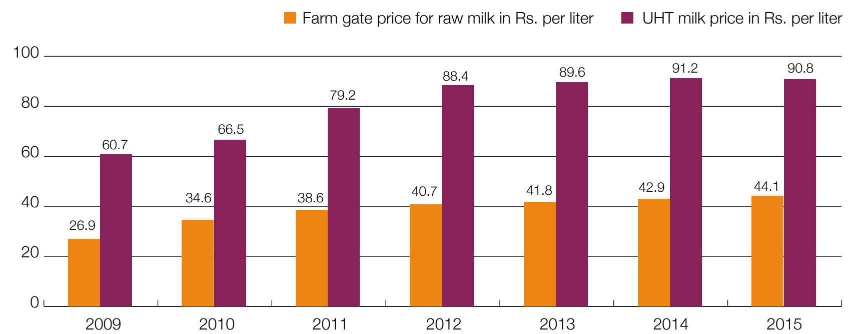
Source: Various Market Sources

However, this may not necessarily increase their bargaining power substantially. This is because farm gate prices offered by village milk collection centers (VMCCs) may differ based on milk quality. VMCC agents are responsible for testing the milk and ascertaining whether it fulfills the quality specifications of the company (Jong, 2013). So they may offer a lower price to the farmer for lower quality milk. Further, like dodhis, VMCC agents also earn their "margin from the difference between the purchase price and the sale price" and get "additional incentives by meeting the quality and quantity targets" of the processor (Jong, 2013). VMCCs may also provide additional benefits to commercial farmers who provide more than 40 liters a day in the form of collection of milk directly from their farms and partial advance payments (Jong, 2013). Therefore, the average farm gate price is determined essentially by market forces.

Figure 7.3 below presents a comparison of farm gate and UHT milk prices for the years 2009 to 2015. A review in 2002 suggests that the price of UHT milk is almost twice the price of raw milk in Pakistan (Sarwar et al., 2002). Figure 7.3 shows that the same is true of current data on Pakistan, and that the relationship between UHT and farm gate prices has on average remained unchanged over the years.

UHT milk prices have also risen from Rs.60.7 in 2009 to Rs.90.8 in 2015. This can be explained in two ways. Firstly, it can be explained in terms of market forces: with the rise in urbanization, income growth, and health and hygiene

Figure 7.3: Comparison of UHT and Farm Gate Milk Prices



Source: Nielsen Pakistan for UHT Prices & Various Market Sources for Farm Gate Prices
Note: UHT Milk includes Plain White Milk, Tea Creamers and Dairy Beverages. Currently Tea Creamers have more than 50% share of the total UHT Milk.

awareness, consumer demand for UHT milk has risen. However, supply of UHT milk has not increased by the same factor, which is why consumers are willing to pay higher prices for it. Secondly, it can be explained through milk processors' marketing efforts. Milk processing companies have established their brand in the market by introducing value added segments in their product line like flavored milk and yoghurt. This has not only helped them capture larger market shares but has also made the market for processed milk a heterogeneous goods market and enabled processors to charge higher prices for UHT milk.

7.2.3 Capacity Utilization of Milk Processing Units

Despite growth of UHT milk processing industry in recent years, the processors are still not operating at their full capacity due to seasonal nature of the milk supply (Fakhar and Walker, 2006).[40] According to industry sources, total processing capacity of the processing units (to process UHT milk, milk powder, chilled and flavored milk) is 3.12 billion liters. However, total production in FY2015 was only 1.82 billion liters, or 58% of its full capacity.

If the milk processing industry is to thrive in the long run, then something needs to be done to increase capacity utilization. This is because lower capacity utilization imposes costs upon processors that are difficult to determine (Fakhar and Walker, 2006). Measures need to be taken to increase supply of raw milk during lean periods. Corporate dairy farms provide temperature controlled environments for their herd which may alleviate fluctuations in milk supply. However, the majority of the country's aggregate milk supply comes from small-scale farmers who do not have the infrastructural support to circumvent seasonal factors. Therefore, the government either needs to provide infrastructural assistance to small-scale farmers, or milk processors must continue to rely on a diverse product line so that they can "switch between products in response to short term market trends" and keep their plants operational (Fakhar and Walker, 2006).

7.3 Distribution of Liquid Dairy Products

Next, we focus on the usage and attitude of dairy consumption and retail of liquid dairy products. This sub-section draws heavily from the two reports conducted by Nielsen (Nielsen, 2016A, 2016B). The attitude of dairy consumption report is based on a nationally representative household survey consisting of 3,633 respondents. A summary of the results of these studies are presented here that follow along with recommendations for the milk processing industry.

7.3.1. Usage and Attitude of Dairy Consumption in Pakistan

From the consumer perspective, the consumption of milk has been divided into four broad categories: loose milk, liquid tea whitener, UHT, and flavored milk. Qualitative and quantitative research[41] has been conducted to determine consumer needs and consumption patterns at the regional and demographic level (Nielsen Pakistan, 2016A).

The results of the study show that consumers either use one milk category exclusively, or use it in conjunction with one or more milk categories. The results show that 47% consumers use loose milk exclusively, compared to only 2% who use liquid tea whitener, and 3% who use plain white UHT milk only. The remainder use combinations of different milk categories. For instance, 11% consumers use a combination of loose milk and UHT milk and 6% use a combination of liquid tea whitener, UHT, and loose milk. Loose milk is more popular in rural areas. In fact, of all the respondents who use loose milk exclusively, 63% are from rural localities (Nielsen Pakistan, 2016A).

[40] In comparison, rural and urban small-scale farmers have not developed any strong forward linkages with other industries. For instance, farmers in peri-urban and rural areas simply sell off their non-lactating animals to the butcher, instead of auctioning them off. Since rural farmers normally do not engage in artificial insemination, they keep their male cattle for mating and as draught animals. This imposes a huge burden on the farmer in terms of feeding these excess animals. 'Dhodhis' and milk shop collectors mostly acquire the milk from these farms at a lower price and prevent these farms from developing their own processing, transport or marketing links with industries directly.
[41] Qualitative research includes focus group discussions, whereas quantitative analysis has been used to enumerate the results.

Milk consumption patterns also differ across age groups. Children between the ages of 4 and 14, and adults who are more 35 years of age are more prone to use loose milk exclusively. On the other hand, a predominant exclusive usage of UHT milk is observed amongst people between 15 to 35 years of age; these people are also consuming loose and UHT milk in combination (Nielsen Pakistan, 2016A).

Other interesting trends unveiled by this study reveal differences in consumption based on region, socio-economic classification, and gender. For instance, category and brand awareness for flavored milk is higher amongst urban consumers, and consumers with higher socio economic classification. Similarly, liquid tea whiteners are also more popular amongst urban consumers; however, they are mostly used by consumers with low socio economic classification. Moreover, awareness for liquid tea whiteners is higher amongst males than females, and awareness for UHT milk is higher in urban areas.

Purposes of milk consumption were also ascertained in the study, and it was found that milk is used primarily for making tea, followed by drinking, and making desserts. Loose milk is preferred the most for drinking, and making tea. UHT milk is consumers' second preference for drinking milk[42], and third preference for making tea. Liquid tea whiteners are preferred more than UHT milk in the preparation of tea (Nielsen Pakistan, 2016A).

Finally, consumers' quantity of milk consumption was tabulated at different times during the day, and it was observed that milk consumption is high during the early hours of the day before the children have gone to school, and is at its highest during the late hours of the night before going to bed. More specifically, the study found that milk drinking in the morning is driven by young children between the ages of 4 and 7 (Nielsen Pakistan, 2016A).

These findings show that milk consumption varies on a number of dimensions including region, age, gender, socio-economic class, purpose of consumption, and time of the day. For milk categories other than loose milk, it also depends heavily on brand awareness and the propensity to consume the brands' products. Perception drives consumers towards brands they find attractive, which is why processed milk brands should focus on developing their brand image and creating brand awareness in order to increase consumption.

7.3.2. Retailing of Liquid Dairy Products

In the retail market, liquid dairy products (LDPs) are divided into five categories: UHT plain milk, dairy beverages, tea creamers, high calcium low fat (HCLF) milk, and flavored milk. To analyze the distribution of LDPs in Pakistan's retails sector, Nielsen constructed a representative sample of retail outlets, including general stores, kiryana stores, paan shops, bakeries, departmental stores, utility stores, and pharmacies (Nielsen Pakistan, 2016B). For the study, 5843 panel outlets were used in the sample. The weightage of each group of outlets was factored in, and expansion factors were used to ensure that the proper weights were attached to the data collected in order to inflate the results to include the whole population of retail outlets in the country.

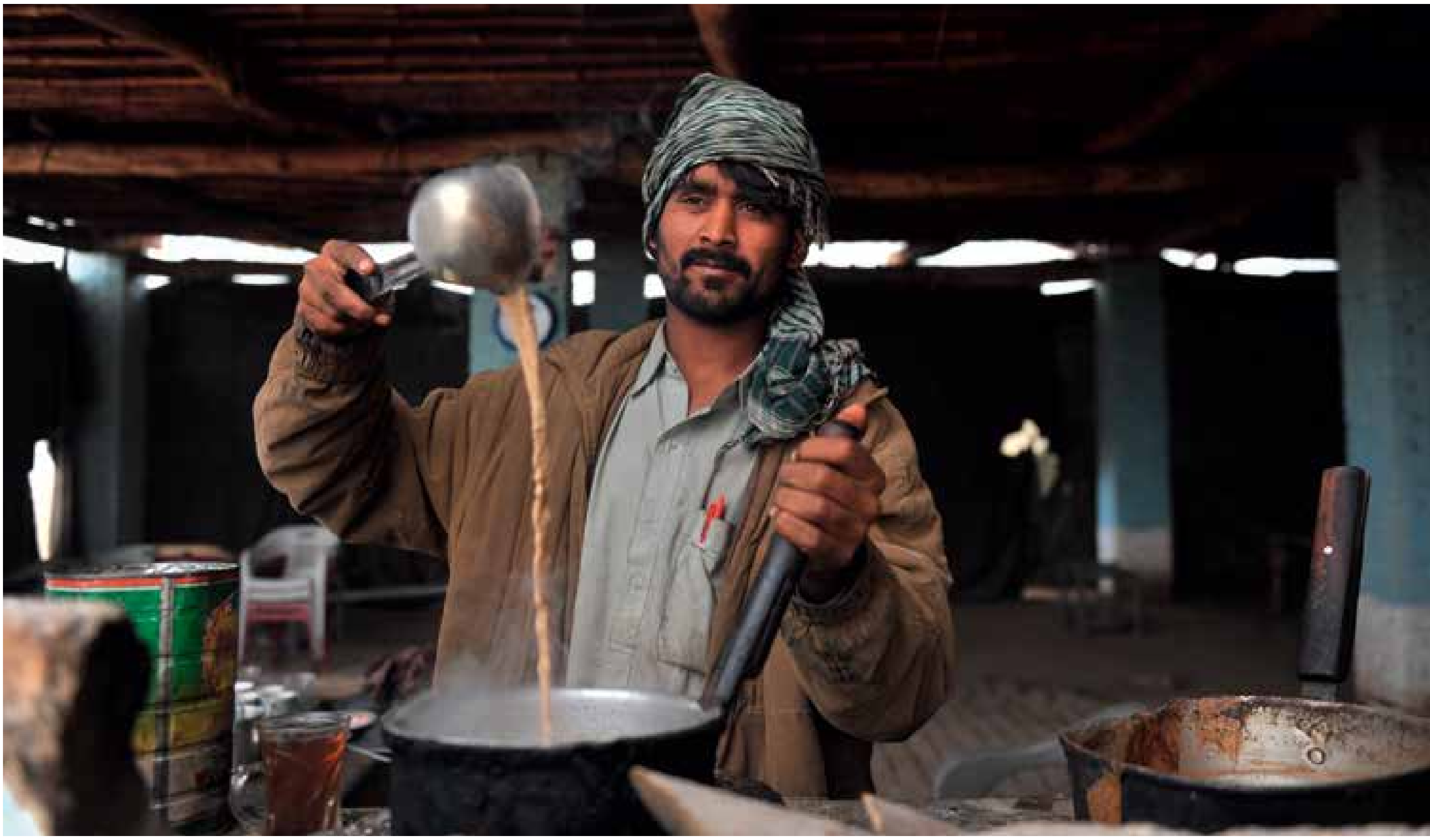
The results show that 20% of total LDP sales volumes are concentrated in three major urban centers of the country: Karachi, Lahore, and Islamabad/ Rawalpindi, and 25% are dispersed in rural Pakistan (Nielsen Pakistan, 2016B). Additionally, the market for flavored milk has a strong hold in Sindh, with 65% of sales coming from Karachi alone, followed by the rest of urban and rural Sindh at 10% each (Nielsen Pakistan, 2016B).

Tea creamers have acquired the highest share in the packaged dairy category (56%), whereas the share of UHT milk is lower than before (35%). The remaining market share, albeit small, is occupied by flavored milk, dairy beverages, and high calcium low fat milk.

Amongst tea creamers, Engro's 'Tarang' has proved itself to be the leading brand in 2015 , followed by Haleeb's 'Tea Max' and Shakarganj's 'Qudrat' (Nielsen Pakistan, 2016B). In the category of UHT plain milk, Nestlé's MilkPak and Engro's Olpers occupy the major market share (Nielsen Pakistan 2016B). Flavored milk occupies a small share within the LDP categories (Nielsen Pakistan 2016B). However, within the flavored milk segment, Pakola has the largest share of total flavored milk sales, followed by Shakarganj and Nestle (Nielsen Pakistan, 2016B).

The results also show that general stores contribute 80% of LDP sales, while the remaining sales volume is scattered over other types of retail outlets. Moreover, average sales per outlet have increased over the last year from 1,176 liters to 1,383 liters per handling shop (Nielsen Pakistan, 2016B). This is consistent with PSLM's study of monthly household expenditures for 2014 and 2012. Their analysis shows that out of the 17 major food items, milk (fresh and boiled) has the highest share in the food basket at 21.08% and has increased by 0.48% between 2011-12 and 2013-14 (PSLM Pakistan, 2016B).

[42] Primary players in drinking milk are Olpers and Nestle Milk Pak.
Additionally, flavored milk is the third preference for drinking milk, amongst which Nestle Milo and Pakola are in the lead.



Lastly, average sales per outlet for flavored milk have increased from 580 liters in 2014 to 629 liters in 2015 (Nielsen Pakistan 2016B), indicating that perhaps the share of flavored milk in the packaged dairy category will increase over the coming years.

7.4 Conclusion

Processed milk products have gained popularity in recent years, and a number of large scale milk processors are now operating in Pakistan. While UHT milk production and prices have risen over the years, milk processors are still not operating at their full capacity due to the seasonal nature of milk supply. If the milk processing industry is to thrive in the long run, then an integrated approach needs to be adopted which focuses on both the suppliers of raw milk and innovations in the processing sector itself. The bulk of the producers of raw milk are subsistence, small scale farmers who need support to enhance their productivity and technical efficiency. Farm gate prices, which are considerably lower than the UHT prices received by processors, are a primary motivator for these farmers. Increasing awareness amongst these farmers regarding consumers' and processors' milk quality specification, and providing them with milk testing kits can help increase their bargaining power and motivate them to remain in dairy production and produce more quantities of milk. Moreover, improving farmers' access to fodder during fodder shortages may also help increase animal productivity. Apart from UHT milk, tea creamers and flavored milk products are also in high demand. Consumers between 15 to 35 years of age are the main stay for demand for UHT milk while tea creamers are popular among urban consumers and lower income groups. These consumption patterns can help milk processing industry shape their marketing strategies in the near future.

79% population in Pakistan is below the minimum benchmark of 2,350 calories/day/adult

Pakistan would need Rs. 64 billion per day to bridge this nutritional gap

75% urban while 70% rural population is below the milk poverty line

Bridgning the milk poverty nationally would require around Rs. 0.75 billion per day

Chapter 8

ECONOMICS OF NUTRITION: CALCIUM AND MILK

8.1 Introduction

Malnutrition takes place when a person eats an inappropriate diet that consists of nutrients that lead to a condition of being underweight or overweight.[43] These problems are caused by under- or over-consumption of calories, proteins, carbohydrates and micronutrients, e.g., vitamins and minerals. Under nutrition refers to a condition where a person is not consuming enough calories, proteins, or vitamins and minerals, which can cause stunting and wasting, micronutrient deficiencies, and other diseases.[44] Malnutrition at an early age can lead to lower physical and mental development of children. For example, estimates show that stunting "affects more than 147 million preschoolers in developing countries", according to UN Standing Committee on Nutrition's World Nutrition Situation 5th report.[45]

There is also a close linkage between disease and malnutrition. According to the UN's Standing Committee on Nutrition, "malnutrition is the largest single contributor to disease in the world.[46]" "Iodine deficiency, the same report shows, is the world's greatest single cause of mental retardation and brain damage.[47]" Moreover, the National Nutrition Survey 2011 of Pakistan reports that:

"… stunting, wasting and micronutrient malnutrition is endemic in Pakistan. These are caused by a combination of dietary deficiencies; poor maternal and child health and nutrition; a high burden of morbidity; and low micronutrient content in the soil, especially iodine and zinc. Most of these micronutrients have profound effects on immunity, growth, and mental development. They may underlie the high burden of morbidity and mortality among women and children in Pakistan."

Unfortunately, over the past decade the anthropometry status has not improved in Pakistan. For example, if we take the case of children under 5 years of age, 43.7% of them were found to be stunted in 2011, which compares well with 41.6% children in 2001 (GoP, n.d.). Moreover, a biochemical test of children under 5 years of age indicate that micronutrient deficiency was also quite high at 61.9% for Anemia, 43.8% for Iron deficiency, 54% for Vitamin A deficiency, 39.2% for Zinc deficiency and 40% for Vitamin D deficiency (GoP, n.d.). A comparison with countries in the SAARC region shows that Pakistan has second highest rates of stunting and third highest rates of wasting (GoP, n.d.).

How these nutritional deficiencies affect Pakistan's economy and what are the other costs to society is not very clear. We seek to provide credible evidence to a number of key questions that directly or indirectly relate to malnutrition in the country. We begin by evaluating the costs of malnutrition on productivity and GDP growth. Then we move on to measure the nature and extent of nutritional deficiency with headcount food poverty in Pakistan by employing latest household survey data. In the next step, we study the magnitude of milk poverty headcount in Pakistan again with the latest available household survey data, which is followed by a review of the studies that empirically estimate the impact of malnutrition on school attendance. Finally, we get motivation from the human capital literature and proceed to empirically estimate the impact of milk calories on school attendance in Pakistan.

[43] *"Food is the fundamental right of the people and government is committed to provide it at all levels. In spite of adequate production and availability of essential food items of consumption, malnutrition continues to persist in the country" (GoP, 2014).*
[44] *For further details, see National Nutrition Survey 2011 (GoP, n.d.).*
[45] *http://www.wfp.org/hunger/malnutrition*
[46] *http://www.wfp.org/hunger/malnutrition*
[47] *http://www.wfp.org/hunger/malnutrition*

8.2 Costs of Malnutrition on Productivity and GDP Growth

For more than one decade, the inclusion of nutritional perspective to the analysis of growth and poverty has greatly strengthened the design of strategies for poverty reduction and economic growth. The nutritional perspective highlights the importance of understanding what role nutrition can play in a person's life. Essentially, there are three key insights provided by this perspective: "reversing the damage of early malnutrition is costly and difficult, and in some cases impossible; poverty is biologically transmitted across generations through malnutrition; and nutrition focuses attention on those who are most vulnerable and at risk" (SCN, 2004). They conclude that "nutritional deprivation in the first year or two of life should be considered a negative legacy due to its partial irreversibility" (SCN, 2004).

The economic manifestation of improvement in birth weight has been reviewed by several studies. Behrman and Rosenzweig (2001) find that a one pound increase in birth weight results in 7% increase in their lifetime earnings in the US. Similarly, moving from low-birth weight to non-low birth weight category there is a gain of US$580 per infant in developing countries (Alderman and Behrman, 2004). In other words, Pakistan can gain benefits to the tune of US$11 billion by adopting policies that help move children from low-birth weight category to non-low birth weight category.[48] Likewise, protein-energy malnutrition leads to very high productivity losses. In this context, Alderman et al. (1996) find that a 1% loss in adult height leads to 0.3% decline in rural wages in Pakistan.

Turning to macroeconomic impact of malnutrition, international examples show that countries with higher national nutritional indicators perform better in economic growth. Table 8.1 presents estimates of cost of malnutrition in lost productivity measured as a percentage of GDP in selected countries. It shows that cost of malnutrition in these countries is huge. In India, stunting and iron deficiency contribute to 2.65% decline in its GDP. Similarly, iron deficiency is the main cause of decline in GDP in Viet Nam. However, in Pakistan there is a 3.3% loss in GDP due to iron deficiency alone. If three types of nutritional gap (i.e., protein energy, iodine deficiency and iron deficiency) were eliminated in Pakistan, the level of GDP would have been 4% higher. The gain in GDP would be substantially more if longer duration childhood cognitive impairment effects are also taken into account (see Table 8.1).

Table 8.1: Estimates of Productivity Costs of Malnutrition, Selected Countries, as Percent of GDP

Country	Losses of Adult Productivity		
	Stunting	Iodine Deficiency	Iron Deficiency
India	1.40	0.30	1.25
Pakistan	0.15	3.30	0.60
Vietn Nam	0.30	0.10	1.10

Country	Losses Including Childhood Cognitive Impairment Associated with Iron Deficiency	
	Cognitive Only	Cognitive plus Manual Work
Bangladesh	1.10	1.90
India	0.80	0.90
Pakistan	1.10	1.30

Source: Horton (1999)

8.3 Projections of Nutritional Deficit and Headcount Food Poverty

A popular yardstick for evaluating the success of government policies has always been its ex-post impact on poverty reduction in the country. A popular measure of poverty in Pakistan is the headcount ratio or percentage of population below national consumption poverty line. For this purpose, Pakistan Bureau of Statistics regularly conducts household surveys such as Household Integrated Economic Survey (HIES) component of the Pakistan Social and Living Standards Measurement Survey (PSLM). This survey is the key instrument used to measure poverty status in the country. This survey is national, provincial and rural-urban representative. It also provides all the required information on consumption expenditure of each surveyed household. The sample size of this survey is around 15,000 households, which is drawn from all the four provinces of Pakistan. The cost of basic needs poverty line is worked out by aggregating expenditure on consumption of 2,350 calories per adult equivalent per day, and expenditure on consumption of non-food items. However, our interest is not to get into the debate of the extent of basic needs poverty in Pakistan. Rather we are interested to review the deficit in calorie consumption in the households.

In this regard, we use food energy intake method to calculate nutritional deficiency on the basis of 2,350 calories

[48] *This is calculated on the basis of 19.1 million children below 5 years of age present in 1998 population census.*

recommended to maintain good health and to achieve mental and physical growth.[49] This nutritional deficiency is also known as food poverty. We use PSLM-HIES 2011-12 data to calculate nutritional deficiency at the national, provincial and urban-rural level. To provide further insights, nutritional deficiency by age-group is also presented.

Table 8.2 reports these estimates where 79% population in Pakistan is below the minimum benchmark of 2,350 calories[50] per day per adult equivalent. Table 8.2 and Figure 8.1 also show that 84% of urban and 76% of rural population is below the benchmark. Approximately, 83% and 80% population of Sindh and Balochistan is below the recommended 2,350 calories, respectively; 78% and 73% population of Punjab and KP is also below the benchmark, respectively. Around 86% population in 10-14 years age-group is below 2,350 calories, which is most alarming. The lowest proportion of under-nourished population is in the age-group of above 50 years.

