LUMS

ECONOMIC IMPACT OF
PAKISTAN'S DAIRY SECTOR

LESSONS FOR BUILDING SUSTAINABLE VALUE

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 on exposition of the material contained in this study. We are also indebted to Ammar Mursalin and Ali Azhar for useful discussions, comments and support in providing background information about the dairy industry in Pakistan. We also thank Torsten Hemme and Dorothee Boelling of the IFCN Dairy Research Network for providing technical support in conducting the analysis. Our thanks also go to Abubakar Memon for handling the survey data and to Tariq Munir and Sananullah for conducting the field survey of the dairy sector. Our special thanks are due to Zunaira Mehmood, Muhammad Husnain Ijaz and Muhammad Raza Mustafa Khan 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. We owe our special thanks to Tetra Pak Pakistan for financial support.

ECONOMIC IMPACT OF
PAKISTAN'S DAIRY SECTOR
LESSONS FOR BUILDING SUSTAINABLE VALUE

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

PREFACE

Agriculture is a key sector of Pakistan's economy, which contributes 18.9% to GDP, i.e., PKR 7,764 billion, and provides jobs to 42.3% of population (GoP, 2018). Livestock sector contributes 11.1% to Pakistan's gross domestic product (GDP) and 58.9% to agricultural value added.

A large majority of the dairy farms in Pakistan are subsistence (1 to 2 cattle/buffalo) or near subsistence (3 to 4 cattle/buffalo). Another major group maintains up to ten dairy animals. However, there has been a noticeable increase in larger dairy farms in recent years resulting in increased efficiency and reduced costs.

Milk is one of the most nutritious food and provides essential nutrients particularly to children with growing nutritional needs. 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. Among other things, milk is an important source of calcium and vitamins effectively used to fight malnutrition. How these nutritional deficiencies affect productivity, GDP growth and other costs to society is largely unexplored. How improved nutrition affects school enrollment and child health outcomes is also mostly ambiguous.

The second edition of report on Emergence of Pakistan's Dairy Sector is an extension of the last report published in 2015 and aims to explore and address five dimensions of dairy sector in Pakistan given below:

1. Changing dynamics of small and large farms
2. Productivity growth in small holder dairy farms with focus on mechanization
3. Economics of modern corporate dairy farms
4. Economics of Nutrition: Calcium and Milk
5. Welfare impact of sales tax on packaged milk and milk products

The report is an outcome of thorough secondary research, primary field research by Lahore University of Management Sciences (LUMS) and International Farms Comparison Network (IFCN).

Taking a complete value chain perspective, the report is a comprehensive document for the dairy sector in Pakistan.

A WORD FROM
OUR PARTNER

Jorge Montero

Managing Director
Tetra Pak Pakistan

Tetra Pak is pleased to be invited to partner with Lahore University of Management Sciences for the second edition of this insightful publication covering the dairy landscape of Pakistan. In times when Dairy across the globe, is progressing and revolutionizing with mechanization and technology, it is important to establish fact base taking a value chain perspective. All of us active in milk production and distribution have a responsibility to educate all stakeholders about the value dairy industry brings to people. We truly believe this publication will continue to be an integral part of increasing awareness and knowledge about the dairy industry in Pakistan.

Assad Abbas

Marketing Director
Tetra Pak Pakistan

Agricultural development for Pakistan is in-fact a national development agenda. Within agriculture, livestock and dairy trump other commodities such as wheat, rice, cotton etc in many ways. For instance, livestock has a much wider geographic presence across corners and terrain of the country, vis a vis aforementioned commodities and therefore offers one of the best means to elevate a maximum number of people out of nutritional and financial poverty.

There has been a constant need to gather reliable base-data upon which good decisions can be planned for dairy sector development, leading to the previous publication in 2015 as well as the current effort to elaborate on previous work, culminating in 2019. Key fundamentals that further augment this effort are:

1. A robust agricultural sector, including dairy, allows for predictability in everyday life such that basic food and nutrition become a non-issue due to consistent availability, affordability and quality. Surpluses further act as low-cost input to various other industries or for export.
2. For a developing economy like Pakistan, with half the population comprising women restricted in their extent of physical mobility due to various reasons, agricultural value addition allows for productive engagement and increase in effective workforce, alongside financial empowerment.
3. Agricultural value addition offers potential for high return through product and brand development e.g. Parmesan cheese, Kobu beef, Manuka honey.
   This is best understood through simple comparisons such as the fact that Australia that produces USD ~1.3 value per litre of milk vs Pakistan which produces USD ~0.3 value per litre of milk.

I hope this work serves as a valuable input to all stakeholders committed to developing the dairy sector within Pakistan.

CONTENTS

EXECUTIVE SUMMARY

This report presents the achievements and constraints of the emerging dairy sector of Pakistan. It studies the evolution of various facets of Pakistan's dairy industry to diagnose its strengths and weaknesses to suggest areas in which government and industry stakeholders could act.

The livestock sector contributes 11.1% to Pakistan's gross domestic product (GDP) and 58.9% to agricultural value added. Buffaloes and cows are two major sources of milk production in Pakistan contributing 65.3% and 34.7%, respectively. Smallholder dairy producers, spread all over Pakistan, dominate the livestock sector. They meet major protein and nutritional needs of the country and earn incomes on a daily or weekly basis.

The demand for dairy products is rapidly increasing due to rising population and urbanization. This has attracted new investors and producers in milk processing and milk production. A number of large-scale milk processors are now operating and producing processed milk and milk products. Some modern corporate dairy farms are also operating by using exotic foreign breeds of cattle because their milk yield is higher than local breeds. This report addresses the following seven questions.

How Can The Quality Of Livestock Data Be Improved?

Availability of consistent but reliable data is the backbone of growth in any sector. Census of Livestock, conducted after every ten-years, is the primary data source to measure growth of livestock population, herd size and milk yield. These numbers play a critical role in national accounts and in formulating government policy for dairy sector development. Concerns have been raised on the quality of the livestock census data before, being included in this study.

For example, there is inconsistency in the inter-census growth in milk yield per animal for some districts of Punjab. Moreover, a comparison of supply side data of milk production with the demand side data in 2013-14 suggests that the amount of milk that the Pakistan Census of Livestock (supply side) said was available for human consumption was only 81% of the amount household (demand side) said they had consumed. This disparity amounted to an estimated shortage of about 7 to 8 billion liters of milk from the system.

This study recommends that the Pakistan Bureau of Statistics and the Government of Pakistan must revisit their sampling strategy and data collection tools to ensure better monitoring and supervision to produce reliable data in its subsequent rounds.

What Are The Gaps In The Feeding Practices Of Smallholder And Progressive Dairy Farms And How These Gaps Can Be Narrowed?

The quality of feed fed to the dairy stock is critical for higher productivity and profitability of the dairy farms. Livestock feed mainly consists 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 productivity of subsistence and near-subsistence dairy farms who are unable to purchase fodder in bulk during the peak seasons.

Feeding practices of the smallholder dairy farms and outdated technology used by them puts upward pressure on fodder costs. They use homemade mixtures of ingredients consisting of low quality fodders and concentrates. By contrast, progressive dairy farms use modern technology and high quality fodder for preparing livestock feed. To increase farm profitability of an average dairy farm, the gap between the practices of small and large-scale dairy farms and the issue of fodder shortages must be resolved. Helping the average dairy farmer reduce fodder costs and increase profitability will help increase aggregate milk supply of the country, as farmers will be able to re-invest their profits towards increasing animal productivity.

Access to silage preparation equipment can greatly help reduce fodder shortages and milk production cost of the dairy farms. Due to lack of demand, there is missing market for renting-out services of private equipment for silage making in many areas. Medium and large-scale commercial dairy farms and private market players are already renting out their excess capacity to small farmers. Where the adoption rates are low or non-existent, the milk processing industry and the provincial governments can play their constructive role by providing awareness. During the peak season, microfinance loans can provide the required capital to purchase fodder for silage making.

To increase productivity of fodder crops, the provincial governments should provide access to quality seeds and assist farmers in improve agronomic practices in fodder crops. Help sessions and training to the dairy farms can get better crop management skills leading to lower fodder cost and increased profitability.

Why The Economic Outlook/Returns To Smallholder Dairy Farms Have Declined In The Last One Decade And How This Can Be Improved?

To answer this question, this report investigates the dynamic outlook and competitiveness of the smallholder dairy farms in Punjab. We use survey data of 725 smallholder dairy farms from 10 districts of Punjab for 2005 and 2014. Two important insights emerge from the analysis.

First, pure buffalo farms are gradually decreasing while pure cow farms and mixed farms are increasing. This is because keeping buffalos has become unprofitable due to rising cost of feed and fodder and stagnant farm gate price of milk. It is well known that buffaloes take longer to calf, have shorter lactation length and eat more than cows, which puts them on a disadvantage relative to cows. Selling milk to milk processing industry has been a popular choice 10 years ago, but not anymore; dairy farms who were selling to milk processing industry have declined by 14 percentage points from 2005 to 2014.

Second, including opportunity cost of labor in total cost, average real return to dairy farms (adjusted for inflation) was increasing at the rate of 1.4% per annum only. Other studies for this period corroborate these findings. In 2005, returns to dairy farms selling to milk processing industry were 32% higher than farmers selling to informal milk collectors. However, the picture was reversed in 2014 when returns to dairy farms selling to milk-processing industry were 12% lower than others.

In general, the dismal economic outlook of the dairy farms is explained by fast changing international and domestic market conditions for the dairy sector. Real farm gate price of raw milk has increased until 2010 but declined ever since due to unfair competition with imported SMPs and WM. Due to falling international prices in post-2010 period and no regulatory protection, there were large-scale imports of SMPs and WM (around 5000 tons of powdered milk per month, which can make around 2% of total milk produced in the country), which directly affected the farm gate price of raw milk (for details, see Chapter 5). Moreover, the increasing popularity of non-dairy products, e.g., tea creamers and dairy liquids, which are a direct substitute of UHT milk for making tea, also affected the demand for UHT milk and farm gate price of raw milk. Mitigating measures that promote a level playing field are necessary to protect the long-term interests of the dairy producers. These measures are discussed in the next sub-section.

Why Productivity Of Smallholder Dairy Farms Is Declining And How It Can Be Enhanced?

Using two rounds of data of the dairy survey (2005 and 2014) to calculate total factor productivity (TFP), this study finds that productivity of small dairy farms is declining, on average, at the rate of 1.42% per annum. It 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.

Both subsistence and landless dairy farms have performed better than their counterparts have. This is understandable since most subsistence farms employ family labor to collect roughages and grasses to feed their dairy 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.

Best performing districts have large presence of 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. The results also suggest that dairy farms selling milk to informal milk collectors are more efficient than others are; higher milk prices offered by informal sector compared with the processing industry partly explains these results.

To enhance productivity of the dairy sector, this study recommends the following:

- Provincial livestock departments must devise strategies to promote genetic improvements through cross breeding of cattle with high yielding exotic breeds. It offers tremendous long-term potential of increasing milk yields at the farm level by three to four times. Such a policy has delivered in other developing countries and it can bear fruit in Pakistan too.
- The provincial governments should also consider introduction of balanced feeding program for dairy animals using IT technology and computer software to advise dairy producers on their doorstep to achieve balanced ration for their lactating dairy animals. With support from the Asian Development Bank, such programs are doing wonders in other developing countries, e.g., India.
- Some 2.5 million dairy farms with herd size of 10 or more have the potential of adopting mechanical and electronic devices for enhancing their productivity including equipment for feed and fodder preparations, milking machines, among others. Our estimates suggest that there is potential demand of around USD 8 to 9 billion for adopting mechanical and electrical devices for enhancing productivity, including equipment for feed and fodder preparations, milking machines, among others.
- A rational tariff structure for level playing field of all the stakeholders is the need of the hour. Dairy farms cannot make investments to increase milk yields unless real farm gate price of milk is increasing. Recently, liberal imports of SMP and WM have flooded the local market hurting the interests of dairy producers by lowering real farm gate price of milk. As long as heavy dairy subsidies are prevalent in milk surplus countries, mitigating measures are necessary to protect the long-term interests of the dairy producers by promoting a level playing field. A gradual increase by the federal government in the levy on powdered milk along with more than 44% devaluation of Pak rupee against the US dollar are steps in the right direction.

What Is The Business Model For A 1300 Cattle Holstein Frisian Dairy Farm And How Average Profits Vary By Farm Size, And Compared With Farms In Peri-Urban Areas Of Big Cities?

This report presents business model for a 1300 cattle purebred Holstein Frisian dairy farm, which shows that 10-year average operating profit of this farm comes to PKR 96.4 million. Moreover, average operating profit for the 10-year period comes to PKR 45,763 per cow and PKR 8.28 per liter of milk. The operating profit is highly sensitive to varying milk price, milk yield and feed cost. The results suggest that a 10% increase in milk price leads to increase in operating profit per cow and operating profit of PKR 32,248 per cow and PKR 6.10 per liter of milk.

This study finds that economies of scale are present in large commercial dairy farms. Average operating profit is highest on 1,300 cattle farm, followed by 500 cattle farm and then 300 cattle farm. Operating profit per liter of milk is also highest on 1300 cattle dairy farm as compared with 500 and 300 cattle farms. The study also finds that the operating margins for these farms are negative in first few years of operations; however, the margins significantly increase in the later period with 10-year average operating margins of 0.3%, 4.6% and 11.3% on 300, 500 and 1300 cow farms, respectively.

The business model of the large modern dairy farms suggests that very large dairy farms are not a viable option due to low rates of return and huge capital requirement. However, setting up of 100 cattle dairy farms in peri-urban areas of big cities appears to be a lucrative investment opportunity where average returns are nearly four-times more than the operating profits on large dairy farms selling milk to the processing companies. Higher retail prices and huge demand for fresh milk by urban households offers a great potential for new investors.

What Are The Costs Of Malnutrition And How Increased Dairy Consumption Could Alleviate Incidence Of Stunting And Underweight In Under-3 Children?

This study also recommends that adopting policies that help eliminate birth weight deficit in Pakistan can bring about benefits to the tune of US$11 billion per annum. Children aged 0 – 35 months who consume dairy products are at a lower risk of being malnourished. If households are encouraged to increase dairy consumption, it can lower the risk of stunting by 18% and underweight by 11%. Moreover, children who are not exclusively breastfed would be better off if they substitute breastfeeding with dairy products rather than switching to family foods; it lowers the risk of stunting by 33%, the risk of underweight by 39% and risk of wasting by 14%. The study recommends integrating milk-feeding programs for vulnerable households with the federal governments ‘Ehsaas’ social safety and poverty alleviation program.

What Can Sales Tax On Packed Milk And Milk Products Do To The Overall Welfare In Pakistan?

The Finance Acts of 2015-16 and 2016-17 abolished zero rating sales tax and imposed reduced rate sales tax at 10% on goods, e.g., concentrated (powder) milk, cream, yoghurt, cheese, butter, whey; however, they have categorized UHT and fat filled milk exempt. Our independent assessment based on partial equilibrium analysis leads us to conclude that although, imposition of reduced rate sales tax at 10% on concentrated (powder) milk, cream, yoghurt, cheese, butter, whey would yield higher tax revenues, yet the efficiency losses to producers and consumers would outweigh the gains in tax revenue. Therefore, if the FBR is keen on promoting net welfare, it should use this policy with great deal of caution. This study recommends the use of sales tax policy wisely to create level playing field for different players.

INTRODUCTION

Agriculture is a key sector of Pakistan's economy, which contributes 18.9% to GDP, i.e., PKR 7,764 billion, and provides jobs to 42.3% of population (GoP, 2018). This sector also plays an important role in other parts of the economy by supplying raw materials, foreign exchange earnings and market for industrial products. A majority of Pakistanis still live in rural areas and depend directly and indirectly on the agricultural sector for their means of livelihood.

Pakistan's GDP growth largely depends on the performance of its agricultural sector due to presence of strong backward and forward linkages (GoP, 2018). The agriculture sector has four sub-sectors namely, crops, livestock, fisheries and forestry. However, the livestock sector is a heavyweight within the agricultural sector, which contributes 58.9% to the agriculture sector's value added. The livestock sector's share in Pakistan's GDP is 11.1%, which is more than the combined share of crops, fisheries and forestry sectors (GoP, 2018). Gross value addition of the livestock sector has increased from PKR 1,327 billion in 2016-17 to PKR 1,377 billion in 2017-18, which translates to 3.8% growth in the value added of the livestock sector (SBP, 2018). Two major milk producing animals in the country are buffaloes and cows with 65.3% milk produced by buffaloes and 34.7% by cows.

Historically, smallholder and subsistence farmers dominate the livestock sector. They 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 previous governments had envisaged the role of the livestock sector in poverty alleviation and curbing disparities in incomes (GoP, 2014). Prime Minister Imran Khan has recently launched the Ehsaas program for poverty alleviation, which envisages a role for the livestock and dairy sector. However, we are yet to read further details of this program.

The study of Pakistan's modern dairy sector dates back to the pioneering work of Anjum et al. (1989) with subsequent contributions including those of Byerlee and Hussain (1992), Chaudhary et al. (1999), Iqbal and Ahmad (1999), Sarwar et al. (2002b), Garcia et al. (2003), Burki et al. (2004) and Fakhar and Walker (2006). More recent contributions include Jalil et al. (2009), Ahmad and Pasha (2009), Afzal (2007, 2008, 2010), FAO (2011), Jong (2013), Younas (2013), Burki and Khan (2011), Zuberi et al. (2016), Ansari et al. (2018) and Godfrey et al. (2018).

Iqbal and Ahmad provide evidence on milk yield gap indicating that productivity in the dairy sector of Pakistan is far below than its genetic potential. Their findings suggest that by overcoming the yield gap, milk production can go up by 50% to 100%. Fakhar and Walker (2006) provide rationale for the informal dairy sector, discuss the government policy support for the dairy sector and propose various dairy development projects for dairy development in the country. Afzal (2007, 2008) highlights the potential role of corporate dairy farms and examines challenges in the light of new policy initiatives for promotion of these farms. FAO (2011) evaluates the situation of Pakistan's dairy sector by providing in-depth analysis of the dairy value chain and argues that huge opportunities are available for donors, government and the private sector to invest in this sector for employment generation and poverty alleviation. The driving force for increased demand for processed milk and milk products comes from rising population and urbanization.

Burki and Khan (2011) study the impact of smallholder dairy farms' participation in the supply chain of the milk-processing industry and find that technical efficiency of the participating farms significantly improves relative to non-participating farms, especially farms located in remote areas and those maintaining large herd sizes.

Ansari et al. (2018) argue that even though the value chain of the milk-processing industry promoted a pro-nutrition value chain in the beginning, but more recently due to market conditions, it has drifted away from the broader goal of providing "affordable nutrient-dense food to consumers." They note that some non-dairy products having little or no nutritional value, e.g., tea creamers and dairy liquids, have taken center stage in their business model as low cost alternatives to cheap supplies of loose milk.

Godfrey et al. (2018) investigate whole farm profitability of smallholder agricultural households, based on data from irrigated and rain fed districts, to conclude that only 10% of the farms are profitable when opportunity cost of labor and capital is taken into account. However, when only cash costs are included, some 80 to 90% farms show positive gross margins. Other studies that have highlighted that many smallholder dairy farms are unprofitable in Pakistan include Garcia (2003) and Ahmad and Pasha (2009), among others.

In the light of this literature, new data and estimates, this report presents the achievements and constraints of the emerging dairy sector of Pakistan by examining the evolution of various facets of the dairy industry to diagnose its strengths and weaknesses and proposes policy options for various stakeholders.

A large majority of the dairy farms in Pakistan is subsistence (1 to 2 cattle/buffalo) or near subsistence (3 to 4 cattle/buffalo). Another major group maintains up to ten dairy animals. However, the researchers have rarely investigated the changing economic outlook of these dairy farms due to changes in the dairy policies. For example, dairy subsidies in advanced countries often lead to production of surplus milk quantities ending up in the global markets. If unchecked through regulatory/dumping duties, these surplus quantities put downward pressure on farm gate prices of fresh milk in the country. More recently, the large-scale import of skimmed milk powder (SMPs) and whey milk powder (WM) has directly influenced the demand and real price for fresh milk. Thus, there is a need to study the changing dynamics of smallholder dairy farms. What is the economic outlook of these dairy farms? The total factor productivity change in small dairy farms and its effect on economic outlook of the dairy sector is also unclear. What short-term and long-term policies can support the smallholder dairying is also uncertain? What repercussions seasonal variations in fodder availability have on farmers and how farmers can help alleviate these shortages? Does mechanization help medium and large dairy farms increase their profits?

The Livestock Development Policy 2007 was instrumental in attracting big business to establish modern and corporate dairy farms, however, its potential for vertical integration, economies of scale and more importantly the business model of purebred Holstein Frisian dairy farms are 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. Among other things, milk is an important source of calcium and vitamins effectively used to fight malnutrition. How these nutritional deficiencies affect productivity, GDP growth and other costs to society is largely unexplored. How improved nutrition affects school enrollment and child health outcomes is also mostly ambiguous.

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. The federal government has recently abolished zero rating sales tax and imposed reduced rate sales tax at 10% on goods whereas UHT and fat filled milk is exempt from the sales tax. The Pakistan Dairy Association demands restoration of the zero-rated regime and withdrawal of 10% sales tax on the pretext that the gap between UHT milk price and loose milk price has increased while the demand for processed milk has decreased. It raises the question whether or not the imposition of sales tax would be a better deal for the dairy processing industry. However, no simulation exercise is available at any level attempting to evaluate and find out answers to this critical policy issue for the milk processing industry.

This study attempts to answer these questions. The next chapter opens the discussion by presenting the profile of the dairy sector based on secondary data with focus on demand and supply of milk, growth in milk yield and the status of milk processing industry. Chapter 3 deals with feed and fodder for the dairy sector focusing on feed sources, economic value of fodder consumed, seasonal variations and ways and means to alleviate feed and fodder shortages. Chapter 4 tries to understand the changing outlook of small and large dairy farms based on primary survey data. In chapter 5, we present evidence on productivity growth in the smallholder dairy farms and propose measures to enhance productivity of the small dairy farms. Chapter 6 explores farm structure, practices and potential for vertical integration of large-scale modern and corporate dairy farms. This chapter also presents business model for a 1300 cattle purebred Holstein Frisian dairy farm, and compares it with 300 and 500 cattle dairy farms for presence of economies of scale. Moreover, it investigates why 100 cattle dairy farms in peri-urban areas of big cities are viable options, compared with very large modern dairy farms. Chapter 7 focuses on the economics of nutrition by surveying the costs of malnutrition on productivity/GDP growth, calculating the nature and extent of nutritional deficiencies by food poverty, evaluating the impact of malnutrition on school attendance and establishes a link between non-consumption of dairy products with malnutrition in under three children. Chapter 8 investigates the welfare implications of abolishing zero rated sales tax on dairy products and replacing it with a reduced rate sales tax of 10% on goods to find out if the new tax would be a better deal for the stakeholders. This chapter tries to figure out the incidence of new tax on packed milk and milk products in short-run and longer-run contexts. The last chapter is about the recommendations for the government, milk-processing industry and the modern and corporate dairy sector.

DAIRY SECTOR **PROFILE**

Establishing The Fact Base

2.1 Introduction

Historically, smallholder subsistence livestock farmers, who are spread all over Pakistan, meet their protein and nutritional needs from this sector, earn cash incomes on a daily or weekly basis and dominate the livestock sector. The previous government's "National Agenda of the Economic Development" envisaged the role of poverty alleviation and curbing disparities in incomes for the livestock sector (GoP, 2014). The new government of Pakistan Tahreek-e-Insaf (PTI) also wants to implement Ehsaas program for poverty alleviation with a role for the livestock and dairy sectors, but the details are not available yet.

Due to 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. 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, role of government policy in dairy sector development followed by some facts about the structure of Pakistan's milk processing industry.

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] Growth in livestock population and milk yields is responsible for faster growth in the livestock sector. 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 as constant, supply was overshooting demand. By contrast, rising trend in the real prices of dairy and livestock products in the country suggests otherwise. The following analysis highlights the discrepancy in the livestock census numbers.

Inter-census growth in cattle population was 45% in 2006, which is remarkably higher than 16% growth in the previous

[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.

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. However, 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	4,268	19	20
Total Animals	**90,891**	**110,250**	**142,858**	**21**	**30**

Source: Pakistan Economic Survey 2006-2007

Table 2.2 presents the distribution of livestock population by provinces 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.

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.

Table 2.2: Livestock Population By Provinces (In '000)

Location	Cattle	Buffaloes	Sheep	Goats	Camels
Pakistan	29,558.81	27,334.98	26,487.74	53,786.99	920.87
Punjab	14,412.32	17,747.47	6,361.77	19,831.04	198.96
Sindh	6,925.02	7,340.16	3,958.51	12,572.22	278.42
KPK	5,967.89	1,927.49	3,363.25	9,599.02	63.95
Balochistan	2,253.58	319.85	12,804.22	11,784.71	379.53

Source: Pakistan Livestock Census 2006

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 going down and the share of commercial dairy farms owning buffaloes is going up (Table 2.3). Unlike buffalo farms, the proportion of households owning up to 30 cattle has generally remained unchanged. Nevertheless, 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 post-2006 period due to growth of corporate dairy farms.[2] Yet no published data is available to substantiate this claim. To some extent, these incentives have helped to restructure local dairy industry; dozens of large modern dairy farms have been set up in Punjab and Sindh provinces where herd size range from few hundreds to few thousand cattle. We provide a detailed analysis of the modern dairy farming in the country in a separate chapter.

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

2.3 Milk Volumes, Productivity And Growth In Milk Yield

The Pakistan Livestock Census reports impressive growth in milk production in recent decades. Table 2.4 reveals that the highest recorded growth rate is in production of milk by cows increasing from 9.36 billion liters to 13.33 billion liters in 2006 over 1996, 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, 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
** Average annual lactation length of 250, 305 and 50 days was used for cows, buffaloes and goats, respectively to work out production of milk.*

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

Together, milk production of cows and buffaloes has increased by 35.6% (see Table 2.4) from 1996 to 2006, or 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. As noted above, this is consistent with the growth in large cattle farms. Over the years, buffaloes remain the largest contributors toward aggregate milk production, despite the decline in total milk yield from buffaloes.

Average milk yield per animal and 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, buffaloes contributed 58.01%, cows 37.53%, and goats only 4.45% of total milk production (from cows, buffaloes, and goats) per day.

Table 2.5: Average Milk Yield Per Animal And Total Milk Production Per Day

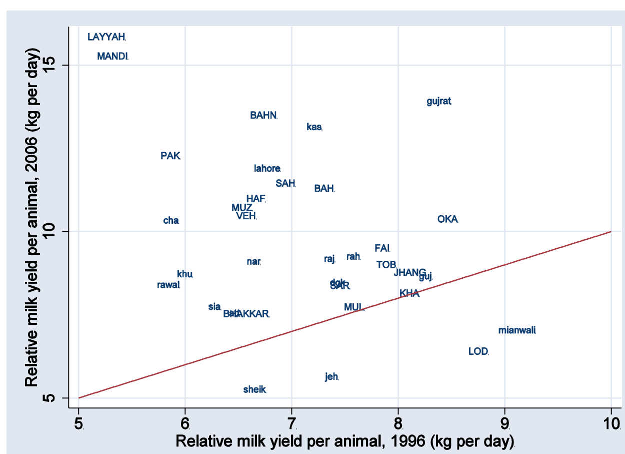
Administrative Unit	Average milk yield per animal per day (liters)			Production of milk per day (liters)			
	Cow	Buffaloes	Goats	Cows	Buffaloes	Goats	Total
Pakistan	6.14	7.93	1.42	53,093,388	82,061,310	6,293,093	141,447,791
KPK	5.08	7.28	1.33	9,538,051	5,883,543	1,593,859	17,015,453
Punjab	6.31	7.71	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

Figure 2.1 presents an inter-census comparison of milk yield per animal across Punjab districts. All districts that lie above the 45 line indicate relative improvement in milk yield over the two periods. Similarly, districts placed below the line show a decline in relative milk yield and those located on the line indicate no change in their milk yield per animal over the two 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 the districts of Mianwali, Lodhran, Jhelum and Sheikhupura. Average milk yield in Jhelum has declined from 7.5 kg to 5.5 kg and from 9 kg to 7 kg in Mianwali.

The most remarkable finding in Figure 2.1 is three times increase in relative milk yield in Layyah and Mandi Bahauddin going from nearly 5 kg per day in 1996 to around 15 kg 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. In addition, 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.