Figure 8.1 Head count of caloric poverty by region and age groups

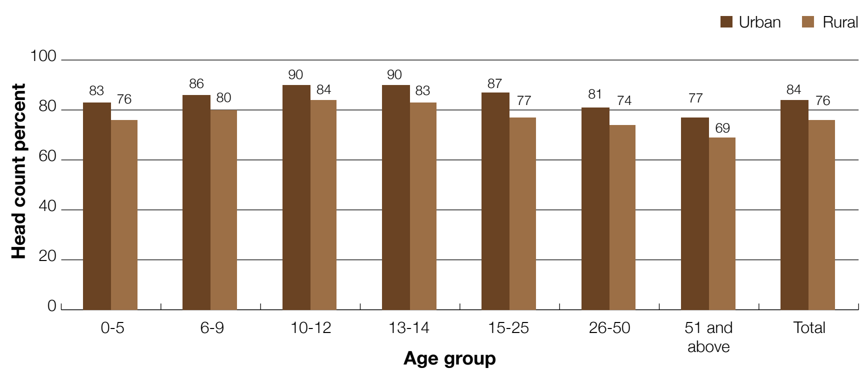


Table 8.2: Head count of caloric poverty by age groups

Age group	Region		Province				Total
	Urban	Rural	Punjab	Sindh	KP	Balochistan	
0-5	82.7%	75.7%	77.5%	81.1%	72.4%	80.3%	77.7%
6-9	86.3%	79.7%	81.5%	86.5%	74.2%	81.4%	81.5%
10-12	90.1%	84.1%	85.9%	90.6%	79.3%	83.1%	85.9%
13-14	90.2%	83.1%	85.6%	91.3%	76.1%	84.0%	85.4%
15-25	87.5%	77.3%	80.5%	85.8%	75.7%	80.3%	81.1%
26-50	81.2%	74.2%	76.7%	80.0%	70.7%	78.4%	76.8%
51&above	76.8%	68.7%	70.3%	77.3%	66.0%	75.6%	71.4%
Total	**84.0%**	**76.3%**	**78.4%**	**83.3%**	**73.0%**	**80.0%**	**78.9%**

Source: Author's calculation from PSLM-HIES 2011-12
Note: Caloric poverty is measured by converting the food quantities into calories using calorie conversion table provided by the Government of Pakistan. The caloric poverty line is 2350 calories per adult equivalent per day. Each household's per day per adult equivalent calories are compared with the poverty line and head count ratio is calculated for those who are unable to consume 2350 calories per day per adult equivalent (see, Haughton and Khandker, 2009).

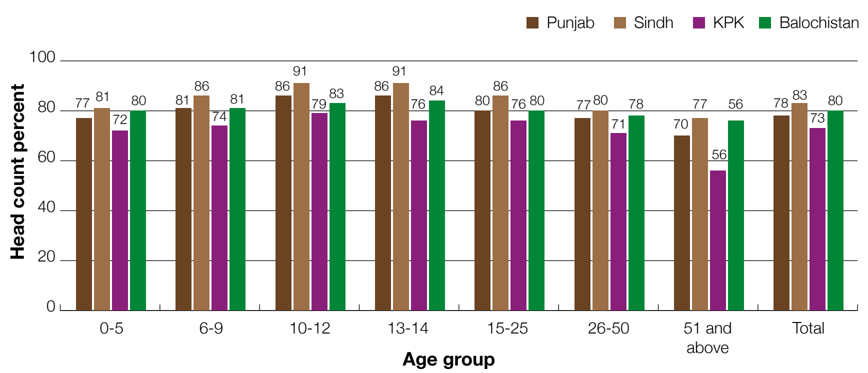
[49] *The national dietary intake patterns are calculated on the basis of desirable dietary patterns in the light of recommendations of Food and Agriculture Organization.*
[50] *For details on how the benchmark of 2350 calories was arrived at by the government, see Cheema (2005).*

Table 8.3: Total daily caloric poverty deficit by age groups (Billion Pak Rupees)							
Age group	**Region**		**Province**				**Total**
	Urban	**Rural**	**Punjab**	**Sindh**	**KP**	**Balochistan**	
0-5	3.03	6.43	5.52	2.33	1.19	0.40	9.45
6-9	2.31	4.94	4.07	1.97	0.92	0.29	7.25
10-12	1.94	3.65	3.21	1.53	0.65	0.21	5.60
13-14	1.23	2.10	1.94	0.89	0.38	0.12	3.33
15-25	6.45	8.48	8.83	3.89	1.69	0.52	14.93
26-50	6.36	9.01	9.24	4.08	1.60	0.50	15.43
51 & above	2.40	3.94	3.90	1.59	0.68	0.17	6.34
Total	**23.72**	**38.61**	**36.72**	**16.29**	**7.11**	**2.22**	**62.33**

Source: Author's calculation from PSLM-HIES 2011-12
Note: Daily caloric poverty deficit is measured as the average normalized shortfall with respect to the poverty line across age groups. This is also known as the poverty gap measure (see, Haughton and Khandker, 2009).

Table 8.3 shows that Pakistan would need Rs.64 billion per day to bridge this nutritional gap, which is huge. Of this, Rs.39 billion per day would be required for rural population below the benchmark and Rs.24 billion per day for urban population. Punjab province would require Rs.36.72 billion or 59% of total funds, followed by Sindh Rs.16.29 billion, KP Rs.7.0 billion and then Balochistan Rs.2.2 billion. The highest amount would be required to bridge nutritional gaps of 15-25 year olds (Rs.14.93 billion per day) and 26 – 50 year old (Rs.15.43 billion per day).

Figure 8.2 Head count of caloric poverty by provinces and age groups



8.4 Deficit in Per Capita Milk Consumption and Milk Poverty

Milk is an important source of calcium while certain vitamins are added to packed milk. However, nutritional experts do not have a specific recommendation for the minimum quantity of milk to be consumed by the households. We conducted as exercise to calculate milk poverty for each household. For this purpose, we benchmarked per capita consumption of fresh and packed milk of households who were meeting the recommended 2,350 calories. Based on data of PSLM-HIES 2011-12 we find that 750 households were consuming exactly 2,350 calories. We calculate per capita milk consumption of these households and use it as benchmark milk consumption requirement for all households in the survey. Those who were consuming less than this benchmark are termed as below milk poverty line. The milk requirement is measured in liters of milk per capita.

Table 8.4 shows milk poverty lines used for urban and rural areas across provinces on the basis of households at the 2350 calorie level. Average per capita milk consumption in an average benchmark household is 0.296 liters. Provincial comparison shows that average milk consumption is highest in urban Punjab followed by rural Punjab where consumption is above the national average. Milk consumption is almost similar in urban Sindh, rural Sindh and urban KP. However, lowest per capital milk consumption is in urban and rural Balochistan. Looking from another angle, per capital milk consumption in urban Punjab is about four times higher and in rural Sindh 2.5 times higher than Balochistan.

Table 8.5 presents milk poverty headcount at various levels. Our results suggest that 75% urban and 70% rural population is below the milk poverty line. Moreover, 73% people in Punjab, and Sindh, 70% in KP and 55% in Balochistan are below milk poverty line. The highest proportion below milk poverty line belongs to children from 10 to 14 years of age.

Table 8.6 presents deficit in daily milk consumption in national, urban/rural and province level. At the national level there is a deficit of 12.5 million liters, which comes to 4.57 billion liters per annum or around 10% of total milk available for human consumption (see also Figure 8.3). Bridging the milk poverty gap at the national level would require around Rs. 275 billion per annum.[51] Moreover, deficit in milk consumption is significantly higher in rural households (7.7 million liters) compared with urban households (4.82 million liters). Likewise, most of the deficit in milk consumption exists in Punjab province at 9.4 million liters per day compared with around 2 million liters in Sindh, 0.9 million liters in KP and only 0.16 million liters in Balochistan (also see Figure 8.4).

Table 8.4: Milk poverty lines used to estimate milk deprivation

Region	Per capita milk consumption by households consuming recommended 2350 calories
Punjab Urban	0.389
Punjab Rural	0.350
Sindh Urban	0.229
Sindh Rural	0.241
KP Urban	0.224
KP Rural	0.176
Balochistan Urban	0.082
Balochistan Rural	0.098
National Average	**0.296**

Notes: Milk poverty line is calculated by using the food energy intake method (see, Haughton and Khandker, 2009). The objective here is to find the households who meet their basic caloric requirement of 2350 calories per day per adult equivalent. Once these households are identified, we take their average per capita milk consumption and term it as milk poverty line. Only consumption of fresh and packed milk quantity is taken into consideration. Quantities of powdered milk, yogurt and other dairy products are not included to work out the milk poverty line.

Table 8.5: Milk poverty head count by regions and provinces

Age group	Region		Province				Total
	Urban	Rural	Punjab	Sindh	KP	Balochistan	
0-5	71.6%	68.7%	69.2%	72.3%	70.9%	56.6%	100.0%
6-9	76.6%	74.1%	76.1%	77.1%	72.4%	56.5%	100.0%
10-12	83.8%	78.2%	82.5%	80.2%	76.3%	59.1%	100.0%
13-14	84.4%	77.7%	82.4%	81.2%	74.9%	57.8%	100.0%
15-25	79.6%	71.3%	76.2%	73.9%	72.7%	55.8%	100.0%
26-50	71.2%	68.1%	70.6%	69.1%	68.0%	53.3%	100.0%
51 and above	69.3%	62.9%	65.8%	66.7%	62.5%	48.5%	100.0%
Total	**75.1%**	**70.2%**	**73.0%**	**72.8%**	**70.5%**	**55.3%**	**100.0%**

Source: Author's calculation from PSLM-HIES 2011-12
Note: Milk poverty headcount measures the percentage of population by age groups that is unable to consume the recommended quantity of per capita milk reported as milk poverty line in Table 3.4 (for poverty headcount see, Haughton and Khandker, 2009).

[51] *This is evaluated at the average price of Rs.60 per liter for lose milk in 2014-15 prices.*

Table 8.6: Daily milk poverty deficit (Quantity in million liters)

Age group	Region		Province				Total
	Urban	Rural	Punjab	Sindh	KP	Balochistan	
0-5	572,578	1,222,314	1,307,813	302,736	153,347	30,996	1,794,892
6-9	465,185	976,482	1,050,384	249,321	120,347	21,616	1,441,667
10-12	400,457	705,871	826,541	181,077	84,064	14,645	1,106,327
13-14	257,922	422,929	517,968	105,004	50,004	7,874	680,850
15-25	1,345,606	1,735,895	2,367,136	461,293	215,256	37,816	3,081,501
26-50	1,274,609	1,825,338	2,356,610	494,716	210,452	38,170	3,099,947
51and Higher	509,550	819,806	1,036,625	192,749	88,952	11,030	1,329,356
Total	**4,825,906**	**7,708,635**	**9,463,078**	**1,986,896**	**922,420**	**162,147**	**12,534,541**

Source: Author's calculation from PSLM-HIES 2011-12
Note: Daily milk poverty deficit is measured as the average normalized shortfall with respect to the milk poverty line set in Table 3.4 by age groups. This is also known as the poverty gap measure (see, Haughton and Khandker, 2009).

Figure 8.3 Headcount of milk poverty

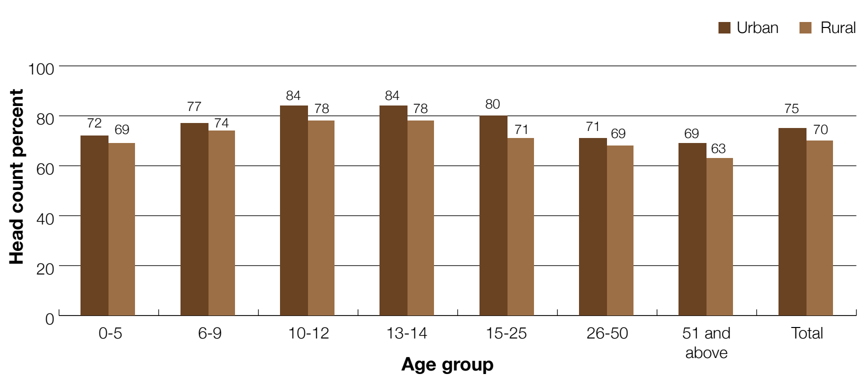
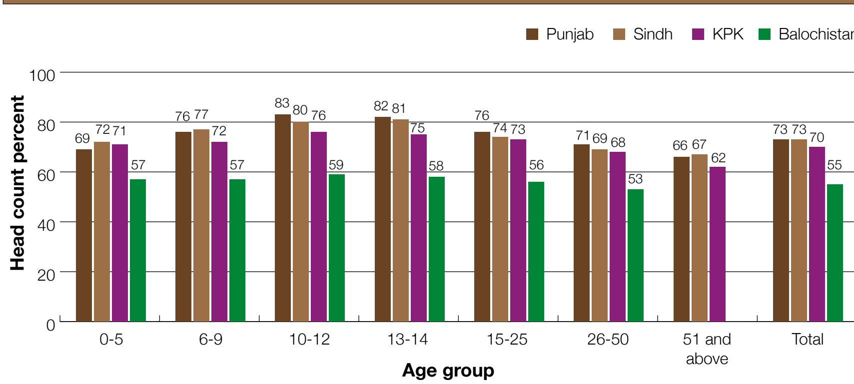


Figure 8.4 Headcount of milk poverty by provinces



8.5 Impact of Malnutrition on School Attendance

Besides the positive impact of elimination of nutritional gap on economic growth, better nutrition and health also affects child school performance and post-school productivity. In recent years, numerous cross-sectional and longitudinal studies have documented the relationship between child health and educational outcomes in developing countries like Pakistan. However, attempts to find a causal relationship between nutrition and schooling have been marred by the econometric problem known as endogeneity between children's nutritional/health status and schooling outcomes. The fact to the matter is that multiple sources of endogeneity have been identified.

Some researchers assert that nutrition/health is endogenous to schooling because investment decisions regarding schooling and health are made simultaneously by the household (Alderman et al (2001), Handa and

Peterman (2007), Aubery (2012), and Khanam (2014).[52] However, Grira (2004) disagrees while pointing out that conventional health indicators (e.g., height for age z-score and weight for age z-score) are determined prior to the school enrollment decision. Hence the decision to invest in health is made before the decision to enroll the child in school. She highlights a rather different source of endogeneity. She argues that since health and cognitive ability of a child at any given time is a function of his/her initial health or genetic endowment (Alderman et al, 2001); parents may offer lesser food to lower ability children. Further, since highly motivated parents are more likely to provide their children with a well-balanced meal as well as send them to school earlier (Behrman and Lavy, 1994), parental attitude toward schooling is also an unobservable characteristic which can affect the endogeneity of child's health/nutritional status. Other unobservable individual characteristics, e.g., child's innate ability, motivation, and capacity to concentrate can also cause endogeneity between these two variables, and thus they need to be controlled for (Behrman 1996).

In light of this, some recent studies on Pakistan and Bangladesh have used a set of unique estimation and empirical procedures. For example, Alderman et al. (2001) study the association between child schooling and health in Pakistan.[53] Using probit regressions they find a significant positive effect of pre-school height-for-age z-score on school enrollment for girls. They also find that children's nutrition has a three times larger impact on schooling when they account for unobserved factors such as preferences and endowments.[54]

Other studies have used cross-sectional data of Bangladeshi children to document the relationship between health/nutrition and child schooling. For example, Grira (2004) looks at the impact of three different health indicators (height for age z-score, weight for age z-score, and body mass index for age z-score[55]) on educational outcomes like school enrollment and schooling delay. She uses availability and distance to the nearest health facilities as well as water availability as instruments for health. Unlike other studies in the literature, she finds weight for age z-score to be the best predictor of health status. Her results indicate that child health impacts school enrollment positively and significantly, but this effect vanishes upon the inclusion of family and community characteristics. However, once a child is enrolled, malnutrition substantially affects school progress. In particular, she finds that "a one standard deviation improvement in weight-for-age would be expected to reduce the grades behind by about 0.25 years or about 13.5% of the actual years attained" (Grira 2004). Khanam (2014) uses cross-sectional data of Bangladeshi children and applies height for age z-score as an indicator of child health to evaluate its impact on three different indicators for child schooling (current school attendance, school enrollment, and grade attainment).[56] She finds that children's nutritional status has a stronger impact on school enrollment compared to grade attainment, but that there is no effect in the case of current school attendance.[57]

A study on Madagascar uses cross-sectional data of two districts and instruments height for age z-score (HAZ) and BMI for age z-score by using rainfall data from the previous five-years, uses test scores to evaluate cognitive achievement and controls for community and school characteristics (Aubery, 2012). This study finds that a "one point increase in HAZ is associated with a 1.4 point increase in the mathematics score, which corresponds to a 8.9% increase according to the average score" (Aubery 2012).

Other studies that find strong relationship between child's nutritional status and schooling outcomes and measure test scores as an indicator of cognitive achievement include the work of Florencio (1988) on the Philippines and Johnston et al. (1987) and Pollit et al. (1993) on Gautemala, however, the results of Gomes-Neto et al. (1997) do not indicate a too strong relationship between the two. Lastly, Glewwe and Jacoby (1995) look at the effect of child health on delayed school enrollment in Ghana and find that nutritional deficiencies at a younger age cause delayed school enrollment.[58]

In sum, one of the most important issues encountered in child health and school outcome studies has been the

[52] With a given budget, a higher investment in schooling will necessitate lower investments in health, leading to a reverse causality between child schooling and nutrition.
[53] They construct a three-stage dynamic decision making model, which helps them treat the potential endogeneity of child health by instrumenting the past nutritional status of the child (as indicated by height for age z-score) using prior period price shocks. Price shocks are defined as the deviation of current price levels (Pi) from long run expected prices (P). Price shocks are captured by including current prices and geographical dummies to capture long run differences in expected prices.*
[54] Estimates of a similar model using longitudinal data from South Africa fail to find a relationship between past height z-score and current schooling, which is attributed to differences in research design (Handa and Peterman, 2007). For instance, Alderman et al. (2001) used a measure of health for five-year old children and study schooling two year later, while Handa and Peterman measure schooling five years later.
[55] According to Behrman (1996), a low height for age z-score is an indicator of chronic malnutrition, whereas low weight for height and weight for age z-scores are used to identify transitory malnutrition.
[56] The dichotomous grade attainment variable was constructed using schooling-over-age (SAGE) which is a continuous variable. This measures school attainment over age, and also considers late enrollment.
[57] Khanam (2014) instrumented child health using mother's and father's height, which are good indicators of the genetic endowment of the child, and are uncorrelated with schooling outcomes.
[58] They instrument height for age z-score with mother's height and health prices.

endogeneity because both schooling and child health reflect household decision making options for investment on human capital of children. However, studies on the impact of malnutrition on schooling success have successfully controlled for the likely bias in the estimated impact of child health on schooling. The principal finding of these studies is that there is a large positive effect of pre-school height-for-age z-score and weight-for-age z-score on schooling outcomes. The effect of child health on delayed school enrollment is also very strong.

8.6 Impact of Milk Calories on School Attendance

In the previous section, we study the impact of malnutrition or child health on schooling outcomes. However, the direct relationship between milk calories consumed on school attendance of children is not obvious from this analysis. This section is aimed at providing empirical evidence on the impact of milk calories on school attendance in Pakistan by eliciting the human capital model of determinants of schooling.

Market demand and supply factors are often used as explanatory variables to evaluate the determinants of schooling and child labor (Basu, 1999, Kambhampati and Rajan, 2006, Kruger, 2007). The supply side factors relate to household behavior towards education and health, which in turn depends on households' socioeconomic background determined by factors surrounding each household including education and employment of parents, household size, infants present in the household, status of household head, etc. The demand side variables pertain to production system in the country and thus, are external to households. Production systems in developing countries are dominantly labor-intensive where often children assist their parents in agricultural, small-scale manufacturing production and service activities of various kinds. Similarly, demand for child work (rather than schooling) also comes from within households where due to greater involvement of households in self-employment activities the substitution possibilities between adults and children are quite high. Moreover, due to some peculiar circumstances, children's involvement in household activities may be necessary to free adults for engaging in more lucrative employments while children look after household chores (Kruger, 2007, Fafchamps and Wahba, 2006).

We use cross-sectional data obtained from PSLM-HIES 2011-12 to provide empirical evidence on the determinants of schooling in Pakistan. The empirical framework is motivated by a standard econometric model, frequently used in child schooling literature (Kruger, 2007, Edmonds and Pavcnik, 2005, Fafchamps and Wahba, 2006). We employ a probit specification given by

$$I_i^* = \alpha + \beta X_i + D_j + u_i,$$

$$I_i = 1 \text{ if } I_i^* > 0$$

$$= 0 \text{ if } I_i^* \leq 0$$

Our dependent variable I_i^* measures child school attendance for 4 to 17 year olds, which is a binary choice variable that equals one if child was attending school at the time of interview and equals zero otherwise; X_i is a vector of individual and household control variables; D_i controls for spatial variation captured by district and province dummy variables; and u_i is the error term. This specification can be viewed as a reduced form model, which reflects the supply and demand for child schooling. The coefficient estimates are obtained from the maximum likelihood estimation procedure. Definition of dependent and explanatory variables is provided in Table 8.7 while summary statistics is shown in Table 8.8.

Table 8.8 shows that our sample size is 26,870. At the time of interview, 89% children in the sample were attending school. Our key explanatory variable is per capita daily milk calories consumed by a household from fresh/boiled, packed and powdered milk. To calculate caloric values for included milk items, we use the updated caloric values from PSLM 2012 questionnaire presented in Table 8.9. Table 8.8 shows that an average household was consuming 153 milk calories per capita with wide variation across household ranging from a minimum of 2 calories to 1741 calories per capita (standard deviation is 118). Summary statistics of other variables shows that there are 43% girls against 57% boys in the sample; 10.5% boys and 8.1% girls have working mothers; 16.3% boys and 15.2% girls have literate mothers; average size of the household is 8.3 members; 33.6% children have less than 5 year old sibling; 89.4% have siblings of 6 to 17 year olds; 8.1% have a female head of the household; 8.4% have nuclear family; 38.09% boys and girls have illiterate head of household, 4.5% have heads with below primary education, 25.5% have primary education, 15.3% have secondary education and 17% have more than secondary education. Moreover, 17% heads are self-employed, 16% are in construction sector, 8% each are in wholesale trade and financial services, and around 4% are employed in agriculture sector. In addition, 43% children in the sample come from Punjab, 23% from Sindh, 22% from KP and 12% from Balochistan.

Table 8.10 presents estimation results for the probit maximum likelihood estimates for school attendance equation. Column (1) includes linear term for per capita milk calories but excludes square term for per capita milk calories. Column (2) includes both linear and square terms of per capita milk calories; all other variables are same in the two models. A key hypothesis tested here is that greater per capita consumption of milk calories raises the probability of school attendance of 4 to 17 year old boys and girls.