Figure 2.1: Relative Milk Yield In Punjab Districts, 1999 Vs. 2006



Source: Authors' calculations from the Census of Livestock, 2006

2.4 Per Capita Milk Consumption: Is There A Disparity?

The dairy industry often contests the supply side estimates of per capita milk consumption. 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 assume milk available for human consumption is equal to 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 proportion of milk for human consumption is fresh, boiled and packed milk while the rest is for commercial dairy products and industrial uses. The Agriculture Statistics of Pakistan 2010-11 notes that 55% of milk available for human consumption is in the form of 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 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]

Table 2.6: Per Capita Availability Of Milk From Supply Side (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 tons. 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). We obtained dry milk import data from the State Bank of Pakistan's website http://sbp.org.pk. One tons of dry milk equals 4 tons of liquid milk. We multiply values in tons with 1000 to convert them into kilograms. We multiple this to 0.96805 to convert milk from kilograms to liters.

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 are 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, 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-week recall basis. We extract data on household consumption of milk and its equivalent milk products.

[3] *http://timesofindia.indiatimes.com/city/vadodara/Indias-per-capita-milk-availability-above-world-average/articleshow/27301696.cms, accessed on 10 April 2019.*

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). Measurement errors in the two data sources explains the discrepancy in production and consumption data. It is not surprising because there are differences in the two data sources in terms of definitions, coverage and methods. However, this significant disparity needs rectification by the relevant quarters.

Per capita milk consumption also varies across rural and urban areas and 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 2.7: Per Capita Milk Consumption In Pakistan From Demand Side

Province	Average per capita consumption per day (liters)	
	2011-12	2013-14
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. To convert milk products to their milk equivalents conversion scales are used. 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.

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 KPK (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. The total milk market would come out to be 36.172 billion liters. (The Agriculture Statistics of Pakistan 2010-11 notes that of the milk available for human consumption, households consume 55% as fresh milk (GoP, 2011, Table 171))

Table 2.8: Disparity Between Demand And Supply Side Estimates Of Milk Production (Million Liters)

Herd Size	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	12,147	15,425	20,764	22,116	8,617	6691
Urban	3,911	5,160	--	--	--	--
Rural	8,236	10,265	--	--	--	--
Punjab	8,005	10,016	--	--	--	--
Sindh	2,390	3,178	--	--	--	--
KPK	1,143	1,573	--	--	--	--
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 from PSLM-HIES data using population weights of the respective regions. Estimates for FATA are average per capita consumption in KPK 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, subsistence farmers dominate the dairy sector of Pakistan. The undeveloped 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 intermediaries 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 who have also introduced credit schemes tailored for dairy production and marketing (Younas, 2013).

The milk collectors comprise of intermediaries known as dodhis. The rural milk collectors who operate at a small scale are katcha dodhis and the milk collectors who operate at a medium or large scale are 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. With 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 whereas the processed chain is a formal marketing chain. According to FAO (2011), informal chains sell almost 95 percent of the milk while the formal chains sell the rest. The main difference between the two supply chains lies in their handling and storage techniques used.

Rural Marketing Chain

In the rural supply chain, most of the milk produced is for domestic consumption and only surplus milk is available for selling. The collection and distribution system rests 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 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 intermediaries 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). They deliver this un-pasteurized and un-chilled milk 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. They sell most of the milk that reaches the milk shops in around 1 or 2 hours (Younas, 2013). Before taking the milk to urban milk shops, they take it to de-creamers and khoya makers for extraction of cream.

This traditional system of milk marketing has a very limited capacity to grow because it depends on a weak and undeveloped structure. Milk is of a perishable nature and dodhis buy it on 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 intermediaries 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 is the Ultra-High Temperature (UHT) process and pasteurized milk, tea creamers, ambient white 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 depends on a 6% fat content, where they pay price premiums for milk with higher fat content (FAO, 2011). They use a cold chain for bulking and transporting the milk. They transport milk from Farm Cooling Tanks (FCTs) via refrigerated tanks to the processing plants.

2.6 Structure Of Milk Processing Industry

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 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 intermediaries. 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.

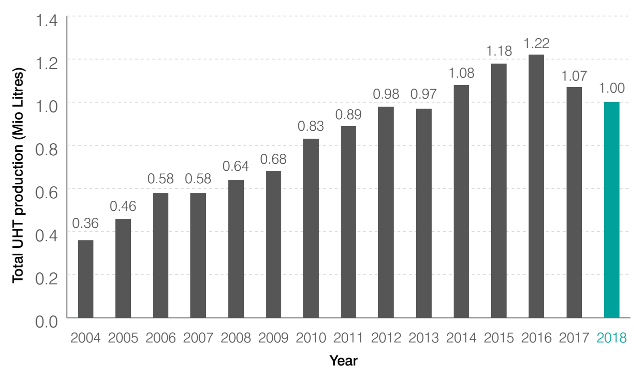
Efforts to increase the production of processed milk in Pakistan dates back to the sixties and the seventies when 23 milk pasteurization and sterilization plants were set up in major cities of the country (Anjum et al., 1989). These plants used, recombined, and pasteurized skim milk powder before selling 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 longer run.

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 2.2 shows that between 2004 and 2016 total UHT milk production has steadily increased from 0.36 billion liters to 1.22 billion liters before falling to one billion liters in 2018, or 18.3% decline. The initial increase in UHT milk production was due 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). The chain of delivery for fresh milk is multi-layered and unreliable in terms of quality. Dodhis purchase fresh milk from dairy farmers and sell it to other economic agents including households, shopkeepers, khoya makers, confectioners/ bakers, etc. (Jong, 2013). However, the quality control mechanisms are weak or non-existent due to which the intermediaries often adulterate fresh milk 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; 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.

Figure 2.2: Total UHT Milk Production



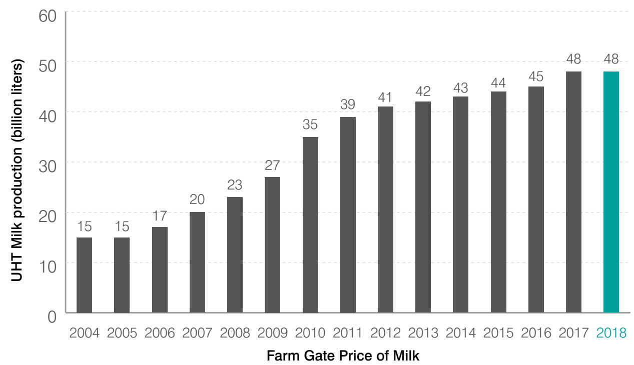
Source: Industry Sources

Two key factors may help explain the recent decline in UHT milk production. Firstly, there was negative media coverage of the processed milk in response to court cases in the Supreme Court of Pakistan dealing with the quality of the processed milk? Despite favorable decisions later, the negative sentiments created by the media hype did influence the demand for UHT milk. Secondly, the increasing popularity of non-dairy tea creamers introduced by the UHT milk manufacturers, which are a direct substitute of UHT milk for making tea, also affected the demand for UHT milk (Ansari et al., 2018). Since 2007, the milk processing industry has introduced tea creamers in powder and liquid forms to make tea/tea creaming. Separate brands of these tea whiteners are available for tea bags or mixed tea for brewing in teapots or saucepans. Tea creamers have 56% share in the packaged dairy category compared with 35% share of UHT milk (Nielsen Pakistan, 2016B). These vegetable fat-based liquids compete directly with fresh and UHT milk for tea creaming. Its attractive price range and wide availability has made tea whiteners as a fast growing segment making a serious dent to the demand for UHT milk.

Figure 2.3 shows that farm gate price of raw milk received by the dairy farms from milk processing companies has rapidly increased from PKR 14.5 in 2004 to PKR 34.6 per liter in 2010, or an annual increase of 23.1% in nominal terms, which translates to 5% annual increase in real terms (in 2007-08 prices). However, in post-2010 period, nominal farm gate price of raw milk increased gradually going from PKR 34.6 to only PKR 48.4 per liter or an annual rate of 4%, which comes to a decline in real terms of 2.3% per year (in constant 2007-08 prices).

Before the entry of milk-processing industry in collection of raw milk from rural areas, dodhis were able to bargain with dairy farmers and offer them lower prices for their milk to obtain a higher profit margin for themselves. The establishment of milk collection centers provided rural farmers the option of selling milk at milk collection centers in villages in order to try to obtain better farm gate prices (Jong, 2013).[4] With more players entering the market, buyer side competition pushed raw milk prices to go to higher levels. By 2010, there were more than 20 private milk processing companies competing to fetch farmer milk including global giant Nestle (Burki and Khan, 2011). However, in post-2010 period, due to falling international prices and no regulatory protection, there were large-scale imports of SMPs and WM (around 5000 tons of powdered milk per month), which directly affected the farm gate price of raw milk (for more details on SMP and WM imports, see Chapter 5).

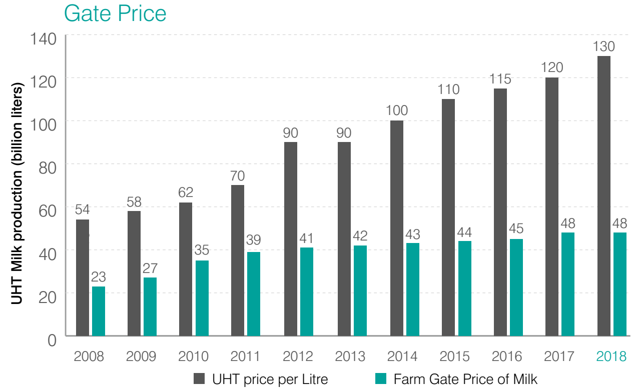
Figure 2.3: Farm Gate Price Of Raw Milk



Source: Industry Sources

Sarwar (2002b) suggests that the price of UHT milk is almost twice the price of raw milk in Pakistan. Figure 2.4 below presents a comparison of farm gate and UHT milk prices for the years 2008 to 2018 and shows that the same is not true of current data on Pakistan where the relationship between UHT and farm gate prices has changed over the years. The ratio of UHT and farm gate price of milk was 2.35 in 2008, which declined to 1.77 in 2010. However, this ratio has significantly increased since 2010 reaching 2.7 in 2018 confirming a declining trend in farm gate price of milk.

Figure 2.4: Comparison Of UHT Milk Price With Farm Gate Price



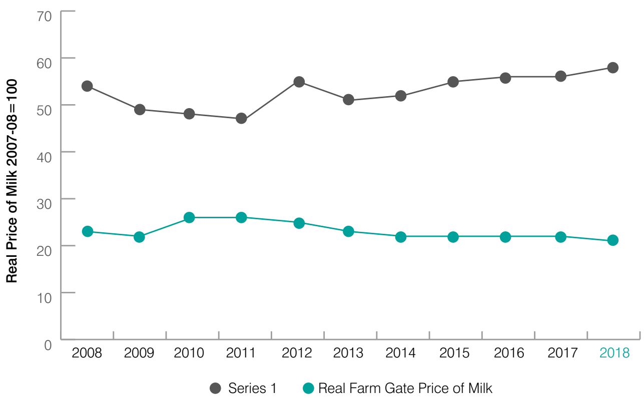
Source: Industry Sources

Figure 2.5 also mimics this trend indicating that in post-2010 period the gap between real UHT price and farm gate price has consistently increased because of increasing trend of UHT milk price and decreasing trend of farm gate price.

[4]This may not have necessarily increased 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). Therefore, 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).

Figure 2.5 also mimics this trend indicating that in post-2010 period the gap between real UHT price and farm gate price has consistently increased because of increasing trend of UHT milk price and decreasing trend of farm gate price.

Figure 2.5: Trend Of UHT And Farm Gate Price Of Milk (2007-08=100)



Source: Authors' calculations

Despite the growth of UHT milk processing industry, the processors are still not operating at their full capacity due to seasonal nature of the milk supply (Fakhar and Walker, 2006).[5] 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 FY 2015 was only 1.82 billion liters, or 58% of its full capacity.

For the milk-processing industry to thrive, capacity utilization issues need to be resolved. This is because lower capacity utilization imposes costs upon processors that are difficult to determine (Fakhar and Walker, 2006). The industry needs measures to increase supply of raw milk during lean periods. The 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, either the government 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).

2.6.1 Distribution Of Liquid Dairy Products

From consumer's perspective, milk consumption consists of four categories: loose milk, liquid tea whitener, UHT, and flavored milk. Nielsen Pakistan, 2016A shows that consumers either use one milk category exclusively, or use it in conjunction with one or more milk categories: 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).

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

A primary use of milk is 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[6], and third preference for making tea. Liquid tea whiteners are preferred more than UHT milk in the preparation of tea (Nielsen Pakistan, 2016A).

In the retail market, liquid dairy products (LDPs) have five categories: 1) UHT plain milk, 2) dairy beverages, 3) tea creamers, 4) high calcium low fat (HCLF) milk, and 5) flavored milk. Around 20% of total LDP sales volumes are concentrated in three major urban centers of Karachi, Lahore and Islamabad/Rawalpindi whereas only 25% of sales are 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 creaming has acquired the highest share in the packaged dairy category (56%), whereas the share of UHT milk is lower (35%). Flavored milk, dairy beverages, and high calcium low fat milk has remaining small market share.

[5] *"Production of milk falls to 55% of peak production at its lowest point in mid-June, while the demand increases 60% during this time compared to December when the milk supply is ample. The huge difference between lean and flush seasons is a significant problem. During the lean season, when the availability of the milk is very limited, the price goes up. During lean periods there is insufficient milk on the market and some of the processors have to close down their factories." (Jong, 2013)*

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

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 at 80% of total flavored milk sales, followed by Shakarganj at 8%, and Nestle at 5% (Nielsen Pakistan, 2016B).

2.7 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.[7]

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 cast of milkmen) colonies from cities like Lahore to the outskirts. Moreover, it recommended milk supply schemes for Karachi and Lahore on a pilot basis. Further, it suggested testing of milk for purity, delivery of pasteurized milk in sealed bottles via milk depots, and concentration of milk production in villages near the cities. In these villages "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 the shift in focus, the Government's Karachi milk supply scheme went into action in 1965, when subsidized milk were made available to low-income families and schoolchildren (Burki et al., 2004). A similar pilot project went into operation in Lahore in 1967. Due to lack of support from the successive governments, eventually both the projects were abandoned (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[8] 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 went out of business, or they 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, new projects came into being 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).[9] In 2005, the government initiated a 5-year long project called the Milk Collection,

---

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

[8]Supplies of skimmed milk powder came through the patronage of the World Food Program.

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

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). There was a launch of another project (known as the Prime Minister's Special Initiative for Livestock) 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 smallholders 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. Therefore, 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 is allowable to encourage foreign investment in this sector. The government also allowed import of high yielding animals, semen and embryos for crossbreeding (GoP, 2008). Local centers for embryo transfer and semen production were also set up with estimates suggesting that these centers would produce 5000 embryos per year 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.[10] The government continued to allow import of exotic animals, high quality feed, and dairy equipment in the following years (GoP, 2014).[11] Moreover, it is continuing to take steps to diagnose and control foot and mouth disease prevalent amongst livestock (GoP, 2015).[12] Nevertheless, the start-up infrastructure costs for such large-scale projects are extremely high. In fact, financial statements of these large dairy businesses report huge losses, raising questions on the long run feasibility of these projects.

2.8 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 raise 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 is unaccounted for in the system. Fourth, to strengthen the livestock and dairy sector, the government has adopted some tangible policy measures over the past 15 years. Four, real farm gate price of raw milk has increased until 2010 but declined ever since due to unfair competition with imported SMPs and WM. At the same time, real price of UHT milk has increased thereby widening the gap with real farm gate price of milk. Finally, the 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. 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.

[10]JK Dairies, Sapphire Dairies, and Al-Tahur Dairy Farm were the initial leaders.
[11]From July 2017 to February 2018, Pakistan imported approximately 768 thousand doses of semen and 9423 exotic dairy cattle of Holstein Frisian and jersey breeds for genetic improvement of indigenous dairy animals (GoP, 2018).

[12]Over the years, the government has introduced initiatives for animal immunization against prevalent diseases. Moreover, the government has implemented plans for improvement of animal's reproductive efficiency targets for both small-scale and large-scale dairy producers.

FEED AND FODDER **RESOURCES**

3.1 Introduction

Pakistan's economy is heavily dependent on livestock, which contributes significantly to the nation's gross domestic product.[13] 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 has four sections, which explore this topic in detail. Section 3.2 discusses the feed sources, practices, and technology used by the small, large and 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. Under fed or under nourished animals are likely to produce lower milk yield. Moreover, it also affects the quality of milk.

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.[14] 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, cottonseed, wheat flour, wheat dalia, gram flour and molasses are also fed to the animals along with fodder. Sometimes, grazing of animals in open fields also takes place.

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

---

[13]Recent figures show that the contribution of livestock amounts to 11.8% of national GDP and 56.3% of Agricultural GDP (GoP, 2015).

[14]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. Moreover, fodders planted in winter include barseem, oats, and rye grass. (Javed and Khan, n.d.)

feed their animals (Jong, 2013). Peri-urban farmers use green fodder supplemented by concentrates (Jong, 2013). Moreover, 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 depending on the weight of the animal, pregnant and lactating animals. Typically, feed requirement of an adult cow is one-third of its total body weight. For young calves, the feed requirement is equal to one-tenth of their total body weight (Awais and Choudhry, 2015). During pregnancy, it is optimal to feed the animal 2 kg of concentrate each day along with good quality fodder and to restrict straw from 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 homegrown 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 modern dairy farms are alarming. Media campaigns and extension services can help overcome this discrepancy, e.g., vocational training on animal requirements, availability of high quality indigenous sources of feed and optimal mixtures of ingredients. They also need to be trained on how to prepare silage from maize, sugarcane tops, oats, and Mott grass, etc. (Pasha, n.d.). Further, they need access to fodder reapers and mixer wagons to save time and 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, private market may emerge for equipment renting. However, in the interim period, efforts to promote demand for this equipment by providing awareness through training and extension services may also help. 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 And Its Cost Share In Dairy Operations

We compute the gross economic value of fodder consumed by dairy animals using data from the Agriculture Statistics of Pakistan and the Pakistan Economic Survey series for several years. Column 6 of Table 3.1 reports the gross value of fodder crops for dairy animals and other livestock.[15] It shows that the cultivated area of fodder crops has declined from approximately 23.6 million hectares in 2006 to 22.2 million hectares in 2014 before rising to 23.3 million hectares in 2018. Consequently, total fodder production has also fallen from 56.6 million tons in 2006 to 49.9 million tons in 2014 before increasing to 52.3 million tons in 2018. In spite of this, the gross value of fodder crops has more than doubled over the years; and with it, the total economic value of fodder consumed by dairy animals has risen consistently and increased by 126% between 2006 and 2018.

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.

[15] 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 adjust individual fodder consumptions. Next, these weighted fodder consumptions were added, first for only dairy animals, and then for all animals. To obtain gross value of fodder for dairy animals, we multiply the ratio of weighted fodder consumption of dairy animals to all animals with gross value of fodder crops.

Table 3.1: Total Value Or Cost Of Fodder Consumed By Dairy Animals

Year	Total cropped area (million hectares	Gross value of all crops (PKR million)	Fodder cropped area (million hectares)	Total fodder production (million tons)	Gross value of fodder crops (PKR million)	Gross value of fodder for dairy animals (PKR million)
	(1)	(2)	(3)	(4)	(5)	(6)
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	50.746	100,537	42,172
2012-13	22.560	2,192,553	2.211	50.681	104,598	43,895
2013-14	22.160	2,625,223	2.224	49.881	129,723	54,459
2014-15	23.270	2,690,102	2.226	52.328	130,632	55,481
2015-16	23.670	2,620,390	2.376	53.254	128,365	54,203
2016-17	23.250	2,821,392	2.418	52.296	137,609	58,107
2017-18	23.250	2,981,340	2.375	52.302	145,729	61,536

Source: Authors' calculations from Agriculture Statistics of Pakistan (GoP, 2018) and Pakistan Economic Survey (GoP, 2018).
Note: We report all values 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. We compute area cultivated with fodder crops by first calculating the ratio of fodder cropped area to total cropped area for the available years and then use moving average to determine this ratio for the remaining years. We then use these ratios along with the respective years' total cropped area to calculate the area cultivated by fodder crops for the years with missing data. Similarly, we fill missing values for total fodder production 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, we calculate missing values for the gross value of fodder crops 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. We use these ratios 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 small dairy farms, cost share of fodder in dairy farm operations is as high as 47.55% excluding family labor, 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, including family labor provides 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 small 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

Source: Pakistan Economic Survey 2006-2007

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 until 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 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 the policy makers take measures 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 farmers utilize all year round that can help alleviate variations in fodder availability.[16] Even so, animals have specific feed requirements. For instance, animals needs approximately 26-28% dry matter in their feed (Awais and Choudhry, 2015). Including maize in their feed can fulfill this requirement. 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. There are two ways to overcome this difficulty.

Firstly, during its peak season, the farmers can directly feed maize to their animals and can conserve their maize stocks 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.[17]

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

[17]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 free. Even if the maize stocks are freely obtainable, the farmers might still incur collection and transportation charges; however, these costs are usually nominal.

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.[18]

Essentially, better crop management and fodder storage can help farmers reduce fodder costs significantly.[19] Firstly, farmers need awareness of the possible measures which they can take to alleviate fodder shortages. Secondly, they need 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 cost in total input cost is high, measures to reduce fodder cost will significantly reduce cost of milk production.

3.5 Conclusion

In sum seasonal variations in fodder availability affect subsistence and small-scale farms 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 milk production costs to 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 is to increase farm profitability. Farmers need awareness of the different ways in which they can alleviate fodder shortages and reduce fodder costs. They need to be trained how to prepare 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, tangible efforts are required 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.

[18] *Summertime or Kharif fodders contain less protein, which helps animals counter the adverse effects of high temperatures; similarly, wintertime or Rabi fodders have a higher protein content that helps animals endure cold climates (Javed and Khan, n.d.).*

[19] *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 PKR 2,774 million (5% of PKR 55,481 million) in 2014 (see Table 3.1).*

CHANGING DYNAMICS AND OUTLOOK: **SMALL AND LARGE FARMS**

4.1 Introduction

Pakistan has around 6.8 million dairy households, but more than 95% of them are subsistence or small-scale dairy farms with holdings of 1 – 9 dairy cattle or buffaloes. The rest 5% of the dairy farms keep 20% of the dairy cows and buffaloes with farm sizes ranging from 10 to 100 with very few dairy farms exceeding 100 dairy animals. The informal sector handles around 96% of the total milk produced in the country for consumption within the households, for collection by the informal milk agents or intermediaries known as *dodhis* and for selling to consumers or milk shops without treatment. The share of treated milk marketed by the dairy processing companies has only 4% share of the total milk produced in the country.

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 were the only players playing the role of intermediaries 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 PKR 3.03 in 1976-77, increased to only PKR 7.71 in 1990-91; in real terms, the price fell from PKR 13.42 in 1976-77 to PKR 11.88 in 1994-95 prices (Burki et al, 2004).

With burgeoning urbanization, income growth and cities growing in size, the demand for milk in urban areas has rapidly increased, which, in turn, has promoted collection of fresh milk and its treatment and marketing by large and small dairy milk processing companies.[20] The milk processing industry has gradually built up fresh milk supply chain 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 (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, milk collection centers, chilling units, among others.

[20] *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 highlighted the potential of this sector.*

The changing dynamics and outlook of the dairy farms in general and the competitiveness of the large dairy farms in particular is a neglected area of research. This chapter tries to understand the changing dynamics of the smallholder dairy sector by focusing on the economic outlook of these dairy farms. To conduct an in-depth analysis of the dairy sector, the authors conducted two rounds of LUMS Survey of Dairy Households in Rural Punjab in 2005 and 2014. A representative sample of 800 dairy farms was drawn from 10 districts. However, due to attrition, the sample size dropped to 725 in second round.

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 much better than other districts. While the dairy sector has experienced marked changes over the last decade, no systematic evidence is available to explore the dynamics of change.

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. Finally, we present economic outlook and competitiveness of the larger dairy farms in the context of mechanization and relative profitability measured by operating profit.

4.2 Survey Of Dairy Farms In Rural Punjab

The Census of Livestock is a primary source of data on the livestock and dairy sector in the country, conducted after a gap of 10 years by the Pakistan Bureau of Statistics (PBS), Statistics Division of the Government of Pakistan. The census data of 1986, 1996 and 2006 is available; however, the data of 2016 census is not publicly available yet. The census provides data on livestock composition and the livestock units. The other important source of data on the livestock 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. To conduct the analysis, a representative sample of dairy farms from rural Punjab was drawn. 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 picked 10 districts (two districts from each agro-climatic zone) from 34 districts of Punjab. The sample districts were Hafizabad, Narowal in wheat-rice zone, Sargodha, 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, we use mouza/village as basic geographical unit due to its convenient and divisible nature.[21] We randomly draw four mouzas/villages 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, we conduct a census of each village for listing of commercial dairy farmers. Based on these lists, we randomly select 20 dairy farms from each village with equal probability. For non-response, we select five replacement dairy households from each village from selected dairy households. Of the 800 dairy households sampled, we draw a sample of 160 dairy households from each agro-climatic zone, 10 districts and 40 villages.

4.2.2 Survey Rounds

We conducted two survey rounds to collect data. We conducted Round one survey in 2006 to collect data for the calendar year 2005 while we conducted Round two in 2015 to collect information for the calendar year 2014.[22] We conducted Round one survey from January to April 2006 while we conducted Round two survey from January to May 2015. In Round one, all 800 dairy farms were interviewed, but when they were approached after a gap of 9 years for Round two 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 households surveyed in both survey rounds, which leaves us with a balanced panel of 725 dairy households.

4.2.3 Distribution Of Sample Respondents

Table 4.1 presents the list of sample villages covered in the survey 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.

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
Jehlum	Chak Mahmand; Hatia Dhamial; Khurd; Hiranpur
Attock	Kasran; Mathyan; Attock Khurd; Gee Kasran

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

[21] 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.

[22] A three-member team of professional enumerators carried out the survey of both rounds. The enumerators had 14 to 16 years of schooling in humanities and social sciences and possessed 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. To ascertain that the enumerators clearly understand the questions and the procedure of conducting the sample survey, the authors organized a one-day orientation session. We revised the questionnaire after its pre-testing in second week of December 2005. We conducted a second orientation session of two-hour duration 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. Detailed interviews with dairy farmers took place during January 2006 to April 2006.

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
Jehlum	64	
Attock	67	
Total	**725**	**725**

Source: Pakistan Economic Survey 2006-2007

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)[23] to measure prevalence of depression in the dairy farmers. We administered the survey questionnaire to collect information on various attributes of commercial dairy farms. The data collected includes household head, personal characteristics of household members, dairy production, marketing of milk, information on dairy animals and livestock. The data also includes 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. The enumerators obtained this information 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 Smallholder Dairy Farms

We evaluate the changing dynamics of smallholder dairy farms 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 surveyed in both 2005 and 2014 with an attrition rate of 9.4%.

4.3.1 Change In Distribution Of Dairy Farms By Herd Size And By Farm Type

Figure 4.1 and Table 4.3 present a distribution of sample dairy households in 2005 and 2014 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

[23] *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 10th April 2019.*

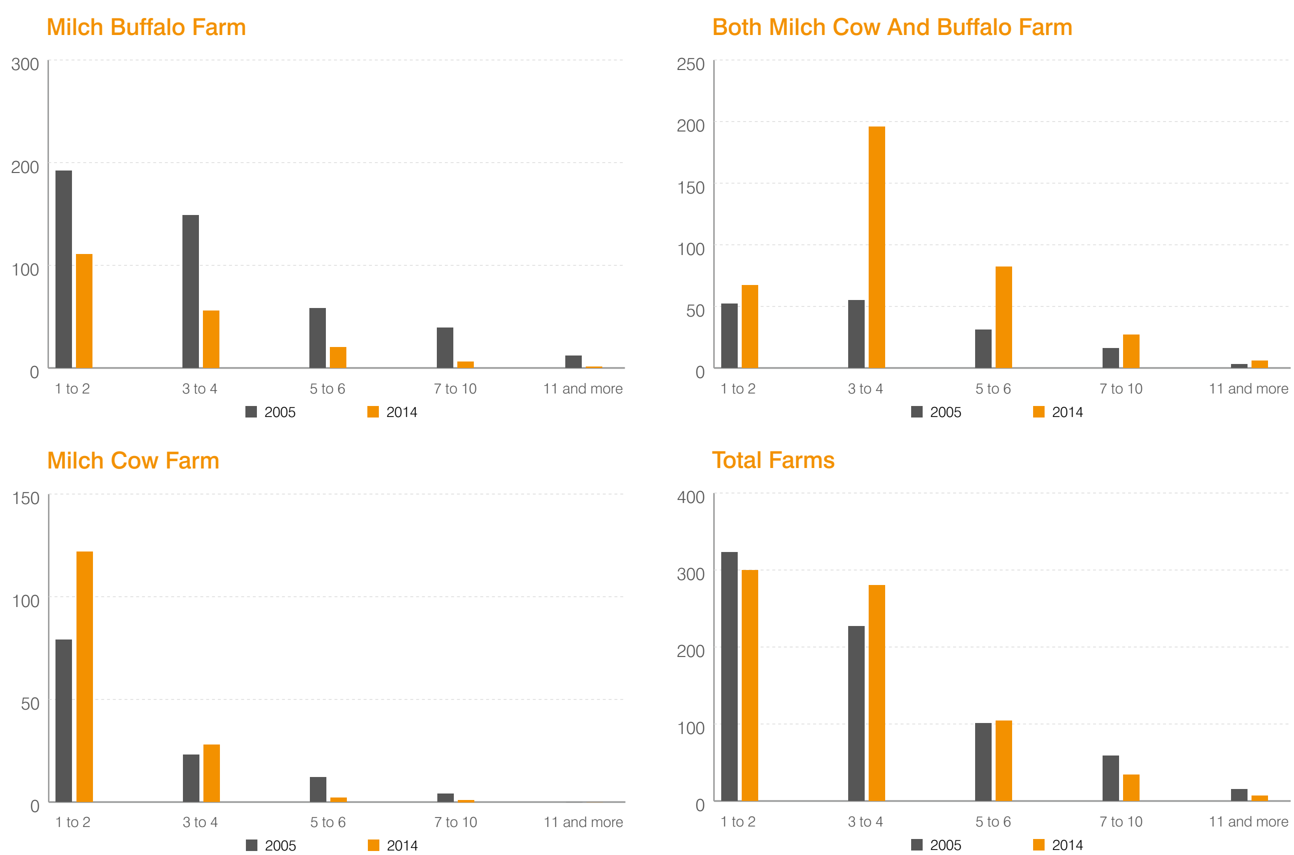
maintained more than four dairy animals and their proportion has decreased from 24% to 20% in the same period.[24]

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 have 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, we found the most dramatic increase 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 of subsistence farms have declined by 7% 2014 over 2005 while the number of near subsistence farms have 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 number of dairy farms owned by landless households and those who own up to 12.5 acres of land have increased while the number 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).

Figure 4.1: Distribution Of Dairy Households By Herd-Size And Farm Type



[24] *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.*

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 (2005)	**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

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 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. The milk processing industry was not present in three of the sampled districts, namely Narowal, Jhelum and Attock in both 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 Smallholders: 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, we define returns to family farms as $RFF = TR - TVC - \bar{R}$ where *RFF* depicts returns to family farms, *TR* is total revenue, *TVC* is total variable cost and $\bar{R}$ 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 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. We work out the cost of shed & structure capital by taking the opportunity cost; cost of animal capital is the user cost worked out based on 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. We based our calculation of revenue from milk and farmyard manure on the actual sale price reported in the survey, or based on the prevailing market prices in the area. We determine the value of capital gain on milch animals based on 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 & structure capital, animal cost, fodders, straw & concentrate and hired labor, average real returns per dairy farm increased by 145% (i.e., from PKR 37,652 in 2005 to PKR 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., PKR 14,638 and PKR 57,337 in 2005 and 2014, respectively), the returns decline to only 12.4% (i.e., PKR 23,499 and PKR 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 PKR 9,303 in 2005 to PKR 27,559 in 2014 or a 22% increase per annum. Real returns per 40 kg of milk increased by 308% in 2014 over 2005 (or 34% per annum) going from only PKR 172 per 40 kg in 2005 to PKR 702 per 40 kg 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 4.6: 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 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: We used CPI to convert 2005 numbers into 2014-15 prices.

Table 4.7 suggests that returns to dairy farms have witnessed marked changes overtime and that returns to farms vary by herd size. Largely females manage subsistence dairy farms (1 – 2 animals) with family labor by feeding animals by grazing, grasses and roughages. However, the involvement of men 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 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 4.7: Returns To Dairy Farms By Herd Size (In PKR)

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	92,356	89,909	96,302	103,682	129,618
Cost per milch cow/buffalo	58,819	66,606	74,620	80,128	86,190
Returns per milch cow/buffalo	33,536	23,303	21,682	23,554	43,428
%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, 2015 & 2014
Note: We used CPI to convert 2005 numbers into 2014-15 prices.

Table 4.8 presents returns to dairy farms by mode of selling milk. Farmers earned 32% more returns in 2005 by selling to milk processors as compared with dodhis and other agents operating in the informal sector.[25] 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, i.e., PKR 25,638 versus PKR 28,791. We noted above that average return per animal in the entire sample is PKR 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 PKR 23,046; the average return to those who sell milk to processors is PKR 25,638; and the average return to those who sell milk to other agents is PKR 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 the processing units and 57% more than dodhis.

Table 4.8: Returns To Dairy Farms By Mode Of Selling Milk (In PKR)

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%

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

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: We used CPI to convert 2005 numbers into 2014-15 prices.

Next, we turn to compare returns per dairy animal with returns on per acre of some major crops. To make returns on major crops comparable with the returns on dairy animals, we convert these crops into annualized combinations based on the length of time they occupy land (see Table 4.9 for a break-up of costs and revenues on major crops in 2014. In Table 4.10, we note that returns per dairy animal are significantly higher than per acre of wheat and coarse rice, but are significantly lower than returns on other major crop combinations, e.g., sugarcane that is a year round crop, wheat-basmati rice and wheat-cotton.

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

4.5 Dairy Farm Competitiveness & Impact Of Mechanization On Profitability?[26]

4.5.1 Introduction

Pakistan is the third largest milk producing country in the world, after India and the USA, with a total milk volume of roughly 46 million tons standardised milk (4% fat and 3.3% protein). The milk production is strongly seasonal with a production about 40% higher in the cool winter months compared to the summer. The production system on most small-farms is simple and based on manual labour. However, larger farms (farms with 10 cows and more) tend to be more progressive and use more machinery, especially in feeding/fodder production and milking. So far, there is little knowledge about the competitiveness of Pakistani dairy farms in general, and about the influence of mechanisation on the profitability of these farms. Therefore, we carried out a special study. We collected economic data on six farms, differing in farm size (three different sizes in total) and the level of mechanisation (low or high). The data was analysed with a special focus on mechanisation. We present the most important economic indicators and results below.

4.5.2 Overview Of The Selected Control And Treatment Farms

The farms: We visited six different farms in Punjab province. They were of three different sizes: 10 cows, 25 cows, and 100 cows. For each size, we selected two farms: a farm without mechanisation, this was marked as a control farm ("ctrl"), and a farm with mechanisation, marked as treatment farm ("trt"). The farms were "typical" in the sense that their production and feeding system represented the most common system within their respective category. Table 4.11 presents a short overview of the farms and some of the key indicators where the data refers to calendar year 2017.

Type of mechanisation: The focus of this analysis is on dairy competitiveness when looking at the level of mechanisation on the dairy farm. We identified two main areas of possible mechanisation: the milking system and the feeding system including growing, harvesting and fodder preparation. Table 4.12 and Table 4.13 present different levels from "no mechanisation" to "highly mechanised". Besides, the status of the control and treatment farms and the next development steps of the treatment farms are also marked in the tables.

[26]Dorothee Boelling (Dorothee.boelling@ifcndairy.org) of the IFCN AG, Kiel, Germany wrote this section based on data collected by the authors; the analysis relies on TIPI-CAL simulation model. Torsten Hemme of IFCN AG originally created and developed this model.

Table 4.11: Overview Of The Selected Farms In Calendar Year 2017

	PK-10-ctrl	PK-25-ctrl	PK-100-ctrl	PK-10-trt	PK-25-trt	PK-100-trt
Production system	Free stall barn	Free stall barn	Free stall barn	Free stall barn	Free stall barn	Free stall barn
Number of cows	10	25	100	10	25	100
Breed	Jersey cross	Sahiwal or Friesian or Jersey cross	Friesian cross	Friesian cross	Sahiwal or Jersey or Friesian cross	Friesian + Friesian cross
Land, for dairy (ha)	3.5	9.1	37.9	1.8	6.8	42.3
Labour for dairy (number)	3.6	6.7	25	2.5	4	20
Milk yield (kg/year)	3450	3350	3650	4200	5050	7300
Milk production (t/farm)	34	83	366	39	126	732
Replacement rate (%)	15%	26%	30%	13%	26%	30%
Milking system	By hand	By hand	By hand	Bucket/parlour	Bucket/parlour	Bucket/parlour
Age at first calving (months)	31	30	30	28	28	27

Table 4.12: Mechanisation Level Of Milking Systems

	Type of milking	Status
1	Hand milking	Control farms
2	Bucket milking (in parlour), no cooling	Treatment farms
3	Bucket milking (in parlour), vat + milk cooling	Next steps treatment farms
4	Pipeline milking into vat, milk cooling	
5	(Herringbone) parlour, vat + milk cooling	
6	Rotary parlour, vat + milk cooling	
7	Robot milking, vat + milk cooling	

Note: 3 x milking practised for high-yielding cows (>20 kg milk) on some treatment farms.

Table 4.13: Mechanisation Levels Of Feeding Systems

	Type of milking	Status
1	Grazing, grasses, herbs + crop residues according to season	
2	Chopped green fodder, crop residues + wanda, according to season	Control farms
3	Maize silage + wanda + additives throughout the year	Treatment farms
4	Maize silage + wanda (ingredients clearly specified) + additives throughout the year tailored to the cows' needs	Next steps treatment farms
5	Total mixed ration of silage, roughage, concentrates and additives exactly tailored to the cow's needs	

4.5.3 Key Findings From The Data Of Treatment And Control Farms

Figure 4.2 shows total cost of the dairy enterprise in relation to total returns of the dairy enterprise, including milk and non-milk returns (mainly cattle return). The costs of the dairy enterprise consist of cash cost, depreciation and opportunity costs.

Milk price is an average of the complete time-period under investigation, excluding taxes (if applicable) and adjusted to solid corrected milk (SCM), i.e., we adjust the milk yield to 4% fat and 3.3% protein. Therefore, milk yield increases for high content milk (as seen in Jerseys and especially in buffaloes) and decreases for low content milk (as often seen in Holstein Friesian cows in hot climates). This correction guarantees that the indicator (100 kg milk) is the same and thus allows for a meaningful comparison between different farms or breeds.

Generally, total costs are higher on control farms. In addition, milk price is lower, i.e., the farmers on control farms do not manage to sell milk for same price as the mechanised farms. When comparing total returns and total costs we find that total returns do not even cover the cash costs on the smallest control farm (PK-10ctrl). On two other control farms, total costs are more or less covered. On the treatment farms, all costs are covered and the two largest farms make profits.

In Figure 4.3, the returns to dairy enterprise comprise milk returns, cattle return, other returns, e.g., for manure or surplus feed. The milk price is around PKR 5,000 for standardised milk on the control farms, and thus higher than on the control farms. Cattle returns, mainly for cull cows and sold calves, are roughly at the same level per 100 kg standardised milk for both groups of farms. Control farms gain an additional income by selling manure – not practised on the treatment farms because they use manure as fertiliser on the fields and plan to establish a small biogas plant for gas (electricity) production in the future.

The cost of milk production only shows the costs for producing milk exclusively. In order to obtain a cost that can be associated with milk price, we deduct non-milk returns from total cost. We assume that the cost of non-milk returns is the value of returns themselves. Based on these calculations, the cost of milk production will only increase with higher input costs and will decrease with non-milk returns (cattle return, manure sales, etc.). As we express

Figure 4.2: Total Cost And Return Of The Dairy Enterprise

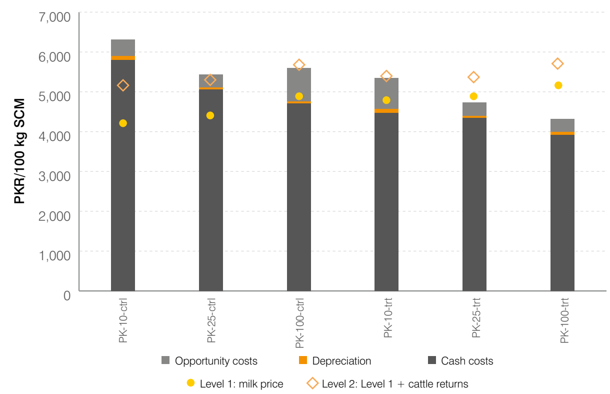


Figure 4.3: Total Revenue On Control And Treatment Farms

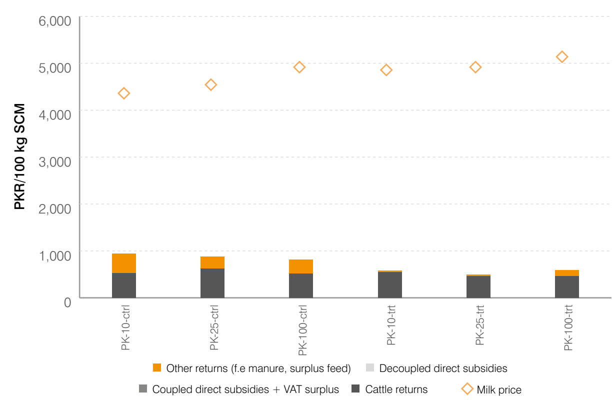
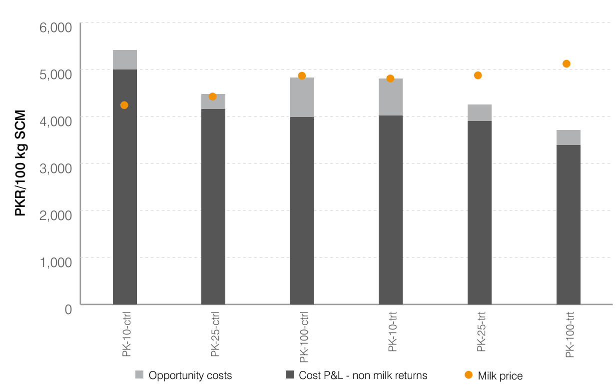


Figure 4.4: Cost Of Milk Production Only



costs per 100 kg standardised milk, an increasing milk yield will lead to lower costs, ceteris paribus. The entrepreneur's profit equals a deduction of the cost of milk production only from the milk price.

Figure 4.4 shows that cost of milk production only varies between approximately PKR 3,900 and PKR 5,400 per 100 kg milk. As shown above, the milk price does not cover cash costs on small control farm. All the treatment farms manage to make an entrepreneur's profit. This profit increases with increasing farm size, showing economies of scale.

We examine in more detail the most important cost factors, i.e. labour, land, and feed. Figure 4.5 shows labour cost per 100kg milk. The cost is split in wages paid to the employees and opportunity costs for own (family) labour. We consider opportunity cost as potential income of farm-owned production factors in alternative uses. For unpaid family labour, the average wage rate for hired labour substituting the family labour is used.

Labour costs are roughly twice as high on the control farms as on the treatment farms. As treatment farms had a higher level of mechanisation, substituting labour with machinery, this result was to be expected. Labour costs are a function of wage rate per hour and labour productivity per hour. The wage rates are on the same level on the control farms and smallest treatment farm but increasing on larger treatment farms. As these farms use more machinery, the employees treatment farms.

Land costs can be analysed in a similar way. They are roughly at the same level for the control farms, but only half of that for the treatment farms (Figure 4.6). All farms have both rented and own land. Opportunity costs for own land is calculated by using the common rent prices. Corresponding to labour costs, land costs are also a function of the level of land rent and land productivity. Land rent is more or less the same on all the example farms. Land productivity, i.e. the amount of fodder grown on the land to produce a certain amount of milk, varies slightly between 13,000 and 18,000 kg milk equivalents on the farms. The difference in total land costs as shown in Figure 4.6 to the left results mainly from different land holdings. The control farms own more land and produce a higher share of total fodder needed on farm, whereas the treatment farms do not own or rent much land and purchase more fodder.

Figure 4.5: Labor Costs, Wages And Labor Productivity

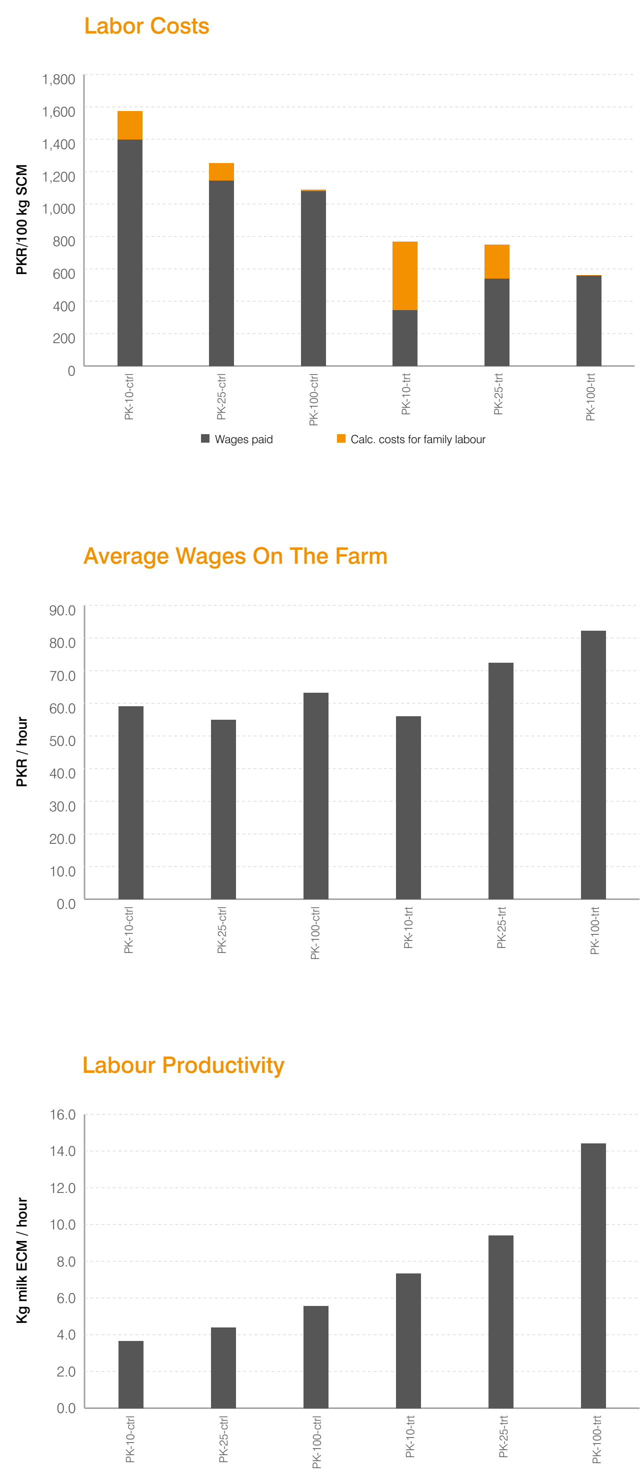
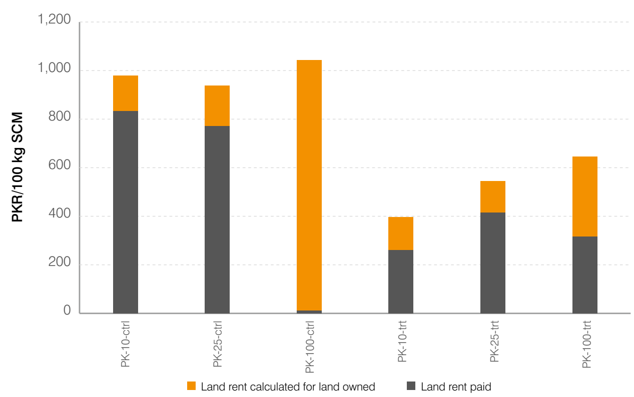
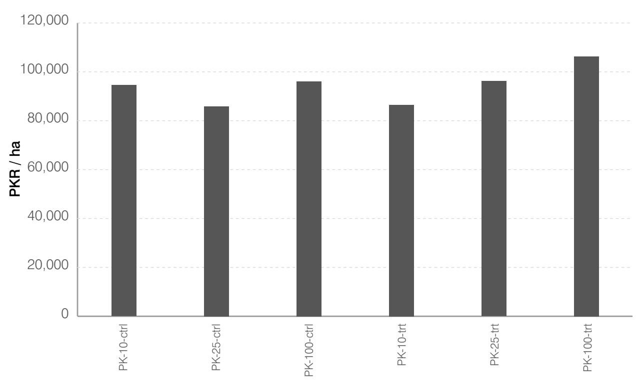


Figure 4.6: Land Cost, Land Rent And Land Productivity

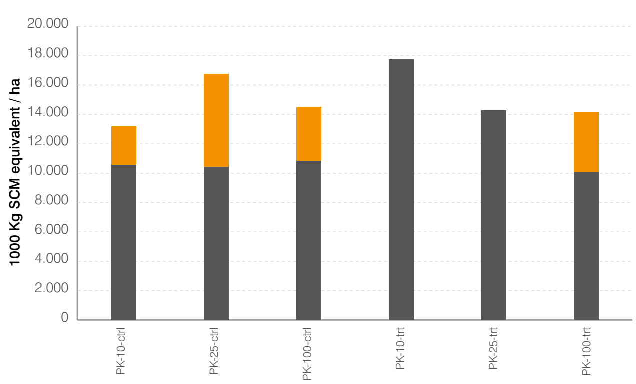
Land Costs



Level Of Land Rent



Land Productivity (Homegrown Feed)



Feed costs make up the highest share of the total costs and therefore we show them in more detail. Feed, especially compound feed and minerals or additives, is purchased or home-grown. Figure 4.7 shows the cost for home-grown feed production, i.e., the costs for seeds, fertiliser, pesticides, but also the costs for land, labour, machinery and so on. As mentioned above, the treatment farms purchase not only concentrates and minerals, but also maize for silage making, thus their share of purchased fodder is higher than the control farms. Consequently, the costs of home-grown feed are lower. Total feed costs are similar on the treatment farms and smallest control farm, but clearly lower on the larger mechanised farms. This is mainly due to higher milk yield on these two farms as the fixed amount of fodder for maintenance and for young stock spreads over a larger amount of milk.

Figure 4.7: Costs For Home-grown Feed Production

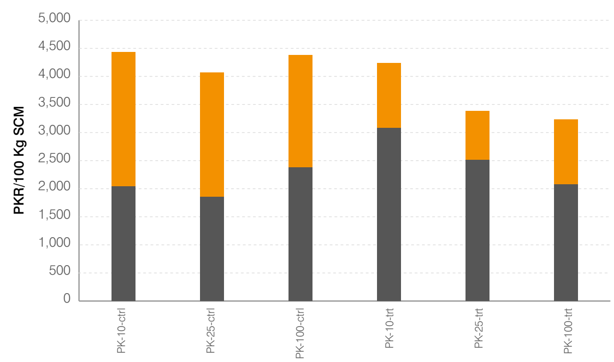
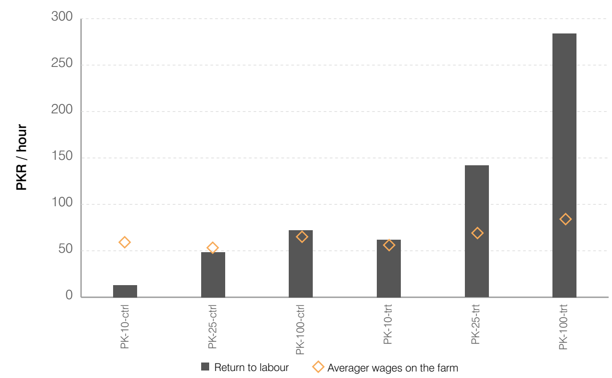


Figure 4.8 presents a more detailed analysis of total costs and the remaining cost factors. As discussed above, costs for purchased feed and inputs for fodder production (seeds, fertiliser, and pesticides) have the highest share in total costs. Land and labour make up the next largest cost items. They are of similar magnitude and larger for the control farms than for the mechanised farms. Veterinary, medicine, and insemination costs are generally higher on the control farms, mainly due to the lower milk yield and thus higher share per 100 kg milk. The machinery costs consist of costs for maintenance, depreciation, contractor and leasing. The costs per 100 kg milk do not differ that much, but as the cows on the treatment farms have a higher milk yield, the machinery costs are higher in absolute terms or per dairy cows on these farms.

Figure 4.8: Bifurcation Of Cost By Components

Figure 4.9: Returns To Labor



Another way of looking at the profitability of a dairy farm is the calculation of return to labour. This indicator shows the level of profit a farm worker (employee or farmer) generates per hour of work on the farm. We calculated this as sum of the entrepreneur's profit, wages for hired labour and opportunity cost for family labour, divided by total hours of labour used for the dairy enterprise. Average wages on the farm represent gross salary plus social fees (insurance, taxes, etc.) the employer has to cover.

We have already presented and discussed the wage rates above. The return to labour is low on small control farm, i.e., the wage rate is about three times as high as the return on one hour of labour invested on the farm. For larger control farms and the smallest treatment farm, the wage rates and returns are more or less at the same level, so the farmers make the same amount of money, as they have to pay for one hour of labour. Two large mechanised farms clearly made profit as their wage rates were much lower than the returns produced on one hour of labour.

4.5.5 Marketing Of Milk

As mentioned above, Pakistan is the third largest dairy producer in the world with a production of nearly 46 million tons standardised milk in 2017. Pakistan is also a country with a high share of informal milk. The dairy processors collect and process only 3% of the total milk produced in the country. The huge majority of milk trade takes place informally either by the farmer himself or by intermediaries, so called "dodhi". Table 4.14 shows the characteristics of the different ways to market milk.

The treatment farms manage to receive a higher milk price than the control farms. Their milk is of a higher quality due to machine milking and the farm owners manage to sell their milk at favourable conditions, mainly to an intermediary.

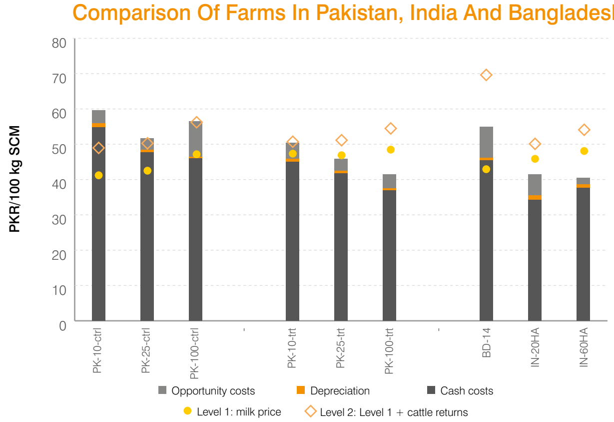
The IFCN collected and analysed similar data in Bangladesh and India. In Bangladesh, the farm owned 14 dairy cows and practised a production system with hand milking, fresh green and crop residues, like the control farms in Pakistan. The two farms in the north of India (Haryana) milked 20 and 60 cows, respectively, and were more mechanised. As shown in Figure 4.10, the costs of Bangladeshi farm were in line with the production costs of the control farms in Pakistan, whereas the larger treatment farms and the Indian farms expressed similar costs. The milk prices resembled each other correspondingly.

Table 4.14: Characteristics Of Different Ways To Market Milk

Own marketing (informal sector)	Middlemen – dodhi (informal sector)	Dairy Processor (formal sector)
Relatively high price (?)	High price	Low price
Milk is consumed in the family or sold to neighbours	Milk is fetched directly after milking	Milk is fetched directly after milking
Milk is not cooled	No storage of milk necessary on the farm	No storage of milk necessary on the farm
For a farm with several cows, selling and marketing of the milk take time	Middlemen might care about milk quality (?)	Milk is processed and treated
No quality guarantee	Milk is sold to shops + consumers without any treatment	Certain quality guarantee for consumer
Imagine government regulations on milk quality		
Still possible for small household farms	Difficult to exist in the long run	Advantage of and future for dairy processors

We detect clear differences for the cattle returns. Beef prices are relatively high in Bangladesh, resulting in high returns per 100 kg milk and thus contributing considerably to the high profitability of the dairy farm. On the contrary, cattle returns are low in India due to the special role of the cow in the Indian culture, and thus they hardly contribute to the farm income.