Table 8.7: Definition of dependent and explanatory variables	
Dependent variable:	
Child school attendance	Dummy equals 1 if a child (aged 4-17 years) was attending school at the time of the interview including government, private, religious, NGO and trust or foundation schools, and 0 otherwise.
Key independent variables:	
PC daily milk calories	Per capital daily milk calories are obtained by dividing the sum of calories consumed by all members of a household. Included milk items are fresh/boiled, packed, and powdered milk. We do not include yogurt, cream, ghee and other products made from milk.
Household control variables:	
Child is female	Dummy equals 1 if girl child, 0 otherwise.
Mother works x Boy	Dummy equals 1 if boy has a working mother, 0 otherwise.
Mother works x Girl	Dummy equals 1 if girl has a working mother, 0 otherwise.
Mother literate x Boy	Dummy equals 1 if boy has a literate mother, 0 otherwise.
Mother literate x Girl	Dummy equals 1 if girl has a literate mother, 0 otherwise.
Household size (number)	Number of household members in child's family.
Infants 0 – 5 years of age present	Dummy equals 1 if child has less than 5-year old siblings.
Children 6-17 years present	Dummy equals 1 if child has 6-17 year old siblings and 0 otherwise.
Head is female	Dummy equals 1 when the head of the household is a female and 0 otherwise.
Nuclear family	Dummy equals 1 if child lives in a nuclear family and 0 otherwise.
Head education is below primary	Dummy equals 1 if household head's education is below primary and 0 otherwise.
Head education is primary	Dummy equals 1 if household head has acquired primary education and 0 otherwise.
Head education is secondary	Dummy equals 1 if household head has acquired secondary education and 0 otherwise.
Head education is above secondary	Dummy equals 1 if household head has more than secondary education, 0 otherwise.
Head employed in agriculture	Dummy equals 1 if head is employed in agricultural sector and 0 otherwise.
Head employed in mining	Dummy equals 1 if head is employed in mining sector and 0 otherwise.
Head employed in manufacturing	Dummy equals 1 if head is employed in manufacturing sector and 0 otherwise.
Head employed in electricity/gas	Dummy equals 1 if head is employed in electricity/gas sector and 0 otherwise.
Head employed in construction	Dummy equals 1 if head is employed in construction sector and 0 otherwise.
Head employed in wholesale trade	Dummy equals 1 if head is employed in wholesale trade sector and 0 otherwise.
Head employed in transport & storage	Dummy equals 1 if head is employed in transport and storage sector, and 0 otherwise.
Head employed in financial services	Dummy equals 1 if head is employed in financial services sector and 0 otherwise.
Head employed in social services	Dummy equals 1 if head is employed in social services sector and 0 otherwise.
Head self-employed	Dummy equals 1 if head is self-employed, and 0 otherwise.
Province fixed-effects	It includes four province dummy variables
District fixed-effects	It includes ninety district dummy variables

Table 8.8: Summary statistics of dependent and explanatory variables				
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Dependent variable				
Child school attendance (yes=1, no=0)	0.890	0.313	0	1
Key independent variables				
PC daily milk calories	153.098	118.011	2	1740.900
PC daily milk calories square	37365.230	89319.770	4	3030915.0
Household control variables				
Child is female (yes=1, no=0)	0.430	0.495	0	1
Mother works x Boy (yes=1, no=0)	0.105	0.307	0	1
Mother works x Girl (yes=1, no=0)	0.081	0.273	0	1
Mother literate x Boy (yes=1, no=0)	0.163	0.369	0	1
Mother literate x Girl (yes=1, no=0)	0.152	0.359	0	1
Household size (number)	8.316	3.396	2	38
Infants up to 5 years of age present (yes=1, no=0)	0.336	0.472	0	1
Children 6-17 years of age present (yes=1, no=0)	0.894	0.307	0	1
Head is female (yes=1, no=0)	0.082	0.274	0	1
Nuclear family (yes=1, no=0)	0.084	0.277	0	1
Head education is below primary (yes=1, no=0)	0.045	0.206	0	1
Head education is primary (yes=1, no=0)	0.255	0.436	0	1
Head education is secondary (yes=1, no=0)	0.153	0.360	0	1
Head education is above secondary (yes=1, no=0)	0.166	0.372	0	1
Head employed in agriculture (yes=1, no=0)	0.042	0.201	0	1
Head employed in mining (yes=1, no=0)	0.018	0.134	0	1
Head employed in manufacturing (yes=1, no=0)	0.014	0.117	0	1
Head employed in electricity/gas (yes=1, no=0)	0.101	0.301	0	1
Head employed in construction (yes=1, no=0)	0.155	0.362	0	1
Head employed in wholesale trade (yes=1, no=0)	0.080	0.272	0	1
Head employed in transport & storage (yes=1, no=0)	0.051	0.220	0	1
Head employed in financial services (yes=1, no=0)	0.084	0.277	0	1
Head employed in social services (yes=1, no=0)	0.075	0.263	0	1
Head self-employed (yes=1, no=0)	0.174	0.379	0	1
Province fixed-effects				
Punjab	0.435	0.495	0	1
Sindh	0.226	0.418	0	1
KP	0.222	0.415	0	1
Balochistan	0.116	0.320	0	1
District fixed-effects	yes	--	--	--
Sample size	26870	--	--	--

Table 8.9: Caloric value of Food items included in the PSLM 2012 Questionnaire				
S. No.	**Code**	**itc**	**calories**	**Unit**
1	1101	milk (fresh & boiled)	800*	Liter
2	1102	milk packed by milk plant	560*	Liter
3	1103	milk, powdered (for adults & children)	4.9**	Gm

Table 8.10 Effects of milk calories consumed on school attendance		
Variable.	**Full sample**	
	(1)	**(2)**
PC daily milk calories	0.00038*** (2.92) [0.00006]	0.00064*** (3.04) [0.0001]
PC daily milk calories square	--	-0.000000416* (-1.82) [-0.0000000682]
Child is female (yes=1, no=0)	-0.229*** (-8.19) [-0.038]	-0.229*** (-8.17) [-0.038]
Mother works x Boy (yes=1, no=0)	0.0240 (0.59) [0.0039]	0.0230 (0.57) [0.0037]
Mother works x Girl (yes=1, no=0)	-0.0405 (-0.92) [-0.0068]	-0.0414 (-0.94) [-0.00694]
Mother literate x Boy (yes=1, no=0)	0.390*** (9.27) [0.0536]	0.389*** (9.25) [0.0535]
Mother literate x Girl (yes=1, no=0)	0.610*** (13.78) [0.0753]	0.608*** (13.74) [0.0751]
Household size (numbers)	-0.0137*** (-3.15) [-0.0022]	-0.0136*** (-3.12) [-0.0022]
Infants up to 5 years of age present (yes=1, no=0)	0.350*** (11.43) [0.0533]	0.351*** (11.49) [0.0535]
Children between 6-17 years of age present (yes=1, no=0)	0.0359 (0.92) [0.006]	0.0377 (0.97) [0.006]
Head is female (yes=1, no=0)	0.455*** (6.54) [0.0575]	0.456*** (6.54) [0.0576]
Nuclear Family (yes=1, no=0)	-0.372*** (-6.01) [-0.0743]	-0.372*** (-6.00) [-0.0743]

Table 8.10 Effects of milk calories consumed on school attendance		
Variable.	**Full sample**	
	(1)	**(2)**
Four head education variables included	Yes	Yes
Ten head employment status variable included	Yes	Yes
Province fixed effects	Yes	Yes
District fixed effects	Yes	Yes
Constant	0.747*** (4.64)	0.712*** (4.38)
Observations	26,870	26,870
Pseudo R-squared	7.74	7.76
Wald chi2	1186.66	1191.52
Prob > chi2	0.0000	0.0000
Sample size	26870	26870

*Note: Robust t-statistics in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels. The model was estimated with the probit maximum likelihood method corrected for heteroskedasticity.*

The linear term for per capita milk calories in column (1) is positive and statistically significant at the 1% level. The estimated coefficient implies that holding other variables as constant, an increase in per capita daily milk calories by its sample mean of 153.1 increases the probability of school attendance by 0.95 percentage points. Consistent with results in column (1), the results in column (2) suggest that per capita milk calories have a non-linear relationship with school attendance. The linear term is significantly positive and square term is significantly negative. Hence the probability of school attendance initially increases with per capita milk calories consumed per day, but later decreases. The estimated coefficients in column (2) imply that this switch occurs at 770 milk calories per capita per day, which is much higher than the mean calories of 153.1. In other words, there is a substantial gap between the current level of consumption and the desirable consumption level of milk to achieve optimal school attendance rates. Our estimates also suggest that the optimal milk calories are 32.8% of the recommended 2,350 calories.

The other estimates in Table 8.10 suggest that holding all else constant, girls are 3.8% less likely than the boys to attend school. Mother literacy has a stronger positive impact on girls compared with boys. Girls (boys) with literate mothers are 7.5% (5.4%) more likely to attend school than girls (boys) with illiterate mothers. Boys and girls coming from larger households and nuclear families are less likely to attend school while those who have female heads of household and who have infants below 5 years of age are more likely to attend school. These results are generally consistent with a large number of empirical studies on child labor and child schooling conducted on data from developing countries including Pakistan (UNICEF, 2013, Shahnaz, 2011, Kruger, 2007, Wahba, 2006, Fafchamps and Wahba, 2006).

8.7 Conclusions

In this chapter, we focus on the economics of nutrition by exploring the costs of malnutrition on productivity and GDP growth, evaluating the nature and extent of nutritional deficiencies measured by headcount food poverty, measuring and evaluating the magnitude of milk poverty headcount in Pakistan and estimating the impact of malnutrition on school attendance in Pakistan. Our key findings are summarized below.

First, analyzing the cost of malnutrition on productivity and GDP growth the findings are that a one pound increase in birth weight leads to 7% increase in lifetime earnings in the US. Adopting policies that help eliminate birth weight deficit in Pakistan is expected to bring about benefits to the tune of US$11 billion per annum. Protein-energy malnutrition leads to very high productivity losses and a 1% loss in adult height in Pakistan leads to a 0.3% decline in rural wages.

Second, countries with low nutritional indicators suffer huge cost in terms of lost productivity and growth in GDP. Estimates from Pakistan suggest that there is a 3.3% loss in GDP due to iron deficiency alone. In Pakistan, if nutritional gap in protein energy, iodine deficiency and iron deficiency is eliminated, it has the potential to increase the level of GDP by 4% per annum. These gains may be substantially higher if longer duration childhood cognitive impairment effects are also taken into account.

Third, our estimates suggest that 79% population in Pakistan consumes less than the recommended 2,350 calories per day of which 84% population is from urban and 76% from rural areas. Respectively, 83% and 80% population of Sindh and Balochistan, and 78% and 73% of Punjab and KP is also below the suggested food poverty benchmarks. Moreover, 86% children of 10-14 years consume less than the recommended calories. It implies that Pakistan would need Rs.64 billion per day to bridge this nutritional gap, of which Rs.39 billion would be required for the rural poor.

Fourth, we find that 70% to 75% urban and rural population consumes less milk than the estimated milk poverty line. The highest proportion of population below this benchmark belongs to children in the age-group of 10 to 14 years. There is a deficit of 12.5 million liters per day in the country, which comes to 4.57 billion liters per annum and that is equal to 10% of total milk currently available for human consumption. To bridge the gap in milk consumption would require Rs.275 billion per annum.

Fifth, recent studies have established that better nutrition and child health affects child school performance and post-school productivity. Specific evidence from Pakistan suggests that there is a positive effect of pre-school height-for-age z-score on school enrollment for girls.

Last, the direct relationship between per capita milk calories consumed on school attendance rate is positive. An average household consumes 153 milk calories per capita. Holding all else constant, an increase in per capita daily milk calories by its sample mean of 153.1 increases the probability of school attendance by 0.95 percentage points. Moreover, the probability of school attendance initially increases with per capita milk calories and reaches its maximum point at 770 milk calories per day, which is much higher than the mean calories. By implication, these results suggest that there is a huge gap between the present level of milk calories consumed and the desirable level.

Imposing sales tax on dairy sector would result in higher efficiency losses to consumers and producers

Long run deadweight loss to society would increase more than proportionately for additional increase in tax rate

Imposing an output tax instead of an input tax will incur higher net cost rather than a gain in revenues

Chapter 9

WELFARE ANALYSIS OF IMPOSING SALES TAX ON PACKED MILK

9.1 Introduction

As part of measures to increase tax to GDP ratio, the Federal Board of Revenue (FBR) is actively exploring ways and means to raise tax revenue in the country. In this context, every year discussions take place between FBR and the milk processing industry. In these parleys, proposals for imposition of Generalized Sales Tax (GST) on output are contemplated, but the tax is never levied. Presently, a zero rating regime is in place on all direct materials used by the milk processing industry. Refunds are admissible on indirect materials used at the rate of 17%. These materials include fuel, electricity, packing, spare parts, lubricants, etc. But in practice these refunds have never materialized. Over the years, the accumulation of these refunds have led to serious problems for some big players since questions are raised on their balance sheets because these receivables do not go well with the good accounting practices in the eyes of their shareholders.

An even more serious problem associated with this policy is that it imposes an input tax of 6% on those dairy processing units who are tax compliant. Non-tax compliant units who do not pay their due taxes on indirect materials get undue cost advantages. In this way, when refundable input tax is not refunded, it serves as a distortionary measure whereby tax compliant units are penalized for paying taxes while non-tax compliant units are favored.

In this chapter, we ask the more important question: Should FBR impose an output tax on packed milk? If yes, then, at what rate? The answer to this question is tricky simply because sales tax is an indirect tax which may have far reaching implications on the welfare of milk consumers and dairy farms producing milk depending upon the incidence of the tax.

It is well known in economic literature that the final incidence of indirect taxes depends on the relative elasticity of demand and supply curves. If the demand curve is elastic and the supply curve is inelastic then the incidence of the sales tax disproportionately falls on producers. However, if the demand curve is inelastic and the supply curve is elastic then the incidence disproportionately falls on consumers. The tax incidence analysis can be done in a partial equilibrium framework where we can work out the impact of tax on tax revenue, consumer surplus, producers' surplus and deadweight loss to the sector.

We conduct the partial equilibrium analysis to figure out the incidence of tax on packed milk. As noted above, the partial equilibrium analysis is based on information on price elasticity of demand and price elasticity of supply of packed milk, which allows us to map the market demand and supply functions, which in turn are used to compute the implications of the tax on consumers, producers, deadweight loss and potential tax revenue at various tax rates. In general, we find that as sales tax is increased, tax revenue also increases but the gains in tax revenue only come at the cost of welfare losses to consumers and dairy farmers. In Section 9.2, we present a theoretical perspective on incidence of tax while in Section 9.3 we estimate the market demand for dairy products. Section 9.4 is on supply elasticity of dairy products. Finally, Section 9.5 examines the long run and short run implications of imposition of sales tax on the dairy processing industry.

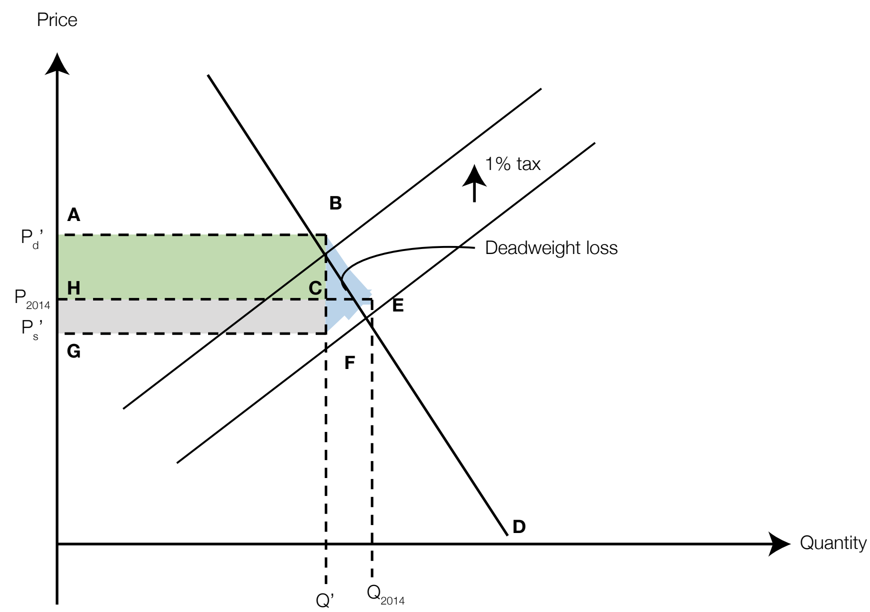
9.2 A Theoretical Perspective on the Incidence of Tax

Figure 9.1 below shows a sketch of the demand and supply curves for milk. As the price of milk increases, its demand falls. Thus, the demand curve has a negative slope. On the other hand, as the price of milk increases, milk production also increases. So, the supply curve has a positive slope. The demand curve is steeper than the supply curve since demand is relatively inelastic compared to supply.

The intersection of the demand and supply curves is represented by the point labeled E on the graph.[59] When a 1% sales tax is imposed on packed milk sector, the supply of milk falls resulting in a parallel upward shift of the supply curve from S to S'. Point B represents the new market equilibrium after the imposition of the sales tax.[60]

The coordinates of the new and old market equilibrium were used along with the slopes and intercepts of the demand and supply functions to compute the tax revenue, deadweight loss to society, and the change in producer and consumer surplus.

Total tax revenue for collection is represented by the area of the rectangle ABFG in Figure 9.1. The deadweight loss to society is equal to the area of the triangle BEF. The change in consumer surplus is the area of the trapezoid ABEH. The region ABCH represents the tax burden on the consumer, and the region BEC represents efficiency losses resulting from changes in consumption behavior. Finally, the change in producer surplus is the area of the trapezoid EFGH. The region CFGH represents the tax burden on the producer, and the region CEF represents the efficiency losses resulting from changes in production behavior.



Tax revenue = Area of rectangle ABFG = $(P_d' - P_s')$ x (Q');

Deadweight loss = Area of triangle BEF = 1/2 x $(P_d' - P_s')$ x $(Q_{2014} - Q')$;

Change in consumer surplus = Area of trapezoid ABEH = 1/2 x $(P_d' - {}_{P2014})$ x $(Q' + Q_{2014})$;

Change in producer surplus = Area of trapezoid EFGH = 1/2 x $(P_{2014} - P_s')$ x $(Q' + Q_{2014})$.

9.3 Estimating Market Demand for Dairy Products

It is well known that consumer demand for goods and services are restricted by budgetary constraints and the demand for these items is also interlinked. To capture the linkages between prices and incomes on demand for these goods and services, we apply Stone's model of simultaneous demand equations to estimate the demand function for packed milk and other goods.

To be able to estimate market demand, we have employed a unique panel data that has been shared with us by a market research firm namely, Foresight Research. This household panel is based on four-year data of 7,700 households, covering the period from 2011 to 2014.[61] This data contains detailed information on household expenditure, prices of packed milk, and quantity of milk consumed by each household.

The specification of the econometric model is given in Appendix – 3. We have grouped household per capita consumption into four categories, viz., packed milk, fresh milk, all food and beverages other than milk, and a composite commodity variable, which includes apparel, textile, footwear, housing, utilities, education, health, transportation, communication, cleaning, personal hygiene, recreation, and entertainment. The demand functions for the four categories listed above are estimated simultaneously by the Stones model. The estimates of compensated elasticity are reported in Table 9.1 along with their standard errors.

[59] This equilibrium point, E, marks the price and amount of milk produced and consumed in the year 2014. These coordinates have been labeled on the graph as P2014 and Q2014 respectively. The Foresight Research panel survey indicates that the average price of milk in 2014 was Rs.93.55/liter. We found from industry sources that the quantity of milk produced and consumed in 2014 was 1854 million liters.
[60] The new market equilibrium, B, has the coordinates Pd' and Q'.
[61] This data set was obtained from 'Foresight Research' based in Karachi. The Foresight Research collects monthly and annual expenditure data from households.

Table 9.1: Estimated Compensated Elasticity					
Equation	Income elasticity of	Price Elasticity of			
		Packed Milk	Fresh Milk	Food & Beverages	Others
Packed Milk	0.139*** (0.004)	-0.827*** (0.023)	- 0.519*** (0.034)	-16.400*** (0.891)	18.400*** (0.887)
Fresh Milk	0.110*** (0.009)	0.568*** (0.054)	-0.838*** (0.079)	6.300*** (2.10)	-5.290** (2.09)
Food & Beverages	0.388*** (0.004)	-0.259*** (0.025)	-0.341*** (0.037)	-0.514 (0.962)	1.210 (0.958)
Others	0.344*** (0.006)	0.0705* (0.038)	-0.110* (0.056)	25.100*** (1.48)	-24.800*** (1.47)

Note: Standard errors are reported in parenthesis.
****, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.*

Table 9.1 reveals that as expected all own price elasticities bear negative signs and their magnitudes are also reasonable. However, the own price elasticity for food & beverages is not statistically different from zero, which means that the consumption of food and beverages other than milk is not responsive to changes in its own price. The inelastic demand for food & beverage suggests that sellers of these commodities have strong incentive to raise prices because doing so would lead to much higher revenues.

The own price elasticity estimates for packed and fresh milk are approximately equal, and the demand for milk is relatively more elastic than food & beverages. The estimates further suggest that a 1% increase in the price of packed milk leads to 0.827% decrease in its consumption, and likewise a 1% increase in the price of fresh milk decreases its consumption by 0.838%.

The cross-price substitution effect between packed milk, fresh milk, and all other food & beverages reveal some interesting patterns. For example, an increase in food price corresponds to a decrease in the consumption of packed milk. Similarly, an increase in the price of fresh milk corresponds to a decrease in the consumption of packed milk. These results suggest that in the case of packed milk, the income effect is stronger than the substitution effect. That is, instead of substituting away from food to packed milk or from fresh to packed milk, the overall consumption of all commodities falls. On the other hand, an increase in food price corresponds to an increase in consumption of fresh milk. Similarly, an increase in price of packed milk corresponds to an increase in consumption of fresh milk. This suggests that packed and fresh milk act as substitutes and that, for fresh milk, the substitution effect is stronger than the income effect. This means that as the price of packed milk and food increases, consumers tend to substitute away from these commodities to the consumption of fresh milk. Using these estimation results, we find that the slope of the demand curve for packed milk is confirming that the demand curve is downward sloping.[62] The intercept was found to be 206,657,957.

9.4 Estimating Supply Elasticity of Packed Milk

In the next step, we also estimate supply elasticity of packed milk. In order to estimate the output supply function for packed milk, we run a transcendental logarithmic (translog) form of the profit function, which is a flexible functional form (Christensen et al., 1973).

For this analysis, we use cross sectional data from the LUMS Survey of Dairy Households in Rural Punjab for the year 2005. Here we assume that the supply elasticity remains stable in the short run. This data contains information on the quantities and prices of dairy output and dairy inputs. A brief explanation of the econometric model specification is given in Appendix – 4. This model accounts for both variable and fixed inputs in the production process, and controls for how these inputs interact together to produce the final commodity.

[62] This slope was computed by using price in rupees per million liter and quantity in million liters (we converted the price of milk from rupees per liter to rupees per million liter for convenience). The resulting tax revenues, deadweight loss, and changes in consumer and producer surplus computed were in Rupees, and then reported in billions of rupees in the finalized tables.

The variable inputs include different types of fodder like rabi fodder, kharif fodder, roughages and grass, wheat straw, and concentrate. However, to simplify the estimation, we combine rabi fodder, kharif fodder, and roughages and grass into one composite input called 'green fodder'.[63] The remaining fodder types (wheat straw and concentrate) are grouped together to form another composite input.[64] The fixed inputs in our production process include electricity, and initial investments in animal capital, sheds, and yards. Note that electricity is considered a fixed input in the short run because there is no significant variation in its prices. The estimation results are presented in Appendix – 4. Based on these results, we find that own price supply elasticity of milk is 3.23, which implies that a 1% increase in the price of milk corresponds to a 3.23% increase in milk production in the long run. This elasticity number is then used to calculate the slope and intercept of the output supply function.[65] Our calculations reveal that the slope of the supply curve for packed milk is 15617, which confirms that the supply curve is upward sloping.[66] Moreover, the calculations further show that the intercept is 64,583,479.

9.5 Welfare Analysis of Imposing Sales Tax on the Dairy Sector

How does the imposition of the GST affect stakeholders in the dairy processing sector? We try to answer this question from different angels. We noted above that the price elasticity of demand for milk is 0.828 (or less than 1) while the price elasticity of supply of milk is 3.23 (or more than one). In other words, the demand for milk is relatively inelastic and the supply is relatively elastic (supply elasticity is almost four times as large as the demand elasticity of milk).

However, a recent study suggests that short run supply elasticity of milk production is quite inelastic (Wasim, 2005). For example, Wasim (2005) finds that the short run supply price elasticity of milk is only 0.258. In other words, a 1% increase in milk price increases milk production by only 0.258% in the short run. This figure is small compared to our long run elasticity estimate reported above. Hence in the case of increased price of milk, producers will choose to produce more milk to reap higher profits. But increasing milk production would require a larger herd of milking animals, or a higher milk yield per animal, which takes time. Consequently, milk supply is more sensitive to price fluctuations in the long run.

The remainder of this section is divided into two subsections. Section 9.5.1 discusses the long run implications of imposing a sales tax on the dairy sector. Section 9.5.2 analyzes the short run consequences of imposing a sales tax on dairy products.

9.5.1 Long Run Tax Incidence Analysis

To compute the tax incidence on producers and consumers in the long run, we use long run estimates of the price elasticity of demand and supply for milk.[67] Table 9.2 and Figure 9.2 depict the results.

Figure 9.2(a) maps the relationship between tax revenue and tax rate. The linear trend depicted in the graph shows that as tax rate increases, tax revenue also rises proportionally. For instance, the imposition of a 1% sales tax on the dairy sector yields tax revenue of Rs.2.16 billion. Imposing a sales tax rate of 10% instead will earn approximately Rs.20 billion. Thus, for every one percentage point increase in tax rate, tax revenues go up by Rs.1.98 billion. While this may serve as an incentive to the government to levy a high sales tax on commodities in the dairy sector, it is important to consider its welfare implications.

In the absence of a sales tax, market forces alone determine optimal price and quantity of milk produced and consumed. Imposition of sales tax forces producers and consumers to change their preferences. This results in misallocation of resources (or efficiency losses) for the economy since aggregate production and consumption fall below the optimal level. These efficiency losses are known as deadweight loss to society.

[63] Combining rabi, kharif, and roughages and grass into one input makes empirical sense because their prices are reported in rupees per acre. The price of this composite input (known as green fodder) was computed by share-weighting the price of each of the individual types of fodder.
[64] Combining wheat straw and concentrate into one input makes empirical sense because their prices are reported in rupees per 40 kg. This composite input has been calculated by share-weighting the price of each of the individual types of fodder.
[65] The calculations for the price elasticity of supply for milk, and the slope and intercept of the supply function have been explained in Appendix - 4 as well.
[66] This slope was computed using price in Rs. per million liter and quantity in million liter (we converted the price of milk from rupees per liter to rupees per million liter for convenience). The resulting tax revenues, deadweight loss, and changes in consumer and producer surplus computed are calculated in rupees, and then reported in billions of rupees in the finalized tables.
[67] Price elasticity of demand and supply were found to be -0.827 and 3.23, respectively.

Table 9.2. Long run sales tax incidence on tax revenue, deadweight loss, producers, and consumers

Sales Tax rate (%)	Tax revenue (Rs. billion)	Deadweight loss (Rs. billion)	Change in producer surplus (Rs. billion)	Change in consumer surplus (Rs. billion)
1	2.16	0.01	-0.44	-1.73
2	4.29	0.04	-0.88	-3.44
3	6.37	0.08	-1.32	-5.14
4	8.43	0.14	-1.75	-6.82
5	10.44	0.23	-2.17	-8.49
6	12.42	0.32	-2.60	-10.15
7	14.37	0.44	-3.02	-11.79
8	16.28	0.58	-3.44	-13.42
9	18.15	0.73	-3.85	-15.03
10	19.99	0.90	-4.26	-16.63
11	21.79	1.09	-4.66	-18.21
12	23.55	1.30	-5.07	-19.78
13	25.28	1.52	-5.46	-21.34
14	26.97	1.77	-5.86	-22.88
15	28.63	2.03	-6.25	-24.41
16	30.25	2.31	-6.64	-25.92
17	31.83	2.60	-7.02	-27.42
18	33.38	2.92	-7.40	-28.90
19	34.89	3.25	-7.78	-30.37
20	36.37	3.60	-8.15	-31.83
21	37.81	3.97	-8.52	-33.27
22	39.21	4.36	-8.88	-34.69
23	40.58	4.77	-9.24	-36.10
24	41.91	5.19	-9.60	-37.50
25	43.21	5.63	-9.96	-38.89
26	44.47	6.09	-10.31	-40.25
27	45.69	6.57	-10.65	-41.61
28	46.88	7.06	-11.00	-42.95
29	48.03	7.58	-11.34	-44.28
30	49.15	8.11	-11.67	-45.59

Note: Changes in producer and consumer surplus have been reported as negative because both producer and consumer surplus decrease upon the imposition of a sales tax.

Figure 9.2: Long Run Impacts of the Sales Tax

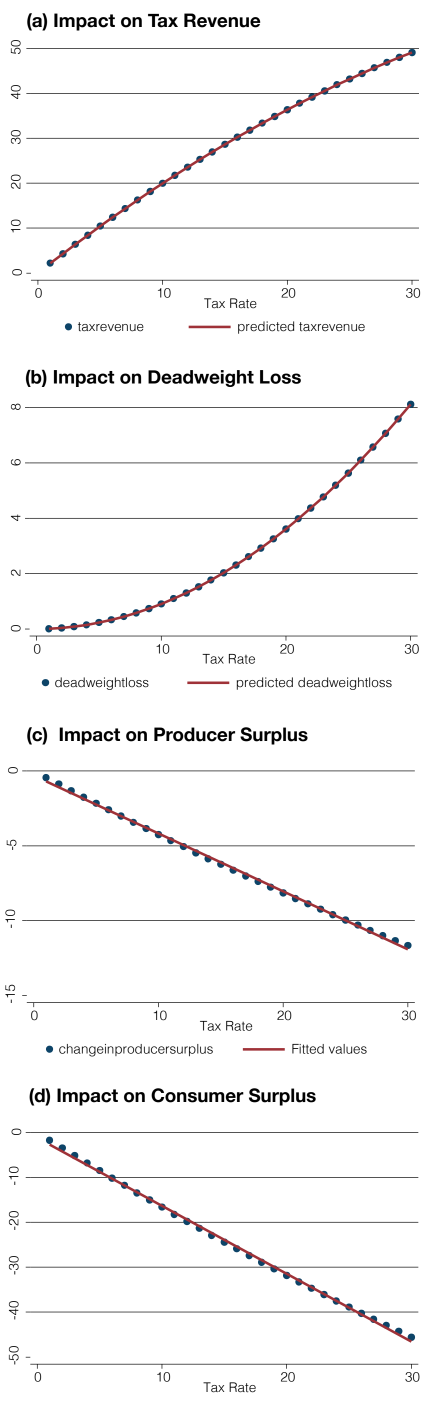


Figure 9.2 (b) indicates that while increasing sales tax rate proportionately increases tax revenue, the deadweight loss to society increases more than proportionately for every additional percentage point increase in tax.[68] Other measures of tax incidence used are producer and consumer surplus. The producer surplus is a measure of producer welfare, which is defined as the difference between what producer is willing to supply and the actual amount received when s/he makes the transaction. Imposing a sales tax on dairy products decreases producer surplus in two ways. Firstly, it exerts a tax burden on producers. Secondly, it incurs efficiency losses to producers in the form of unemployment and reduced profits for rural subsistence dairy farms.

Similarly, consumer surplus is a measure of consumer welfare, which is defined as the difference between what consumers are willing and able to pay what they actually pay. Like producer surplus, levying a sales tax on dairy sector decreases consumer surplus in two ways. Firstly, it exerts a tax burden on consumers. Secondly, it incurs efficiency losses to consumers in the form of reduced nutrient intake from milk.

Figure 9.2(c) plots the relationship between change in producer surplus[69] and the tax rate. The graph depicts a linear trend indicating that as tax rate increases, producer surplus decreases linearly. The imposition of a 1% sales tax reduces producer surplus by Rs.0.44 billion. If this tax rate is increased to 10% instead, producer surplus decreases by Rs.4.26 billion. These figures suggest that for a one percentage point increase in tax rate producer surplus decreases by Rs.0.42 billion. In other words, as the tax rate increases, the tax burden on producers increases.

A similar trend is observed in the case of consumers. Figure 9.2(d) shows the relationship between change in consumer surplus and the tax rate. The graph depicts a linear trend: as the tax rate increases consumer surplus decreases. Imposing a sales tax of 1% reduces consumer surplus by Rs.1.73 billion. If this tax rate is increased to 10%, consumer surplus decreases by Rs.16.63 billion. These figures suggest that for every one percentage point increase in tax rate, consumer surplus decreases by Rs.1.66 billion.

Comparing the changes in producer and consumer surplus leads us to conclude that in the long run the tax burden imposed on consumers is higher than the tax burden imposed on producers since average change in consumer surplus is higher than the average change in producers surplus: increasing tax rate by 1% decreases consumer surplus by Rs.1.66 billion, whereas producer surplus decreases by Rs.0.42 billion. The differential in tax burden of producers and consumers arises from variation in price elasticity of milk supply over time. Milk supply is relatively elastic in the long run, therefore, imposing a sales tax imposes a higher tax burden on consumers in the long run.

Data from industry sources indicates that the existing net input tax on the dairy sector in 2014 was 6%, which amounts to Rs.6 billion tax. Instead, if the same amount was collected in the form of an output tax or sales tax, then the effective output or sales tax to be levied on the industry would be approximately 3% (see Table 9.2).[70] Our results show that at a sales tax of 3%, the FBR would earn a total tax revenue of Rs. 6.37 billion. However, the efficiency losses to society would amount to Rs. 0.08 billion; producers surplus would fall by Rs.1.32

[68] For instance, suppose that an initial tax rate of 5% is imposed on the industry. This will result in a deadweight loss of Rs. 0.23 billion. If the tax rate is increased from 5% to 6%, the deadweight loss would increase by Rs. 0.09 billion. If this tax rate was further increased from 6% to 7%, the deadweight loss would increase by Rs. 0.12 billion.
[69] Note that this is aggregate producer surplus for the dairy industry, and includes all milk producing agents (processing companies, rural small holders, and corporate dairy farms).
[70] This is computed by dividing the amount of input tax collected in 2014 by total sales of dairy sector in that year.

billion from Rs. 26.85 billion to Rs. 25.53 billion; and consumers surplus would fall by Rs.5.14 billion from Rs. 104.88 billion to Rs. 99.74 billion. Total deadweight loss to society and change in consumers and producers welfare (or surplus) would amount to Rs.6.54 billion, which is greater than the total tax revenue to be collected at 3% sales tax rate.

Therefore, we conclude that imposing sales tax on the dairy sector would yield higher tax revenues, but efficiency losses to producers and consumers would also he high. Hence imposing an output tax or sales tax instead of an input tax seems to incur a higher net cost rather than a net gain in revenues.

9.5.2 Short Run Tax Incidence Analysis

To compute the short run incidence of tax on producers and consumers, we use a short run estimate of supply price elasticity of milk. Table 9.3 and Figure 9.3 present the results.

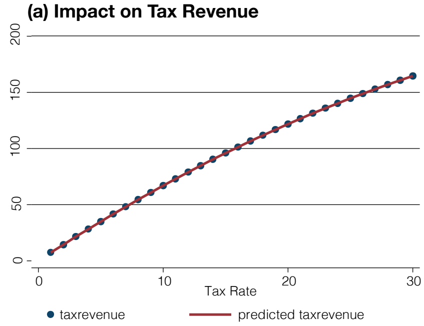
Figure 9.3(a) shows the relationship between tax revenue and tax rate. It reveals that as the tax rate increases, tax revenue also rises linearly. A 1% sales tax on the dairy sector earns the FBR tax revenue of Rs.7.23 billion. Imposing a tax rate of 10% yields approximately Rs.67 billion in tax revenues. These figures suggest that for every one percentage point increase in tax rate tax revenues go up by Rs.6.63 billion. This figure is much higher if compared with the tax revenues in the long run. The FBR would earn higher revenues in the short run by imposing a sales tax. However, as dairy producers alter their milk supply and adjust to new market equilibrium in the long run, the average tax revenue earned from each percent increase in sales tax will fall from Rs.6.63 billion to Rs.1.98 billion.

Table 9.3. Short run sales tax incidence on tax revenue, deadweight loss, producers, and consumers

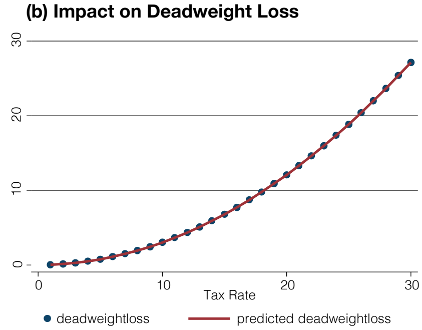
Tax rate (%)	Tax revenue (Rs. billion)	Deadweight loss (Rs. billion)	Change in producer surplus (Rs. billion)	Change in consumer surplus (Rs. billion)
1	7.23	0.03	-5.54	-1.73
2	14.35	0.12	-11.03	-3.44
3	21.34	0.27	-16.47	-5.14
4	28.22	0.48	-21.87	-6.82
5	34.97	0.75	-27.23	-8.49
6	41.60	1.09	-32.54	-10.15
7	48.11	1.48	-37.80	-11.79
8	54.50	1.93	-43.01	-13.42
9	60.77	2.44	-48.18	-15.03
10	66.92	3.02	-53.31	-16.63
11	72.95	3.65	-58.38	-18.21
12	78.86	4.34	-63.42	-19.78
13	84.64	5.10	-68.40	-21.34
14	90.31	5.91	-73.34	-22.88
15	95.86	6.79	-78.24	-24.41
16	101.28	7.72	-83.08	-25.92
17	106.58	8.72	-87.89	-27.42
18	111.77	9.77	-92.64	-28.90
19	116.83	10.89	-97.35	-30.37
20	121.77	12.07	-102.01	-31.83
21	126.60	13.30	-106.63	-33.27
22	131.30	14.60	-111.20	-34.69
23	135.88	15.96	-115.73	-36.10
24	140.34	17.38	-120.21	-37.50
25	144.68	18.85	-124.64	-38.89
26	148.89	20.39	-129.03	-40.25
27	152.99	21.99	-133.37	-41.61
28	156.97	23.65	-137.67	-42.95
29	160.83	25.37	-141.92	-44.28
30	164.56	27.15	-146.12	-45.59

Figure 9.3: Short Run Impacts of the Sales Tax

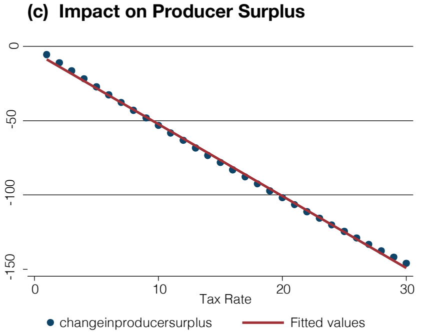
(a) Impact on Tax Revenue



(b) Impact on Deadweight Loss



(c) Impact on Producer Surplus



Imposing a tax rate on the dairy sector may increase tax revenues, but it will also incur a deadweight loss on society and exert a tax burden on both producers and consumers. The results in Figure 9.3(b) indicate that as the sales tax rate increases, the deadweight loss to society increases more than proportionately.[71] The deadweight loss at each tax rate is much higher in the short run than in the long run.

Figure 9.3(c) plots the relationship between change in producer surplus and tax rate in the short run. As the tax rate increases, the producer surplus decreases linearly. The imposition of 1% sales tax reduces producer surplus by Rs.5.54 billion and for 10% sales tax producer surplus decreases by Rs.53.31 billion. These figures suggest that for every percent increase in tax rate, producer surplus decreases by Rs.5.31 billion in the short run. In the long run, however, producer surplus decreases by only Rs.0.42 billion on average.

Finally, the existing net input tax on milk processing industry in 2014 comes to 6%, which is equivalent to an output or sales tax of approximately 3% in the long run. Our results show that at a sales tax of 3%, the FBR would earn a total tax revenue of Rs. 21.34 billion in the short run. The efficiency losses to society amount to Rs. 0.27 billion; producer surplus falls by Rs. 16.47 billion; and consumer surplus falls by Rs. 5.14 billion. The total deadweight loss to society and change in consumer and producer welfare (or surplus) amounts to Rs. 21.88 billion, which is higher than the total tax revenue collected at 3% sales tax.

Consequently, even in the short run, imposing an output or sales tax instead of an input tax seems to incur a higher net cost rather than a gain in revenues. In fact, the deadweight loss to society and the change (decrease) in producer surplus is much higher in the short run as compared to the long run.

9.6 Welfare Analysis of Imposing Sales Tax on Processed Milk Products

Section 9.5 discussed the implications of imposing a sales tax on packed milk. We now enlarge upon that discussion by performing a welfare analysis of imposing sales tax on different packed or processed milk products. Specifically, this section discusses the impact of imposing a sales tax on three sub-categories of packed or processed milk: ambient white milk,[72] tea creamers, and dairy drinks & beverages. We use the long run and short run price elasticities of demand and supply for packed milk,[73] as well as the reported prices and quantities of these three categories to compute their respective tax revenues, deadweight loss, and producer and consumer surplus at different tax rates.

A discussion of our analysis is organized as follows in the remainder of this section. Section 9.6.1 and 9.6.2 analyze the long run and short run implications of imposing a sales tax on ambient white milk. Next, sections 9.6.3 and 9.6.4 provide a discussion of the effects of imposing sales tax on tea creamers. Sections 9.6.5 and 9.6.6 perform the same analysis for dairy drinks & beverages. Finally, section 9.6.7 provides a comparative analysis of the welfare implications of imposing a sales tax on each of these sub-categories of packed or processed milk.

---

[71] For instance, suppose that an initial tax rate of 5% is imposed on the industry. This will result in a deadweight loss of Rs.0.75 billion. If the tax rate is increased from 5% to 6%, the deadweight loss would increase by Rs.0.34 billion. If this tax rate was further increased from 6% to 7%, the deadweight loss would increase by Rs.0.39 billion.

[72] This category includes high carb low fat (HCLF), liquid cultured, pasteurized, and UHT milk.

[73] The price elasticity of demand for packed milk is 0.828, while the price elasticity of supply of milk is 3.23 in the long run (as estimated in our model) and 0.258 in the short run (Wasim, 2005). Note that we use the same price elasticity of demand and supply as used in Section 9.5, which encompasses all packed or processed milk produced and consumed. But the prices and quantities used to compute the demand and supply slopes for our analysis are those of each of the sub-categories of packed milk.

9.6.1 Long Run Impact of Imposing Sales Tax on Ambient White Milk

As mentioned in the introduction of this section, to compute the tax incidence on producers and consumers in the long run, we use the long run price elasticities of demand and supply for packed milk, and the reported price and quantity of ambient white milk. Table 9.4 and Figure 9.4 depict the results.

Figure 9.4(a) maps the relationship between tax revenue and tax rate. The linear trend depicted in the graph shows that as tax rate increases, tax revenue also rises proportionally. On average, for every one percentage point increase in tax rate, tax revenues go up by Rs. 0.52 billion.

While increasing sales tax rate proportionately increases tax revenue, Figure 9.4 (b) indicates that the deadweight loss to society increases more than proportionately for every additional percentage point increase in tax.[74]

Other measures of tax incidence used are producer and consumer surplus. As elaborated in section 9.5, imposing a sales tax on dairy products decreases both producer and consumer surplus in two ways. Firstly, it exerts a tax burden on producers and consumers. Secondly, it incurs efficiency losses to producers in the form of unemployment and reduced profits for rural subsistence dairy farms, and to consumers in the form of reduced nutrient intake from milk. In keeping with this, Figure 9.4(c) shows that that as tax rate increases, producer surplus decreases linearly. More specifically, it suggests that for a one percentage point increase in tax rate, producer surplus decreases by Rs.0.11 billion. Similarly, Figure 9.4(d) demonstrates that for every one percentage point increase in tax,

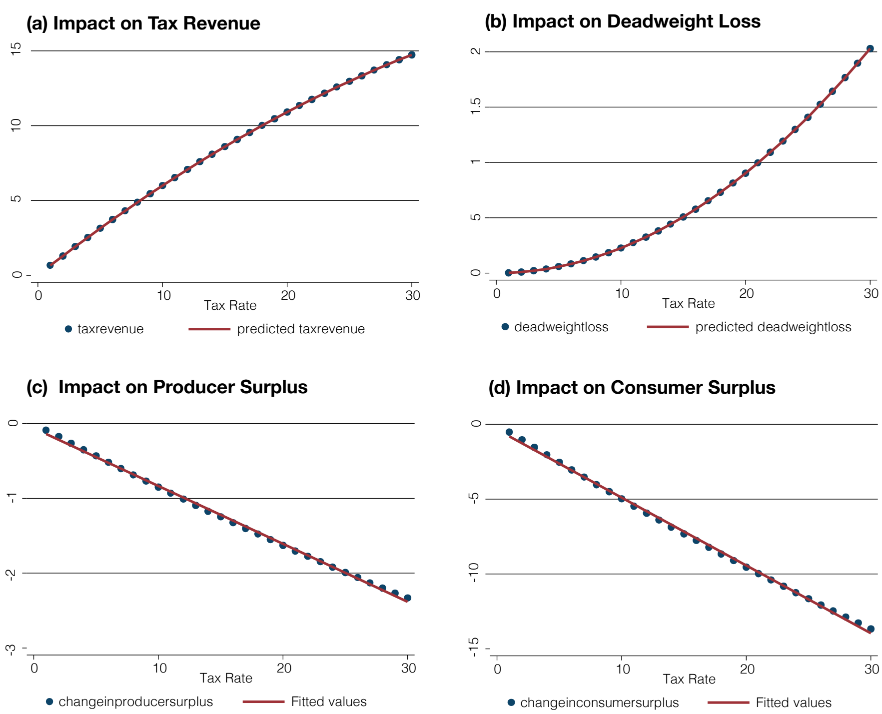
Table 9.4. Long run incidence of sales tax for ambient white milk

Sales tax rate (%)	Tax revenue (Rs. billion)	Deadweight loss (Rs. billion)	Change in producer surplus (Rs. billion)	Change in consumer surplus (Rs. billion)	Change in output (billion liters)
1	0.57	0.00	-0.12	-0.46	0.00
2	1.13	0.01	-0.23	-0.91	-0.01
3	1.69	0.02	-0.35	-1.36	-0.01
4	2.23	0.04	-0.46	-1.81	-0.02
5	2.76	0.06	-0.58	-2.25	-0.02
6	3.29	0.09	-0.69	-2.69	-0.02
7	3.80	0.12	-0.80	-3.12	-0.03
8	4.31	0.15	-0.91	-3.55	-0.03
9	4.80	0.19	-1.02	-3.98	-0.04
10	5.29	0.24	-1.13	-4.40	-0.04
11	5.76	0.29	-1.23	-4.82	-0.04
12	6.23	0.34	-1.34	-5.23	-0.05
13	6.69	0.40	-1.45	-5.65	-0.05
14	7.14	0.47	-1.55	-6.05	-0.06
15	7.57	0.54	-1.65	-6.46	-0.06
16	8.00	0.61	-1.76	-6.86	-0.06
17	8.42	0.69	-1.86	-7.25	-0.07
18	8.83	0.77	-1.96	-7.65	-0.07
19	9.23	0.86	-2.06	-8.04	-0.08
20	9.62	0.95	-2.16	-8.42	-0.08
21	10.00	1.05	-2.25	-8.80	-0.08
22	10.38	1.15	-2.35	-9.18	-0.09
23	10.74	1.26	-2.45	-9.55	-0.09
24	11.09	1.37	-2.54	-9.92	-0.10
25	11.43	1.49	-2.63	-10.29	-0.10
26	11.77	1.61	-2.73	-10.65	-0.10
27	12.09	1.74	-2.82	-11.01	-0.11
28	12.40	1.87	-2.91	-11.36	-0.11
29	12.71	2.00	-3.00	-11.71	-0.12
30	13.00	2.15	-3.09	-12.06	-0.12

Note: Changes in output, and producer and consumer surplus have been reported as negative because both producer and consumer surplus decrease upon the imposition of a sales tax.