Figure 4.10: Looking Across Borders: Comparison Of Farms In Pakistan, India And Bangladesh



In sum, the mechanised farms showed a clear cost advantage over control farms. The owner/farmers of mechanised farms are highly dedicated who take direct interest in their farm. They dream big and want to expand their herds substantially. Mechanisation and expansions takes place without taking any bank loans but carried out gradually with personal funds. The mechanised farms do not necessarily have much land. They plan either to rent-in or to buy land, or to purchase fodder (maize for silage making) from the market. Mechanisation is also seen/experienced as a way to improve product quality: silage increases feed quality and availability throughout the year and thus milk yield while milking machines ensure high milk quality. A higher level of mechanisation on dairy farms requires (a) skilled farm managers/owners; (b) good infrastructure; (c) availability of farm machinery and milk cooling/storage; (d) possibly access to bank loans; and (e) less, but higher skilled employees.

The profitability of a dairy farm is not only dependent on the cost level, but also on the returns. The milk price realised by the farms varied, depending on whether the milk market is informal or formal, i.e. collected by a dairy processor. Currently, the informal sector achieves a higher milk price at the farm gate than the formal sector and thus contributes to higher profitability. However, highly mechanised farms will eventually have a higher milk output, which intermediaries may or may not be able to handle. If the informal sector cannot handle it, then the formal sector may have to play a greater role. Therefore, the development of farm mechanisation and the development of the formal dairy sector (the value chain) may concurrently move forward.

4.6 Conclusions

This chapter was an attempt to evaluate the dynamics of the smallholder dairy producers in a changing environment and to explore the impact of farm mechanization on profitability of large dairy farms.

The first general insight of this chapter, based on 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. The increasing cost of dairy inputs overtime explains this, which has made buffaloes 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 PKR 37652 in 2005 to PKR 92161 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 40 kg of milk are also impressive, excluding cost of family labor; however, it presents a dismal picture when we also take into account cost of family labor. We also note that in 2005, returns (excluding cost of family labor) to dairy farms who were selling 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 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.

Finally, the analysis based on three treatment and control farms each of 10, 25 and 100 cows suggests that mechanized farms have a clear advantage on control farms. On the control farms, costs are generally higher and farm gate price of milk is lower than the treatment farms. Total returns do not cover costs on smallest control farm, but they more or less cover on the other two control farms. However, the treatment farms (mechanised farms) cover all costs whereas the two largest treatment farms make profits.

PRODUCTIVITY GROWTH IN SMALL-HOLDER DAIRY FARMS

5.1 Introduction

The dairy sector of Pakistan has witnessed dramatic changes over the last more than two 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.[27] Using survey data of 800 smallholder dairy farms, Burki and Khan (2011) have found that technical efficiency of the dairy farms significantly increases on large herd size. Moreover, technical efficiency also increases if farmer is experienced, farmer sells milk to processing industry, a farm is located in remote rural village and increased competition for buying milk (due to increase in the number of players buying farmer milk in a village).

More recently, informal milk collecting agents have also become powerful. They transport surplus milk from rural to urban areas and metropolitan centers. Formal and informal milk collecting agents are injecting billions of rupees annually into the participating villages and towns.

The Average nominal farm gate price of raw milk has increased from PKR 14.5/liter in 2003-04 to PKR 34.6/liter in 2009-10, further increasing to PKR 44.1/liter in 2014-15 and PKR 47/liter in June 2018. Our estimates suggest that from

[27]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, and technical support and farmer extension services favorable production conditions were created for the dairy producers.

2003-04 to 2009-10 real farm gate price of milk (in constant 2007-08 prices) has increased by 5% per annum.[28] However, between 2009-10 and 2014-15, real farm-gate milk price has declined at the rate of 3.43% per annum.[29]

Side by side, the prices of major dairy inputs have continued to increase in real terms. Even though growth rates of both dairy outputs and dairy inputs have been positive over the last one 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 attempts to measure total factor productivity and its components for a group of 725 smallholder dairy producers for the last one decade, using non-parametric Malmquist productivity index. We evaluate productivity change and its components from different angels and 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 Smallholder Dairy Farms

5.2.1 Background

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, due to data limitations only a few studies have provided estimates of productivity change in the livestock sector of Pakistan.

Avila and Evenson (2010) have used cross-country data obtained from FAOSTAT to calculate TFP growth in both agriculture and livestock sectors during 1961-2001. 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.[30] Ali and Byerlee (2002) provide estimates of TFP in Punjab for the period 1966 to 1994 using Tornqvist-Theil index. They find that TFP increased by 1.51% per annum, whereas they estimate annual livestock TFP growth at 1.26%.

Nadeem et al. (2012) provide estimates of TFP growth in the livestock sector of Punjab for the period 1970 to 2009 by using Tornqvist-Theil index. They find that TFP growth has been a major contributor to the growth of the livestock sector in Punjab where overall livestock TFP growth has increased by 1.54% per annum (Table 5.1). Moreover, annual TFP growth has been negative at –0.88% during 1970-1980, 2.70% during 1980-1990, 1.87% during 1990-2000 and 2.55% during 2000-2009.[31]

Increases in TFP growth (65.5%) rather than increases in input use largely explain livestock output growth of 3.89% in the latest period (Table 5.1). However, because aggregate livestock TFP growth estimates are of limited use to understand the dynamics of the dairy sector, a dairy-specific analysis may be more informative.

Table 5.1: Decade-Wise Average Growth Rates (%) Of Livestock Output, Input And Tfp Indices In Punjab

Period	Output Index	Input Index	TFP Index
1970 – 1980	1.83	2.73	-0.88
1980 – 1990	4.76	2.01	2.70
1990 – 2000	3.81	1.90	1.87
2000 – 2009	3.89	1.31	2.55
1970 – 2009	3.61	2.03	1.54

Source: Nadeem et al. (2012)

[28]Real farm gate price of milk has increased from PKR 20.64/liter in 2003-04 to PKR 26.85/liter in 2009-10, or a 30.10% increase in 6-years.

[29]Real farm gate price per liter of milk has increased from PKR 26.85 in 2009-10 to PKR 22.25 in 2014-15, or a 17.13% fall in 5-years.

[30]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 significant 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.

[31]Chaudhry et al. (1999) corroborate these results for the period 1972-73 to 1997-98.

5.2.2 Estimates Of TFP Growth In The Dairy Sector

We provide this analysis by exploring productivity change for a group of commercial smallholder dairy producers in Punjab over the last one decade. We estimate TFP indexes by employing non-parametric Malmquist productivity index on the survey of smallholder dairy producers for rural Punjab for 2005 and 2014. Annex-A outlines the methodology for the Malmquist productivity index, describes data and the construction of variables. The Malmquist index constructs a best-practice frontier based on the survey data and compares individual dairy farms to that frontier.[32] 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 5.2 presents a summary description of the average performance of the dairy farms. 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. We obtain growth or regress in productivity per annum by dividing this number by 9.

Table 5.2: Productivity Growth And Its Components In The Dairy Sector (Geometric Means)

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)	282	1.440	0.553
Technical efficiency change (TECHCH) < 1	582	0.816	0.104
Technical efficiency change (TECHCH)	143	1.102	0.078
Efficiency change (EFFCH) < 1	375	0.707	0.180
Efficiency change (EFFCH)	350	1.473	0.535
Pure efficiency change (PECH) < 1	416	0.688	0.182
Pure efficiency change (PECH)	309	1.452	0.504
Scale efficiency change (SECH) < 1	220	0.919	0.071
Scale efficiency change (SECH)	505	1.136	0.141

Source: Authors' calculations from LUMS Survey of Dairy Households in Rural Punjab, 2015 & 2014

[32]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).

The TFP indexes obtained from 725 dairy farms show that during 2005 to 2014 productivity declined at the rate of 1.42% per year from 2005 to 2014. Looking at the full sample results, we find that on average productivity (TFPCH) of the dairy farms cumulates to a 2014 value of 0.872, implying that they were 12.8% less productive in 2014 than they were in 2005 with average annual productivity decline estimated at –1.42%. This is in sharp contrast to the TFP growth of 2.37% for the overlapping period of 1998 – 2009, reported by Nadeem et al. (2012). Average productivity growth of the dairy sector might have been positive during 2005 to 2009 when farm gate price of milk was increasing in real terms, but we cannot validate this claim due to non-availability of farm-level data for this period.

Virtually all the productivity decline at an aggregate level is attributable to technical regress (TECHCH) on the benchmark technology, implying an inward shift of the frontier itself. The 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 slight improvement in resource use efficiency of 0.8% in 2014 over 2005. Pure efficiency change (PECH) and scale change (SECH) jointly explain the growth in efficiency change index. 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 dairy farms or 61% 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%.

The disaggregated results for technical efficiency change suggest that the failure to innovate is much more common in the sample than otherwise because 582 farms (or 80.3%) experienced technical regress of –18% from the benchmark technology, while the rest of the farms experienced technical progress of 10.2%. Nonetheless, there is somewhat equal split between the dairy farms who 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%). We observe a similar pattern in pure efficiency change and scale change measures.

5.2.3 Correlates Of Productivity Change

Pearson's correlation coefficients between TFP change and its components show that TFP change is positively and significantly correlated with technical efficiency change, efficiency change and pure efficiency change (Table 5.3). Thus, it confirms that technical efficiency change had a much smaller influence on TFPCH. Moreover, change in scale efficiency (SECH) does not significantly correlate with productivity change.

Table 5.4 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 positively and significantly correlates with most input combinations. For example, productivity change is animal capital using relative to both fodder and straw & concentrate and shed & structure capital using relative to fodder. However, the productivity change in the dairy sector is saving shed & structure capital 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.

5.2.4 Productivity Change By Various Farm Categories

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 5.5). 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

Table 5.3: Pearson's Correlation Between Productivity Change And Its Components

Herd Size (2005)	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]

Source: Authors' calculations from LUMS Survey of Dairy Households in Rural Punjab, 2015 & 2014. Numbers in brackets are *p*-values.

Table 5.4: Pearson's Correlation Between TFP Change And Changes In Production Processes

Output and input mixes	Correlation coefficient	p-values
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

Source: Authors' calculations from LUMS Survey of Dairy Households in Rural Punjab, 2015 & 2014.

in productivity than the overall average. While these dairy farms have improved upon resource use efficiency, their productivity decline is due to failure to innovate.

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, there was larger gain in productivity due to 9% improvement in efficiency change. 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.

Table 5.5: Productivity And Its Components By Various Dairy Farm Categories (Geometric Means)

	TFP change (TFPCH)	Tech. efficiency change (TECHCH)	Efficiency change (EFFCH)	Pure efficiency change (PECH)	Scale efficiency change (SECH)
Herd Size					
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
Farm Size					
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
District					
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
Farm type					
Buffalo farm	0.877	0.863	1.016	0.964	1.054
Cow farm	0.899	0.911	0.987	0.943	1.046
Mixed farm	0.859	0.849	1.012	0.938	1.079
Full sample	**0.872**	**0.866**	**1.008**	**0.946**	**1.065**

Source: Authors' calculations from LUMS Survey of Dairy Households in Rural Punjab, 2015 & 2014.

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 5.5). Muzaffargarh is the least performing district that 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.

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 5.5). 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 is due to technical regress of 0.911, and virtually no growth in efficiency of resource use at 0.987. Mixed cow & buffalo farms have performed poorly with productivity change index of 0.859; failure to achieve technical progress explains this while they experienced a very slow improvement in resource use efficiency.

5.3 Input Elasticity And Technical Inefficiency In Smallholder 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 Annex-B.

Our estimates suggest that animal capital, straw & concentrate and family & hired labor continue to be the most important determinants of raising output in smallholder 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, 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 is 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 technically most efficient.

5.4 How To Enhance Productivity Of Smallholder Dairy Farms?

Smallholder dairy producers are the main source of dairy supply chain in the country, but their total factor productivity is often low. Pakistan cannot make progress in dairy production without enhancing productivity of the small-scale dairy farms. India has demonstrated remarkable success by becoming the largest producer of milk in the world mainly through smallholder dairy production systems (Gautam et al., 2010). Any attempts to enhance productivity of smallholder dairy producers will depend upon simultaneously addressing various short term and long-term issues.

5.4.1 Tariff Structure For A Level Playing Field For Dairy Producers

Our results show that average annual TFP change in the dairy sector has declined by –1.42% during the period of 2005 and 2014. It indicates that growth in value of dairy output has fallen short of growth in value of dairy inputs leading to a decline in dairy sector productivity of which technical efficiency change is the dominant component. We may attribute the decline in technical efficiency change to the influx of cheap skimmed milk powder (SMP) and whey milk powder (WM) in post-2010 period. Pakistan was importing around 5,000 tons per month of milk powder.[33] Such a large

[33] According to the Pakistan Milk Powder Importers Association (PMPIA), Pakistan was importing around 5,050 tons of milk power per month by May 2017 at a price of US$1725 per metric tons. The PMPIA also claimed, “ten liters of fresh milk costs PKR 900 more than the one kilogram of milk powder, which costs PKR 475 for same quantity”. For details, see https://dailytimes.com.pk/9387/duty-on-imported-milk-powder-increased-up-to-60/

imported quantities of SMP and WM were enough to prepare around 606 million litres of liquid milk per annum, or around 2% of total milk produced in the country (we assume that 1 kg powder = 10 litres of liquid milk). Since the processing industry has only around 5% share in total raw milk, these imports made significant impact on rural dairy farms selling milk to the milk-processing industry. This policy resulted in lower real farm gate price of milk, which until then had been consistently rising.[34] Real farm gate price of milk has increased by 5% per annum between 2004 and 2010, while it has declined at an annual rate of –2.29% between 2010 and 2018. Declining real farm gate price of milk had implications on farmers' incentive to work efficiently due to which there were major gaps between the existing and potential milk yields.

Rather than reversing this trend, custom duty on SMP and WM was lowered from 25% to 20% in 2015-16 budget, since the maximum import tariff slabs were reduced from six to five and maximum slab of 25% was abolished. Subsequently, import duties on all kinds of imported milk powder went up to 45% with further increase due to regulatory duties in the 2017-18 budget. In recent months, increase in the international price of SMP and WM as well as more than 44% devaluation of Pak rupee versus US$ has further improved the situation from farmers' point of view.

Clearly, liberal import of SMP and WM at low tariff rates is in the interest of milk powder importers, milk processing units, commercial food producers, confectionery business, informal milk collecting agents, among others. However, this policy badly hurts the interests of smallholder (as well as modern and corporate) dairy producers by depriving them of fair profit margins required for normal growth. Total factor productivity and rate of return on smallholder dairy farms is fast declining. If this trend continues, it would produce disastrous effects on the future of the dairy sector in the country. Dairy farmers cannot be motivated to increase average milk yields by making investments unless real farm gate price of milk is positive. Therefore, this study recommends that the dairy industry must vouch for a more rational policy by keeping in view the long-term interests of all the stakeholders rather than defending their short-run profits. Keeping in view huge dairy subsidies in Europe and Ireland, a tariff structure that provides a level playing field to the dairy farmers in Pakistan would be a more prudent long-term policy.

5.4.2 Genetic Improvements Through Cross Breeding

In the longer run, cross breeding of cattle with high yielding exotic breeds has the largest potential to increase the production of milk in Pakistan by improving productivity of low yielding cattle. As per Pakistan Livestock Census 2006, there were 29.6 million cattle in the country. The share of crossbred and foreign cattle was only 27% whereas there were around 15 million breed able cattle. Now this number may have increased further. Average per day milk yield of cattle (both indigenous and crossbred) was only 1.23 liter per day. The provincial livestock departments need to extend the crossbreeding program to all parts of the country to realize the potential of higher average milk yield per animal. At the farm level, there is tremendous potential of increasing milk yield by three-to four times in crossbred cows. Higher output of milk and lower per unit cost of milk output can benefit small-scale dairy producers. In India, genetic improvement through crossbreeding policies has delivered where the contribution of crossbred cows have exceeded 50% of total cow milk as part of flush revolution initiated in early 1970s (Gautam et al., 2010). Presently, artificial insemination facilities provided by the government departments and the private sector are insufficient because they cover a small proportion of adult female cattle and buffalo population. For uniform application of crossbreeding program, these services should be available across all regions. For successful implementation of genetic improvement, the government needs to restructure the entire breeding program with support from the private sector.

[34] SMP&WM is widely used by the dairy processing industry to manufacture dairy related products, confectionary industry and tea whitening segment. Increasingly, informal milk collecting agents and intermediaries also fabricate milk from SMP & WM to sell as loose milk. Excessive use of imported powdered milk and whey powder has decreased the demand for farmer milk and influenced real farm gate price of milk.

5.4.3 Adequate Feed And Fodder Supply

Dairy animal yields largely depend on adequate supplies of feed and fodder resources, but the existing feed resources are short of the requirements. Pakistan has shortage of dry matter of 19.4%, crude protein of 37.2% and metabolized energy of 38% (Habib et al., 2016). Crop residue, fodder, grazing and other by-products support the entire livestock population in the country. Out of total feed supply, 58.8% comes from crop residues, 23.8% from fodder and 9.2% from grazing while grains and by-products contribute 8.2% of feed supply (Habib et al., 2016; Sarwar, 2002a). While common grazing lands are declining, the popularity of hybrid and genetically modified forage crops have greatly helped farmers to increase crop production and to meet their fodder needs. Mechanized harvesting of the crops is also a reason for the decline in crop residue. Even though crop residue offers an alternative to fodder in main crop growing areas, but they serve as poor nutritional source for dairy animals unless supplemented by concentrates. The land available for fodder cultivation has progressively declined since 1980 (Habib et al., 2016). Increasing land for cultivation of fodder crops is highly unlikely due to its competition with food crops. However, application of high-yielding local and imported fodder varieties, e.g., hybrid maize fodder for silage making, compensate the decline in land area for fodder cultivation.

Since majority of the livestock and dairy farms consist of small landowners and landless households, they often face serious shortages of feed and fodder. With expansion in livestock and dairy farming in the country, the gap between demand and supply of feed will further increase. Thus, we need to devise effective strategies to mitigate the feed gap. Studies show that fodder production per unit of land can increase by two to three times with improved varieties of seeds and agronomic practices alone (Dost, 2003). Easy access to quality seeds is a major hurdle due to which the improved forages are very slow to reach to small-scale farms.

5.4.4 Balanced Feeding Program For Improved Productivity

Apart from shortage of feed, nutritional imbalance in dairy animals is a major cause of low livestock productivity in smallholder dairy farms. Since feeding costs account for more than 70% of total cost of milk production, dairy animals must receive the required quantity of protein, energy, minerals and vitamins from indigenous feed resources for optimal allocation of resources. However, smallholder dairy producers do not have the ability and resources to implement the balanced ration requirements. Recent evidence suggests that one can effectively use balanced feeding program to improve productivity of cows and buffaloes by increasing milk production and achieving nutrient use efficiency. In this regard, the National Dairy Development Board (NDDB) of India has built a user-friendly hand-held device installed with computer software to advise dairy producers on their doorstep to help them achieve balanced ration for their lactating dairy animals by using locally "available feed resources and area-specific mineral mixtures" (FAO, 2012). "Nutrition Masters" operate the devices who have data in their hand-held machines on chemical composition of popularly used feed ingredients and nutritional needs of lactating cows and buffaloes for optimal milk production keeping into account other physiological functions. The selected "Nutrition Masters" not only get training to prepare balanced rations but also are required to train local resource persons in villages. The results of this experiment suggest that daily income of farmers owning one-two cows or buffaloes have increased by 10-15% through higher milk yield and lower cost of feeding. Balanced ration program is a unique approach that Pakistan can implement to help achieve higher milk yield, reduce feeding cost and in turn increase total factor productivity of the smallholder dairy producers. Additional benefits of this program include reduced "methane emissions and nitrogen excretion into the environment" (FAO, 2012).

5.4.5 Mechanical Interventions For Higher Productivity

Mechanization of small-scale dairy farms is the use of mechanical and electronic equipment to decrease the need for human labour. Small-scale dairying is the dominant form consisting of more than 90% of the dairy farms with one to ten cows/buffaloes (GoP, n.d.). These family farms provide employment to millions of family & hired workers, mostly in rural areas. If labour is cheap and abundant, mechanization of these farms will remain at a low ebb. However, there are more than 2.5 million dairy cattle farms in the country with herd size of more than ten cattle, which offer potential for mechanization.

While corporate dairy farms abundantly use modern milking parlours, small and medium scale farms can increase their milk production by using mobile milking machines or bucket milking systems. Hand milking is not feasible in these farms because it is slow due to which milking of the whole herd takes a long time. Seasonal labour shortage augments the difficulties faced by these farms. Moreover, milk removal with hand milking is not satisfactory; it leads to lower average yield per lactation. Small capital investment on bucket milking systems can significantly improve labour productivity, milking performance and hygiene. This is a future alternative to current hand-milking technique with potential for increasing productivity, seasonal on-farm labour issues faced by the dairy farms and potential to provide more flexibility in the daily routine of the dairy farm staff.

Harvesting and chaffing of fodder with mechanical equipment and silage making machines are other forms of mechanical intervention that can go a long way in promoting higher productivity of these dairy farms. Demand for mechanical equipment for harvesting and chaffing of fodder is gradually increasing in the small and medium sized dairy farms. Likewise, the equipment for silage making is also readily available in the market. However, as discussed before, due to lack of demand there is missing market for renting-out services for silage making equipment. Awareness campaigns through training and extension services can help promote demand for silage making equipment. Silage requires less storage space while silage preparations can reduce the cost of fodder and concentrates, which consist of around 60% of the cost share of inputs used on the dairy farms.

The potential demand for dairy machinery is unknown. It is also unclear how many dairy farms have already switched to mechanization; no survey reports these numbers? However, it is widely believed that huge potential demand for dairy machinery exists in the country. To fill this gap, we attempt to estimate the potential demand for dairy machinery on. Even though some progressive dairy farms practice advanced technology for harvesting and chaffing of fodder with mechanical equipment, we take data from a typical (representative) dairy farm that is not using mechanization and compare it with a typical mechanized dairy farm to calculate potential demand for dairy machinery. Our estimates in Table 5.6 and Table 5.7 suggest that there is potential demand of around USD 8 to 9 billion for the dairy machinery in the country.

5.5 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.

Table 5.6: Demand Of Dairy Machinery In Pakistan

Herd size (dairy cows)	Value of machinery without mechanization (PKR million)	Value of machinery with mechanization (PKR million)	Investment required for mechanization (col. 2 minus col.1) (PKR million)	Number of dairy cattle farms in Pakistan	Demand for machinery (PKR million)		
					Assuming 10% dairy farms are already mechanized	Assuming 15% dairy farms are already mechanized	Assuming 20% dairy farms are already mechanized
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
10 – 19	3.5	4.7	1.2	660,983	67,667.4	63,908.1	60,148.8
20 – 29	5.5	8.4	2.9	400,148	102,783.3	97,073.1	91,362.9
30 – 39	7.6	12.2	4.6	324,002	134,734.0	127,248.8	119,763.5
40 – 49	9.6	16.0	6.4	284,794	162,441.0	153,416.5	144,392.0
50 – 59	11.7	19.7	8.1	245,586	178,013.1	168,123.5	158,233.9
60 – 69	13.7	23.5	9.8	206,378	181,450.4	171,369.8	161,289.2
70 – 79	15.8	27.3	11.5	167,170	172,752.7	163,155.4	153,558.0
80 – 89	17.8	31.1	13.2	127,962	151,920.2	143,480.2	135,040.2
90 – 100	22.0	38.5	16.5	95,473	128,567.8	121,425.1	114,282.5
Total	**107.2**	**181.4**	**74.3**	**2,512,499**	**1,280,329.9**	**1,209,200.4**	**1,138,071.0**

Note: We obtain value of machinery for 10, 25 and 100 cattle mechanized and non-mechanized farms from IFCN survey conducted by LUMS (see Section 4.5). We interpolate data to get value of machinery for other farm sizes. For simplicity, we fix the number of dairy cattle farms at the 2006 level reported in the Pakistan Livestock Census 2006.

Table 5.7: Demand For Dairy Machinery In Pakistan In US Dollars

Herd size	Demand for machinery (in USD)		
	Assuming 10% dairy farms are already mechanized	Assuming 15% dairy farms are already mechanized	Assuming 20% dairy farms are already mechanized
10 – 19	483,338,571	456,486,429	429,634,286
20 – 29	734,166,429	693,379,286	652,592,143
30 – 39	962,385,714	908,920,000	855,453,571
40 – 49	1,160,292,857	1,095,832,143	1,031,371,429
50 – 59	1,271,522,143	1,200,882,142	1,130,242,143
60 – 69	1,296,074,286	1,224,070,000	1,152,065,714
70 – 79	1,233,947,857	1,165,395,714	1,096,842,857
80 – 89	1,085,144,286	1,024,858,571	964,572,857
90 – 100	918,341,429	867,322,143	816,302,500
Total	**9,145,213,571**	**8,637,145,714**	**8,129,078,571**

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 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 have. This is understandable since most subsistence farms employ family labor to collect roughages and grasses to feed their mulching 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. In addition, dairy farms who feed silage to their herd experience higher productivity growth.

Fifth, best performing districts have 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 over there is most surprising. Equally surprising is the inferior 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 determinant 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 are. Increase in herd size, age of head of farm household and education of head of farm household increase technical efficiency of the dairy farms.

We also propose measures for enhancing productivity of the small dairy farms. Firstly, we have emphasized that dairy farms cannot make investments to increase milk yields unless real farm gate price of milk is positive. In recent years, liberal import of SMP and WM has hurt the interests of dairy producers due to declining real farm gate price of milk and falling total factor productivity. Due to heavy dairy subsidies prevalent in Europe and Ireland, mitigating measures are necessary to protect the long-term interests of the dairy producers by promoting a level playing field.

Secondly, we stress that provincial livestock departments must devise strategies to promote genetic improvements through cross breeding of cattle with high yielding exotic breeds, which offers tremendous long-term potential of increasing milk yields at the farm level by three to four times. Such a policy has delivered in other developing countries and can bear fruit in Pakistan.

Thirdly, we note that present feed resources are inadequate to the requirements of the dairy sector. With expansion in the dairy sector, the gap between demand and supply of feed will further intensify. There is an urgent need to increase productivity of fodder crops, providing access to quality seeds and improving agronomic practices in fodder crops.

Fourthly, there is a need to introduce balanced feeding program for dairy animals by using IT technology and computer software to advise dairy producers on their doorstep to achieve balanced ration for their lactating dairy animals.

Finally, there are around half a million dairy farms that has the potential of adopting mechanical and electronic devices for enhancing their productivity including equipment for harvesting and chaffing of fodder and silage making, among others. Awareness schemes and training programs can be effective to promote early adoption so that productivity of these dairy farms goes up.

Annex – A: Malmquist Productivity Change Index And Its Components

To measure total factor productivity 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

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

We decompose TFP change 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).

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

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). We may decompose the Malmquist TFP index 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., *TFPH* $=$ *TECHCH x EFECH.* Similarly, efficiency change index is obtained by multiplying pure efficiency change and scale change index, or *EFFCH* $+$ *PECH x SECH.*

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, farmyard manure and capital gain from milch animals earned by each farm converted into 2013-14 prices. We use four input proxies namely, cost of shed, structure & animal capital, cost of fodder, cost of straw & concentrate and hired & family labor. We take these inputs 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, farmyard 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. We use the LUMS Survey of Dairy Households in Rural Punjab for the years 2005 and 2014 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, we compute the actual revenue from selling milk by adding up the value of milk sold to milk processors,

[33] *According to the Pakistan Milk Powder Importers Association (PMPIA), Pakistan was importing around 5,050 tons of milk power per month by May 2017 at a price of US$1725 per metric tons. The PMPIA also claimed, "ten liters of fresh milk costs PKR 900 more than the one kilogram of milk powder, which costs PKR 475 for same quantity". For details, see https://dailytimes.com.pk/9387/duty-on-imported-milk-powder-increased-up-to-60/*

transporters, dodhi, village shopkeepers, neighbors, and city shops by each household. Next, we construct average price of selling milk by working out the price to different economic agents[35] and then computing a share-weighted average of these prices.[36] We multiply this share-weighted price 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 farmyard manure. We compute this 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 farmyard manure sells during that year.

Capital gain on animals is also an important source of revenue. We compute its value 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. We adjust the value of heifers in the year-end value of the animal before computing capital gain.

Moving on to the inputs involved in the production process, a major startup cost for dairy farming is investment in infrastructure and machinery. The farms invest a lump sum amount in the building of animal sheds and courtyards for the upkeep of the animals, and procure cutter machines for cutting up fodder and straw. While this investment is fixed-cost incurred on the farm, it has a variable component as well: farm structures and machinery depreciate over time, which need repairs and maintenance. Further, loans obtained for these investments also need repayments. 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, we add the depreciation on shed and structure capital and the interest on loans 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. We multiply this average with an assumed ‘depreciation’[37] rate of 10% to find the cost of animal capital.