[74] For instance, suppose that an initial tax rate of 7% is imposed on the industry. This will result in a deadweight loss of Rs.0.12 billion. If the tax rate is increased from 7% to 8%, the deadweight loss would increase by Rs.0.03 billion. If this tax rate was further increased from 8% to 9%, the deadweight loss would increase by Rs.0.04 billion.

Figure 9.4: Long Run Impact of Imposing Sales Tax on Ambient White Milk



consumer surplus decreases by Rs.0.43 billion. Note that the impact of imposing a sales tax is higher on consumers than on producers, indicating that consumers fare worse in the long run if a sales tax is imposed on ambient white milk. On average, the impact on consumers is Rs.0.32 billion higher than on producers for every one percentage point increase in tax.[75]

Finally, it is important to note that while tax revenues rise by Rs.0.52 billion for every percentage point increase in tax, the combined decrease in producer and consumer surplus (Rs.0.54 billion) alone exceeds this amount even before we account for the deadweight loss to society.

9.6.2 Short Run Impact of Imposing Sales Tax on Ambient White Milk

To compute the short run incidence of tax on producers and consumers, we use a short run estimate of price elasticity of milk supply (as reported by Wasim, 2005). Table 9.5[76] and Figure 9.5 present the results.

Figure 9.5(a) reveals that as tax rate increases, tax revenues also rise linearly. Every percentage point increase in tax rate on ambient white milk increases tax revenues by Rs.1.75 billion. That is, in the short run, the increase in tax revenues is much higher compared to the long run.

However, a comparison of Figure 9.4(b) and Figure 9.5(b) indicates that the deadweight loss to society is also much higher in the short run[77] and that it increases at a faster rate in the short run[78] as tax rate increases.

Similarly, in the short run, producer surplus decreases by approximately Rs.1.40 billion for a one percentage point rise in tax rate as depicted in Figure 9.5(c). The change in consumer surplus as a result of changes in sales tax rate remains constant over the long run and short run. This is because consumer surplus depends on consumer demand rather than market supply. Since the consumer demand function remains unchanged in our analysis (the price elasticity of demand serves as both a long run and a short run estimate), the change in consumer surplus remains unchanged as well. But what is important to note in this scenario is that in the short run, producers fare worse than consumers: for a one percentage point increase in tax rate, consumer surplus decreases by only Rs.0.43 billion whereas producer surplus decreases by Rs.1.40 billion.

Finally, it is worth noting that a percentage point increase in the tax rate imposed on ambient white milk increases tax revenues by Rs.1.75 billion, but the combined decrease in producer and consumer surplus (Rs.1.83 billion) as well as the deadweight loss to society offset this amount.

Therefore, on average, imposing a sales tax on ambient white milk incurs higher efficiency losses to society than the amount of tax revenue it generates in both the long run and the short run. Consumers are more affected

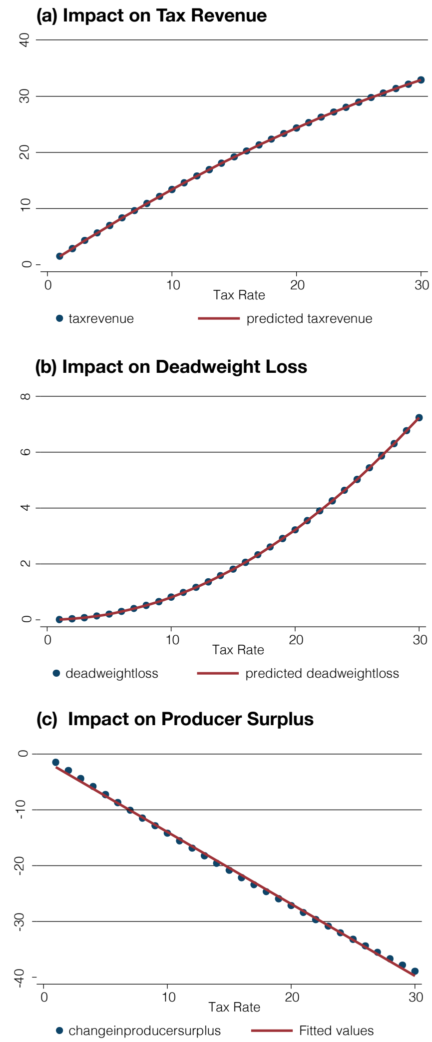
[75] In other words, the cost to consumers or the decrease in consumer surplus is higher compared to the decrease in producer surplus and this magnitude differs by Rs. 0.32 billion.
[76] Change in output, which is computed using the slope of the demand curve, has not been reported in this table since it remains the same over the short run and long run. This is because demand elasticity for packed milk remains constant so the slope of the demand curve does not change over time either.
[77] First, imposing an initial tax rate of 7% on ambient white milk results in a deadweight loss of Rs.0.39 billion in the short run. In the long run, however, deadweight loss amounts to only Rs.0.12 billion (Table 9.4). Second, if the tax rate is increased from 7% to 8%, the deadweight loss would increase by Rs.0.12 billion in the short run, whereas our calculations show that it would increase by only Rs.0.03 billion in the long run (Table 9.4).
[78] In other words, the graph that plots the relationship between deadweight loss and tax rate is steeper in the short run than the long run.

Table 9.5. Short run incidence of sales tax for ambient white milk

Tax rate (%)	Tax revenue (Rs. billion)	Deadweight loss (Rs. billion)	Change in producer surplus (Rs. billion)	Change in consumer surplus (Rs. billion)
1	1.91	0.01	-1.47	-0.46
2	3.80	0.03	-2.92	-0.91
3	5.65	0.07	-4.36	-1.36
4	7.47	0.13	-5.79	-1.81
5	9.25	0.20	-7.20	-2.25
6	11.01	0.29	-8.61	-2.69
7	12.73	0.39	-10.00	-3.12
8	14.42	0.51	-11.38	-3.55
9	16.08	0.65	-12.75	-3.98
10	17.71	0.80	-14.10	-4.40
11	19.30	0.97	-15.45	-4.82
12	20.86	1.15	-16.78	-5.23
13	22.40	1.35	-18.10	-5.65
14	23.89	1.56	-19.41	-6.05
15	25.36	1.80	-20.70	-6.46
16	26.80	2.04	-21.98	-6.86
17	28.20	2.31	-23.25	-7.25
18	29.57	2.59	-24.51	-7.65
19	30.91	2.88	-25.76	-8.04
20	32.22	3.19	-26.99	-8.42
21	33.50	3.52	-28.21	-8.80
22	34.74	3.86	-29.42	-9.18
23	35.95	4.22	-30.62	-9.55
24	37.13	4.60	-31.81	-9.92
25	38.28	4.99	-32.98	-10.29
26	39.40	5.40	-34.14	-10.65
27	40.48	5.82	-35.29	-11.01
28	41.53	6.26	-36.43	-11.36
29	42.55	6.71	-37.55	-11.71
30	43.54	7.18	-38.66	-12.06

Note: Changes in output, and producer and consumer surplus have been reported as negative because both producer and consumer surplus decrease upon the imposition of a sales tax.

Figure 9.5: Short Run Impact of Sales Tax on Ambient White Milk



by tax collection in the long run since their preferences remain unaltered. In comparison, producers bear the brunt of the tax burden in the short run and fare better in the long run. This is because, in the long run, they can alter their milk supply in response to the imposition of sales tax.

9.6.3 Long Run Impact of Sales Tax on Tea Creamers

We now turn to the long run effects of imposing a sales tax on tea creamers. As before, we use long run price elasticity of demand and supply for packed milk, and the price and quantity of tea creamers to perform our welfare analysis. The results from our calculations are presented in Table 9.6 and Figure 9.6.

As depicted in Figure 9.6(a), as tax rate increases, tax revenue also rises proportionally. On average, for every one percentage point increase in tax rate, tax revenues go up by Rs.0.68 billion.

Figure 9.6(b) shows a non-linear graphical trend between deadweight loss and tax rate: the deadweight loss to society increases more than proportionately for every additional percentage point increase in tax. This essentially means that higher tax rates impose greater efficiency losses on society compared to lower tax rates[79]. Further, it is important to note that while the government would earn higher tax revenues by imposing a sales tax on tea creamers rather than ambient white milk (please refer to section 9.6.1), the deadweight loss to society at each tax rate is also higher for tea creamers compared to ambient milk.

Figures 9.6(c) and (d) show a linear relationship between producer surplus and tax rate, and consumer surplus and tax rate. As the sales tax rate on tea creamers increases by one percentage point, producer surplus decreases by only Rs.0.14 billion whereas consumer surplus decreases by Rs.0.57 billion. This indicates that consumers are worse off in the long run. That is, in the long run, they bear a higher tax burden than producers as far as the market for tea creamers is concerned.

Table 9.6. Long run Incidence of sales tax for tea creamers

Sales tax rate (%)	Tax revenue (Rs. billion)	Deadweight loss (Rs. billion)	Change in producer surplus (Rs. billion)	Change in consumer surplus (Rs. billion)	Change in output (billion liters)
1	0.74	0.00	-0.15	-0.59	0.00
2	1.48	0.01	-0.30	-1.18	-0.01
3	2.19	0.03	-0.45	-1.77	-0.01
4	2.90	0.05	-0.60	-2.35	-0.02
5	3.59	0.08	-0.75	-2.92	-0.02
6	4.28	0.11	-0.89	-3.49	-0.03
7	4.95	0.15	-1.04	-4.06	-0.03
8	5.60	0.20	-1.18	-4.62	-0.04
9	6.25	0.25	-1.32	-5.17	-0.04
10	6.88	0.31	-1.47	-5.72	-0.04
11	7.50	0.38	-1.61	-6.27	-0.05
12	8.11	0.45	-1.74	-6.81	-0.05
13	8.70	0.52	-1.88	-7.34	-0.06
14	9.28	0.61	-2.02	-7.88	-0.06
15	9.85	0.70	-2.15	-8.40	-0.07
16	10.41	0.79	-2.28	-8.92	-0.07
17	10.96	0.90	-2.42	-9.44	-0.07
18	11.49	1.00	-2.55	-9.95	-0.08
19	12.01	1.12	-2.68	-10.45	-0.08
20	12.52	1.24	-2.80	-10.95	-0.09
21	13.01	1.37	-2.93	-11.45	-0.09
22	13.50	1.50	-3.06	-11.94	-0.10
23	13.97	1.64	-3.18	-12.43	-0.10
24	14.43	1.79	-3.30	-12.91	-0.11
25	14.87	1.94	-3.43	-13.38	-0.11
26	15.31	2.10	-3.55	-13.85	-0.11
27	15.73	2.26	-3.67	-14.32	-0.12
28	16.14	2.43	-3.78	-14.78	-0.12
29	16.53	2.61	-3.90	-15.24	-0.13
30	16.92	2.79	-4.02	-15.69	-0.13

Note: Changes in output, and producer and consumer surplus have been reported as negative because both producer and consumer surplus decrease upon the imposition of a sales tax.

[79] *If an initial tax rate of 8% is imposed on tea creamers, it will result in a deadweight loss of Rs. 0.20 billion. If the tax rate is increased from 8% to 9%, the deadweight loss would increase by Rs. 0.05 billion. If this tax rate was further increased from 9% to 10%, the deadweight loss would increase by Rs. 0.06 billion.*

Figure 9.6: Long Run Impact of Sales Tax on Tea Creamers

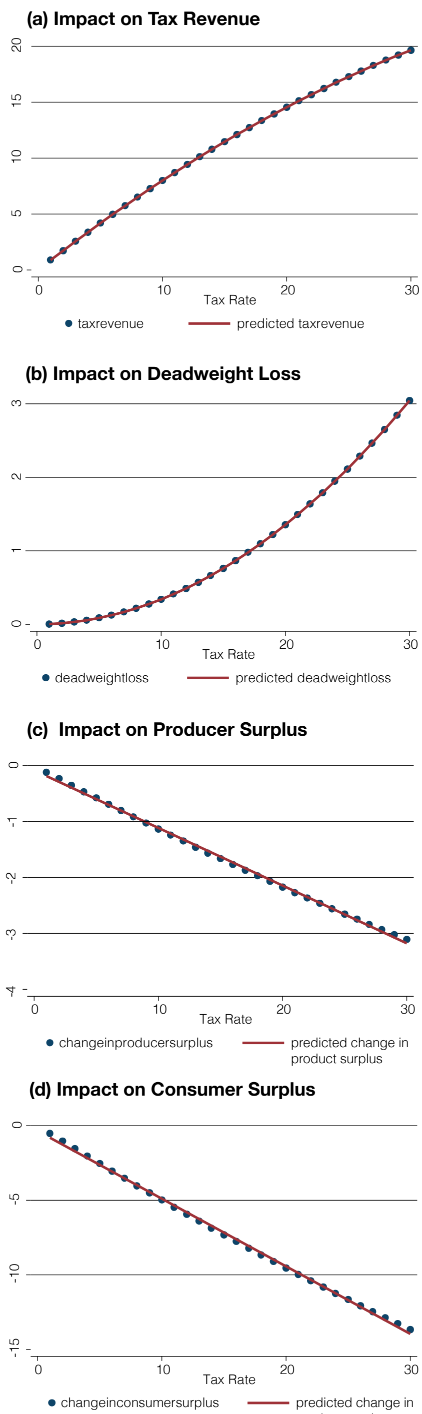
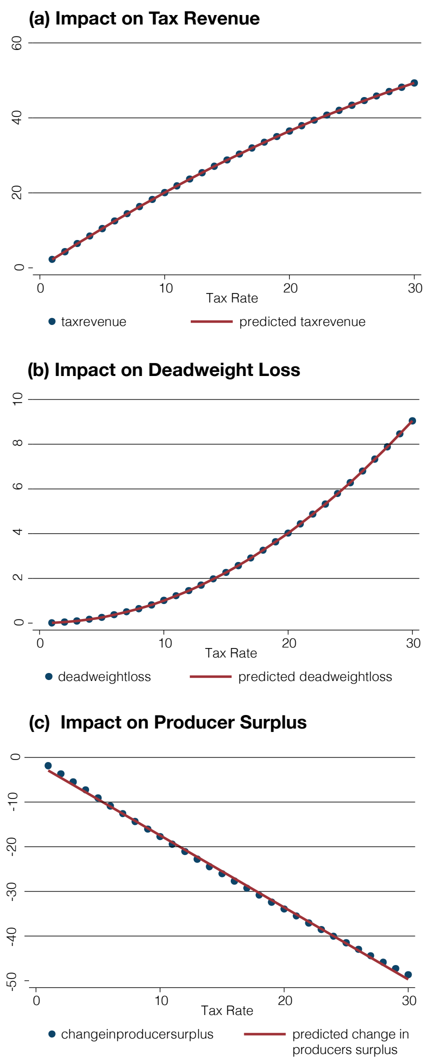


Table 9.7. Short run incidence of sales tax for tea creamers

Tax rate (%)	Tax revenue (Rs. billion)	Deadweight loss (Rs. billion)	Change in producer surplus (Rs. billion)	Change in consumer surplus (Rs. billion)
1	2.49	0.01	-1.91	-0.59
2	4.94	0.04	-3.80	-1.18
3	7.35	0.09	-5.67	-1.77
4	9.71	0.17	-7.53	-2.35
5	12.04	0.26	-9.37	-2.92
6	14.32	0.37	-11.20	-3.49
7	16.56	0.51	-13.01	-4.06
8	18.76	0.66	-14.80	-4.62
9	20.92	0.84	-16.58	-5.17
10	23.03	1.04	-18.35	-5.72
11	25.11	1.26	-20.09	-6.27
12	27.14	1.50	-21.83	-6.81
13	29.13	1.75	-23.54	-7.34
14	31.08	2.04	-25.24	-7.88
15	32.99	2.34	-26.93	-8.40
16	34.86	2.66	-28.60	-8.92
17	36.68	3.00	-30.25	-9.44
18	38.47	3.36	-31.89	-9.95
19	40.21	3.75	-33.51	-10.45
20	41.91	4.15	-35.11	-10.95
21	43.57	4.58	-36.70	-11.45
22	45.19	5.03	-38.27	-11.94
23	46.77	5.49	-39.83	-12.43
24	48.30	5.98	-41.37	-12.91
25	49.79	6.49	-42.90	-13.38
26	51.25	7.02	-44.41	-13.85
27	52.66	7.57	-45.91	-14.32
28	54.03	8.14	-47.38	-14.78
29	55.35	8.73	-48.85	-15.24
30	56.64	9.34	-50.29	-15.69

Note: Changes in output, and producer and consumer surplus have been reported as negative because both producer and consumer surplus decrease upon the imposition of a sales tax.

Figure 9.7: Short Run Impact of Sales Tax on Tea Creamers



Also, it is worthwhile to note that while tax revenues rise by Rs.0.68 billion for every percentage point increase in sales tax on tea creamers, the combined decrease in producer and consumer surplus (Rs.0.71 billion). When the deadweight loss to society is added to this change in producer and consumer surplus, we find that the losses to society outweigh the gain from tax revenue collection.

Finally, our results show that in the long run tax revenues earned from imposing a sales tax on tea creamers are higher compared to ambient white milk, but that the efficiency losses to society in the form of losses in consumer and producer welfare as well as misallocation of resources as production and consumption fall below the optimal level are also higher for tea creamers than for ambient white milk.

9.6.4 Short Run Impact of Sales Tax on Tea Creamers

To compute the short run tax incidence on producers and consumers, we use a short run estimate of price elasticity of milk supply (as reported by Wasim, 2005) as well as the price and quantity of tea creamers. The results from our calculations are reported in Table 9.7 and Figure 9.7.

Figure 9.7(a) indicates that as the tax rate increases, tax revenues also rise linearly. According to the data, every percentage point increase in tax rate on tea creamers increases tax revenues by Rs.2.28 billion in the short run. Comparing this to our findings from the previous sections, there are two points that are worth noting. First, tax revenues earned from imposing a sales tax on tea creamers are, on average, higher in the short run compared to the long run. Second, tax revenues earned from tea creamers are higher than those earned from ambient white milk.

Figure 9.7(b) shows the all too familiar trend between deadweight loss and sales tax rate: As tax rate increases, deadweight loss increases non-linearly.

A comparison of Figure 9.4(b) and Figure 9.5(b) indicates that the deadweight loss to society is also much higher in the short run[80] and that it increases at a faster rate in the short run[81] as tax rate increases.

Similarly, in the short run, producer surplus decreases by approximately Rs.1.82 billion for a one percentage point rise in tax rate as depicted in Figure 9.7(c). The change in consumer surplus as a result of changes in sales tax rate remains constant over the long run and short run[82]. Also, it is important to note that in the short run, producers fare worse than consumers: for a one percentage point increase in tax rate, consumer surplus decreases by only Rs.0.57 billion whereas producer surplus decreases by Rs.1.82 billion.

Finally, it is worth noting that a percentage point increase in the tax rate imposed on tea creamers increases tax revenues by Rs.2.28 billion, but the combined decrease in producer and consumer surplus (Rs.2.39 billion) as well as the deadweight loss to society offset this amount.

Therefore, on average, imposing a sales tax on tea creamers incurs higher efficiency losses to society than the amount of tax revenue it generates in both the long run and the short run. Consumers are more affected by tax collection in the long run. In comparison, producers bear the brunt of the tax burden in the short run and fare better in the long run.

9.6.5 Long Run Impact of Imposing Sales Tax on Dairy Drinks and Beverages

Next, we compute the long run tax incidence for dairy drinks and beverages

[80] First, imposing an initial tax rate of 7% on ambient white milk results in a deadweight loss of Rs.0.51 billion in the short run. In the long run, however, deadweight loss amounts to only Rs.0.15 billion (Table 9.6). Second, if the tax rate is increased from 7% to 8%, the deadweight loss would increase by Rs.0.15 billion in the short run, whereas our calculations show that it would increase by only Rs.0.05 billion in the long run (Table 9.6).

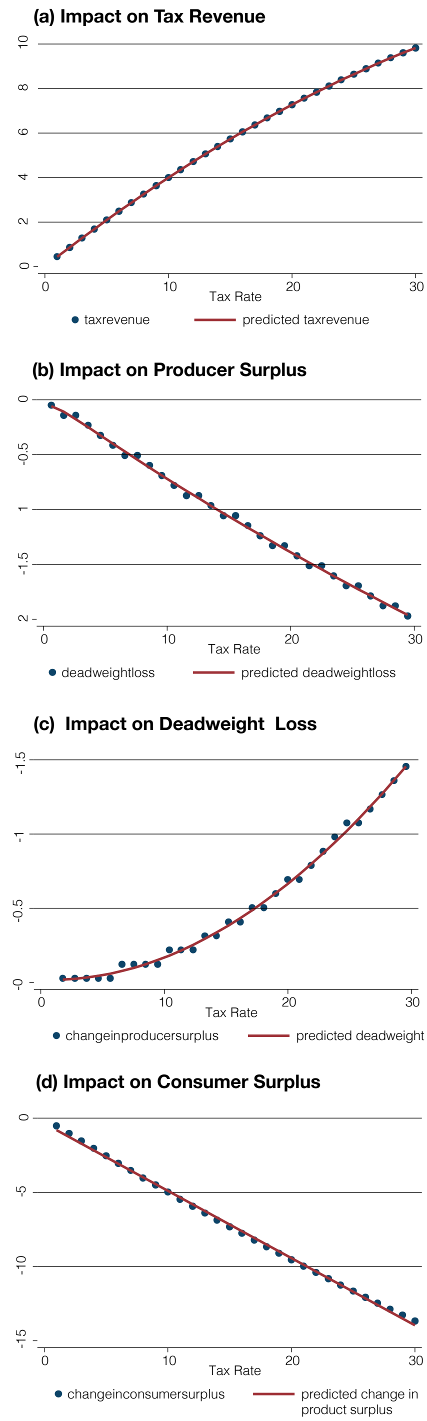
[81] In other words, the graph that plots the relationship between deadweight loss and tax rate is steeper in the short run than the long run.

[82] Since the consumer demand function remains unchanged in our analysis (the price elasticity of demand serves as both a long run and a short run estimate), the change in consumer surplus remains unchanged as well.