[35] Households sell to milk processors, transporters, dodhi, village shopkeepers, neighbors, and city shops. Our data contains information on total value (in Rupees) and total quantity (in kg) of milk sold to each of these economic agents. We compute selling price of milk to each agent by dividing total value of milk by quantity sold to each agent given by $P_i = \frac{V_i}{Q_i}$, , where i represents 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.

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

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. We compute total cost of fodder 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 animals by using a share-weighting technique before making the total cost computations. The cost of straws and concentrate were calculated using the same share-weighting technique; 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 working on the farm do not get monthly or daily payments. Yet they get compensation based on returns from dairy production. Even so, we calculated the opportunity cost of family labor by multiplying the wage rate per hour for hired labor[38] with the number of hours worked by family members (per year) on livestock and dairy.[39] 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.[40] Table A5.1 presents their descriptive statistics of output and input variables used to measure TFP growth.

Table A5.1: 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.

[37] *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'.*
[38] *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.*
[39] *This includes the number of hours spent in cleaning, milking, feeding, management & marketing activities, and the collection of roughages and grass.*
[40] *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.*

Annex-B: The Stochastic Frontier and Technical Inefficiency Effects Model

We investigate the determinants of technical inefficiency in smallholder 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 stochastic production frontier represent the milk production technology:

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

where Y_{it} is the output of the *i*th dairy farm in *t*th time, X_{it} $(i = 1,\ldots,n)$ is a 1x*k* vector of values of known functions of inputs for the *i*th dairy farm in time period t, β is a *k*x1 vector of unknown parameters to be estimated, and $f(X_{it};\beta)$ is the assumed functional form. As usual in the frontier literature, we decompose the stochastic composite error term into V_{it} and u_{it} where V_{it} is iid$N(0, \sigma_v^2)$ 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. We also assume that u_i'S are independent V_i'S of such that we obtain u_{it} by truncation at zero, that is, $u_{it} \sim N(\mu_{it}, \sigma^2)$, where $\mu_{it} = \delta z_{it}$ and Z_{it} is a vector of observable explanatory variables linked with technical inefficiency of farms, and δ is a vector of unknown coefficients. In effect, we can replace the technical inefficiency, u_{it} for each dairy farm in Eq. (4.1) by a linear function of explanatory variables reflecting farm-specific characteristics specified by

$$u_{it} = \delta z_{it} + \varepsilon_{it}$$

where δ 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, σ^2. The point of truncation occurs at $-\delta z_i$ or $\varepsilon_{it} \geq -\delta z_{it}$.

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

$$u_{it} = \delta_0 + \sum_{j=1}^{N} \delta_j z_{ijt} + \varepsilon_{it}$$

where $\mathbf{z}_{ijt}$ are the determinants of technical inefficiency. We drop the variables that tested as insignificant determinants of inefficiency 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.

Table B5.1 presents summary statistics of the variables used to estimate the stochastic production frontier and technical inefficiency effects model. Value of production of milk, farmyard manure and capital gain per dairy farm is PKR 310,998 which has increased by 11.6% from 2005 to 2014. The value of production varies from PKR 33,590 to PKR 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 PKR 13,774 in 2005 to PKR 17,408 in 2014 or 26.4% with an overall mean of PKR 15,591. The mean value of animal capital is PKR 38,923 per farm that has slightly increased over time. Mean value of fodder cost is PKR 126,049 which has decreased by

Table B5.1: Descriptive Statistics Of Frontier Production Function Variables

Variables	Mean	Std. Dev	Min	Max
Frontier Production Function:				
Value of dairy milk, farmyard manure & capital gain	310,851	390,959	33,590	11,200,000
Cost of shed & structure capital	15,591	15,585	0	219,768
Cost of animal capital	38,923	40,537	3,696	1,022,763
Cost of fodder	125,828	121,474	840	1,425,618
Cost of straw & concentrates	61,150	77,936	547	1,806,776
Cost of hired & family labor	35,988	43,075	363	859,542
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	1,450	---	---	---

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

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 PKR 61,150. Average cost of family & hired labor is PKR 35,988 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).[41] 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. Tying of cows and buffaloes with a rope prevents them to drink water freely. 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 inefficiency effects model are estimated simultaneously using the procedure in computer program FRONTIER 4.1 (Coelli, 1996). Table B5.2 reports estimation results of the frontier production function and inefficiency effects model, 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. We measure the estimated scale elasticity by the sum of all the input elasticities.

[41]Positively associated factors with 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)].

Table B5.2: 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)
$\gamma = \sigma_u^2 / \left(\sigma_u^2 / \sigma_v^2 \right)$	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 the sake of brevity, we do not report these coefficients in the table.

The 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.

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.[42]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 B5.2 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 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 positive, 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 because of distances. In other words, distances do not matter, not any more, in determining technical inefficiency of the dairy farms.

[42]In Table B5.2, 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. The test of the null hypothesis $(\gamma = \delta_0 = \ldots = \delta_{17} = 0)$ confirms this, suggesting that technical inefficiency effects are not present in the model. However, we reject the null at the 1% level of statistical significance because the generalized likelihood ratio test statistics given by $LR = -2\{-180.32 - (-84.07)\} = 192.5$ is greater than its critical value of 34.17 for 18 degrees of freedom, obtained from Table 1 of Kodde and Palm (1986).

ECONOMICS OF MODERN AND **CORPORATE DAIRY FARMING**

6.1 Introduction

Livestock is an important sub-sector of agriculture, which contributes 58.9% of the value addition in the agriculture sector, and 11.1% of in gross domestic product (GoP, 2018). Net foreign exchange earnings from livestock constitute more than 8.5% of the total exports (GoP, 2018). In addition, it is 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). Moreover, 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-thirds 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). It implies that the quantity demand is much higher than the milk supply in Pakistan.

Imported powdered milk helps to meet the excess demand by local population (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. Therefore, in an attempt to protect the local dairy industry, the Government of Pakistan has 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.[43] The incentives offered by the government attracted some corporate groups to invest in the dairy farming sector (Afzal, 2008). Nevertheless, these dairy farms report huge losses in the financial statements 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. Then we discuss the potential for vertical integration and knowledge economies in the dairy sector. Next, we present business model of a 1300 cattle purebred Holstein Frisian dairy farm based on operating

[43]The estimates suggest that 8.42 million families raise 26.79 million cattle and buffaloes for milk production in the country (Agricultural Census Organization, 2006). Most of the dairy 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.

profits, conduct sensitivity analysis to changes in milk price, milk yield, and feed cost and evaluate sensitivity of operating profit to variation in herd-size. Finally, we present business model of a 100 cattle dairy farm to evaluate its investment potential in peri-urban areas of big cities by examining sensitivity of their operating profits to upward movement of retail milk prices.

6.2 Farm Structure And Practices

Rural market-oriented smallholder dairy farms dominate the dairy industry in Pakistan (Burki et al., 2004; Afzal, 2008).[44] 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[45] 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). However, initial financial statements of these businesses report huge losses. 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, feeding, 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 they fail to detect animal's 'heat' at the right time. Since they can test the pregnancy of an animal only after 35 days, they repeat the entire process if the animal is not successfully impregnated.[46] In the meantime, the animals need feeding and vaccination so that its milk yield upon impregnation is high.

The calf-rearing department feeds calves and maintains their health until they grow up for sending to the maternity department for impregnation. Normally, they keep calves until the age of 14 months. However, if their diet is not good, it takes much longer than the optimum fourteen months for an adult cow to achieve standard weight and size; this causes delay in their insemination, which in turn increases the upkeep cost. Further, if insemination is inefficient, there will not be enough cows to replace the older cows,[47] 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. However, 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 available 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

[44]There are four main types of farming systems currently prevalent in Pakistan: rural subsistence holdings, rural market-oriented smallholdings, rural commercial farms, and peri-urban/urban commercial dairy farms (Food and Agriculture Organization, 1987). Rural market oriented smallholdings aim to produce a greater quantity of milk than the amount required by the family. They sell excess milk in nearby markets. These farms usually keep less than six animals, of which two to three are milking animals. The milking animals feed on seasonal green fodder, straw, and concentrate, whereas the other animals feed on grazing. Generally, they retain calf during lactations. They dispose of male calf but keep female calf as replacements.

[45]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.

[46]Inefficiencies in insemination vary from 1 out of 5 positive pregnancies to 1 out of 40.
[47]Cows normally have only 4 to 5 high yielding cycles.

bunkers 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, animals need more feed to fill their stomach. Further, animal feeding is differentiated based on milk yield. They give more feed to high yielding cows compared to those that have lower yields. The high yielding cows are usually the younger ones and their impregnation is a top priority.

Another name for the milking department is the 'milking parlor'. In this department, the milk from the cows goes directly into the chillers. Since corporate dairy farms 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 gain 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. Therefore, 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 the dairy farms hire these foreign personnel 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, at the time of setting up of the Makhdoom Farm 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. However, 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 downsized 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 "16000 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 PKR 4,000 per month and "providing breed improvement services to farmers in over 7000 villages in Punjab" (USAID, 2013a).

This human capital development by USAID has had both a positive impact on small-scale dairy farmers; also, it is likely to have positive spillover effects on corporate dairy farms. 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. Nevertheless, 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 term.

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 dairy animals from Australia only. However, 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 that has an average yield of 18 to 22 liters of milk daily. In comparison, local breeds like the Nili Ravi[48] (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 30-35ºC (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 are 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. However, 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 usually damage their hooves when 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 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.[49] 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.

[48]Milking animals used by conventional farms are predominantly buffaloes. However, they breed buffaloes 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 attaining maturity. Cows also have a larger lactation period with a dry period of 2 months, whereas buffaloes have a dry period of 4 months.

[49]The feed given to both breeds comprises of silage, green fodder and concentrate. The farmers feed cows in their stalls and allow them 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 terms of water.

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 de-worming for protection against stomach parasites. Butalux medicine is an absolute essential without which mixed breed calves can die; they also need Imizol from time to time. Medical costs for Sahiwal cows, on the other hand, are comparatively low: Sahiwal cows have an inherent tendency to keep shivering 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 PKR 2,500 for 60 animals at a time.

Fourthly, mixed breeds have uneven teats, which make it difficult to collect milk by using 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), excess males not used for breeding are sold-off? However, selling these animals for meat is not feasible since they have to wait until 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 cows, the milk from Sahiwal cows has more fat content compared to the mixed breed.[50] This means that the milk from Sahiwal cows sells for a higher price because consumers consider it as 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 no known link with any such health problem and thus is 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). In addition, according to the CEO of Dada Dairies, the initial conception rate for their farm was only 20% (Riaz and Toor, 2015). However, 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, only around 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 mate 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 crossbreed 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.

[50]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.

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. They house their animals using 'free' stalls in which cows move freely, and are only restricted during milking. The shed has an adequate supply of drinking water and fodder, and they make flooring out of rubber or sand. They also use electric fencing systems to prevent cows from being lost, avoid dog attacks, or stolen. The handling of manure is more systematized and frequent in order to prevent diseases and insect infestations. The farms install fans and cooling systems 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 an automatic suction pumps system for milking the cows. The mechanized milking parlors[51] allow for automatic and efficient milking alongside cleansing and drying of the teats and udders. Tagging of cows with transponders identifies them for milking, breeding, and feeding. They send the collected fresh milk to a buffer tank for cooling.

Since cooling helps avoid the formation of bacteria in fresh milk, the corporate dairy farms use sophisticated cooling mechanisms in the form of immersion coolers and heat exchangers. They automatically filter milk before pumping it into the storage tanks at a temperature of 4ºC until 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 milking time and amount of milk given by each animal. 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. Although, Makhdoom Farm is not fully automatic, yet it has repaired the housing facilities and improved the drainage of dung and urine systems for the cows (Awais and Choudhry, 2015). They clean animal sheds daily using disinfectants.

They have constructed larger open compounds with sheds on one side for the cows allowing them to roam freely and drink as much water as they want (Awais and Choudhry, 2015). Previously, they took water from an un-cemented (kacha) canal flowing nearby (Awais and Choudhry, 2015). Nevertheless, water quantity from the canal fluctuated and the water was not always clean. Therefore, 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 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.[52] They usually tie up their cows, which 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. Therefore, normally, a group of small farmers joins to invest in the machine (Jalil et al., 2009). They manually milk cows, 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 lower cost of up-keep of animals, 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 PKR 21,500, on average, to PKR 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,

[51]Firms such as ProFarm, DeLaval and Altaf & Co provide specialized services to corporate dairy farms related to farm equipment, breeding (artificial insemination), herd management, farm management software, 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, De Laval technology is useful to milk pregnant, injured and ill cows. It can milk 32 cows at a time and one cow in 5 minutes.

[52]They divide the work amongst the family members and spend almost nothing 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.

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. They purchase healthy green fodder and prepare corn silage 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 by procuring the green fodder locally, but importing minerals from Spain, Turkey, and U.S.A. (Saigol and Farooqui, 2015). Unlike traditional farms, these farms also use mixer wagons to prepare balanced rations. In addition, they feed animals with higher yield more compared to those with lower yields.

Even though there is an inextricable link between the quality of fodder provided to animals and their milk yield and quality, feed procurement costs are high for corporate farms. For example, as mentioned above, good quality maize is available 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. However, farms without proper storage bunkers 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.[53] They normally feed an adult cow one-third of its body weight, and a calf one-tenth of its body weight. Since corporate farms use imported/exotic or mixed breed cattle, their fodder costs per animal are considerably higher than traditional farms. According to the management team of Nishat Dairy, the most important cost in running a dairy farm is its feed, which is 60 – 65% of a farm’s revenue (Saigol and Farooqui, 2015). In addition, 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. However, this does not always prove fruitful. For example, the Makhdoom farm is now producing its feed itself. However, 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 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.[54]

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 fills the stomach of the animals. Some farms purchase imported-nutrients from local vendors whereas larger farms get the supply directly from international exporters. If established, local production units can manufacture this nutrient mix at lower costs. However, this nutrient mix is only about 15 percent of total cost of feed. More important portion is fodder that they purchase from local suppliers, but this is a costly option as maize is a seasonal crop grown only in the spring season. Moreover, 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

[53]For example, as mentioned before, a mixed breed cow, on average, weighs around 700 kilograms whereas a Sahiwal cow weighs only 450 kilograms.

[54]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.

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[55], 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.

In addition, considering that the corporate dairy industry is still in its initial stages of development, there is much to gain 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 its initial years, this industry is likely to face obstacles, but it 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 cost of hiring specialized veterinarians is more disperse 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 efficiencies by outsourcing the work of its inefficient departments to these firms. Consequently, large efficiency gains await this sector in the long term.

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 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. Because corporate farms are not constrained by location, they are able to locate near cities where they have better access to communication and transportation infrastructure. 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 of cost of milk production. However, 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

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

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. They also need a cold chain infrastructure 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. There is a need to cut down feed procurement cost to lower milk production cost. However, feed content affects animal productivity and milk quality. If the feed is not properly prepared, the milk that the animal produces does not have the required contents that come under the incentive contract of milk processors. For instance, Nestle Pakistan 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 Alfa-toxin levels. If the total platelet count and Alfa-toxin levels are high, dairy farms get lower prices for their milk.[56] 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. 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, in spite of backward integration into fodder production, Makhdoom Farm has been unable to reduce their feed procurement costs (Awais and Choudhry, 2015). 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. This is because investing in pasteurizing units is not enough to battle away the market share occupied by popular milk brands. They need a lot of investment 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 and medium dairy farms where the large part of the country's milk production comes from.

6.5 Operating Profits Of Large Commercial Dairy Farms[57]

FAO (2011) provide value chain analysis and separate business models for buffaloes and cow farms. What are the costs and returns to large commercial dairy farms in Pakistan? How their returns compare by farm-size? This information is generally not available due to constraints on published data of these farms. In this sub-section, we attempt to provide economic outlook of large commercial dairy farms based on their operating profits. First, we provide economic outlook of the large commercial dairy farms by analyzing the operating profits of a typical 1300-cow purebred Holstein Frisian dairy farm followed by its sensitivity analysis to changes in milk price, milk yield and feed cost. Second, we evaluate the sensitivity of the operating profits to variations in herd-size of purebred Holstein Frisian cows by considering 500-cow and 300-cow dairy farms. Lastly, we consider investment potential of a 100-cow dairy farm in peri-urban areas of big cities/metropolitan areas by examining sensitivity of their operating profits to upward movement of retail milk prices.

6.5.1 Financial Model Of A Typical 1300-Cow Pure-Bred Holstein Frisian Dairy Farm

We present financial model of a typical 1300 cattle purebred Holstein Frisian dairy farm based on data compiled by a consultant hired for this purpose by Tetra Pak Pakistan. The financial model relies on numerous technical assumptions originally compiled by the consultant. However, we revised these assumptions where necessary after discussions with experienced practitioners from the large commercial dairy sector. To strengthen the financial analysis, we supplement the technical information by data obtained from Tetra Pak Pakistan.

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

[57]This analysis draws from Seyyed et al. (2018). We are grateful to Dr. Fazal Jawad Seyyed for technical advice and to Hafsa Ashfaq of SDSB, LUMS for generating tables for the financial analysis.

Assumptions

The dairy cattle is purebred Holstein Frisian heifers imported from Australia. The first lot of imported cattle consisted of 1200 heifers followed by import of second lot of 150 cattle in the second year (Table 6.1). On arrival, these heifers were five to six months pregnant. The imported cattle were first time pregnant without any previous abortion or calving. The financial model assumes an average calving interval of 12 months; actual calving intervals may range from 10 to 14 months. For simplicity, the model also assumes that all calving takes place in one month. The model also assumes gender distribution of calves at 50% each. All male calves sold within one week of birth.

Keeping in view the norms in large commercial dairy, mortality rates of 2%, 3% and 5% were applied to heifers, lactating cows in year 1, and calves & lactating cows in year 2 onwards, respectively (Table 6.1). Culling rates of 5% applied to heifers, 10% to lactating cows in year 1, 15% in year 2 and 20% in year 3 onwards (Table 6.1). For simplicity, these rates apply at the time of transfer, not during the whole year. Table 6.1 also shows that capital investment for a 1300 cow dairy farm comes to PKR 1.1 billion, which includes cost of 1,350 cattle for year 1 and year 2, cost of 40-acre land, cost of civil works, machinery & equipment and water & pumping.

Table 6.1: Herd Size Assumptions For 1300 Cattle Farm

Herd Size					
Number of cows imported					
Start of Year 1				1,200	
Start of Year 2				150	
Herd related Assumptions					
Mortality					
Lactating cows - Year 1				3%	per annum
Lactating cows - Year 2 onwards				5%	per annum
Heifers				2%	per annum
Calves				5%	per annum
Culling rate					
Lactating cows - Year 1				10%	per annum
Lactating cows - Year 2				15%	per annum
Lactating cows - Year 3 onwards				20%	per annum
Heifers				5%	per annum
Value of Animals					
Import price			PKR	350,000	per cow
Price - culled cow			PKR/kg	120	550
Price - culled heifer			PKR/kg	120	450
Price - calf			PKR	5,000	per cow
Capital Investment					
	Useful life (years)		**PKR**		**Total**
Land (acres x purchase price per acre)		40 acres	3,000,000	PKR	120,000,000
Civil work (sq ft area x price per sq ft)	20	255,900	1,200	PKR	307,080,000
Electrical	10			PKR	65,300,000
Machinery & Equipment	20			PKR	131,700,000
Water & Plumbing	10			PKR	8,120,000

Source: Dairy sector consultant's data revised and simplified for the analysis

Operating cost includes feed, vaccination, medicines, parlor chemical (acid and alkali), teat dip cost, utilities, fuel and maintenance (POL), among others (Table 6.2). Table 6.3 presents milk related assumptions, which cover milk yield per day, milk days per lactating cows and milk wastage. Another assumption of the model is that lactating cow milk for 305 days from year 2 onwards and remain dry for 60 days in a calendar year. However, milking days for lactating cows are 210 in first year of lactation. During first lactation, average milk yield per day was 23 liters, which gradually goes up to 26 liters in fourth year and 30 liters in 8th year onwards. The quantity of milk produced in a year depends on the number of lactating cows in a year. The wastage of milk assumed is 2%. To account for inflation, we scale up all operating expenses by 2% per annum. We apply depreciation rates of 10% and 20% depending upon the useful life of assets (see, Table 6.1) while the tax rate of 10% is applied (Table 6.4). We assume equity to debt ratio of 70:30 where the debt obtained is at a long-term rate of 14% per annum.

Table 6.2: Operating Cost Assumption For 1300 Cattle Farm

Feed			
Straws for insemination	PKR	950	
Cows	Quantity	3.5	
Heifers	Quantity	2	
Vaccination	Quantity	PKR	
FMD	2	182	per vaccine
HS	1	26	per vaccine
3Day Fever	1	800	per vaccine
Elite 9	2	330	per vaccine
Clostridium	1	64	per vaccine
RB 51	2	51	per vaccine
Medicine	PKR	9,000	per animal
Parlor Chemical	Quantity (liter)	PKR	
Acid	1,500	204	per liter
Alkali	3,000	180	per liter
Teat dip			
Quantity per milking per day	Liters	0.001	per lactating cow
No of milking per day		3	
No of days		365	
Cost	PKR	1,573	per liter
HR	PKR	4,000,000	per month
Utilities			
Energy required	kw	0.34	per lactating cow
No of hours	h	16	
Tariff		12	per kwh
P.O.L.			
Year 1	PKR	18,810,912	per annum
Year 2 onwards	PKR	27,758,112	per annum
Mess Expenses			
Per day expenses	PKR	120	per staff member
No of days		365	
Staff		125	

Source: Dairy sector consultant's data revised and simplified for the analysis

Table 6.3: Milk Related Assumptions For 1300 Cattle Farm

Milk price			
Year 1	PKR	61	per liter
Year 2 (increasing by Re.1 per year)	PKR	62	per liter
Milk yield per day			
Year 1	Liters	23	per animal
Year 2	Liters	25	per animal
Year 3	Liters	25	per animal
Year 4	Liters	26	per animal
Year 5	Liters	27	per animal
Year 6	Liters	28	per animal
Year 7	Liters	29	per animal
Year 8 onwards	Liters	30	per animal
Milk wastage		2%	
Milk days			
Year 1		210	per animal
Year 2 onwards		305	per animal

Source: Dairy sector consultant's data revised and simplified for the analysis

Table 6.4: Other Assumptions For 1300 Cattle Farm

Calving interval		12 months
Inflation		2%
Tax rate		10%
Net working capital		2% of total revenue
Long term growth rate		5%
	Weights	**Costs**
Debt (Interest rate)	30%	14%
Equity	70%	16%

As shown in Table 6.2, the components of operating cost include feed as one of the major items. The feed requirements of milking and dry cows, calves and heifers significantly vary. We carefully worked out these costs to determine their total mixed ratio. Table 6.5 provides details on type of feed, its quantity/cost, number of days for milking and dry cows as well as for heifers and calves. We use these assumptions to obtain total feed cost.

Table 6.5: Feed Cost Assumptions For 1300 Cattle Farm

	Cost/kg	Requirements (kg)				No of Days						
		Lactating cows		R1YO	R2YO	Lactating cows				R1YO	R2YO	
		Milking days	Dry period			Milking days		Dry period		Calves	Cows	Heifers
						Year 1	Year 2 onwards	Year 1	Year 2 onwards		Year 1	Year 1
Maize Silage	6.25	25.00	12.00	8.00	12.00	210	305	0	60	275	155	365
Wheat Straw	8.88	-	5.00	-	3.00	210	305	0	60	275	155	365
Maize Grain	23.75	4.00	-	0.80	1.00	210	305	0	60	275	155	365
Cotton Seed	38.35	2.50	-	-	-	210	305	0	60	275	155	365
Corn Gluten	22.16	2.50	-	0.80	-	210	305	0	60	275	155	365
Wheat Bran	24.00	2.50	-	-	-	210	305	0	60	275	155	365
Soya Bean	55.00	2.50	-	0.80	-	210	305	0	60	275	155	365
Canola Meal	35.60	0.50	1.00	-	1.00	210	305	0	60	275	155	365
Bypass Fat	90.00	0.50	-	-	-	210	305	0	60	275	155	365
Molasses	10.00	2.00	-	-	-	210	305	0	60	275	155	365
Mineral Mix	123.66	0.10	0.10	0.05	0.05	210	305	0	60	275	155	365
Mycotoxin Binder	230.00	0.02	-	-	-	210	305	0	60	275	155	365
Urea	28.00	0.10	0.10	-	0.07	210	305	0	60	275	155	365
Salt	5.00	0.10	-	-	-	210	305	0	60	275	155	365
Bi carb	44.44	0.20	-	-	-	210	305	0	60	275	155	365
Yeast	1,000.00	0.02	-	-	-	210	305	0	60	275	155	365
Cow Milk Replacer (CMR)	32.00	-	-	6.00	-	0	0	0	0	90	0	0
Calf Starter	45.00	-	-	0.40	-	0	0	0	0	90	0	0
Feed cost/ cow		731.98	170.17	136.91	169.1							

Source: Dairy sector consultant's data revised and simplified for the analysis

Notes: Calves and R1YO: Newborn calves must receive 4 liter of colostrum within first hour of their birth and then second feed after 12 hours and then transitionally moved to cow milk or replacer. For first 90 days, calves feed on almost 6 liters of milk or replacer per day. Later on, calves feed on pallet diet before gradually moving on to calf starter.

Dry Cows and R2YO: Dry cows do not need much energy. Since most of the energy is required for milk production, the energy requirement of dry cows is low as compared to milking cows. Dry matter requirement for dry cows is 3 percent of their body weight. Their feed is mostly silage and roughage, i.e., grasses and hay, to fulfill their dry matter requirement with some energy to keep their body condition moderate since too fat cows were prone to milk fever and problems in calving.

Because the size of milking parlor is set at 1300 cows, the maximum limit of the lactating cows is reached by the 5th year; from that point onwards, all excess cows are sold to maintain the upper limit at around 1300 lactating cows (Annex-A, Table A6.1 and A6.2). We assume average number of lactations per cattle at 5 to 6 calving.

Operating Profits For A 1300-Cow Pure-Bred Holstein Frisian Dairy Farm

Table 6.6 exhibits assumptions for milk price and milk production. Table 6.7 reveals 10-year projections of income statement. This is based on herd movement from year 1 to 10 on account of increase/decrease in herd size due to new purchases, births, transfers, deaths, sale & culling (Annex-A, Table A6.1) and stock movements covering opening stock, closing stock, average stock, sale of calf and culled stock and death of stock (Annex-A, Table A6.2). Net operating profit increases from PKR 14 million in year 2 to PKR 163 million in year 10 at average operating profit of PKR 96.4 million. Operating profit per cow monotonically increases from PKR 10,544 in year 2 to PKR 84,490 in year 10 with an overall average of PKR 45,763. Operating profit per liter of milk also monotonically increases from PKR 2.10 in year 2 to PKR 15.54 in year 10 with 10-year average of PKR 8.28.

Table 6.8 shows that the feed cost to total revenue ratio goes down from nearly 70% in year 1 to around 55% in year 10 with a 10-year average of 58.9%. Perhaps, this is one of the key factors for the monotonic growth in net operating profit. Note, however, that if feed cost remains above 60%, it would be almost impossible for the dairy farm to remain profitable. Thus, curtailing feed cost appears to be the key for success of this dairy farm in the business model. Therefore, feed cost management strategies are critical for the dairy farms to achieve profitability.

In Table 6.8, common size income statements also indicate that the operating margins remain low in the beginning but significantly increase in the later period. The operating margins average 5.9% from year 2 to year 4 but after year 4 they post an average increase of 19%.

Table 6.6: Assumptions For Base-Case Analysis Of A 1300 Cow Farm

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Average
Milk price	61.00	62.00	63.00	64.00	65.00	66.00	67.00	68.00	69.00	70.00	65.5
Milk production (liters)	4,941,670	7,469,511	7,612,120	8,772,884	10,075,957	10,839,584	10,976,363	11,470,890	11,638,467	11,678,238	9,547,568

Table 6.7: Projected Income Statements Of A 1300 Cow Farm

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Average
Milk Sales	301,441,846	463,109,682	479,563,555	561,464,602	654,937,187	715,412,531	735,416,337	780,020,511	803,054,232	817,476,684	631,189,717
Sale of calves	2,622,000	2,661,068	3,280,089	3,634,445	4,167,267	4,724,707	4,884,309	5,169,517	5,379,889	5,583,335	4,210,663
Sale of culled heifers	-	1,444,198	1,465,716	1,806,673	2,001,852	2,295,330	2,602,369	2,690,278	2,847,370	2,963,243	2,235,225
Sale of culled cows	7,920,000	12,057,012	19,815,640	21,956,370	25,175,249	43,116,721	46,230,552	50,183,348	53,766,549	57,392,823	33,761,426
Total Revenue	**311,983,846**	**479,271,959**	**504,125,000**	**588,862,089**	**686,281,555**	**765,549,290**	**789,133,567**	**838,063,654**	**865,048,040**	**883,416,085**	**671,173,509**
Feed	(217,503,273)	(298,919,245)	(312,577,355)	(354,257,237)	(400,918,499)	(430,716,609)	(440,365,072)	(457,291,644)	(474,723,123)	(488,360,779)	(387,563,284)
Insemination	(3,471,300)	(4,099,004)	(4,245,196)	(4,793,522)	(5,437,087)	(5,819,105)	(5,954,869)	(6,197,557)	(6,428,638)	(6,615,152)	
Vaccination	(3,161,894)	(4,039,990)	(4,365,453)	(4,968,641)	(5,646,851)	(6,198,144)	(6,547,570)	(6,864,609)	(7,154,733)	(7,406,873)	
Medicine	(14,115,600)	(18,035,671)	(19,488,631)	(22,181,435)	(25,209,156)	(27,670,285)	(29,230,224)	(30,645,575)	(31,940,772)	(33,066,397)	
Parlor Chemical	(846,000)	(862,920)	(880,178)	(897,782)	(915,738)	(934,052)	(952,733)	(971,788)	(991,224)	(1,011,048)	
Teat Dip	(1,798,222)	(1,756,181)	(1,825,504)	(2,063,415)	(2,327,770)	(2,463,045)	(2,456,283)	(2,531,011)	(2,619,346)	(2,680,863)	
Human Resource	(48,000,000)	(48,960,000)	(49,939,200)	(50,937,984)	(51,956,744)	(52,995,879)	(54,055,796)	(55,136,912)	(56,239,650)	(57,364,443)	
Utilities	(24,875,597)	(24,294,023)	(25,253,004)	(28,544,121)	(32,201,071)	(34,072,385)	(33,978,844)	(35,012,583)	(36,234,561)	(37,085,550)	
P.O.L	(18,810,912)	(27,758,112)	(28,313,274)	(28,879,540)	(29,457,131)	(30,046,273)	(30,647,199)	(31,260,143)	(31,885,345)	(32,523,052)	
Mess Expenses	(5,475,000)	(5,584,500)	(5,696,190)	(5,810,114)	(5,926,316)	(6,044,842)	(6,165,739)	(6,289,054)	(6,414,835)	(6,543,132)	
Depreciation	(29,281,000)	(29,281,000)	(29,281,000)	(29,281,000)	(29,281,000)	(29,281,000)	(29,281,000)	(29,281,000)	(29,281,000)	(29,281,000)	
Total Expenses	**(367,338,799)**	**(463,590,645)**	**(481,864,986)**	**(532,614,791)**	**(589,277,361)**	**(626,241,618)**	**(639,635,328)**	**(661,481,875)**	**(683,913,227)**	**(701,938,289)**	**(574,789,692)**
Earnings before Interest and Tax	**(55,354,953)**	**15,681,315**	**22,260,014**	**56,247,298**	**97,004,195**	**139,307,671**	**149,498,239**	**176,581,779**	**181,134,813**	**181,477,796**	**96,383,817**
Taxes	-	(1,568,131)	(2,226,001)	(5,624,730)	(9,700,419)	(13,930,767)	(14,949,824)	(17,658,178)	(18,113,481)	(18,147,780)	
Net Profit	**(55,354,953)**	**14,113,183**	**20,034,013**	**50,622,568**	**87,303,775**	**125,376,904**	**134,548,415**	**158,923,601**	**163,021,332**	**163,330,016**	**86,191,885**

Table 6.8: Common Size Income Statements For A 1300 Cow Farm

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Milk Sales	96.6%	96.6%	95.1%	95.3%	95.4%	93.5%	93.2%	93.1%	92.8%	92.5%
Sale of calves	0.8%	0.6%	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Sale of culled heifers	0.0%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Sale of culled cows	2.5%	2.5%	3.9%	3.7%	3.7%	5.6%	5.9%	6.0%	6.2%	6.5%
Total Revenue	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Feed	-69.7%	-62.4%	-62.0%	-60.2%	-58.4%	-56.3%	-55.8%	-54.6%	-54.9%	-55.3%
Insemination	-1.1%	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.7%	-0.7%	-0.7%
Vaccination	-1.0%	-0.8%	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%
Medicine	-4.5%	-3.8%	-3.9%	-3.8%	-3.7%	-3.6%	-3.7%	-3.7%	-3.7%	-3.7%
Parlor Chemical	-0.3%	-0.2%	-0.2%	-0.2%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Teat Dip	-0.6%	-0.4%	-0.4%	-0.4%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%
Human Resource	-15.4%	-10.2%	-9.9%	-8.7%	-7.6%	-6.9%	-6.9%	-6.6%	-6.5%	-6.5%
Utilities	-8.0%	-5.1%	-5.0%	-4.8%	-4.7%	-4.5%	-4.3%	-4.2%	-4.2%	-4.2%
P.O.L	-6.0%	-5.8%	-5.6%	-4.9%	-4.3%	-3.9%	-3.9%	-3.7%	-3.7%	-3.7%
Mess Expenses	-1.8%	-1.2%	-1.1%	-1.0%	-0.9%	-0.8%	-0.8%	-0.8%	-0.7%	-0.7%
Depreciation	-9.4%	-6.1%	-5.8%	-5.0%	-4.3%	-3.8%	-3.7%	-3.5%	-3.4%	-3.3%
Total Expenses	**-117.7%**	**-96.7%**	**-95.6%**	**-90.4%**	**-85.9%**	**-81.8%**	**-81.1%**	**-78.9%**	**-79.1%**	**-79.5%**
Earnings before Interest & Tax	**-17.7%**	**3.3%**	**4.4%**	**9.6%**	**14.1%**	**18.2%**	**18.9%**	**21.1%**	**20.9%**	**20.5%**

Sensitivity Of Operating Profits To Milk Price, Milk Yield And Feed Cost

To shed light on main driving force behind the profitability of the 1300 cow dairy farm, we conduct sensitivity analysis. Figures 6.1 and 6.2 show the sensitivity of varying milk price, milk yield and feed costs by 10% each on the operating profit per cow and operating profit per liter of milk, respectively. Note that a 10% increase in either milk price or milk production leads to an increase in operating profit per cow of PKR 32,248 (Figure 6.1). A similar increase in milk price and milk yield leads to PKR 6.10 and PKR 5.24 increase in operating profit per liter of milk, respectively (Figure 6.2).

Note, however, that farm gate price of milk is sticky, and it will remain so until cheaper SMPs and HM imports keep on flooding local markets. Since the dairy farms have little control on the farm gate price of milk, it is highly unlikely that they will be able to increase farm profitability due to increase in milk price. However, they can venture to increase milk yield per cow and achieve optimal yields by adopting better farm management practices.

Due to high share of feed cost in total cost, a decrease in the price of feed significantly increases operating profit per cow and operating profit per liter of milk in the business model (see, Figures 6.1 and 6.2). For example, a 10% decrease in feed cost increases operating profit per cow by PKR 21,526 and operating profit per liter of milk by PKR 4.08, which is a huge increase. Even though the decrease in feed cost has smaller impact on operating profit per cow and operating profit per liter of milk, compared with the impact of increase in milk price, yet it can serve as an effective measure of increasing profitability since management of feed cost is within the ambit of the dairy farms. Adopting best practices in feed preparation, securing discounts in bulk buying of feed components, negotiated feed prices with vendors can all help to control feed costs.

Figure 6.1: Impact Of Changes In Key Variables On Operating Profit Per Cow

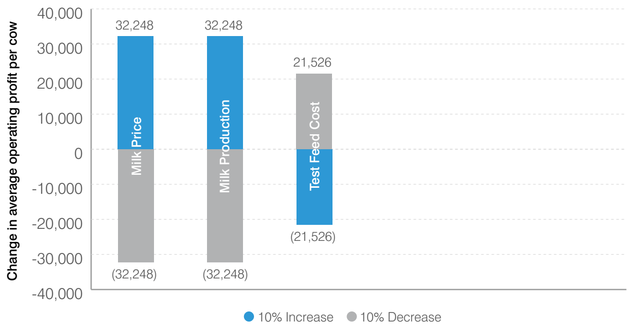
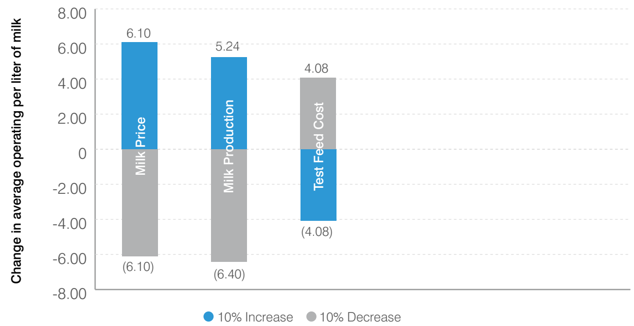


Figure 6.2: Impact Of Changes In Key Variables On Operating Profit Per Liter Of Milk



6.5.2 Sensitivity Of Operating Profits To Herd Size

We repeat the financial analysis by varying herd size to explore how economies of scale affects operating profits of the dairy farms. We base our analysis on comparison of 1300-cow dairy farm with two smaller dairy farms holding 500 cows and 300 cows. As before, we base our analysis on purebred Holstein Frisian heifers from Australia. Assumptions about calving interval, gender distribution, calves sold within one week of birth and calving taking place in one month are same as in 1300 cattle farm. We take mortality rate for lactating cows in year 1 at 4% rather than 3% for 1300 cow farm. All other assumptions in Table 6.1 equally apply to the 500- and 300-cow farms. Moreover, in both dairy farm sizes, we apply culling rates of 12% to lactating cows in year 1 unlike 10% rate in 1300 cattle farm. Other applied rates in these farms were same as in 1300-cow dairy farm. We assume the value of animals remains same irrespective of the farm size.

Financial Model Of A Typical 500-Cow Pure Bred Holstein Frisian Dairy Farm

As noted in Annex-B, Table B6.1, the number of imported cattle in year 1 and year 2 are 500 and 75, respectively. These heifers were six months pregnant on arrival. However, capital investment on a 500 cattle farm comes to PKR 440 million, which includes cost of 575 cattle, cost of 20-acre land, cost of civil works, machinery, equipment and water and pumping cost.

In Annex-B, Table B6.2, most of the operating cost assumptions for a 500-cow farm are same as in Table 6.2 for a 1300-cow farm, except three. First, in parlor chemical, acid quantity is taken as 577 liters at PKR 1,000/liter whereas the quantity of alkali is taken as 1154 liter at PKR 2,000/liter. Second, we take HR cost of 75 employees as PKR 2,400,000. Last, we assume POL cost on fuel & maintenance at PKR 7,234,966 for year 1 and PKR 10,676,197 for year 2. Milk related, and other assumption are given in Annex-B, Table B6.3 and Table B6.4 with only one change from Table 6.3 that milk price is taken as PKR 60 in year 1, PKR 61 in year 2 and so on. Annex-B, Table B6.5 presents feed cost assumptions, which are same as in Table 6.5. Finally, Annex-B, Table B6.6 presents herd movement while Table B6.7 presents stock movement of a 500 cattle dairy farm.

Turning to the financial analysis, Annex-B, Table B6.8 gives milk price and milk production for a 500-cow farm while Table B6.9 exhibits 10-year projected income statement for a 500-cow farm. As before, we apply the tax rate of 10%, equity to debt ratio of 70:30 and interest rate at 14%. For the 10-year period, the average operating profit per annum comes to PKR 20.05 million, which is much lower than the profit on 1300 cattle farm (Annex-B, Table B6.9). Operating profit remains negative from year 1 to year 3, but increases monotonically throughout. The operating profit increases from PKR 8.8 million in year 4 to 46.6 million in year 10. Similarly, average operating profit per cow on a 500 cow farm is PKR 20,576 which is far less than PKR 45,763 profit per cow on a 1300 cow farm. Operating profit per liter of milk is PKR 3.54, compared with PKR 8.28 on a 1300 cow farm. Operating margins are negative in first few years but significantly increase in the later period with an average operating margin of 4.6% in the 10-year period, compared with 11.3% operating margin on a 1300 cow farm. Thus, there is clear evidence to suggest that economies of scale are present in the large commercial dairy sector.

Financial Model Of A Typical 300-Cow Pure Bred Holstein Frisian Dairy Farm

On a 300 cow dairy farm, the number of imported cows was 300 in year 1 and 45 in year 2 (Annex-C, Table C6.1). Capital investment on this farm comes to PKR 258.1 million, which includes land cost of purchasing 10-acres of land, civil works, machinery & equipment and water & pumping expenditures (see, Table A4.13). In Annex-C, Table C6.2, the assumptions for a 300-cow farm are same as taken in Table 6.1 for a 1300-cow farm, except the following differences. One, for parlor chemical, acid quantity is taken as 346 liters at PKR 750/liter while quantity of alkali is taken as 692 liters at PKR 1,500/liter. Two, we take cost of HR for 45 staff as PKR 1.44 million per month. Finally, we assume fuel & maintenance cost as PKR 4.34 million per annum for year 1 and PKR 6.41 million in year 2 onwards. We take milk related assumptions in Annex-C, Table C6.3 while other assumptions are in Annex-C, Table C6.4. We present feed cost assumptions for a 300-cow farm in Annex-C, Table C6.5. Annex-B, Table C6.6 presents herd movement for this farm whereas Table C6.7 reports stock movement.

For the financial analysis, Annex-C, Table C6.8 and Table C6.9 present 10-year projected income statement for a 300-cow dairy farm where we assume the tax rate at 10% and interest rate at 14% for an equity to debt ratio of 70: 30. Our estimates suggest that average operating profit for 300-cow farm is PKR 5.5 million, compared with profit of PKR 20.05 million on 500-cow farm and PKR 96.4 million on 1300-cow farm. Operating profit on 300-cow farm remains negative from year 1 to year 4 but increases from PKR 6.7 million in year 5 to PKR 21 million in year 10. Annex-C, Table C6.10 shows that the operating margins were negative until year 4 but increases in the later period. Average operating margin from year 2 to year 10 is 4% but after year 4, the operating margin average is 8.9%.

Comparison Of Operating Profit On 300, 500 And 1300-Cow Dairy Farms

Table 6.9 presents comparison of operating profits per cow and per liter of milk on 300, 500 and 1300 cow dairy farms. It is interesting to note that average operating profit per cow on a 300-cow farm is lowest at PKR 5,461, compared with operating profit of PKR 20,576 and PKR 45,763 per cow on 500-cow and 1300-cow farms, respectively. Operating profit per liter of milk is also lowest on 300-cow farm at PKR 0.69 relative to PKR 3.57 and PKR 8.28 on 500-cow and 1300-cow dairy farms, respectively. Operating margins in the 10-year period are negative in first few years but the margins significantly increase in the later period with an average operating margin of 0.3%, 4.6% and 11.3% in 300-, 500- and 1300-cow farms, respectively (Table 6.9). Thus, there is clear evidence to suggest that economies of scale are present in the large commercial dairy sector.

Table 6.9: Comparison Of Operating Profits On 300, 500 And 1300 Cow Dairy Farms

	300-cow dairy farm					500-cow dairy farm					1300-cow dairy farm				
Year	Milk price (PKR)	Cows (no.)	Operating profit per cow (PKR)	Operating profit per liter of milk (PKR)	Operating margin (earnings before interest & tax)	Milk price (PKR)	Cows (no.)	Operating profit per cow (PKR)	Operating profit per liter of milk (PKR)	Operating margin (earnings before interest & tax	Milk price (PKR)	Cows (no.)	Operating profit per cow (PKR)	Operating profit per liter of milk (PKR)	Operating margin (earnings before interest & tax
Year 1	58	252	-93,993	-19.86	-32.8	60	420	-84,084	-17.76	-28.4	61	1,044	-53,022	-11.20	-17.7
Year 2	59	367	-28,907	-5.80	-9.5	61	611	-13,623	-2.73	-4.3	62	1,487	10,544	2.10	3.3
Year 3	60	375	-22,371	-4.43	-7.0	62	625	-7,292	-1.44	-2.2	63	1,505	14,789	2.92	4.4
Year 4	61	415	-2,774	-0.53	-0.8	63	691	12,741	2.42	3.7	64	1,665	33,788	6.41	9.6
Year 5	62	448	14,929	2.80	4.2	64	747	30,684	5.76	8.5	65	1,860	52,146	9.63	14.1
Year 6	63	470	24,963	4.65	6.9	65	779	40,528	7.57	10.9	66	1,972	70,653	12.85	18.2
Year 7	64	485	35,971	6.65	9.6	66	800	50,086	9.31	13.1	67	2,022	73,924	13.62	18.9
Year 8	65	489	44,199	8.08	11.5	67	817	60,115	10.95	15.2	68	2,081	84,872	15.39	21.1
Year 9	66	494	41,170	7.64	10.7	68	825	60,233	11.09	15.1	69	2,120	85,449	15.56	20.9
Year 10	67	499	41,420	7.68	10.6	69	826	56,378	10.51	14.1	70	2,148	84,490	15.54	20.5
Avg (PKR)		--	**5461**	**0.69**	**0.3%**		--	**20,576**	**3.57**	**4.60%**		--	**45,763**	**8.28**	**11.3%**

6.6 Investment Potential Of A 100-Cow Dairy Farm In Peri-Urban Areas

6.6.1 Introduction

Keeping in view huge capital investment required on large commercial dairy farms, the number of such dairy farms in the country is below 50; the growth in such dairy farms has failed to gain momentum over the past 10 years. As noted above, capital investment required on a 1300-cow dairy farm is PKR 1.1 billion. Even a 300-cow dairy farm requires capital investment of PKR 258 million. Thus, it is reasonable to assume that such dairy farms are not a viable option for most investors in the country. Presence of huge demand for raw milk in metropolitan and major cities of Pakistan and higher milk prices offers huge potential for investment in dairy farming. As discussed below, a more viable business proposition appears to be in setting up of a 100-cow dairy farm in peri-urban areas.

Peri-urban areas in all major cities of Pakistan has high demand for raw and processed milk but those peri-urban areas where there is enough water, fodder availability, veterinary services and marketing opportunities offer a better choice for dairy sector investment. Near all big cities, milk price of unadulterated milk ranges from PKR 70 to PKR 120 per liter, which is much higher than the average farm gate price of raw milk offered by milk processing industry or their agents, ranging from PKR 47 to PKR 57. Dairy farms located in peri-urban areas of big cities can sell milk to end-consumers by delivering it at their doorsteps, milk contractors, milk centers in urban markets through the contractors and manufacturers of numerous dairy products.

Our estimates show that for every one-million population, the daily milk intake ranges from 260,000 to 340,000 liters of milk.[58]Commercial dairy farms of various sizes are already present in peri-urban areas of all big cities. However, due to population size advantage metropolitan urban centers offer lucrative markets for sale of raw milk. For example, the daily demand for milk in Lahore ranges from 2.9 million liters to 3.6 million liters. Similarly, the daily demand for milk in Faisalabad ranges from 0.83 million liters to 1.04 million liters.

A cursory look at the retail price for raw milk charged by informal milk collectors and milk shops in Karachi and Lahore suggests that end-consumers pay in the range of PKR 100 to PKR 120 per liter for unadulterated full cream milk. Average milk price charged by informal milk suppliers (dodhis) from end-consumers starts from PKR 70 and steeply goes up depending upon the quality of milk. This price range together with high demand for good quality fresh milk in peri-urban areas of big cities/metropolitan areas offers huge investment potential for 100-cow dairy farms. To examine the investment potential of dairy farming in peri-urban areas, we conduct the financial analysis of a typical 100-cow purebred Holstein Frisian dairy farm under certain assumptions.

6.6.2 Capital Investment, Project Cost And Operating Profits At Various Milk Prices

Our estimates suggest that this venture will require a total capital investment of PKR 96 million, including cost of 115 pure bred Holstein Frisian cows imported in years 1 and 2, cost of 10-acres land, cost of civil works, machinery & equipment and water & pumping cost (Annex-D, Table D6.1). Annex-D, Table D6.2 to Table D6.4 present operating cost, milk related assumptions and other assumptions whereas Annex-D, Table D6.5 presents feed cost assumptions.

We assume that the project is working on 70:30 debts to equity ratio. The project will maintain 84 lactating cows in year 1, 90 in year 3 and 100 lactating cows in year 5 when it will reach at its maturity; from then onwards, it will maintain around 100 lactating cows Annex-D, Table D6.6 and Table D6.7). We assume that the project sells or culls less productive cows and surplus stock to maintain 100 lactating cows. Annex-D, Table D6.8 and Table D6.9 presents 10-year projected income statements based on milk price of PKR 70 per liter.

The financial model suggests that the internal rate of return of this venture at milk price of PKR 70 is 11%, which increases to 19% at milk price of PKR 80, 25% at milk price of PKR 90 and 30% at milk price of PKR 100 (Figure 6.3).

[58]*We obtain daily milk intake by multiplying per capita milk consumption with population numbers. Per capita milk consumption ranges from 0.326 liter per day (Table 2.6) to 0.26 liter per day (Table 2.7).*

Figure 6.3: Internal Rate Of Return At Various Prices

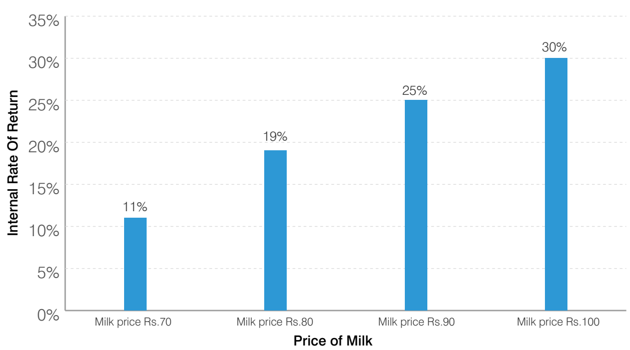


Figure 6.4 indicates that as this dairy farm gains maturity in year 5, net operating profit (earnings before interest and tax) significantly increases with increase in milk price in the area of operations. For instance, the operating profit in year 5 reaches PKR 8 million at milk price of PKR 70 per liter, which doubles to PKR 16 million at milk price of PKR 80. The operating profit of dairy farms that are able to fetch milk price of PKR 90 and PKR 100 are able to get operating profits of PKR 24 million and PKR 32 million, respectively.

Figure 6.4: Operating Profit Per Farm At Various Prices

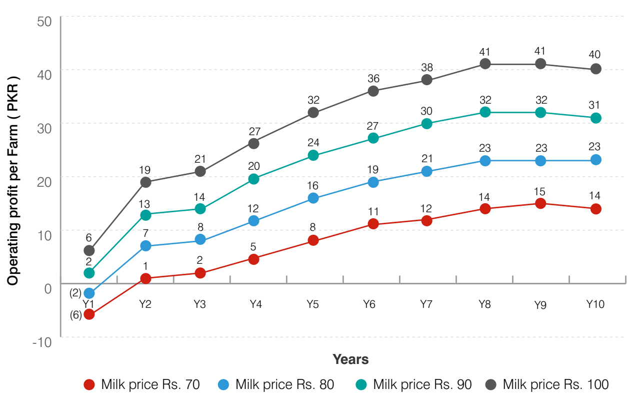
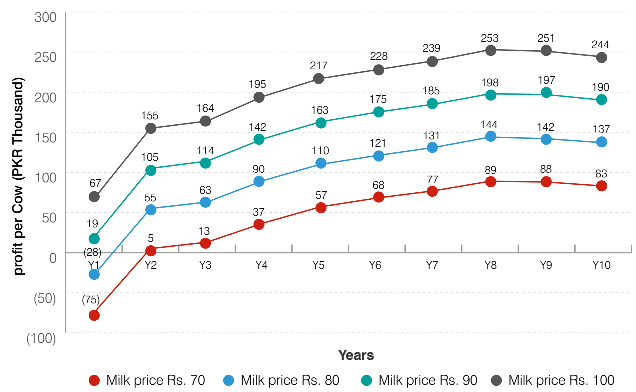


Figure 6.5 indicates that average operating profit per cow gradually increases as the dairy farm gains maturity from year 1 to year 5. For instance, in year 5, average operating profit per cow at milk price of PKR 70 per liter is PKR 57,000. This profit is nearly four times higher than the operating profit of PKR 14,929 on a 300 cow farm in year 5.

Note, however that the operating profit goes up to PKR 110,000, PKR 163,000 and PKR 217,000 at milk prices of PKR 80, PKR 90 and PKR 100, respectively. In other words, holding other things as constant, increase in milk price in the area of operation makes this venture highly profitable.

Figure 6.5: Operating Profit Per Cow At Various Prices



Likewise, operating profit per liter of milk also increases with the dairy farm gaining maturity from year 1 to year 5. For example, Figure 6.6 reveals that operating profit per liter of milk is PKR 13 at milk price of PKR 70; this is significantly higher than the year 5 profit per liter of milk of PKR 9.63, PKR 5.76 and PKR 2.80 on 1300-, 500- and 300-cow dairy farms, respectively. The profit on 100-cow farm goes up to PKR 21 at milk price of PKR 80, PKR 31 at milk price of PKR 90 and PKR 41 at milk price of PKR 100.

Figure 6.6: Operating Profit Per Liter Of Milk At Various Prices

In sum, the business feasibility of investment in a 100 cow dairy farm in peri-urban areas suggests high internal rate of return, which monotonically increases with increase in effective milk price in the area of operations. The project offers handsome net operating profits either measured per farm, per cow and per liter of milk.

6.7 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 organized their operations 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 sends them to the maternity department for impregnation. The feed department looks after procurement and storage of animal feed. Due to mechanized milking, milk 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. The USAID dairy project have achieved significant improvements in dairy farming practices of the small-scale dairy producers, 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 more feed, which inevitably increases fodder cost. Further, both foreign and mixed breeds are unable to adapt to local climatic conditions and are susceptible to local diseases, which is why specialized veterinarians are required for their immunization and medical care. Moreover, temperature-controlled sheds are also required, which adds to energy costs incurred by the farm. Since the advent of corporate dairy farming in Pakistan is a recent development, the corporate farms hire skilled foreign personnel 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 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 because it requires a lot or investment 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 longer run. Additionally, as the corporate dairy industry grows, it is likely to become more efficient by sharing expertise. Nevertheless, there are no short-term solutions. In addition, 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.

The financial model of a 1300 cattle purebred Holstein Frisian dairy farm shows 10-year average operating profit of PKR 96.4 million but increasing from PKR 14 million in year 2 to PKR 163 million in year 10. Average operating profit per cow for the 10-year period comes to PKR 45,763 while the 10-year average operating profit per liter of milk comes to PKR 8.28. The operating profit is highly sensitive to varying milk price, milk yield and feed cost. The results suggest that a 10% increase in milk price leads to an increase in operating profit per cow of PKR 32,248 and PKR 6.10 increase in operating profit per liter of milk.

There is clear evidence to suggest that economies of scale are present in the large commercial dairy sector. For example, a comparison of operating profit of 1300 cattle farm with 500 cattle and 300 cattle farms reveals that the average profit per cow is highest on 1300 cattle farm, followed by 500 cattle farm and then 300 cattle farm. Operating profit per liter of milk is also highest on 1300 cattle dairy farm. The operating margins in first few years of operations are negative for these farms; however, the margins significantly increase in the later period with 10-year average operating margins of 0.3%, 4.6% and 11.3% on 300, 500 and 1300 cow farms, respectively.

This study shows that due to huge capital investment required on very large dairy farms, they are not a viable option for most investors in the country. On the contrary, 100 cattle dairy farms in peri-urban areas of big cities are a more viable business proposition due to huge demand for fresh milk in big cities at higher retail prices than the average price offered by the milk processing industry. The demand for fresh milk in Karachi and Lahore is around 3 million liters per day at retail price ranging from PKR 70 to PKR 120 per liter. Our estimates show that the internal rate of return on a 100 cattle dairy farm in peri-urban areas at milk price of PKR 70 and PKR 80 is 11% and 19%, respectively. This return goes up to 25% and 30% at retail price of PKR 90 and PKR 100, respectively. This farm gains maturity in 5th year of its operations when average profit per cow comes to PKR 57,000 at milk price of PKR 70 per liter, which is nearly four-times higher than the operating profit of a 300-cow farm.