Table 9.8. Long run incidence of sales tax on dairy drinks and beverages

Sales tax rate (%)	Tax revenue (Rs. billion)	Deadweight loss (Rs. billion)	Change in producer surplus (Rs. billion)	Change in consumer surplus (Rs. billion)	Change in output (billion liters)
1	0.04	0.00	-0.01	-0.03	0.00
2	0.08	0.00	-0.02	-0.06	0.00
3	0.12	0.00	-0.02	-0.10	0.00
4	0.16	0.00	-0.03	-0.13	0.00
5	0.20	0.00	-0.04	-0.16	0.00
6	0.23	0.01	-0.05	-0.19	0.00
7	0.27	0.01	-0.06	-0.22	0.00
8	0.31	0.01	-0.06	-0.25	0.00
9	0.34	0.01	-0.07	-0.28	0.00
10	0.37	0.02	-0.08	-0.31	0.00
11	0.41	0.02	-0.09	-0.34	0.00
12	0.44	0.02	-0.10	-0.37	0.00
13	0.47	0.03	-0.10	-0.40	0.00
14	0.51	0.03	-0.11	-0.43	0.00
15	0.54	0.04	-0.12	-0.46	0.00
16	0.57	0.04	-0.12	-0.49	-0.01
17	0.60	0.05	-0.13	-0.51	-0.01
18	0.63	0.05	-0.14	-0.54	-0.01
19	0.65	0.06	-0.15	-0.57	-0.01
20	0.68	0.07	-0.15	-0.60	-0.01
21	0.71	0.07	-0.16	-0.62	-0.01
22	0.74	0.08	-0.17	-0.65	-0.01
23	0.76	0.09	-0.17	-0.68	-0.01
24	0.79	0.10	-0.18	-0.70	-0.01
25	0.81	0.11	-0.19	-0.73	-0.01
26	0.83	0.11	-0.19	-0.76	-0.01
27	0.86	0.12	-0.20	-0.78	-0.01
28	0.88	0.13	-0.21	-0.81	-0.01
29	0.90	0.14	-0.21	-0.83	-0.01
30	0.92	0.15	-0.22	-0.86	-0.01

Figure 9.8: Short Run Impact of Sales Tax on Dairy Drinks & Beverages



by using long run estimates of demand and supply for milk as well as the price and quantity of dairy drinks and beverages. The results are given in Table 9.8 and Figure 9.8.

As indicated by Figure 9.8(a), as tax rate increases, tax revenues also rise linearly. In specific, a one percentage point increase in tax rate increases tax revenue by only Rs.0.04 billion.

Figure 9.8(b) reveals the usual non-linear graphical trend between deadweight loss and tax rate[83]: as before, deadweight loss to society increases more than proportionately for every additional percentage point increase in tax. This means that higher tax rates impose greater efficiency losses on society compared to lower tax rates.

Figure 9.8(c) and Figure 9.8(d) show the relationship between producer surplus and tax rate, and consumer surplus and tax rate. When the tax rate on dairy drinks and beverages increases by one percentage point, the consumer surplus decreases by Rs.0.03 billion whereas producer surplus decreases by only Rs.0.01 billion.

What is interesting to note here is that, according to the data, the tax revenue and the combined decrease in producer and consumer surplus are equal. However, when we compute the difference between welfare gain (revenue earned through tax collection) and welfare loss (deadweight loss to society, and decrease in producer and consumer surplus) to society, there is a net welfare loss.[84]

9.6.6 Short Run Impact of Imposing Sales Tax on Dairy Drinks and Beverages

Finally, to compute the tax incidence of dairy drinks & beverages in the short run, we use a short run estimate of price elasticity of milk supply (as reported by Wasim, 2005), and the price and quantity of dairy drinks & beverages produced and consumed. The results are reported in Table 9.9 and Figure 9.9.

Figure 9.9(a) depicts the usual linear trend between tax revenue and tax rates. As the tax rate imposed on dairy drinks and beverages increases by one percentage point, tax revenues rise by Rs.0.12 billion in the short run. Comparing this to our findings in the previous sections, it is evident that between these three categories of packed milk products the government can earn the most tax revenue by imposing a sales tax on tea creamers and the least by imposing a tax on dairy drinks and beverages.

However, the deadweight loss to society, and the decrease in producer and consumer surplus are also the highest when a sales tax is imposed on tea creamers and the least when it is imposed on dairy drinks and beverages.[85]

Addressing producer and consumer surplus more specifically, Figure 9.9(c) and Figure 9.9(d) show a linear relationship between producer surplus and tax rate, and consumer surplus and tax rate, respectively: For every one percentage point increase in tax rate on dairy drinks and beverages, producer surplus decreases by Rs.0.10 billion whereas consumer surplus decreases by only Rs.0.03 billion. Note that the change in consumer surplus remains constant over the long run and the short run since consumer preferences remain unchanged. Additionally, producer surplus changes more significantly in the short run when a sales tax is imposed on dairy drinks and beverages compared to the long run. As with the other two categories of packed milk products, producers bear the brunt of the tax burden in the short run. In the long run, producers alter their milk supply function and consumers bear the burden.

9.6.7 A Comparison of the Effects of Sales Tax on Sub-Categories of Packed Milk

In this section, we analyze the long run and short run effects of imposing a sales tax on different sub-categories of packed or processed milk, namely, ambient white milk, tea creamers, and dairy drinks & beverages. Our findings reveal that while imposing a sales tax on processed milk products can yield high tax revenues, the resulting welfare losses to society[86] are higher than the revenues generated via taxation.

Our long run estimates indicate that for every percentage point increase in tax rate, tax revenue generated by imposing a sales tax on tea creamers is the highest (Rs.0.68 billion), revenue generated by ambient white milk is second in rank (Rs.0.52 billion), and tax revenue generated by dairy drinks & beverages are the lowest (Rs.0.04

[83] The tax revenue, deadweight loss, and producer and consumer surplus are reported in billions of rupees so that they can be easily compared with the figures for ambient white milk and tea creamers. It appears from information available from industry sources that the quantity produced and consumed of dairy drinks and beverages is much smaller compared to ambient white milk and tea creamers. This is why there is little variation in the deadweight loss to society when it is reported in billions of rupees instead of millions. Due to this, the scatter plot in Figure 9.8(b) seems unusual compared to Figure 9.4(b) and Figure 9.6(b). However, when view holistically, all 3 figures show the same trend between deadweight loss and tax rate.

[84] Even though a sales tax of 1-5% results in a deadweight loss of 0 billion rupees (Table 9.8), this amount is non-zero when reported in millions of rupees. Consequently, the economy experiences a net welfare loss at all tax rates.

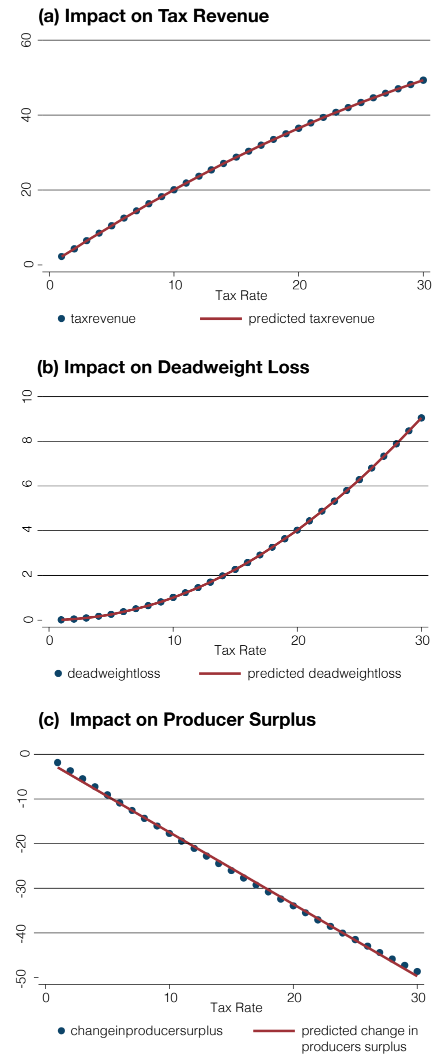
[85] When a sales tax is imposed ranging from 1% to 30%, short run deadweight loss to society ranges from Rs.0.01 billion to Rs.7.18 billion for ambient white milk, Rs.0.01 billion to Rs.9.34 billion for tea creamers, and from zero to Rs.0.51 billion for dairy drinks and beverages.

[86] As mentioned in Section 9.5, the imposition of a sales tax forces producers and consumers to change their preferences. This not only reduces producer and consumer welfare but also results in a misallocation of resources (or efficiency losses) for the economy since aggregate production and consumption fall below the optimal level. These efficiency losses or misallocation of resources are known as deadweight loss to society.

Table 9.9. Short run incidence of sales tax on dairy drinks and beverages

Tax rate (%)	Tax revenue (Rs. billion)	Deadweight loss (Rs. billion)	Change in producer surplus (Rs. billion)	Change in consumer surplus (Rs. billion)
1	0.14	0.00	-0.10	-0.03
2	0.27	0.00	-0.21	-0.06
3	0.40	0.01	-0.31	-0.10
4	0.53	0.01	-0.41	-0.13
5	0.66	0.01	-0.51	-0.16
6	0.78	0.02	-0.61	-0.19
7	0.90	0.03	-0.71	-0.22
8	1.02	0.04	-0.81	-0.25
9	1.14	0.05	-0.90	-0.28
10	1.26	0.06	-1.00	-0.31
11	1.37	0.07	-1.10	-0.34
12	1.48	0.08	-1.19	-0.37
13	1.59	0.10	-1.28	-0.40
14	1.69	0.11	-1.38	-0.43
15	1.80	0.13	-1.47	-0.46
16	1.90	0.14	-1.56	-0.49
17	2.00	0.16	-1.65	-0.51
18	2.10	0.18	-1.74	-0.54
19	2.19	0.20	-1.83	-0.57
20	2.28	0.23	-1.91	-0.60
21	2.37	0.25	-2.00	-0.62
22	2.46	0.27	-2.09	-0.65
23	2.55	0.30	-2.17	-0.68
24	2.63	0.33	-2.25	-0.70
25	2.71	0.35	-2.34	-0.73
26	2.79	0.38	-2.42	-0.76
27	2.87	0.41	-2.50	-0.78
28	2.94	0.44	-2.58	-0.81
29	3.02	0.48	-2.66	-0.83
30	3.09	0.51	-2.74	-0.86

Figure 9.9: Short Run Impact of Imposing Sales Tax on Dairy Drinks & Beverages



billion). It is worth noting, however, that the deadweight loss incurred on society is also the highest for tea creamers, followed by ambient white milk, and the lowest for dairy drinks & beverages.[87] Further, imposing a sales tax on tea creamers results in higher losses in producer and consumer welfare compared to ambient white milk and dairy drinks & beverages. For every percentage point increase in tax rate, producer surplus decreases by approximately Rs.0.14 billion for tea creamers, Rs.0.11 billion for ambient white milk, and Rs.0.01 billion for dairy drinks & beverages. Similarly, for every percentage point increase in tax rate, consumer surplus decreases by Rs.0.57 billion for tea creamers, Rs.0.43 billion for ambient white milk, and Rs.0.03 billion for dairy drinks & beverages. Our analysis shows that, on average, the combined decrease in producer and consumer surplus alone is higher than the tax revenue generated from imposing a sales tax on ambient white milk and tea creamers. Once the deadweight losses to society are also added to the welfare losses faced by producers and consumers, the average gap between welfare losses and welfare gains widens[88], and there is a net welfare loss for all three categories.

Our short run estimates show a similar trend in tax revenues and welfare losses to society. As before, imposing a sales tax on tea creamers still yields the highest tax revenue, deadweight losses, and decline in producer welfare whereas imposing a sales tax on dairy drinks and beverages yields the lowest tax revenues and welfare losses. However, the magnitude of these gains and losses are much higher in the short run compared to the long run. More specifically, for every percentage point increase in tax rate, tax revenue generated from tea creamers is Rs.2.28 billion, from ambient white milk is Rs.1.75 billion, and from dairy drinks & beverages is Rs.0.12 billion. Deadweight losses to society are also higher in the short run compared to the long run for each of these categories[89]. Consumer surplus remains unaltered in the short run since it depends upon consumer demand not market supply.[90] However, there is a significant change in producer surplus in the short run: a one percentage point increase in tax rate decreases producer surplus by Rs.1.82 billion for tea creamers, Rs.1.40 billion for ambient white milk, and Rs.0.10 billion for dairy drinks & beverages. This indicates that consumers fare better than producers in the short run, but that producers are better off in the long run since they are able to alter their milk supply[91] in response to the imposition of a sales tax or changes in sales tax rate.

[87] When a sales tax between 1% to 30% is imposed, long run estimates of deadweight loss to society range from Rs.0 billion to Rs.2.15 billion for ambient white milk (see Table 9.4), zero to Rs.2.79 billion for tea creamers (see Table 9.6), and zero to Rs.0.15 billion for dairy drinks and beverages (see Table 9.8).
[88] Welfare gains from imposing a sales tax are essentially the tax revenues earned, and welfare losses are given by the sum of deadweight loss and decreases in producer and consumer surplus.
[89] When a sales tax between 1% to 30% is imposed, short run estimates of deadweight loss to society range from Rs.0.01 billion to Rs.7.18 billion for ambient white milk (see Table 9.5), Rs.0.01 billion to Rs.9.34 billion for tea creamers (see Table 9.7), and zero to Rs.0.51 billion for dairy drinks and beverages (see Table 9.9).
[90] In our analysis, price elasticity of demand remains the same across the long run and the short run so change in consumer surplus remains unaltered.
[91] This change in output is reported in each of Tables 9.4, 9.6, and 9.8.

9.7 Conclusions

In this Chapter, we conduct partial equilibrium analysis to study welfare implications of imposition of sales tax on packed milk. Our results suggest that sales tax rate and sales tax revenue have a linear relationship. As sales tax rate increases, tax revenue increases proportionately. In the long run, sales tax at the rate of 1% would yield tax revenue of Rs.2.16 billion. Likewise, sales tax rates of 6% and 10% would yield tax revenue of Rs.12 billion and Rs.20 billion, respectively. While it may be alluring to the FBR, this should be seen in the context of its implications on consumers and dairy farmers who supply small quantities of milk to the processing industry. Moreover, it also shields efficiency losses to be incurred by the society. The long run deadweight loss to society would increase more than proportionately for additional increase in tax rate. Every one percentage point increase in tax rate decreases producer surplus by Rs.0.42 billion. A similar trend is observed in the case of consumer surplus where the relationship is again linear. A 1% sales tax would reduce consumer surplus by Rs.1.73 billion. These figures suggest that for every percent increase in tax rate, consumer surplus would decrease by Rs.1.66 billion. To put it differently, these results imply that as tax rate increases, the tax burden on consumer increases.

We note that the existing net input tax on the dairy sector in 2014 was 6%, which amounts to Rs.6 billion. If the same amount was collected output tax or sales tax, the effective output or sales tax to be levied on the industry would be approximately 3%. We find that at a sales tax of 3%, the government would earn a total tax revenue of Rs. 6.37 billion. The efficiency losses to society would amount to Rs. 0.08 billion. Producer surplus would fall by Rs.1.32 billion and consumer surplus would fall by Rs.5.14 billion. The deadweight loss to society and change in consumer and producer welfare would amount to Rs.6.54 billion, which would be higher than the total tax revenue collected at 3% sales tax rate.

The short run analysis, on the other hand, suggests that tax revenue collection would be much higher. A tax rate of 3% in the short run would yield tax revenue of Rs.21 billion. The efficiency losses to society would be Rs.0.27 billion; producer surplus would fall by Rs.16.47 billion, and consumer surplus would fall by Rs.5.14 billion. Total deadweight loss and decrease in consumer and producer would amounts to Rs.21.88 billion, which is higher than the total tax revenue collected at 3% sales tax. Hence, even in the short run, imposing an output or sales tax instead of an input tax seems to incur a higher net cost rather than a gain in revenues.

Our results further reveal that when a sales tax is imposed on tea creamers, ambient white milk, and dairy drinks & beverages, the aggregate change (or fall) in milk supply would be substantial (see Tables 9.4, 9.6, and 9.8). While lowering output would help processors minimize their losses from new tax, it would also lower dairy farmers' profits. Moreover, farmers would be forced to diversify away from dairy production to maintain their standard of living. Farmers who would fail to do so may suffer adverse consequences of reduced profits and unemployment of their family and hired labor.

Chapter 10

RECOMMENDATIONS FOR THE FUTURE

The basic point of this study has been to focus on the economics of milk production in Pakistan to provide important insights on the contribution of the dairy sector to Pakistan's economy, the changing dynamics of the non-corporate and corporate dairy sectors, the state of the milk processing industry in the country, economics of nutrition and welfare implications of imposition of sales tax on milk processing industry. This study has also raised some important questions and concerns on the dairy sector.

Based on our analysis of secondary data and empirical findings from primary data, we have the following recommendations for the government of Pakistan, milk processing industry, corporate dairy farms, international investors, and stakeholders.

Firstly, the Pakistan Livestock Census suggests that the inter-census growth in livestock supply overshoots growth in human population. But rising trend in real prices of dairy products belies this impression. Moreover, estimates of total milk production, again based on the Pakistan Livestock Census, and the estimates of average milk yield per animal are also far from realistic. So much so that in some of the districts of Punjab, milk yield is reported to have increased at the rate of 20% per annum between 1996 and 2006 while in other districts growth in milk yield has exceeded 10% per annum. This is in sharp contrast to our finding of TFP regress in recent years. What does this mean for the macroeconomic picture in the country? If these numbers are indeed exaggerated or compromised, then the GDP growth rates in the post-2005 period, the shares of agriculture and livestock in the economy and available supplies of dairy stock would all be called into question. Our comparison of supply and demand for milk also suggests that the amount of milk that the Pakistan Census of Livestock said is available for human consumption is only 81% of the amount households said they consumed. This disparity between supply and demand amounts to a shortage of 8 billion liters of milk in the system. Therefore, we recommend to the Pakistan Bureau of Statistics, Islamabad and the government of Pakistan to revisit the data collection tools for the Pakistan Livestock Census and ensure better monitoring and supervision so that we arrive at the true numbers. The next round of the Pakistan Livestock Census would be conducted in 2016. The dairy industry and its major stakeholders would eagerly await the outcome of the new livestock census.

Secondly, the government has realized that only focusing on the growth of smallholder dairying would not suffice to meet the rising demand for dairy products in the country. To promote growth of large scale commercial dairy and corporate dairy farms, the Livestock Development Policy 2007 has played a constructive role for the growth of the dairy sector. However, huge start-up infrastructural costs are serving as a major barrier to entry. To rid this sector from challenges faced by the industry, this policy needs to be fine-tuned in line with the changing dynamics of this sector.

Thirdly, seasonal variation in fodder availability is a major cause of poor quality of feed and rising fodder cost, especially for the smallholder dairy producers. The share of fodder cost in total cost of dairy farms is around 40%. Attempts to lower cost of milk production cannot succeed unless the cost of fodder is reduced. Farmers need support and training to create awareness about different methods that could be followed to alleviate fodder shortages. More specifically, they must be trained to prepare low cost silage to reduce fodder shortage. However, the equipment and resources needed for silage making are beyond the reach of the smallholder dairy farms. At the moment, due to lack of demand there is a missing market for renting out services of private equipment for silage making. The government can assist by providing awareness through training and awareness programs to promote demand for this equipment.

The milk processing industry and the provincial governments can also play a constructive role. Moreover, microfinance loans can also provide the much needed capital to purchase fodder during peak seasons for silage making.

Fourthly, the estimates based on two rounds of the dairy survey conducted in 2005 and 2014 suggest that TFP of non-corporate dairy farms is declining at the rate of 1.4% per annum. This is an indication that the value of dairy production is growing at a slower rate than the cost of dairy inputs. This is an eye opener for the long-run sustainability of the milk processing industry. The farms which are using purchased dairy inputs have suffered the most. Some effective policy measures are warranted to address this critical policy issue. This should also serve government's agenda for poverty alleviation since most subsistence dairy households are near the poverty line. The milk processing industry is also operating below its full potential. Efforts to enhance TFP of smallholder dairy farmers would also help the cause of the milk processing industry.

Finally, we recommend that sales tax policy should be used wisely to create a level playing field for different players. The existing policy of giving refunds at the rate of 17% on indirect materials used by the milk processing industry is wise, but due to non-payment of refunds this policy is distortionary. The current refund policy imposes an input tax of 6% on tax compliant processing units; however, non-tax compliant units get undue cost advantages, which is a distortion. The alternatives to the current policy were explored through partial equilibrium analysis. Even though sales tax rate has a linear relation with the tax revenue, but this policy would have welfare losses for both consumers and producers. Imposition of sales tax would have major gains in the short run, but long run gains in tax revenue would be outweighed by welfare losses. Therefore, any such policy has to be used with a great deal of caution.

REFERENCES

Afzal, M. (2007). Livestock Development Policy, Livestock and Dairy Development Board, Ministry of Food, Agriculture and Livestock, Government of Pakistan, Islamabad.

Afzal, Muhammad (2008). Corporate Dairy Farming in Pakistan: Is there a Future? Pakistan Journal of Agricultural Sciences. 45(2), 250 – 253.

Aigner, D., C.A.K. Lovell, P. Schmidt (1977). Formulation and estimation of stochastic frontier production function models. Journal of Econometrics, 6, 21–37.

Alderman, H., J.R. Behrman (2004). Estimated Economic Benefits of Reducing LBW in Low Income Countries. Health, Nutrition and Population (HNP) Discussion Paper Series, World Bank, Washington, D.C.

Alderman, H., J.R. Behrman, D.R. Ross, R. Sabot (1996). The Returns to Endogenous Human Capital in Pakistan's Rural Wage Labour Market. Oxford Bulletin of Economics and Statistics, 58(1), 30 – 55.

Alderman, Harold, Jere R. Behrman, Victor Lavy, Rekha Menon (2001). Child Health and School Enrollment: A Longitudinal Analysis. Journal of Human Resources, 36(1), 185-205.

Anjum, M.S., K. Lodhi, A. A. Raza, F. Walters, and S. Krause (1989). Pakistan's Dairy Industry: Issues and Policy Alternatives. Directorate of Agricultural Policy and Chemonics International Consulting Division, Islamabad (for the Economic Analysis Network Project and the USAID). Special Report Series No. 14.

Anzar, M., U. Farooq, M. Shahab (2003). Factors Affecting the Efficiency of Artificial Insemination in Cattle in Punjab, Pakistan. Pakistan Veterinary Journal, 23(3), 106 – 113.

Aubery, Frederic (2012). The Detrimental Effect of Malnutrition on School Achievement: Evidence from Two Districts of Madagascar. Centre for Studies and Research in International Development.

Avila, A.F.D., Robert E. Evenson (2010). Total Factor Productivity Growth in Agriculture: The Role of Technological Capital. In P.L. Pingali and Robert E. Evenson (eds.). Handbook of Agricultural Economics, Vol.4, Burlington Academic Press.

Awais, M., Ehsan Choudhry (2015). Dairy Farm Modernization and Profitability: A Case Study of the Makhdoom Farm – Tehsil Sadiqabad, Rahim Yar Khan. Background paper based on interview of Makhdoom Farm, Department of Economics, Lahore University of Management Sciences, Lahore, January.

Basu, K. (1999). Child Labour: Cause, Consequence, and Cure, with Remarks on International Labour Standards. Journal of Economic Literature, 37, 1083–1119.

Battese, G.E., T.J. Coelli (1995). A model for technical inefficiency effects in a stochastic frontier production function for panel data. Empirical Economics, 20, 325–332.

Behrman, J., M. Rosenzweig (2001). The Returns to Increasing Bodyweight. Department of Economics, Penn Institute for Economic Research (PIER), Research Paper Series, PIER Working Paper No. 01-052, University of Pennsylvania, Philadelphia, PA.

Behrman, Jere R. (1996). The Impact of Health and Nutrition on Education. The World Bank Research Observer, 11(1), 23-37.

Behrman, Jere R., V. Lavy (1994). Children's Health and Achievement in School. Living Standards Measurement Study Working Paper 104, Washington DC, World Bank.

Burki, Abid A., Mushtaq A. Khan (2011). Formal Participation in a Milk Supply Chain and Technical Inefficiency of Smallholder Dairy Farms in Pakistan. Pakistan Development Review, 50(1), 63–81.

Burki, Abid A., Mushtaq A. Khan, Faisal Bari (2004). The State of Pakistan's Dairy Sector: An Assessment. Pakistan Development Review. 43(2), 149–174.