Annex-A: Assumptions Of A 1300 Cattle Dairy Farm

Table A6.1: Herd Movements For 1300 Cattle Farm

								Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
		Calf	M					-	-	-	-	-	-	-	-	-	-
			F					-	524	522	631	685	770	856	867	900	918
Opening Balance		Heifer	M					-	-	-	-	-	-	-	-	-	-
			F					-		0	(0)	(0)	-	0	0	0	0
		Adult						-	-	488	485	586	637	716	796	807	837
		Lactating						-	1,044	955	1,082	1,176	1,321	1,269	1,264	1,295	1,301
		Total						-	1,568	1,965	2,198	2,447	2,728	2,841	2,927	3,002	3,056
	Purchase	Calf	M														
			F														
		Heifer	M														
			F														
		Adult						1,200	150								
		Lactating															
Increase	Birth	Calf	M	46%				552	549	664	721	811	901	913	947	967	984
			F	46%				552	549	664	721	811	901	913	947	967	984
	Transfer	Heifer	M														
			F						524	522	631	685	770	856	867	900	918
		Adult							488	485	586	637	716	796	807	837	854
		Lactating						1,200	150	488	485	586	637	716	796	807	837
	Death	Calf	M	5%				28	27	33	36	41	45	46	47	48	49
			F	5%				28	27	33	36	41	45	46	47	48	49
		Heifer	M	2%													
			F	2%				-	10	10	13	14	15	17	17	18	18
		Adult	M														
		Lactating	F	3%	5%	5%	5%	36	60	72	78	88	98	99	103	105	107
	Transfer	Calf	M														
			F						524	522	631	685	770	856	867	900	918
Decrease		Heifer	M														
			F						488	485	586	637	716	796	807	837	854
		Adult						1,200	150	488	485	586	637	716	796	807	837
		Lactating	M														
	Sale & Culling	Calf	F					524	522	631	685	770	856	867	900	918	934
			M														
		Heifer	F														
				5%	5%	5%		-	26	26	32	34	38	43	43	45	46
		Adult															
		Lactating		10%	15%	20%	20%	120	179	289	313	352	592	622	662	695	728
		Calf	M					-	-	-	-	-	-	-	-	-	-
			F					524	522	631	685	770	856	867	900	918	934
Closing Balance		Heifer	M					-	-	-	-	-	-	-	-	-	-
			F					-	0	(0)	(0)	-	0	0	0	0	0
		Adult						-	488	485	586	637	716	796	807	837	854
		Lactating						1,044	955	1,082	1,176	1,321	1,269	1,264	1,295	1,301	1,304
		Total						1,568	1,965	2,198	2,447	2,728	2,841	2,927	3,002	3,056	3,092
Percentage Milking animals								67%	49%	49%	48%	48%	45%	43%	43%	43%	42%
Percentage non milking animals								33%	51%	51%	52%	52%	55%	57%	57%	57%	58%

Source: Dairy sector consultant's data revised and simplified for the analysis

Table A6.2: Stock Movements For A 1300 Cattle Farm

Opening Stock		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Calf	M	-	-	-	-	-	-	-	-	-	-
	F	-	524	522	631	685	770	856	867	900	918
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	-	0	(0)	(0)	-	0	0	0	0
Adult		-	-	488	485	586	637	716	796	807	837
Lactating		-	1,044	955	1,082	1,176	1,321	1,269	1,264	1,295	1,301
Total		**-**	**1,568**	**1,965**	**2,198**	**2,447**	**2,728**	**2,841**	**2,927**	**3,002**	**3,056**
Closing Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	-	-	-	-	-	-	-	-	-	-
	F	524	522	631	685	770	856	867	900	918	934
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	0	(0)	(0)	-	0	0	0	0	0
Adult		-	488	485	586	637	716	796	807	837	854
Lactating		1,044	955	1,082	1,176	1,321	1,269	1,264	1,295	1,301	1,304
Total		**1,568**	**1,965**	**2,198**	**2,447**	**2,728**	**2,841**	**2,927**	**3,002**	**3,056**	**3,092**
Average Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	-	-	-	-	-	-	-	-	-	-
	F	262	523	576	658	727	813	862	884	909	926
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	0	-	(0)	(0)	0	0	0	0	0
Adult		-	244	486	536	612	677	756	801	822	846
Lactating		522	1,000	1,019	1,129	1,249	1,295	1,266	1,279	1,298	1,302
Total		**784**	**1,767**	**2,081**	**2,322**	**2,588**	**2,785**	**2,884**	**2,964**	**3,029**	**3,074**
Sale of Calf and Culled Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	524	522	631	685	770	856	867	900	918	934
	F	-	-	-	-	-	-	-	-	-	-
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	26	26	32	34	38	43	43	45	46
Adult		-	-	-	-	-	-	-	-	-	-
Lactating		120	179	289	313	352	592	622	662	695	728
Death of Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	28	27	33	36	41	45	46	47	48	49
	F	28	27	33	36	41	45	46	47	48	49
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	10	10	13	14	15	17	17	18	18
Adult		-	-	-	-	-	-	-	-	-	-
Lactating		36	60	72	78	88	98	99	103	105	107

Source: Dairy sector consultant's data revised and simplified for the analysis

Annex-B: Assumptions And Income Statements Of 500 Cattle Dairy Farm

Table B6.1: Herd Size Assumptions For A 500 Cattle Dairy Farm

Herd Size					
Number of cows imported				500	
Start of Year 1				75	
Start of Year 2					
Herd related Assumptions					
Mortality					
Lactating cows - Year 1				4%	per annum
Lactating cows - Year 2 onwards				5%	per annum
Heifers				2%	per annum
Calves				5%	per annum
Culling rate				12%	per annum
Lactating cows - Year 1				15%	per annum
Lactating cows - Year 2				20%	per annum
Lactating cows - Year 3 onwards				5%	per annum
Heifers					
Value of Animals					
Import price			PKR	350,000	per cow
Price - culled cow			PKR/kg	120	550 kg
Price - culled heifer			PKR/kg	120	200 kg
Price - calf			PKR	5,000	per cow
Capital Investment					
Land (acres x purchase price per acre)	Useful life (years)		PKR	PKR	60,000,000
Civil work (sq ft area x price per sq ft)	20	20	3,000,000	PKR	100,000,000
Electrical	10	100,000	1,000	PKR	25,115,385
Machinery & Equipment	20			PKR	50,653,846
Water & Plumbing	10			PKR	3,123,077

Source: Dairy sector consultant's data revised and simplified for the analysis

Table B6.2: Operating Cost Assumptions For A 500 Cattle Farm

Feed			
Straws for insemination	PKR	950	
Cows	Quantity	3.5	
Heifers	Quantity	2	
Vaccination	Quantity	PKR	
FMD	2	182	per vaccine
HS	1	26	per vaccine
3Day Fever	1	800	per vaccine
Elite 9	2	330	per vaccine
Clostradium	1	64	per vaccine
RB 51	2	51	per vaccine
Medicine	PKR	9,000	per animal
Parlor Chemical	Quantity (liter)	PKR	
Acid	577	1,000	per liter
Alkali	1,154	2,000	per liter
Teat dip			
Quantity per milking per day	Liters	0.001	per lactating cow
No of milkings per day		3	
No of days		365	
Cost	PKR	1,573	per liter
HR	PKR	2,400,000	per month
Utilities			
Energy required	kw	0.34	per lactating cow
No of hours	h	16	
Tariff		12	per kwh
P.O.L.			
Year 1	PKR	7,234,966	per annum
Year 2 onwards	PKR	10,676,197	per annum
Mess Expenses			
Per day expenses	PKR	120	per staff member
No of days		365	
Staff		75	

Source: Dairy sector consultant's data revised and simplified for the analysis

Table B6.3: Milk Related Assumptions

Milk price			
Year 1	PKR	60	per liter
Year 2 onwards	PKR	61	per liter
Milk yield per day			
Year 1	Liters	23	per animal
Year 2	Liters	25	per animal
Year 3	Liters	25	per animal
Year 4	Liters	26	per animal
Year 5	Liters	27	per animal
Year 6	Liters	28	per animal
Year 7	Liters	29	per animal
Year 8 onwards	Liters	30	per animal
Milk wastage		2%	
Milk days			
Year 1		210	per animal
Year 2 onwards		305	per animal

Source: Dairy sector consultant's data revised and simplified for the analysis

Table B6.4: Other Assumptions For A 300 Cattle Farm

Calving interval	12	months
Inflation		2%
Tax rate		10%
Net working capital	2%	of total revenue
Long term growth rate		5%
	Weights	**Costs**
Debt (Interest rate)	30%	14%
Equity	70%	16%

Source: Dairy sector consultant's data revised and simplified for the analysis

Table B6.5: Feed Cost Assumptions For A 500 Cattle Farm

	Cost per kg	Requirements (kg)				No of Days						
		Lactating cows		R1YO	R2YO	Lactating cows		kg	kg	R1YO	R2YO	
		Milking days	Dry period			Milking days		Dry period		Calves	Cows	Heifers
						Year 1	Year 2 onwards	Year 1	Year 2 onwards		Year 1	Year 2 onwards
Maize Silage	6.25	25.00	12.00	8.00	12.00	210	305	0	60	275	155	365
Wheat Straw	8.88	-	5.00	-	3.00	210	305	0	60	275	155	365
Maize Grain	23.75	4.00	-	0.80	1.00	210	305	0	60	275	155	365
Cotton Seed	38.35	2.50	-	-	-	210	305	0	60	275	155	365
Corn Gluten	22.16	2.50	-	0.80	-	210	305	0	60	275	155	365
Wheat Bran	24.00	2.50	-	-	-	210	305	0	60	275	155	365
Soya Bean	55.00	2.50	-	0.80	-	210	305	0	60	275	155	365
Canola Meal	35.60	0.50	1.00	-	1.00	210	305	0	60	275	155	365
Bypass Fat	90.00	0.50	-	-	-	210	305	0	60	275	155	365
Molases	10.00	2.00	-	-	-	210	305	0	60	275	155	365
Mineral Mix	123.66	0.10	0.10	0.05	0.05	210	305	0	60	275	155	365
Mycotoxin Binder	230.00	0.02	-	-	-	210	305	0	60	275	155	365
Urea	28.00	0.10	0.10	-	0.07	210	305	0	60	275	155	365
Salt	5.00	0.10	-	-	-	210	305	0	60	275	155	365
Bi carb	44.44	0.20	-	-	-	210	305	0	60	275	155	365
Yeast	1,000.00	0.02	-	-	-	210	305	0	60	275	155	365
Cow Milk Replacer (CMR)	32.00	-	-	6.00	-	0	0	0	0	90	0	0
Calf Starter	45.00	-	-	0.40	-	0	0	0	0	90	0	0

Source: Dairy sector consultant's data revised and simplified for the analysis
Notes: Calves and R1YO: Newborn calves must receive 4 liter of colostrum within first hour of their birth and then second feed after 12 hours and then transitionally moved to cow milk or replacer. The farms feed calves almost 6 liters of milk or replacer per day for first 90 days, and later introduce with pallet diet and gradually move to calf starter.
Dry Cows and R2YO: Dry cows do not need much energy. Since most of the energy is required for milk production, the energy requirement of dry cows is low as compared to milking cows. Dry matter requirement for dry cows is 3 percent of their body weight. Their feed consists of silage and roughage, i.e., grasses and hay, to fulfill their dry matter requirement with some energy to keep their body condition moderate since too fat cows were prone to milk fever and problems in calving.

Table B6.6: Herd Movement For A 500 Cattle Farm

								Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Opening Balance		Calf	M					-	-	-	-	-	-	-	-	-	-
			F					-	219	216	262	284	320	333	347	352	362
		Heifer	M					-	-	-	-	-	-	-	-	-	-
			F					-	-	-	-	-	(0)	-	-	-	-
		Adult						-	-	203	201	244	264	297	310	323	328
		Lactating						-	420	396	449	488	499	497	496	504	496
		Total						**-**	**639**	**816**	**912**	**1,016**	**1,083**	**1,128**	**1,153**	**1,180**	**1,185**
Increase	Purchase	Calf	M														
			F														
		Heifer	M														
			F														
		Adult						500	75								
		Lactating															
	Birth	Calf	M	46%				230	228	276	299	336	351	365	371	381	379
			F	46%				230	228	276	299	336	351	365	371	381	379
	Transfer	Heifer	M														
			F						219	216	262	284	320	333	347	352	362
		Adult							203	201	244	264	297	310	323	328	336
		Lactating						500	75	203	201	244	264	297	310	323	328
Decrease	Death	Calf	M	5%				12	11	14	15	17	18	18	19	19	19
			F	5%				12	11	14	15	17	18	18	19	19	19
		Heifer	M	2%													
			F	2%				-	4	4	5	6	6	7	7	7	7
		Adult															
		Lactating		4%	5%	5%	5%	20	25	30	33	37	38	40	40	41	41
	Transfer	Calf	M														
			F						219	216	262	284	320	333	347	352	362
		Heifer	M														
			F						203	201	244	264	297	310	323	328	336
		Adult						500	75	203	201	244	264	297	310	323	328
		Lactating															
	Sale & Culling	Calf	M					219	216	262	284	320	333	347	352	362	360
			F														
		Heifer	M														
			F	5%	5%	5%		-	11	11	13	14	16	17	17	18	18
		Adult															
		Lactating		12%	15%	20%	20%	60	74	120	130	196	228	259	261	290	290
Closing Balance		Calf	M					-	-	-	-	-	-	-	-	-	-
			F					219	216	262	284	320	333	347	352	362	360
		Heifer	M					-	-	-	-	-	-	-	-	-	-
			F					-	-	-	-	(0)	-	-	-	-	-
		Adult						-	203	201	244	264	297	310	323	328	336
		Lactating						420	396	449	488	499	497	496	504	496	492
		Total						**639**	**816**	**912**	**1,016**	**1,083**	**1,128**	**1,153**	**1,180**	**1,185**	**1,188**
Percentage Milking animals								66%	49%	49%	48%	46%	44%	43%	43%	42%	41%
Percentage non milking animals								34%	51%	51%	52%	54%	56%	57%	57%	58%	59%

Source: Dairy sector consultant's data revised and simplified for the analysis

Table B6.7: Stock Movements For A 500 Cattle Farm

Opening Stock		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Calf	M	-	-	-	-	-	-	-	-	-	-
	F	-	219	216	262	284	320	333	347	352	362
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	-	-	-	-	(0)	-	-	-	-
Adult		-	-	203	201	244	264	297	310	323	328
Lactating		-	420	396	449	488	499	497	496	504	496
Total		**-**	**639**	**816**	**912**	**1,016**	**1,083**	**1,128**	**1,153**	**1,180**	**1,185**
Closing Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	-	-	-	-	-	-	-	-	-	-
	F	219	216	262	284	320	333	347	352	362	360
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	-	-	-	(0)	-	-	-	-	-
Adult		-	203	201	244	264	297	310	323	328	336
Lactating		420	396	449	488	499	497	496	504	496	492
Total		**639**	**816**	**912**	**1,016**	**1,083**	**1,128**	**1,153**	**1,180**	**1,185**	**1,188**
Average Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	-	-	-	-	-	-	-	-	-	-
	F	109	217	239	273	302	327	340	350	357	361
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	-	-	-	(0)	(0)	-	-	-	-
Adult		-	102	202	222	254	281	304	316	325	332
Lactating		210	408	423	469	493	498	497	500	500	494
Total		**319**	**727**	**864**	**964**	**1,049**	**1,105**	**1,141**	**1,166**	**1,182**	**1,186**
Sale of Calf and Culled Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	219	216	262	284	320	333	347	352	362	360
	F	-	-	-	-	-	-	-	-	-	-
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	11	11	13	14	16	17	17	18	18
Adult		-	-	-	-	-	-	-	-	-	-
Lactating		60	74	120	130	196	228	259	261	290	290
Death of Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	12	11	14	15	17	18	18	19	19	19
	F	12	11	14	15	17	18	18	19	19	19
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	4	4	5	6	6	7	7	7	7
Adult		-	-	-	-	-	-	-	-	-	-
Lactating		20	25	30	33	37	38	40	40	41	41

Source: Dairy sector consultant's data revised and simplified for the analysis

Table B6.8: Milk Price And Milk Production For A 500 Cattle Farm

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Average
Milk price	60.00	61.00	62.00	63.00	64.00	65.00	66.00	67.00	68.00	69.00	
Milk production (liters)	1,988,028	3,048,780	3,158,640	3,642,208	3,980,773	4,167,175	4,304,278	4,485,145	4,483,568	4,429,037	3,768,763

Table B6.9: Projected Income Statements For A 500 Cattle Dairy Farm

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Average
Milk Sales	119,281,680	185,975,580	195,835,665	229,459,077	254,769,453	270,866,371	284,082,352	300,504,726	304,882,633	305,603,539	
Sale of calves	1,092,500	1,103,207	1,362,157	1,508,518	1,729,976	1,840,656	1,955,035	2,022,897	2,118,154	2,149,318	
Sale of culled heifers	-	267,444	270,065	333,456	369,285	423,498	450,592	478,593	495,205	518,524	
Sale of culled cows	3,960,000	4,998,510	8,229,050	9,113,243	14,023,138	16,584,950	19,243,413	19,802,029	22,462,361	22,843,950	
Total Revenue	**124,334,180**	**192,344,741**	**205,696,937**	**240,414,293**	**270,891,852**	**289,715,475**	**305,731,393**	**322,808,245**	**329,958,354**	**331,115,331**	
Feed	(87,927,396)	(122,494,048)	(129,725,019)	(147,068,487)	(160,106,295)	(167,873,850)	(173,341,312)	(179,297,168)	(183,942,536)	(186,670,086)	(153,844,620)
Insemination	(1,396,500)	(1,679,090)	(1,762,025)	(1,989,943)	(2,167,021)	(2,269,734)	(2,346,723)	(2,428,451)	(2,490,918)	(2,527,944)	
Vaccination	(1,287,216)	(1,676,970)	(1,812,141)	(2,062,577)	(2,289,542)	(2,460,186)	(2,589,463)	(2,701,053)	(2,792,251)	(2,858,545)	
Medicine	(5,746,500)	(7,486,474)	(8,089,913)	(9,207,932)	(10,221,171)	(10,982,972)	(11,560,103)	(12,058,274)	(12,465,407)	(12,761,361)	
Parlor Chemical	(2,884,615)	(2,942,308)	(3,001,154)	(3,061,177)	(3,122,400)	(3,184,848)	(3,248,545)	(3,313,516)	(3,379,787)	(3,447,382)	
Teat Dip	(723,423)	(716,809)	(757,491)	(856,661)	(919,647)	(946,894)	(963,208)	(989,631)	(1,009,069)	(1,016,732)	
Human Resource	(28,800,000)	(29,376,000)	(29,963,520)	(30,562,790)	(31,174,046)	(31,797,527)	(32,433,478)	(33,082,147)	(33,743,790)	(34,418,666)	
Utilities	(10,007,424)	(9,915,928)	(10,478,703)	(11,850,562)	(12,721,883)	(13,098,804)	(13,324,485)	(13,690,003)	(13,958,893)	(14,064,901)	
P.O.L	(7,234,966)	(10,676,197)	(10,889,721)	(11,107,515)	(11,329,666)	(11,556,259)	(11,787,384)	(12,023,132)	(12,263,594)	(12,508,866)	
Mess Expenses	(3,285,000)	(3,350,700)	(3,417,714)	(3,486,068)	(3,555,790)	(3,626,905)	(3,699,444)	(3,773,432)	(3,848,901)	(3,925,879)	
Depreciation	(10,356,539)	(10,356,539)	(10,356,539)	(10,356,539)	(10,356,539)	(10,356,539)	(10,356,539)	(10,356,539)	(10,356,539)	(10,356,539)	
Total Expenses	**(159,649,579)**	**(200,671,061)**	**(210,253,938)**	**(231,610,251)**	**(247,963,999)**	**(258,154,519)**	**(265,650,683)**	**(273,713,348)**	**(280,251,685)**	**(284,556,901)**	
Earnings before Interest and Tax	**(35,315,399)**	**(8,326,321)**	**(4,557,001)**	**8,804,043**	**22,927,853**	**31,560,956**	**40,080,710**	**49,094,897**	**49,706,669**	**46,558,429**	**20,053,484**
Taxes	-	-	-	(880,404)	(2,292,785)	(3,156,096)	(4,008,071)	(4,909,490)	(4,970,667)	(4,655,843)	
Net Profit	**(35,315,399)**	**(8,326,321)**	**(4,557,001)**	**7,923,638**	**20,635,068**	**28,404,860**	**36,072,639**	**44,185,408**	**44,736,002**	**41,902,586**	

Table B6.10: Common Size Income Statements For A 500 Cattle Farm

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Milk Sales	95.9%	96.7%	95.2%	95.4%	94.0%	93.5%	92.9%	93.1%	92.4%	92.3%
Sale of calves	0.9%	0.6%	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Sale of culled heifers	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%
Sale of culled cows	3.2%	2.6%	4.0%	3.8%	5.2%	5.7%	6.3%	6.1%	6.8%	6.9%
Total Revenue	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Feed	-70.7%	-63.7%	-63.1%	-61.2%	-59.1%	-57.9%	-56.7%	-55.5%	-55.7%	-56.4%
Insemination	-1.1%	-0.9%	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%
Vaccination	-1.0%	-0.9%	-0.9%	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.9%
Medicine	-4.6%	-3.9%	-3.9%	-3.8%	-3.8%	-3.8%	-3.8%	-3.7%	-3.8%	-3.9%
Parlor Chemical	-2.3%	-1.5%	-1.5%	-1.3%	-1.2%	-1.1%	-1.1%	-1.0%	-1.0%	-1.0%
Teat Dip	-0.6%	-0.4%	-0.4%	-0.4%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%
Human Resource	-23.2%	-15.3%	-14.6%	-12.7%	-11.5%	-11.0%	-10.6%	-10.2%	-10.2%	-10.4%
Utilities	-8.0%	-5.2%	-5.1%	-4.9%	-4.7%	-4.5%	-4.4%	-4.2%	-4.2%	-4.2%
P.O.L	-5.8%	-5.6%	-5.3%	-4.6%	-4.2%	-4.0%	-3.9%	-3.7%	-3.7%	-3.8%
Mess Expenses	-2.6%	-1.7%	-1.7%	-1.5%	-1.3%	-1.3%	-1.2%	-1.2%	-1.2%	-1.2%
Depreciation	-8.3%	-5.4%	-5.0%	-4.3%	-3.8%	-3.6%	-3.4%	-3.2%	-3.1%	-3.1%
Total Expenses	**-128.4%**	**-104.3%**	**-102.2%**	**-96.3%**	**-91.5%**	**-89.1%**	**-86.9%**	**-84.8%**	**-84.9%**	**-85.9%**
Earnings before Interest & Tax	**-28.4%**	**-4.3%**	**-2.2%**	**3.7%**	**8.5%**	**10.9%**	**13.1%**	**15.2%**	**15.1%**	**14.1%**

Annex-C: Assumptions And Income Statements Of 300 Cattle Dairy Farm

Table C6.1: Herd Size Assumptions For A 300 Cattle Farm

Herd Size					
Number of cows imported					
Start of Year 1				300	
Start of Year 2				45	
Herd related Assumptions					
Mortality					
Lactating cows - Year 1				4%	per annum
Lactating cows - Year 2 onwards				5%	per annum
Heifers				2%	per annum
Calves				5%	per annum
Culling rate					
Lactating cows - Year 1				12%	per annum
Lactating cows - Year 2				15%	per annum
Lactating cows - Year 3 onwards				20%	per annum
Heifers				5%	per annum
Value of Animals					
Import price			PKR	350,000	per cow
Price - culled cow			PKR/kg	120	550
Price - culled heifer			PKR/kg	120	200
Price - calf			PKR	5,000	per cow
Capital Investment					
	Useful life (years)				
Land (acres x purchase price per acre)		10	3,000,000	PKR	30,000,000
Civil work (sq ft area x price per sq ft)	20	60,000	1,000	PKR	60,000,000
Electrical	10			PKR	15,069,231
Machinery & Equipment	20			PKR	30,392,308
Water & Plumbing	10			PKR	1,873,846

Source: Dairy sector consultant's data revised and simplified for the analysis

Table C6.2: Operating Cost Assumptions For A 300 Cattle Farm

Feed			
Straws for insemination	PKR	950	
Cows	Quantity	3.5	
Heifers	Quantity	2	
Vaccination	Quantity	PKR	
FMD	2	182	per vaccine
HS	1	26	per vaccine
3Day Fever	1	800	per vaccine
Elite 9	2	330	per vaccine
Clostridium	1	64	per vaccine
RB 51	2	51	per vaccine
Medicine	PKR	9,000	per animal
Parlor Chemical	Quantity (liters)	PKR	
Acid	346	750	per liter
Alkali	692	1,500	per liter
Teat dip			
Quantity per milking per day	Liters	0.001	per lactating cow
No of milkings per day		3	
No of days		365	
Cost	PKR	1,573	per liter
HR	PKR	1,440,000	per month
Utilities			
Energy required	kw	0.34	per lactating cow
No of hours	h	16	
Tariff		12	per kwh
P.O.L.			
Year 1	PKR	4,340,980	per annum
Year 2 onwards	PKR	6,405,718	per annum
Mess Expenses			
Per day expenses	PKR	120	per staff member
No of days		365	
Staff		45	

Source: Dairy sector consultant's data revised and simplified for the analysis

Table C6.3: Milk Related Assumptions For A 300 Cattle Farm

Milk price			
Year 1	PKR	58	per liter
Year 2 onwards	PKR	59	per liter
Milk yield per day			
Year 1	Liters	23	per animal
Year 2	Liters	25	per animal
Year 3	Liters	25	per animal
Year 4	Liters	26	per animal
Year 5	Liters	27	per animal
Year 6	Liters	28	per animal
Year 7	Liters	29	per animal
Year 8 onwards	Liters	30	per animal
Milk wastage		2%	
Milk days			
Year 1		210	per animal
Year 2 onwards		305	per animal

Source: Dairy sector consultant's data revised and simplified for the analysis

Table C6.4: Other Assumptions For A 300 Cattle Farm

Calving interval	12	months
Inflation		2%
Tax rate		10%
Net working capital	2%	of total revenue
Long term growth rate		4%
	Weights	**Costs**
Debt (Interest rate)	30%	14%
Equity	70%	16%

Source: Dairy sector consultant's data revised and simplified for the analysis

Table C6.5: Feed Cost Assumptions For A 300 Cattle Farm

	Cost per kg	Requirements (kg)				No of Days						
		Lactating cows		R1YO	R2YO	Lactating cows		kg	kg	R1YO	R2YO	
		Milking days	Dry period			Milking days		Dry period		Calves	Cows	Heifers
						Year 1	Year 2 onwards	Year 1	Year 2 onwards		Year 1	Year 2 onwards
Maize Silage	6.25	25.00	12.00	8.00	12.00	210	305	0	60	275	155	365
Wheat Straw	8.88	-	5.00	-	3.00	210	305	0	60	275	155	365
Maize Grain	23.75	4.00	-	0.80	1.00	210	305	0	60	275	155	365
Cotton Seed	38.35	2.50	-	-	-	210	305	0	60	275	155	365
Corn Gluten	22.16	2.50	-	0.80	-	210	305	0	60	275	155	365
Wheat Bran	24.00	2.50	-	-	-	210	305	0	60	275	155	365
Soya Bean	55.00	2.50	-	0.80	-	210	305	0	60	275	155	365
Canola Meal	35.60	0.50	1.00	-	1.00	210	305	0	60	275	155	365
Bypass Fat	90.00	0.50	-	-	-	210	305	0	60	275	155	365
Molasses	10.00	2.00	-	-	-	210	305	0	60	275	155	365
Mineral Mix	123.66	0.10	0.10	0.05	0.05	210	305	0	60	275	155	365
Mycotoxin Binder	230.00	0.02	-	-	-	210	305	0	60	275	155	365
Urea	28.00	0.10	0.10	-	0.07	210	305	0	60	275	155	365
Salt	5.00	0.10	-	-	-	210	305	0	60	275	155	365
Bi carb	44.44	0.20	-	-	-	210	305	0	60	275	155	365
Yeast	1,000.00	0.02	-	-	-	210	305	0	60	275	155	365
Cow Milk Replacer (CMR)	32.00	-	-	6.00	-	0	0	0	0	90	0	0
Calf Starter	45.00	-	-	0.40	-	0	0	0	0	90	0	0
Feed cost/ cow		731.98	170.17	136.91 210	169.13							

Source: Dairy sector consultant's data revised and simplified for the analysis
Notes: Calves and R1YO: Newborn calves must receive 4 liter of colostrum within first hour of their birth and then second feed after 12 hours and then transitionally moved to cow milk or replacer. The farms feed calves almost 6 liters of milk or replacer per day for first 90 days, and later introduced with pallet diet and gradually moved to calf starter.
Dry Cows and R2YO: Dry cows do not need much energy. Since most of the energy is required for milk production, the energy requirement of dry cows is low as compared to milking cows. Dry matter requirement for dry cows is 3 percent of their body weight. The feed consists of silage and roughage, i.e., grasses and hay, to fulfill their dry matter requirement with some energy to keep their body condition moderate since too fat cows were prone to milk fever and problems in calving.