Burki, Abid A., S.M. Hussain, Mushtaq A. Khan (2016). Pakistan KLEMS Database and Productivity Measurement at the Industry Level, Working Paper, International Growth Centre, London School of Economics & Political Science, London.

Caves, D.W., L.R. Christensen, W.E. Diewert (1982). The Economic Theory of Index Numbers and the Measurement of Input, Output and Productivity. Econometrica, 50, 1393 – 1414.

Cheema, Iftikhar A. (2005). A Profile of Poverty in Pakistan, Centre for Research on Poverty Reduction and Income Distribution, Planning Commission, Government of Pakistan.

Christensen, Laurits R., Dale W. Jorgenson, Lawrence J. Lau (1973). Transcendental Logarithmic Production Frontiers. Review of Economics and Statistics, 55(1), 28-45.

Coelli, T. (1996). A Guide to FRONTIER Version 4.1: A Computer Program for Frontier Production Function Estimation. CEPA Working Paper 96/07, Department of Economics, University of New England, Armidale.

Coelli, T., D.S. Prasada Rao, George E. Battese (1998). An Introduction to Efficiency and Productivity Analysis. Kluwer Academic Publishers, Boston.

Edmonds, E.V., N. Pavcnik (2005). The Effect of Trade Liberalization on Child Labour. Journal of International Economics, 65, 401–419.

Fafchamps, M., J. Wahba (2006). Child Labour, Urban Proximity, and Household Composition. Journal of Development Economics, 79, 374–397.

Fakhar, Huma, G. Walker (2006). The White Revolution “Doodh Darya”: White Paper on Pakistan’s Dairy Industry, Pakistan Dairy Development Board.

FAO (2011). Dairy Development in Pakistan, by Umm e Zia, T. Mahmood and M.R. Ali. Rome.

Fare, R., S. Grosskopf, M. Norris, Z. Zhang (1994). Productivity Growth, Technical Progress, Efficiency Changes in Industrialized Countries. American Economic Review, 84, 66 – 83.

Florencio, Cecilia A. (1988). Nutrition, Health, and Other Determinants of Academic Achievement and School Related Behavior of Grades One to Six Pupils. University of the Philippines.

Food and Agriculture Organization (1987). Pakistan Livestock Sector Study, Report of the FAO/ADB Cooperative Programme Investment Centre, Vol. 1 and 2, FAO, Rome.

Fuglie, K. (2012). Productivity Growth and Technology Capital in the Global Agricultural Economy. In K. Fuglie, S.L. Wang, V.E. Ball (eds.) Productivity Growth in Agriculture: An International Perspective, CAB international, Wallingford.

Garcia, O., K. Mahmood, T. Hemme (2003). A Review of Milk Production in Pakistan with Particular Emphasis on Small-scale Producers. Rome: Food and Agriculture Organization of the United Nations (PPLPI Working Paper No. 3).

Glewwe, Paul, Hanan Jacoby (1995). An Economic Analysis of Delayed Primary School Enrollment in a Low Income Country: The Role of Early Childhood Nutrition. Review of Economics and Statistics. 77(1), 156-169.

Gomes-Neto, Joao Batista, Eric A. Hanushek, Raimondo H. Leite, Roberto C. Frota-Bezzera (1997). Health and Schooling: Evidence and Policy Implications for Developing Countries. Economics of Education Review, 16(3), 271-82.

GoP (Government of Pakistan) (1957). The First Five-Year Plan, 1955-60. National Planning Board, Karachi.

GoP (Government of Pakistan) (1966). Final Evaluation of the Second Five-Year Plan (1960-65). Planning Commission, Islamabad.

GoP (Government of Pakistan) (1990). Final Evaluation of the Sixth Five-Year Plan (1983-88). Planning Commission, Islamabad.

GoP (Government of Pakistan) (1999). Pakistan Mouza Statistics 1998, Agriculture Census Organization, Statistics Division, Islamabad.

GoP (Government of Pakistan) (2007). Pakistan Livestock Census 2006, Agriculture Census Organization, Statistics Division, Islamabad.

GoP (Government of Pakistan) (2008). Pakistan Economic Survey 2007-08, Economic Adviser’s Wing, Finance Division, Islamabad.

GoP (Government of Pakistan) (2009). Pakistan Economic Survey 2008-09, Economic Adviser’s Wing, Finance Division, Islamabad.

GoP (Government of Pakistan) (2011). Agriculture Statistics of Pakistan 2010-11. Statistics Division, Pakistan Bureau of Statistics, Islamabad.

GoP (Government of Pakistan) (2014). Pakistan Economic Survey 2013-14, Economic Adviser's Wing, Finance Division, Islamabad.

GoP (Government of Pakistan) (2015). Pakistan Economic Survey 2014-15, Economic Adviser's Wing, Finance Division, Islamabad.

Government of Pakistan (n.d.). National Nutrition Survey 2011. Ministry of Planning and Development, Ministry of National Health Services, Islamabad.

Grifell-Tatje, E., C.A. Knox Lovell (1995). A Note on the Malmquist Productivity Index. Economics Letters, 4, 169 – 175.

Grira, H. (2004). The Determinants of Grade Attainment in Low-Income Countries: Evidence from Bangladesh. Developing Economies, 42(4), 494-509.

Handa, S., A. Peterman (2007). Child Health and School Enrollment: A Replication. Journal of Human Resources, 42(4), 863-880.

Haq, Shahram (2014). Meeting Demand: Milking the Dairy Farming Business, Daily Express Tribune, 16th November.

Haughton, J., Shahid R. Khandker (2009). Handbook on Poverty and Inequality, World Bank, Washington, D.C.

Horton, S. (1999). Opportunities for investments in nutrition in low-income Asia. In: Hunt, J., M.G. Quibria (eds.) Investing in Child Nutrition in Asia. Nutrition and Development Series No. 1, Asian Development Bank, Manila.

Jalil, Hamid (2008). Economics of Milk Production in Peri-Urban Areas, Directorate of Planning and Evaluation Cell, Livestock Punjab, Government of Punjab, 1 – 31.

Johnston, F. E., Setha M. Low, Yetilu De Baessa, Robert B. Mac Vean (1987). Interaction of Nutritional and Socioeconomic Status as Determinant of Cognitive Development and Disadvantaged Urban Guatemalan Children. American Journal of Physical Anthropology, 73(4), 501-6.

Jong, Martin (2013). Dairy Value Chain Assessment Final Report for Agribusiness Project, United States Agency for Internaional Development (USAID).

Kambhampati, U.S. and Rajan, R. (2006). Economic Growth: A Panacea for Child Labour? World Development, 34, 426–445.

Khan, J. K., Asad Abbas, Muhammad Naeem, Muhammad M. Ayaz, Saleem Akhter (2013). Current Issues and Future Prospects of Dairy Sector in Pakistan, Science, Technology and Development, 32(2), 126 – 139.

Khanam, Rasheda (2014). Child Health and Schooling Achievement in Bangladesh. International Journal of Social Economics, 41(1), 60-74.

Kodde, D.A., F.C. Palm (1986). Wald criteria for jointly testing equality and inequality restrictions. Econometrica, 54, 1243–1246.

Kruger, D.I. (2007). Coffee Production Effects on Child Labour and Schooling in Rural Brazil. Journal of Development Economics, 82, 448–463.

Mirza, I., R. Jenkins (2004). Risk factors and treatment of anxiety and depressive disorders in Pakistan: systematic review. British Medical Journal, 328, 794–797.

Nielsen Pakistan (2016). Liquid Dairy Products Retail Landscape: Nielsen Retail Audit, Nielsen Pakistan, Karachi.

Nielsen-Pakistan (2016). Dairy Usage and Attitudes, Brief Report, Nielsen Pakistan, Karachi.

Patel, Muzzammil, Misha Raza (2015). The Economic Feasibility and Sustainability of Corporate Dairy Farms in Pakistan. Background paper based on interviews with Tetra Pak Pakistan, Department of Economics, Lahore University of Management Sciences, Lahore, January.

Pickney, Thomas C. 1989. The Demand for Public Storage of Wheat in Pakistan. Research Report 77. International food Policy Research Institute, Washington, D.C.

Pollit, E., Kathleen S. Gorman, Patrice L. Engle, Reynaldo Martorell, Juan Riviera (1993). Early Supplementary Feeding and Cognition. Monographs of the Society for Research in Child Development, 58, 235.

Riaz, Khalid (2008). A Case Study of Milk Processing: The Idara-e-Kissan Cooperative. Lahore Journal of Economic, 13(1), 87 – 128.

Riaz, Saad, Shayan Toor (2015). Corporate Farms: The Future of the Dairy Industry of Pakistan, Background paper based on Interviews with Dada Dairies, Department of Economics, Lahore University of Management Sciences, Lahore, January.

S. Seth, M. Lokshin, Z. Sajaia

Saigol, Muhammad Ahmed, Sara Ahmad Farooqui (2015). The Economics of Corporate Dairy Farming – A Sustainable Enterprise or a Non-Sustainable Phenomenon? Background paper based on interviews of Nishat Dairy Private Limited and Maxim International, Department of Economics, Lahore University of Management Sciences, Lahore, January.

Sarwar, M., M.A. Khan, Mahr-un-Nisa, and Z. Iqbal (2002). Dairy Industry in Pakistan: A Scenario, International Journal of Agriculture and Biology, 4(3), 420 – 428.

SCN (United Nations Standing Committee on Nutrition) (2004), Fifth Report on the World Nutrition Situation: Nutrition for Improved Development Outcomes, United Nations System Standing Committee on Nutrition, March.

Shah, H., Akmal, N., Sharif, M. (2008). Characterization of Dairy Value Chain in Pakistan's Punjab: A Preliminary Analysis, National Agricultural Research Centre, Islamabad.

Shahnaz, L. (2011). Households' Time Allocation for Children and their Interaction with Adult Labour: Evidence from Pakistan. PhD dissertation. Department of Economics, Quaid-i-Azam University, Islamabad.

Sherlund, Shane M., B.B. Christopher, A.A. Akinwumi (2002). Smallholder technical efficiency controlling for environmental production conditions. Journal of Development Economics, 69, 85–101.

Tetra Pak Pakistan (n.d.). Fodder: Healthy Animals, Wealthy Farmers, Tetra Pak, Lahore

UNICEF (2013). Out-of-School Children in the Balochistan, Khyber Pakhtunkhwa, Punjab and Sindh Provinces of Pakistan, Global Initiative on Out-of-School Children, UNICEF, Pakistan Country Office, Islamabad, June.

USAID (2013a). Dairy Project Report, United States Aid for International Development, Islamabad, 22nd October.

USAID (2013b). Dairy Project Portal, Dairy Project Publication, 2(1), 1 – 12.

Wahba, J. (2006). The Influence of Market Wages and Parental History on Child Labour and Schooling in Egypt. Journal of Population Economics, 19: 823–852.

Wasim, Mohammad P. (2005). Milk Production Response in Pakistan. Lahore Journal of Economics, 10(1), 105-121.

Woodford, K. B. (2009). Devil in the Milk: Illness, Health and Politics of A1 and A2 Milk, Chelsea Green Publishing.

Younas, M. (2013). The Dairy Value Chain: A promoter of development and employment in Pakistan, ICDD Working Paper No.9, The International Center for Development and Decent Work, Kassel.

APPENDIX – 1:

MALMQUIST PRODUCTIVITY CHANGE INDEX AND ITS COMPONENTS

To measure total factor productivity (TFP) change we use the Malmquist productivity index introduced by Caves, Christensen and Diewert (CCD) (1982) and extended by Fare et al. (1994). This is a non-parametric data envelopment method (DEA) that "calculates the ratio of the distances of each data point relative to a common technology" (Coelli et al. (1998). Following Fare et al. (1994), we specify an output-oriented Malmquist TFP change index between base period (year 2005) and period t (year 2014) as geometric mean of two CCD type Malmquist productivity indexes written as

$$\frac{TFP_{t+1}}{TFP_t} = \left[\left(\frac{D_0^T(x^{t+1}, y^{t+1})}{D_0^T(x^t, y^t)} \right) \cdot \left(\frac{D_0^{T+1}(x^{t+1}, y^{t+1})}{D_0^{T+1}(x^t, y^t)} \right) \right]^{\frac{1}{2}}$$

TFP change is decomposed into two components as given below where the first term outside square brackets measures efficiency change, which is deviation from the frontier and is also known as catching-up. The second term in square brackets is for technical change or shift in technology, which is measured by "the geometric mean of the shift in technology between the two periods" (Coelli et al., 1998).

$$\frac{TFP_{t+1}}{TFP_t} = \left(\frac{D_O^{T+1}(x^{t+1}, y^{t+1})}{D_0^T(x^t, y^t)} \right) \times \left[\left(\frac{D_0^T(x^{t+1}, y^{t+1})}{D_0^{T+1}(x^{t+1}, y^{t+1})} \right) \cdot \left(\frac{D_0^T(x^t, y^t)}{D_0^{T+1}(x^t, y^t)} \right) \right]^{\frac{1}{2}}$$

Unlike the Tornqvist and the Fisher indices, the Malmquist index does not need to assume that farms are "cost minimizers and revenue maximizers" (Coelli et al., 1998). The Malmquist TFP index may be decomposed into its components such as technical change (TECHCH), efficiency change (EFFCH), pure efficiency change (PECH) and scale efficiency change (SECH). Technical change measures shift in the frontier function itself while efficiency change assumes constant returns to scale to measure catching-up, which means that the farms are getting closer to the frontier made up of the best performing farms. Efficiency change under constant returns to scale is further decomposed into pure efficiency change (under variable returns to scale) and scale change. In other words, scale change measures the difference in efficiency due to constant and variable returns to scale. Because the Malmquist TFP index represents the geometric mean of the two CCD type indexes, TFP is obtained by multiplying technical change index with efficiency change index, i.e., . Similarly, efficiency change index is obtained by multiplying pure efficiency change and scale change index, or .

We calculate TFP growth and its components by using data from the LUMS Survey of Dairy Households in Rural Punjab for the two survey rounds conducted in 2005 and 2014. Our measure of aggregate output is real value of milk, farm yard manure and capital gain from milch animals earned by each farm converted into 2013-14 prices. Four input proxies used in the measurement are cost of shed, structure & animal capital, cost of fodder, cost of straw & concentrate and hired & family labor all at the farm level in 2013-14 prices. Because there were more than 250 missing observations in cost of shed and structure capital series, we have merged it with animal capital to avoid computational problems in the measurement of the distance functions.

Variable Construction for Total Factor Productivity

Our analysis encapsulates three sources of revenue and five main inputs involved in dairy production. Dairy farms in Pakistan earn revenue from milk, farm yard manure, and capital gain on milch animals. Costs incurred in dairy production include the running cost of shed and structure capital, the cost of animal capital, cost of fodder, straws, and concentrates, and cost of labor. The LUMS Survey of Dairy Households in Rural Punjab for the years 2005 and 2014 was used to construct the input - output data used in our estimations. We discuss each of these variables in turn to explain the definition used and how they were constructed.

The largest source of revenue for dairy farms is the revenue earned from milk. This includes the actual revenue earned from selling milk, as well as the indirect or potential revenue earned from the consumption of milk produced on the farm. First, the actual revenue from selling milk was computed by adding up the value of milk sold to milk processors, transporters, dodhis, village shopkeepers, neighbors, and city shops by each household. Next, we constructed the average price at which milk is sold in the market by working out the price at which milk is sold to different economic agents[92] and then computing a share-weighted average of these prices.[93] This share-weighted price was then multiplied by the quantity of fresh milk consumed and the quantity of milk converted to butter/ghee and cheese to form the potential revenue earned by milk consumption. Finally, the actual revenue earned from selling milk and the potential revenue earned by consuming milk produced in the household rather than purchasing it were added up to form the total revenue earned from milk.

Another source of revenue for dairy farms is revenue earned from farm yard manure. This is computed by multiplying the number of trolley loads of farmyard manure produced by the farm during the year by the price per trolley load at which farm yard manure was sold during that year.

Capital gain on milch animals is also an important source of revenue. Its value is computed by subtracting the reported price of each animal at the beginning of the year from its price at the end of the year and then adding up this value for all dairy animals kept by the household. The value of heifers was adjusted in the year- end value of the animal before computing capital gain.[94]

Moving on to the inputs involved in the production process, a major startup cost for dairy farming is investment in infrastructure and machinery. A lump sum amount is initially invested in the building of animal sheds and courtyards for the upkeep of the animals, and cutter machines are procured for cutting up fodder and straw. While this investment is deemed to be a fixed cost incurred on the farm, it has a variable component as well: farm structures and machinery depreciate over time and need to be repaired and maintained. Further, loans obtained for these investments need to be repaid. Therefore, to construct the 'running cost' of shed and structure capital, we have included both these elements in our calculations. First, we computed the sum of the present values of all animal sheds, courtyards, and cutter machines used by the farm and multiplied that with an assumed depreciation rate of 10%. Next, all loans taken by the household were multiplied with their respective interest rates and added up to calculate the interest on loans that needs to be repaid during that year or has accumulated during that year. Finally, the depreciation on shed and structure capital and the interest on loans were added up to construct the running cost of shed and structure capital.

The cost of animal capital was also included in our analysis since it calls to attention the fact that each animal goes through only a fixed number of lactations during its lifetime and every subsequent lactation an animal goes through lowers its value on the market. This decrease in value is essentially a cost incurred on the farm. To account for this cost, we computed the average value of the animal during the year by taking a simple average of the reported price or value of the animal at the beginning and the end of the year. This average was then multiplied with an assumed 'depreciation'[95] rate of 10% to find the cost of animal capital.

Cost of fodders fed to the farm animals includes the cost of rabi and kharif fodder, as well as the cost of procuring roughages and grass for the animals. Total cost of fodder was computed by multiplying the quantity of each fodder type (reported in number of acres) with its respective price (per acre) and then adding these costs up. Since the quantity of fodder reported is the total quantity of fodder fed to all animals (regardless of whether they are milch or draught animals or sheep/goats), we separated out the cost of fodder purchased for milch animals from the total cost of fodder purchased for all

---

[92] Households sell milk to milk processors, transporters, dodhis, village shopkeepers and neighbors, and city shops. Our data contains detailed information on the total value (in Rupees) and total quantity (in kg) of milk sold to each of these economic agents. The price at which milk was sold to each of these agents is computed by dividing the total value by the total quantity of milk sold to each agent, and is given by:

$$P_i = \frac{V_i}{Q_i}$$

Where i represents the ith economic agent, P_i is the price at which milk is sold to agent i, V_i is the total amount of money offered by agent i for quantity Q_i of milk.

[93] The share-weighted average price of milk was computed using the following formula:

$$P_M = \sum_{i=1}^{n} \left[P_i * \left(\frac{Q_i}{Q_T} \right) \right]$$

Where subscript 'i' represents the ith economic agent, P_M is the share-weighted price of milk, P_i is the price at which milk is sold to agent i, Q_i is the quantity of milk sold to agent i, and Q_T is the total quantity of milk sold by the household to all agents.

[94] This adjustment was necessary since heifers are separated from the animal when it stops milching. To make this adjustment, we multiplied the year- end value of animals whose heifers had been separated from them with 1.50 indicating a 50% rise in the value of the animal if the value of its heifer had not been separated from its value.

[95] We are calling this rate a depreciation rate for the simple reason that with every subsequent lactation, the value of the animal falls or the animal 'depreciates'.

animals by using a share-weighting technique before making the total cost computations.[96] The cost of straws and concentrate were calculated using the same share-weighting technique[97]; this cost includes the cost of wheat straw, sugarcane tops, maize stock, rice straw, cotton seed cake, cotton seed, wheat flour, wheat dalia, gram flour, and molasses.

Finally, dairy farms use both hired labor and family labor. The cost of hired labor is simply the sum of the total money paid to casual and permanent hired labor. On the other hand, family members that work on the farm are not paid a daily or even monthly wage. Instead, they are compensated based on the returns from dairy production. Even so, we calculated the opportunity cost of family labor by multiplying the wage rate per hour for hired labor[98] with the number of hours worked by family members (per year) on livestock and dairy.[99] Note that for both hired and family labor, we again separated out the cost of labor used for milch animals from the cost of labor employed for all farm animals by share-weighting the final cost.[100] Table A1 presents their descriptive statistics of output and input variables used to measure TFP growth.

A1: Descriptive statistics of output and input variables

Variable	Mean 2005	Mean 2014	Mean of full sample
Output:			
Value of milk, farmyard manure & capital gain	293,612 (277,788)	328,090 (477,658)	310,851 (390,959)
Inputs:			
Cost of shed, structure & animal capital	52,280 (45,927)	56,748 (54,230)	54,514 (50,283)
Cost of fodder	135,585 (132,075)	116,071 (109,107)	125,828 (121,474)
Cost of straw & concentrates	67,610 (72,856)	54,690 (82,249)	61,150 (77,936)
Cost of hired & family labor	14,638 (17,767)	57,337 (49,845)	35,988 (43,075)
Sample size	**725**	**725**	**1,450**

Note: Numbers in this table are in Pak rupees (PKR) converted in 2013-14 prices using CPI of the relevant years. Standard deviations are in parenthesis.

[96] *Since milk yield depends on the quantity and quality of fodder, straws, and concentrate fed to the animals, milch animals are typically fed more than draught animals and sheep/goats. To account for this differential, we made a rough estimate of the total weight of fodder fed to all animals and the weight of fodder fed to milch animals. These weights were then used to separate out the cost of fodder fed to milch animals from the cost of fodder fed to all animals as follows:*

$W_T = 1.5 * N_M + 1 * N_D + 0.1 * N_{SG}$

where W_T is the total weight of fodder fed to all animals, N_M is the number of milch animals kept by the household, and N_D and N_{SG} are the number of draught animals and sheep/goats kept by the household, respectively.

$W_M = 1.5 * N_M$

where W_M is the weight of fodder fed to milch animals, and N_M is the number of milch animals kept by the household.
The quantity of fodder for milch animals, then, is computed as:

$$Q_M^F = \left(\frac{W_M}{W_T}\right) * Q_T^F$$

where Q_M^F is the quantity of fodder fed to milch animals, and Q_T^F is the total quantity of fodder fed to all animals.
Finally the cost of fodder fed to milch animals is obtained by multiplying the price per acre of each fodder type with its corresponding Q_M^F and then adding up all the costs together.

[97] *For each of the straws and concentrates reported, the quantity fed to animals is reported collectively and does not differentiate the amount fed to milch animals, draught animals, and sheep/goats. Here, we again use a share-weighting technique similar to that mentioned in note 5 to separate out the cost of straws and concentrates fed to milch animals from that fed to all animals. The only difference is that straws and concentrates are not fed to sheep/goats and a weight of 1 is assigned to both milch animals and draught animals in the computation of W_T and W_M (instead of 1.5 for milch and 1 for draught).*

[98] *We use the wage rate for hired labor to compute the total opportunity cost of family labor because that is the wage each family member would get had they worked on any farm other than their own.*

[99] *This includes the number of hours spent in cleaning, milking, feeding, management & marketing activities, and the collection of roughages and grass.*

[100] *The method used to share-weight the cost of labor used for milch animals is the same as that employed in note 5, except that we assume that both milch and draught animals require equal care and are both assigned a weight of 1 whereas sheep/goats require less care and are assigned a weight of 0.1 in the weight calculations.*

APPENDIX – 2:
THE STOCHASTIC FRONTIER AND TECHNICAL INEFFICIENCY EFFECTS MODEL

We investigate the determinants of technical inefficiency in non-corporate dairy farms. For this purpose, we use the stochastic frontier technical inefficiency effects model. This model postulates the existence of technical inefficiency during the production process (Aigner et al., 1977; Battese and Coelli, 1995; Sherlund et al., 2002).

Let the milk production technology be represented by

$$Y_{it} = f(X_{it}; \beta)\, e^{v_{it} - u_{it}}$$

where Y_{it} is the output of the ith dairy farm in *t*th time, $X_{it}(i = 1,...,n)$ is a 1 x *k* cector of values of known functions of inputs for the *i*th dairy farm in time period t, β is a *k* x 1 vector of unknown parameters to be estimated, and $f(X_{it}; \beta)$ is the assumed functional form. As usual in frontier literature, the stochastic composite error term in is decomposed into v_{it} and u_{it} where v_{it} is typically taken as iid$N(O, o_v^2)$ and accounts for random variation in output due to factors beyond the control of the farm. The technical inefficiency term, u_{it}, is a non-negative random variable, independent of v_{it}, which captures farm-specific inefficiency effects reflecting the extent of the stochastic shortfall of the *i*th dairy farm's outputs from the most efficient production.

When *u* equals zero the farm is perfectly technically efficient because it is on the production frontier. It is further assumed that the u_i's are independently distributed, such that u_{it} is obtained by truncation at zero, that is, $u_{it} N(u_{it}, o^2)$, where $u_{it} = O z_{it}$ where z_{it} is a vector of observable explanatory variables linked with technical inefficiency of farms, and O' is a vector of unknown coefficients. In effect, the technical inefficiency, u_{it}, for each dairy farm in Eq. (4.1) could be replaced by a linear function of explanatory variables reflecting farm-specific characteristics specified by

$$u_{it} = O' z_{it} + \epsilon_{it}$$

where O' is a vector of unknown farm-specific parameter estimates associated with technical inefficiency of dairy farms and ϵ_{it} is an unobservable random variable that is obtained by truncation of the normal distribution with mean zero and variance, O^2. The point of truncation occurs at $-O' z_i$ or $\epsilon_{it} \geq -O' z_{it}$.

We follow Battese and Coelli (1995) technical inefficiency effects model for the panel data. We estimate the Cobb-Douglas production frontier for the two year panel data by using the empirical specification as defined below:

$$\ln Y_{it} = \beta_0 + \sum_i \beta_{it} \ln X_{it} + v_{it} - u_{it}$$

where the dependent variables Y_{it} measures dairy output and X_{it} measures inputs for the ith farm in each time period. Dairy input variables include shed & structure capital, animal capital, fodder, straws & concentrates, and hired & family labor. The technical inefficiency effects, u_{it}, are assumed to be defined by a linear function of explanatory variables reflecting farm-specific characteristics given by

$$u_{it} = O'_0 + \sum_{j=1}^{N} O'_j z_{ijt} + \epsilon_{it}$$

where z_{ijt} are the determinants of technical inefficiency. The variables that tested as insignificant determinants of inefficiency were dropped from the regression models. The relevant variables explaining technical inefficiency of dairy farms are herd size, age of household head, distance from pucca road, dummy variable for depressive disorder, education of household head, dummy for market structure and dummy variables for district fixed-effects.

Summary statistics of the variables used to estimate the stochastic production frontier and technical inefficiency effects model is presented in Table A2. Value of production of milk, farmyard manure and capital gain per dairy farm is Rs.310998, which has increased by 11.6% from 2005 to 2014. The value of production varies from Rs.33590 to Rs.11,200,000 per farm depending upon the size of the dairy farms. Investment on shed and structure capital has also increased over the study period from Rs.13774 in 2005 to Rs.17408 in 2014 or 26.4% with an overall mean of Rs.15591. The mean value of animal capital is Rs.38923 per farm that has slightly increased over time. Mean value of fodder cost is Rs.126049, which has decreased by 14.13% from 2005 to 2014, but it remains the major cost to the dairy farms. Likewise, the cost of straw & concentrate has also decreased by 19.1% over the study period with a mean value of Rs.61150. Average cost of family & hired labor is Rs.35988 per farm, which has increased 291% over time.

Summary statistics of variables in the technical inefficiency effects model suggest that 61% of the dairy farms sell milk directly to informal milk collecting agents increasing from 54% in 2005 to 68% in 2014. Average herd size in our sample is between 3 to 4 dairy animals while average age of the head of farm household is 51 years. The psychiatric epidemiological studies show that anxiety and depressive disorder is not only common occurrence in developing countries, but is also associated with disability (Mirza and Jenkins, 2004).[101] Quite consistent with these numbers we note that about 9.1% of the dairy farmers in our sample were under high degree of long-term depression measured by the self-reporting questionnaire (SRQ-20). These disorders are likely to have important economic consequences.

Mean age of the head of dairy household is roughly 5 years. Mean distance of the dairy farms from a pucca road has decreased from 1.18km in 2005 to 0.52km in 2014 with a mean distance in full sample of 0.85. Likewise, mean distance of the farm from an urban center is 11.8km. Only 5.2% dairy farms feed molasses to their milch cows and buffaloes. When cows and buffalos are tied with a rope, they can't freely drink water. Therefore, the frequency of feeding water may increase their technical efficiency. The frequency of feeding water is from 1 to 4 with a mean value of 2.2.

Production frontier results

The maximum likelihood estimates of the parameters of the production function and the inefficiency effects model are estimated simultaneously using the procedure in computer program FRONTIER 4.1 (Coelli, 1996). Estimation

A2: Descriptive statistics of frontier production function variables

Variables	Mean	Std. Dev	Min	Max
Frontier Production Function:				
Value of dairy milk, farmyard manure & capital gain	310851	390959	33590	11200000
Cost of shed & structure capital	15591	15585	0	219768
Cost of animal capital	38923	40537	3696	1022763
Cost of fodder	125828	121474	840	1425618
Cost of straw & concentrates	61150	77936	547	1806776
Cost of hired & family labor	35988	43075	363	859542
Technical Inefficiency Model:				
Sells milk to informal agents	0.610	0.488	0	1
Herd size (number)	3.486	2.936	1	65
Head age (years)	51.53	14.01	16	96
Depression (if SRQ≥8=1, otherwise=0)	0.0913	0.288	0	1
Education of head (years)	4.796	5.241	0	18
Distance pucca road (km)	0.848	0.939	0	7
Distance from urban center	11.804	7.598	0	38
Feed molasses to milching animals (yes=1, no=0)	0.052	0.223	0	1
Number of time feed water to milching animals	2.20	0.401	1	4
Hafizabad district (yes=1, no=0)	0.106	0.308	0	1
Jhelum district (yes=1, no=0)	0.088	0.283	0	1
Khanewal district (yes=1, no=0)	0.099	0.299	0	1
Layyah district (yes=1, no=0)	0.107	0.309	0	1
Muzafargarh district (yes=1, no=0)	0.091	0.287	0	1
Narowal district (yes=1, no=0)	0.106	0.308	0	1
Okara district (yes=1, no=0)	0.108	0.311	0	1
Pakpattan district (yes=1, no=0)	0.102	0.302	0	1
Sargodha district (yes=1, no=0)	0.097	0.297	0	1
Attock district (yes=1, no=0)	0.096	0.296	0	1
Sample size	1450	---	---	---

Source: LUMS Survey of Dairy Households in Rural Punjab, 2005 & 2014

[101] *Some of the factors positively associated with the occurrence of anxiety and depressive disorders in Pakistan are female sex, middle age, low level of education, financial difficulty and relationship problems [Mirza and Jenkins (2004)].*

results of the frontier production function and inefficiency effects model are reported in Table A3, which indicate that all input elasticities possess the expected signs. The estimated coefficients are very similar in magnitude in both the specifications.

Our estimates suggest that animal capital, straw & concentrate and family & hired labor continue to be the most important determinants of raising output in smallholder dairying while fodder and shed & structure capital do not significantly increase dairy output. The coefficient on animal capital in both models is large, positive and statistically significant, implying that the elasticity of output with respect to animal capital is highest in the sample. These estimates show that every 1-percent increase in the value of animal capital results in about 0.77 percent increase in dairy output. Similarly, dairy output is also statistically significantly correlated with straw & concentrate where elasticity is 0.07, implying that its 1-percent increase leads to 0.7% increase in dairy output. The elasticity coefficient for family & hired labor is 0.04, implying a 1-percent increase in labor leads to 0.04% increase in dairy output. Similarly, statistically insignificant coefficients of shed & structure capital and fodder suggest that these inputs do not play a significant role in raising dairy production in the sample. The estimated scale elasticity is measured by the sum of all the input elasticities.

Our results show that the estimated returns to scale at the point of approximation is less than one (0.85) or decreasing returns to scale. We reject the null hypothesis by the Wald test of constant returns to scale. A proportionate increase in inputs brings about a less than proportionate growth in dairy output. In other words, the dairy farms in our sample operate on increasing cost portion of their average cost curves.

A3: Estimation results for the frontier production function and inefficiency model

Variables	Model 1	Model 2
Frontier Production Function:		
Shed & structure capital	-0.004 (-1.61)	-0.003 (-1.59)
Animal capital	0.766*** (33.61)	0.783*** (34.92)
Fodders	-0.004 (-0.415)	-0.004 (-0.43)
Straws and concentrates	0.073*** (4.599)	0.073*** (4.52)
Family & hired labor	0.043*** (5.277)	0.046*** (5.86)
Technical Inefficiency Model:		
Sells milk to informal agents (yes=1, no=0)	-0.048* (-1.82)	-0.056* (-1.78)
Herd size (number)	-0.031*** (-11.49)	-0.031*** (-13.61)
Head age (years)	-0.002** (-2.70)	-0.003** (-2.53)
Depression (if SRQ≥8=1, otherwise=0)	0.054 (1.41)	0.059 (1.42)
Education of head (years)	-0.006** (-2.52)	-0.007** (-2.21)
Hafizabad district (yes=1, no=0)	0.266*** (3.27)	0.489*** (6.05)
Jhelum district (yes=1, no=0)	0.239*** (3.02)	0.435*** (5.90)
Khanewal district (yes=1, no=0)	0.274*** (3.34)	0.507*** (6.27)
Layyah district (yes=1, no=0)	0.325*** (3.80)	0.583*** (7.22)
Muzafargarh district (yes=1, no=0)	0.315*** (3.70)	0.565*** (6.76)
Narowal district (yes=1, no=0)	0.217** (2.78)	0.439*** (4.89)
Okara district (yes=1, no=0)	0.140* (1.83)	0.309*** (3.39)
Pakpattan district (yes=1, no=0)	0.110 (1.45)	0.265** (2.84)
Sargodha district (yes=1, no=0)	0.275*** (3.39)	0.521*** (6.75)
$y=O^2_u/(O^2_u / O^2_v)$	0.559*** (8.16)	0.560*** (13.21)
Log-likelihood	-69.55	-71.47
Mean efficiency	0.713	0.774
Sample size	1450	1450

*Note: *, ** and *** denote statistical significance at the 10, 5 and 1% levels, respectively. Figures in parenthesis are t-values. Constant terms were included but not reported. Distance from pucca road was included in both models, but in each case it was statistically insignificant. Similarly, feed molasses and number of times fed water were included in model 1, but both turned out to be statistically insignificant. Finally, we also tried distance from urban center in model 2, which was also statistically equal to zero. For brevity these coefficients are not reported in the table.*

Technical Inefficiency Effects Results

A test of hypothesis that technical inefficiency effects are not present in the estimated model is strongly rejected, which indicates that most of the dairy farms in our sample are operating below the best practice frontier.[102] The estimated mean technical efficiency of the dairy farms in the sample ranges from 65% to 66%, which implies that on average the dairy farms in the sample could have produced 34% to 35% more output had they been fully technically efficient by being on the frontier.

The dependent variable in the technical inefficiency effects model in Table A3 is measured in units of inefficiency ranging over the (0, ∞) interval where a score of zero depicts full efficiency and scores of greater than zero depict inefficiency. Therefore, a negative (positive) sign of a coefficient indicates a decrease (increase) in inefficiency.

First, our primary interest is to examine the differential impact of milk collection by milk processing industry on technical inefficiency of the smallholder dairy farms. We note that the estimate of 'sell milk to informal agents' in both the models are negative at the 5% level of statistical significance and qualitatively similar. For example, the negative coefficient (-0.49 in model 1) indicates that, holding all else as constant, dairy farms selling milk to informal milk collectors are more efficient since their technical inefficiency decreases (in the study period) than those who sell milk directly to milk processing industry.

Second, a negative coefficient on herd size also indicates that increase in herd size decreases technical inefficiency of the dairy farms.

Third, the estimated coefficient for head age is also significantly negative predicting on average that older and experienced farmers are less inefficient than the younger ones.

Fourth, the coefficient for depressive disorder is significantly positively correlated with technical inefficiency index, which shows that farmers suffering from severe depression are technically more inefficient than the excluded category of farms. Fourth, increase in years of education of the head of the household also decreases technical inefficiency of the dairy farms in the sample.

Fifth, the statistically positive coefficients for all district dummy variables (where Attock district is the excluded category) indicate that farmers from Attock district are technically most efficient as compared with the farmers from other districts in the sample. The highest positive coefficient is for Layyah district (0.245 in model 1), which indicates that the farmers from this district are technically most inefficient.

Last, variables on "distance from pucca road" and "distance from urban center" were also included in the specifications, but in each case they turned out to be statistically insignificant. Other things being equal, there is no significant difference in technical inefficiency on account of distances. In other words, distances do not matter, not any more, in determining technical

[101] *In Table A.3, the estimate for γ parameter in model 1 is 0.51 (t=8.64), which indicates that about half of the residual variation is explained by the inefficiency effects. This is also confirmed by the test of the null hypothesis ($\gamma = O'_0 = \ldots = O'_{17} = 0$) suggesting that technical inefficiency effects are not present in the model. However, we reject the null at the 1% level of statistical significance since the generalized likelihood ratio test statistics of 192.5, LR= –2 {–180.32–(–84.07)} where –180.32 is the value for OLS fit, is greater than its critical value of 34.17 for 18 degrees of freedom, obtained from Table 1 of Kodde and Palm (1986).*

APPENDIX – 3:
DEMAND CURVE ESTIMATION

Consumer demand for commodities is restricted by budgetary constraints and is, consequently, interlinked. To capture these linkages in our analysis, we have used Stone's model of simultaneous demand equations to estimate the demand function for packed milk.
Our basic econometric model is given as:

$$\log q_i = \alpha_i + e_i \log\left(\frac{x}{p}\right) + \sum_{k\epsilon K} e^*_{ik} \log\left(\frac{pk}{P}\right) \quad (1)$$

for i= 1,2,3,4 and k=1,2,3,4

where q_i is the per capita quantity consumed of the ith commodity, x is the per capita income, P is a general index of prices[103], and p_k is the price of the k^{th} commodity. The parameters e_i and e^*_{ik} represent the income elasticity of commodity i and the compensated cross-price elasticity between commodities i and k, respectively.

Typically, the actual prices of the commodities are used in the estimation of the demand function. However, we have chosen to use the price indices of the commodities instead of their actual prices. This is because we wanted to include a wide range of commodities in our analysis. Since it is not possible to find a common unit of measurement for the consumption of commodities like clothing, travel, education, health, etc., it makes theoretical sense to combine their prices into a single price index.[104] For the same reason, we have constructed quantity indices[105] rather than using the actual quantities of the commodities in our analysis.

The results from our estimation were used to compute the slope of the demand function, $\frac{dP^d}{dQ^d}$,

$\frac{dP^d}{dQ^d}$,

for packed milk using the following calculation:

$$\epsilon_q^p = \frac{dQ^d}{dP^d} * \frac{\bar{P}^d}{\bar{Q}^d}$$

$$\Rightarrow \quad \frac{dQ^d}{dP^d} = \epsilon_q^p * \frac{\bar{Q}^d}{\bar{P}^d}$$

$$\Rightarrow \quad \frac{dP^d}{dQ^d} = \frac{1}{\epsilon_q^p} * \frac{\bar{P}^d}{\bar{Q}^d}$$

where ϵ_q^p is the own-price elasticity of packed milk[106], and P^d and Q^d are the average price of milk and average quantity of milk consumed in the year 2014 respectively.[107] The slope and intercept of the demand curve were then found by plugging in the relevant values.

---

[103] The consumer price index was used to normalize the per capita income and commodity prices. This index was obtained from the Monthly Statistical Bulletins published by the Pakistan Bureau of Statistics.

[104] The Monthly Statistical Bulletin published by the Pakistan Bureau of Statistics contains a general consumer price index as well as indices for specific expenditure categories. For instance, these publications contain a separate index for clothing and footwear, a separate index for housing and utilities, and so on. We tabulated the price indices for each of the expenditure categories in the composite commodity, and then share-weighted these price indices using the average weights of the commodity groups in the standard basket of goods and services covered in the consumer price index.

[105] We added household expenditure on all the items within the composite commodity. The sum of these expenditures was then converted into an expenditure index. To obtain the quantity index for the composite commodity, we divided its expenditure index by its price index.

[106] This figure was obtained from our estimation and is equal to -0.827.

[107] The average price of milk in 2014 was found to be Rs.93.55/liter. This figure was obtained from the panel expenditure data provided by Foresight Research. The quantity of milk produced and consumed in 2014 was 1854 million liters as indicated by industry sources.

APPENDIX – 4:
SUPPLY CURVE ESTIMATON

In order to estimate the output supply function for packed milk, we have run a transcendental logarithmic (translog) form of the profit function because this is a flexible form of specification with the fewest technical assumptions compared to other functional forms such as the CES or Cobb Douglas form. Our basic econometric model is given by the following system of equations:

$$\ln \prod = \alpha_0+\sum_i \alpha_i \ln W_i + \alpha_q \ln P_q + \beta_z \ln Z + 1/2 \sum_j \sum_i \gamma_{ij} \ln W_i \ln W_j + 1/2\ \gamma_{qq} \ln P_q^2 + 1/2\ \beta_{zz} \ln Z^2 + \sum_i \gamma_{iq} \ln W_i \ln P_q + \sum_i \rho_{zi} \ln Z \ln W_i + \rho_{zq} \ln Z \ln P_q + \varepsilon_i \quad (1)$$

Share Equations

$$S_i = \alpha_i + \sum_j \gamma_{ij} \ln W_j + \gamma_{iq} \ln P_q + \rho_{zi} \ln Z + \mu_i \quad (2)$$

$$S_q = \alpha_q + \sum_j \gamma_{iq} \ln W_j + \gamma_{qq} \ln P_q + \rho_{zq} \ln Z + \mu_i \quad (3)$$

where, Π is the restricted profit or returns to family labor derived as total revenue minus total costs of variable inputs[108]. W_i is the price of the ith variable input, P_q is the price of output, and Z represents the fixed inputs in the production process.

S_i is the share of the i^{th} input cost in restricted profits ($S_i=(P_i X_i)/\Pi$), and S_q is the share of revenue in restricted profits ($S_q=(P_q X_q)/\Pi$).

We impose constant returns to scale in our model such that the linear terms in the translog profit function (i.e. equation (1)), $\sum_i \alpha_i$, equal 1. We have also imposed the necessary homogeneity restrictions on the profit function, whereby the sum of the linear terms in each share equation (i.e. equations (2) and (3)), $\sum_j \gamma_{ij}$, equals 0. In addition, cross equation symmetry has also been imposed, whereby $\gamma_{ij}=\gamma_{ji}$.

Additionally, note that for each observation, the sum of the dependent variables over all share equations, $S_q+\sum_i[-(S_i)]$ equals 1, making the disturbance covariance matrix singular. To address this singularity problem, we drop the share equation for wheat straw and concentrate, and then estimate this model.

The results from this estimation are reported in Table A4. Using these results, we can now estimate the slope of the output supply function by using the following formula for own price elasticity of output supply (i.e. the elasticity of output with respect to its own price):

$$\epsilon_q^p = S_q + \frac{\gamma_{qq}}{S_q} - 1$$

The elasticity figure obtained from this calculation can then be used to compute the slope of the output supply function, $\frac{dP^s}{dQ^s}$, using the following formula:

$$\epsilon_q^p = \frac{dQ^s}{dP^s} * \frac{\bar{P}^s}{\bar{Q}^s}$$

$$\Rightarrow \quad \frac{dQ^s}{dP^s} = \epsilon_q^p * \frac{\bar{Q}^s}{\bar{P}^s}$$

$$\Rightarrow \quad \frac{dP^s}{dQ^s} = \frac{1}{\epsilon_q^p} * \frac{\bar{P}^s}{\bar{Q}^s}$$

Where ε_q^p is the price elasticity of output supply[109], and P^s and Q^s are the values of price of output supplied and quantity of output supplied in 2014 respectively.

[108] Note here that the total cost of variable inputs does not include wages or salaries given to family members. This is because the restricted profit in our model represents the returns to family labor rather than actual profit.
[109] This figure was obtained using our estimation.

A2: Descriptive statistics of frontier production function variables			
Variables	**In ∏**	**S_1**	**S_q**
	(1)	**(2)**	**(3)**
InW_1	13.68*** (4.490)	-1.624** (0.684)	2.385*** (0.790)
InP_q	-16.57*** (5.674)	2.385*** (0.790)	-3.463*** (1.051)
InW_2	3.892* (2.275)	-0.442 (0.340)	1.108** (0.461)
InZ	0.880 (2.380)	-0.319 (0.268)	-0.0298 (0.176)
$(InW_1)^2$	-1.624** (0.684)		
InW_1*InP_Q	2.385*** (0.790)		
InW_1*InW_C	-0.442 (0.340)		
InW_1*InZ	-0.319 (0.268)		
$(InP_Q)^2$	-3.463*** (1.051)		
InP_Q*InW_2	1.108** (0.461)		
InP_Q*InZ	-0.0298 (0.176)		
$(InW_2)^2$	-0.618* (0.337)		
InW_2*InZ	-0.0486 (0.209)		
$InZ*InZ$	0.344** (0.169)		
Observations	339	339	339
R-squared	0.200	-0.020	-0.019

*Note: Standard errors in parentheses. * Indicates significance at the 10% level, ** Indicates significance at the 5% level, and *** Indicates significance at the 1% level. W1 is the price of green fodder and W2 is the price of wheat straw and concentrate. Pq is the price of milk. Z represents the value of fixed inputs in the production process, and includes electricity, initial investment in animal capital, animal sheds, and courtyard.*

LIST OF TABLES

ACRONYMS

AI	Artificial Insemination
BMI	Body Mass Index
CPI	Consumer Price Index
DEA	Data Envelopment Index
DP	Digestible Protein
EFFCH	Efficiency Change
FAO	Food and Agriculture Organization
FBR	Federal Board of Revenue
FCT	Farm Cooling Tank
GDP	Gross Domestic Product
GoP	Government of Pakistan
GST	Generalized Sales Tax
HAZ	Height for Age Z-Score
HCLF	High Carb Low Fat
HIES	Household Integrated Economic Survey
PBS	Pakistan Bureau of Statistics
PECH	Pure Efficiency Change
PSLM	Pakistan Social and Living Standards Measurement Survey
RFF	Return to Family Farm
SAGE	Schooling Over Age
SCN	United Nations Standing Committee on Nutrition
SECH	Scale Efficiency Change
SLSP	Strengthening of Livestock Services Project
SRQ-20	Self-Reporting Questionnaire
TC	Total Cost
TDN	Total Digestible Nutrients
TE	Transfer Earnings
TECHCH	Technical Efficiency Change
TFP	Total Factor Productivity
TFPCH	Total Factor Productivity Change
TMR	Total Mixed Ration
TR	Total Revenue
UHT	Ultra-High Temperature
UN	United Nations
USAID	United States Agency for International Development
WHO	World Health Organization

LUMS

Lahore University of Management Sciences
Sector U, DHA, Lahore 54792, Pakistan
Call: +92-42 111-11-LUMS (5867)
Fax: +92 42 35896559

www.lums.edu.pk