Table C6.6: Herd Movements For A 300 Cattle Farm

								Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Opening Balance		Calf	M					-	-	-	-	-	-	-	-	-	-
			F					-	131	130	157	171	192	200	211	213	215
		Heifer	M					-	-	-	-	-	-	-	-	-	-
			F					-	-	0	-	(0)	-	-	-	-	-
		Adult						-	-	122	121	146	159	178	186	196	198
		Lactating						-	252	238	270	293	299	303	301	296	298
		Total						**-**	**383**	**489**	**547**	**609**	**650**	**682**	**698**	**704**	**711**
Increase	Purchase	Calf	M														
			F														
		Heifer	M														
			F														
		Adult						300	45								
		Lactating															
	Birth	Calf	M	46%				138	137	165	180	202	211	222	224	226	228
			F	46%				138	137	165	180	202	211	222	224	226	228
	Transfer	Heifer	M														
			F						131	130	157	171	192	200	211	213	215
		Adult							122	121	146	159	178	186	196	198	200
		Lactating						300	45	122	121	146	159	178	186	196	198
Decrease	Death	Calf	M	5%				7	7	8	9	10	11	11	11	11	11
			F	5%				7	7	8	9	10	11	11	11	11	11
		Heifer	M	2%													
			F	2%				-	3	3	3	3	4	4	4	4	4
		Adult															
		Lactating		4%	5%	5%	5%	12	15	18	20	22	23	24	24	25	25
	Transfer	Calf	M														
			F						131	130	157	171	192	200	211	213	215
		Heifer	M														
			F						122	121	146	159	178	186	196	198	200
		Adult						300	45	122	121	146	159	178	186	196	198
		Lactating															
	Sale & Culling	Calf	M					131	130	157	171	192	200	211	213	215	217
			F														
		Heifer	M														
			F	5%	5%	5%		-	7	6	8	9	10	10	11	11	11
		Adult															
		Lactating		12%	15%	20%	20%	36	45	72	78	118	132	156	167	168	169
			F					131	130	157	171	192	200	211	213	215	217
		Heifer	M					-	-	-	-	-	-	-	-	-	-
			F					-	0	-	(0)	-	-	-	-	-	-
		Lactating						252	238	270	293	299	303	301	296	298	302
		Total						**383**	**489**	**547**	**609**	**650**	**682**	**698**	**704**	**711**	**719**
Percentage Milking cows								66%	49%	49%	48%	46%	44%	43%	42%	42%	42%
Percentage non milking								34%	51%	51%	52%	54%	56%	57%	58%	58%	58%

Source: Dairy sector consultant's data revised and simplified for the analysis

Table C6.7: Stock Movements For A 300 Cattle Farm

Opening Stock		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Calf	M	-	-	-	-	-	-	-	-	-	-
	F	-	131	130	157	171	192	200	211	213	215
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	-	0	-	(0)	-	-	-	-	-
Adult		-	-	122	121	146	159	178	186	196	198
Lactating		-	252	238	270	293	299	303	301	296	298
Total		**-**	**383**	**489**	**547**	**609**	**650**	**682**	**698**	**704**	**711**
Closing Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	-	-	-	-	-	-	-	-	-	-
	F	131	130	157	171	192	200	211	213	215	217
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	0	-	(0)	-	-	-	-	-	-
Adult		-	122	121	146	159	178	186	196	198	200
Lactating		252	238	270	293	299	303	301	296	298	302
Total		**383**	**489**	**547**	**609**	**650**	**682**	**698**	**704**	**711**	**719**
Average Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	-	-	-	-	-	-	-	-	-	-
	F	66	130	143	164	181	196	205	212	214	216
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	0	0	(0)	(0)	-	-	-	-	-
Adult		-	61	121	133	152	169	182	191	197	199
Lactating		126	245	254	281	296	301	302	298	297	300
Total		**192**	**436**	**518**	**578**	**630**	**666**	**690**	**701**	**708**	**715**
Sale of Calf and Culled Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	131	130	157	171	192	200	211	213	215	217
	F	-	-	-	-	-	-	-	-	-	-
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	7	6	8	9	10	10	11	11	11
Adult		-	-	-	-	-	-	-	-	-	-
Lactating		36	45	72	78	118	132	156	167	168	169
Death of Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	7	7	8	9	10	11	11	11	11	11
	F	7	7	8	9	10	11	11	11	11	11
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	3	3	3	3	4	4	4	4	4
Adult		-	-	-	-	-	-	-	-	-	-
Lactating		12	15	18	20	22	23	24	24	25	25

Source: Dairy sector consultant's data revised and simplified for the analysis

Table C6.8: Assumptions For A Base Case Analysis Of A 300 Cattle Farm

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Average
Milk price	58.00	59.00	60.00	61.00	62.00	63.00	64.00	65.00	66.00	67.00	
Milk production (liters)	1,192,817	1,829,268	1,895,184	2,185,325	2,388,464	2,521,228	2,620,490	2,675,675	2,662,997	2,693,857	2,266,530

Table C6.9: Projected income statements of a 300 cattle farm

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Average
Milk Sales	69,183,374	107,926,812	113,711,031	133,304,797	148,084,745	158,837,362	167,711,346	173,918,880	175,757,827	180,488,435	
Sale of calves	655,500	661,924	817,294	905,111	1,037,985	1,104,393	1,185,325	1,223,150	1,257,694	1,296,530	
Sale of culled heifers	-	160,466	162,039	200,074	221,571	254,099	270,355	290,167	299,427	307,884	
Sale of culled cows	2,376,000	2,999,106	4,937,430	5,467,946	8,413,883	9,586,623	11,620,374	12,696,210	13,011,036	13,353,911	
Total Revenue	**72,214,874**	**111,748,308**	**119,627,795**	**139,877,927**	**157,758,184**	**169,782,477**	**180,787,400**	**188,128,407**	**190,325,984**	**195,446,760**	
Feed	(53,300,475)	(75,884,158)	(80,148,404)	(90,762,106)	(98,818,630)	(104,255,37)	(108,250,302)	(110,389,157)	(112,833,224)	(116,369,274)	(95,101,110)
Insemination	(837,900)	(1,007,454)	(1,057,215)	(1,193,966)	(1,300,212)	(1,371,018)	(1,424,416)	(1,452,169)	(1,485,727)	(1,532,426)	
Vaccination	(772,330)	(1,006,182)	(1,087,284)	(1,237,546)	(1,373,725)	(1,481,676)	(1,566,091)	(1,623,432)	(1,671,675)	(1,722,913)	
Medicine	(3,447,900)	(4,491,884)	(4,853,948)	(5,524,759)	(6,132,702)	(6,614,625)	(6,991,477)	(7,247,465)	(7,462,835)	(7,691,578)	
Parlor Chemical	(1,298,077)	(1,324,038)	(1,350,519)	(1,377,530)	(1,405,080)	(1,433,182)	(1,461,845)	(1,491,082)	(1,520,904)	(1,551,322)	
Teat Dip	(434,054)	(430,085)	(454,494)	(513,996)	(551,788)	(572,891)	(586,411)	(590,378)	(599,332)	(618,403)	
Human Resource	(17,280,00)	(17,625,600)	(17,978,112)	(18,337,674)	(18,704,428)	(19,078,516)	(19,460,087)	(19,849,288)	(20,246,274)	(20,651,200)	
Utilities	(6,004,454)	(5,949,557)	(6,287,222)	(7,110,337)	(7,633,130)	(7,925,050)	(8,112,087)	(8,166,960)	(8,290,829)	(8,554,644)	
P.O.L	(4,340,980)	(6,405,718)	(6,533,833)	(6,664,509)	(6,797,799)	(6,933,755)	(7,072,430)	(7,213,879)	(7,358,157)	(7,505,320)	
Mess Expenses	(1,971,000)	(2,010,420)	(2,050,628)	(2,091,641)	(2,133,474)	(2,176,143)	(2,219,666)	(2,264,059)	(2,309,341)	(2,355,527)	
Depreciation	(6,213,923)	(6,213,923)	(6,213,923)	(6,213,923)	(6,213,923)	(6,213,923)	(6,213,923)	(6,213,923)	(6,213,923)	(6,213,923)	
Total Expenses	**(95,901,092)**	**(122,349,020)**	**(128,015,583)**	**(141,027,988)**	**(151,064,892)**	**(158,056,153)**	**(163,358,736)**	**(166,501,794)**	**(169,992,221)**	**(174,766,531)**	
Earnings before Interest and Tax	**(23,686,218)**	**(10,600,712)**	**(8,387,788)**	**(1,150,061)**	**6,693,292**	**11,726,324**	**17,428,664**	**21,626,614**	**20,333,763**	**20,680,229**	**5,466,411**
Taxes	-	-	-	-	(669,329)	(1,172,632)	(1,742,866)	(2,162,661)	(2,033,376)	(2,068,023)	
Net Profit	**(23,686,218)**	**(10,600,712)**	**(8,387,788)**	**(1,150,061)**	**6,023,963**	**10,553,692**	**15,685,798**	**19,463,952**	**18,300,387**	**18,612,206**	

Table C6.10: Common Size Income Statements Of A 300 Cattle Farm

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Milk Sales	95.8%	96.6%	95.1%	95.3%	93.9%	93.6%	92.8%	92.4%	92.3%	92.3%
Sale of calves	0.9%	0.6%	0.7%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Sale of culled heifers	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%
Sale of culled cows	3.3%	2.7%	4.1%	3.9%	5.3%	5.6%	6.4%	6.7%	6.8%	6.8%
Total Revenue	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Feed	-73.8%	-67.9%	-67.0%	-64.9%	-62.6%	-61.4%	-59.9%	-58.7%	-59.3%	-59.5%
Insemination	-1.2%	-0.9%	-0.9%	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%
Vaccination	-1.1%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%
Medicine	-4.8%	-4.0%	-4.1%	-3.9%	-3.9%	-3.9%	-3.9%	-3.9%	-3.9%	-3.9%
Parlor Chemical	-1.8%	-1.2%	-1.1%	-1.0%	-0.9%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%
Teat Dip	-0.6%	-0.4%	-0.4%	-0.4%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%
Human Resource	-23.9%	-15.8%	-15.0%	-13.1%	-11.9%	-11.2%	-10.8%	-10.6%	-10.6%	-10.6%
Utilities	-8.3%	-5.3%	-5.3%	-5.1%	-4.8%	-4.7%	-4.5%	-4.3%	-4.4%	-4.4%
P.O.L	-6.0%	-5.7%	-5.5%	-4.8%	-4.3%	-4.1%	-3.9%	-3.8%	-3.9%	-3.8%
Mess Expenses	-2.7%	-1.8%	-1.7%	-1.5%	-1.4%	-1.3%	-1.2%	-1.2%	-1.2%	-1.2%
Depreciation	-8.6%	-5.6%	-5.2%	-4.4%	-3.9%	-3.7%	-3.4%	-3.3%	-3.3%	-3.2%
Total Expenses	**-132.8%**	**-109.5%**	**-107.0%**	**-100.8%**	**-95.8%**	**-93.1%**	**-90.4%**	**-88.5%**	**-89.3%**	**-89.4%**
Earnings before Interest and Tax	**-32.8%**	**-9.5%**	**-7.0%**	**-0.8%**	**4.2%**	**6.9%**	**9.6%**	**11.5%**	**10.7%**	**10.6%**

Annex-D: Assumptions And Income Statements Of 100 Cattle Dairy Farm

Table D6.1: Herd Size Assumptions For A 100 Cattle Farm

Herd Size					
Number of cows imported					
Start of Year 1				100	
Start of Year 2				15	
Herd related Assumptions					
Mortality					
Lactating cows - Year 1				4%	per annum
Lactating cows - Year 2 onwards				5%	per annum
Heifers				2%	per annum
Calves				5%	per annum
Culling rate				12%	per annum
Lactating cows - Year 1				15%	per annum
Lactating cows - Year 2				20%	per annum
Lactating cows - Year 3 onwards				5%	per annum
Heifers					
Value of Animals					
Import price		PKR		350,000	per cow
Price - culled cow		PKR/kg		120	550
Price - culled heifer		PKR/kg		200	350
Price - calf		PKR		5,000	per cow
Capital Investment					
	Useful life				
Land (acres x purchase price per acre)			5	PKR 3,000,000	PKR 15,000,000
Civil work (sq ft area x price per sq ft)	20	25,000		PKR 1,000	PKR 25,000,000
Electrical	10				PKR 5,023,077
Machinery & Equipment	20				PKR 10,130,769
Water & Plumbing	10				PKR 624,615

Source: Dairy sector consultant's data revised and simplified for the analysis

Table D6.2: Operating Cost Assumption For A 100 Cattle Farm

Feed			
Straws for insemination	PKR	950	
Cows	Quantity	3.5	
Heifers	Quantity	2	
Vaccination	Quantity	PKR	
FMD	2	182	per vaccine
HS	1	26	per vaccine
3Day Fever	1	800	per vaccine
Elite 9	2	330	per vaccine
Clostradium	1	64	per vaccine
RB 51	2	51	per vaccine
Medicine	PKR	9,000	per animal
Parlor Chemical	Quantity (liters)	PKR	
Acid	115	250	per liter
Alkali	231	500	per liter
Teat dip			
Quantity per milking per day	Liters	0.001	per lactating cow
No of milkings per day		3	
No of days		365	
Cost	PKR	1,573	per liter
HR Utilities	PKR	720,000	per month
Energy required	kw	0.34	per lactating cow
No of hours	h	16	
Tariff		12	per kwh
P.O.L.			
Year 1	PKR	1,446,993	per annum
Year 2 onwards	PKR	2,135,239	per annum
Mess Expenses			
Per day expenses	PKR	120	per staff member
No of days		365	
Staff		23	

Source: Dairy sector consultant's data revised and simplified for the analysis

Table D6.3: Milk Related Assumptions For A 100 Cattle Farm

Milk price			
Year 1	PKR	57	per liter
Year 2 onwards	PKR	58	per liter
Milk yield per day			
Year 1	Liters	23	per animal
Year 2	Liters	25	per animal
Year 3	Liters	25	per animal
Year 4	Liters	26	per animal
Year 5	Liters	27	per animal
Year 6	Liters	28	per animal
Year 7	Liters	29	per animal
Year 8 onwards	Liters	30	per animal
Milk wastage		2%	
Milk days			
Year 1		210	per animal
Year 2 onwards		305	per animal

Source: Dairy sector consultant's data revised and simplified for the analysis

Table D6.4: Other Assumptions For A 100 Cattle Farm

Calving interval	12	months
Inflation		2%
Tax rate		10%
Net working capital	2%	of total revenue
Long term growth rate		4%
	Weights	**Costs**
Debt (Interest rate)	30%	14%
Equity	70%	16%

Source: Dairy sector consultant's data revised and simplified for the analysis

Table D6.5: Feed Cost Assumptions For A 100 Cattle Farm

	Cost per kg	Requirements (kg)				No of Days						
		Lactating cows		R1YO	R2YO	Lactating cows		kg	kg	R1YO	R2YO	
		Milking days	Dry period			Milking days		Dry period		Calves	Cows	Heifers
						Year 1	Year 2 onwards	Year 1	Year 2 onwards		Year 1	Year 2 onwards
Maize Silage						210	305	0	60	275	155	365
Wheat Straw						210	305	0	60	275	155	365
Maize Grain						210	305	0	60	275	155	365
Cotton Seed						210	305	0	60	275	155	365
Corn Gluten						210	305	0	60	275	155	365
Wheat Bran						210	305	0	60	275	155	365
Soya Bean						210	305	0	60	275	155	365
Canola Meal						210	305	0	60	275	155	365
Bypass Fat						210	305	0	60	275	155	365
Molasses						210	305	0	60	275	155	365
Mineral Mix						210	305	0	60	275	155	365
Mycotoxin Binder						210	305	0	60	275	155	365
Urea						210	305	0	60	275	155	365
Salt						210	305	0	60	275	155	365
Bi carb						210	305	0	60	275	155	365
Yeast						210	305	0	60	275	155	365
Cow Milk Replacer (CMR)						0	0	0	0	90	0	0
Calf Starter						0	0	0	0	90	0	0
Feed cost per cow		750	250	150	210							

Source: Dairy sector consultant's data revised and simplified for the analysis
Notes: Calves and R1YO: Newborn calves must receive 4 liter of colostrum within first hour of their birth and then second feed after 12 hours and then transitionally moved to cow milk or replacer. The farms feed calves almost 6 liters of milk or replacer per day for first 90 days, and later introduced with pallet diet and gradually moved to calf starter.
Dry Cows and R2YO: Dry cows do not need much energy. Since most of the energy is required for milk production, the energy requirement of dry cows is low as compared to milking cows. Dry matter requirement for dry cows is 3 percent of their body weight. The feed consists of silage and roughage, i.e., grasses and hay, to fulfill their dry matter requirement with some energy to keep their body condition moderate since too fat cows were prone to milk fever and problems in calving.

Table D6.6: Herd Movement Of A 100 Cattle Farm

								Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Opening Balance		Calf	M					-	-	-	-	-	-	-	-	-	-
			F					-	44	43	52	57	64	67	69	70	72
		Heifer	M					-	-	-	-	-	-	-	-	-	-
			F					-	-	-	-	-	-	-	0	0	-
		Adult						-	-	41	40	49	53	59	62	65	66
		Lactating						-	84	79	90	98	100	99	99	101	99
		Total						**-**	**128**	**163**	**182**	**203**	**217**	**226**	**231**	**236**	**237**
Increase	Purchase	Calf	M														
			F														
		Heifer	M														
			F														
		Adult						100	15								
		Lactating															
	Birth	Calf	M	46%				46	46	55	60	67	70	73	74	76	76
			F	46%				46	46	55	60	67	70	73	74	76	76
	Transfer	Heifer	M														
			F						44	43	52	57	64	67	69	70	72
		Adult							41	40	49	53	59	62	65	66	67
		Lactating						100	15	41	40	49	53	59	62	65	66
Decrease	Death	Calf	M	5%				2	2	3	3	3	4	4	4	4	4
			F	5%				2	2	3	3	3	4	4	4	4	4
		Heifer	M	2%													
			F	2%				-	1	1	1	1	1	1	1	1	1
		Adult															
		Lactating		4%	5%	5%	5%	4	5	6	7	7	8	8	8	8	8
	Transfer	Calf	M														
			F						44	43	52	57	64	67	69	70	72
		Heifer	M														
			F						41	40	49	53	59	62	65	66	67
		Adult						100	15	41	40	49	53	59	62	65	66
		Lactating															
	Sale & Culling	Calf	M					44	43	52	57	64	67	69	70	72	72
			F														
		Heifer	M														
			F	5%	5%	5%		-	2	2	3	3	3	3	3	4	4
		Adult															
		Lactating		12%	15%	20%	20%	12	15	24	26	39	46	52	52	58	58
Closing Balance		Calf	M					-	-	-	-	-	-	-	-	-	-
			F					44	43	52	57	64	67	69	70	72	72
		Heifer	M					-	-	-	-	-	-	-	-	-	-
			F					-	-	-	-	-	-	0	0	-	-
		Adult						-	41	40	49	53	59	62	65	66	67
		Lactating						84	79	90	98	100	99	99	101	99	98
		Total						**128**	**163**	**182**	**203**	**217**	**226**	**231**	**236**	**237**	**238**
Percentage Milking animals								66%	49%	49%	48%	46%	44%	43%	43%	42%	41%
Percentage non milking animals								34%	51%	51%	52%	54%	56%	57%	57%	58%	59%

Source: Dairy sector consultant's data revised and simplified for the analysis

Table D6.7: Stock Movement Of A 100 Cattle Farm

Opening Stock		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Calf	M	-	-	-	-	-	-	-	-	-	-
	F	-	44	43	52	57	64	67	69	70	72
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	-	-	-	-	-	-	0	0	-
Adult		-	-	41	40	49	53	59	62	65	66
Lactating		-	84	79	90	98	100	99	99	101	99
Total		**-**	**128**	**163**	**182**	**203**	**217**	**226**	**231**	**236**	**237**
Closing Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	-	-	-	-	-	-	-	-	-	-
	F	44	43	52	57	64	67	69	70	72	72
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	-	-	-	-	-	0	0	-	-
Adult		-	41	40	49	53	59	62	65	66	67
Lactating		84	79	90	98	100	99	99	101	99	98
Total		**128**	**163**	**182**	**203**	**217**	**226**	**231**	**236**	**237**	**238**
Average Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	-	-	-	-	-	-	-	-	-	-
	F	22	43	48	55	60	65	68	70	71	72
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	-	-	-	-	-	0	0	0	-
Adult		-	20	40	44	51	56	61	63	65	66
Lactating		42	82	85	94	99	100	99	100	100	99
Total		**64**	**145**	**173**	**193**	**210**	**221**	**228**	**233**	**236**	**237**
Sale of Calf and Culled Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	44	43	52	57	64	67	69	70	72	72
	F	-	-	-	-	-	-	-	-	-	-
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	2	2	3	3	3	3	3	4	4
Adult		-	-	-	-	-	-	-	-	-	-
Lactating		12	15	24	26	39	46	52	52	58	58
Death of Stock		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Calf	M	2	2	3	3	3	4	4	4	4	4
	F	2	2	3	3	3	4	4	4	4	4
Heifer	M	-	-	-	-	-	-	-	-	-	-
	F	-	1	1	1	1	1	1	1	1	1
Adult		-	-	-	-	-	-	-	-	-	-
Lactating		4	5	6	7	7	8	8	8	8	8

Source: Dairy sector consultant's data revised and simplified for the analysis

Table D6.8: Assumptions For Base-Analysis Of A 100 Cattle Farm

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Average
Milk price	70.00	71.00	72.00	73.00	74.00	75.00	76.00	77.00	78.00	79.00	
Milk production (liters)	397,606	609,756	631,728	728,442	796,155	833,435	860,856	897,029	896,714	885,807	753,753

Table D6.9: Projected Income Statements Of A 100 Cattle Farm

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Average
Milk Sales	27,832,392	43,292,676	45,484,413	53,176,230	58,915,436	62,507,624	65,425,027	69,071,236	69,943,663	69,978,781	
Sale of calves	218,500	220,641	272,431	301,704	345,995	368,131	391,007	404,579	423,631	429,864	
Sale of culled heifers	-	156,009	157,538	194,516	215,416	247,041	262,846	279,179	288,870	302,472	
Sale of culled cows	792,000	999,702	1,645,810	1,822,649	2,804,628	3,316,990	3,848,683	3,960,406	4,492,472	4,568,790	
Total Revenue	**28,842,892**	**44,669,028**	**47,560,192**	**55,495,099**	**62,281,475**	**66,439,786**	**69,927,562**	**73,715,400**	**75,148,636**	**75,279,907**	**59,935,998**
Feed	(17,766,825)	(25,294,719)	(26,716,135)	(30,254,035)	(32,939,543)	(34,527,525)	(35,666,201)	(36,896,782)	(37,850,961)	(38,412,901)	(31,632,563)
Insemination	(279,300)	(335,818)	(352,405)	(397,989)	(433,404)	(453,947)	(469,345)	(485,690)	(498,184)	(505,589)	
Vaccination	(257,443)	(335,394)	(362,428)	(412,515)	(457,908)	(492,037)	(517,893)	(540,211)	(558,450)	(571,709)	
Medicine	(1,149,300)	(1,497,295)	(1,617,983)	(1,841,586)	(2,044,234)	(2,196,594)	(2,312,021)	(2,411,655)	(2,493,081)	(2,552,272)	
Parlor Chemical	(144,231)	(147,115)	(150,058)	(153,059)	(156,120)	(159,242)	(162,427)	(165,676)	(168,989)	(172,369)	
Teat Dip	(144,685)	(143,362)	(151,498)	(171,332)	(183,929)	(189,379)	(192,642)	(197,926)	(201,814)	(203,346)	
Human Resource	(8,640,000)	(8,812,800)	(8,989,056)	(9,168,837)	(9,352,214)	(9,539,258)	(9,730,043)	(9,924,644)	(10,123,137)	(10,325,600)	
Utilities	(2,001,485)	(1,983,186)	(2,095,741)	(2,370,112)	(2,544,377)	(2,619,761)	(2,664,897)	(2,738,001)	(2,791,779)	(2,812,980)	
P.O.L	(1,446,993)	(2,135,239)	(2,177,944)	(2,221,503)	(2,265,933)	(2,311,252)	(2,357,477)	(2,404,626)	(2,452,719)	(2,501,773)	
Mess Expenses	(1,007,400)	(1,027,548)	(1,048,099)	(1,069,061)	(1,090,442)	(1,112,251)	(1,134,496)	(1,157,186)	(1,180,330)	(1,203,936)	
Depreciation	(2,321,308)	(2,321,308)	(2,321,308)	(2,321,308)	(2,321,308)	(2,321,308)	(2,321,308)	(2,321,308)	(2,321,308)	(2,321,308)	
Total Expenses	**(35,158,969)**	**(44,033,784)**	**(45,982,654)**	**(50,381,338)**	**(53,789,413)**	**(55,922,554)**	**(57,528,749)**	**(59,243,704)**	**(60,640,751)**	**(61,583,783)**	
Earnings before Interest and Tax	**(6,316,077)**	**635,244**	**1,577,538**	**5,113,761**	**8,492,062**	**10,517,232**	**12,398,813**	**14,471,696**	**14,507,884**	**13,696,124**	**7,509,428**
Taxes	-	(63,524)	(157,754)	(511,376)	(849,206)	(1,051,723)	(1,239,881)	(1,447,170)	(1,450,788)	(1,369,612)	
Net Profit	**(6,316,077)**	**571,720**	**1,419,784**	**4,602,385**	**7,642,856**	**9,465,509**	**11,158,932**	**13,024,526**	**13,057,096**	**12,326,512**	**6,695,324**

ECONOMICS OF NUTRITION: **CALCIUM AND MILK**

7.1 Introduction

Malnutrition takes place when a person eats inappropriate diet that consists of nutrients that lead to a condition of being underweight or overweight.[59] Under- or over-consumption of calories, proteins, carbohydrates and micronutrients, e.g., vitamins and minerals causes these problems. 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.[60] Moreover, malnutrition in 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.[61]

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."[62] "Iodine deficiency, the same report shows, is the world's greatest single cause of mental retardation and brain damage."[63]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 one-decade, 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, 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

[59] *"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).*

[60] *For further details, see National Nutrition Survey 2011 (GoP, n.d.).*

[61] *http://www.wfp.org/hunger/malnutrition*

[62] *http://www.wfp.org/hunger/malnutrition*

[63] *http://www.wfp.org/hunger/malnutrition*

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 using the latest available household survey data, 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 empirically estimate the impact of milk calories on school attendance in Pakistan.

7.2 Costs Of Malnutrition On Productivity And GDP Growth

For the last 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).

Several studies have reviewed the economic manifestation of improvement in birth weight. 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.[64] 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 7.1 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 Vietnam. However, in Pakistan there is a 3.3% loss in GDP i.e., PKR 829 billion due to iron deficiency alone. Eliminating three types of nutritional gap (i.e., protein energy, iodine deficiency and iron deficiency) Pakistan would have increased the level of GDP by 4%. The gain in GDP would be substantially more if longer duration childhood cognitive impairment effects are also included. (see Table 7.1).

[64]This calculation assumes the presence of 19.1 million children below 5 years of age in 1998 population census.

Table 7.1: 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
Vietnam	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)

7.3 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, drawn from all the four provinces of Pakistan. We work out the cost of the basic needs poverty line 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 of 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 (or food poverty) based on 2,350 calories recommended to maintain good health and to achieve mental and physical growth.[65] We use PSLM-HIES 2011-12 data to calculate nutritional deficiency at the national, provincial and urban-rural level. We also present nutritional deficiency by age group to provide further insights.

Table 7.2 reports these estimates where 79% population in Pakistan is below the minimum benchmark of 2350 calories[66] per day per adult equivalent. Table 7.2 and Figure 7.1 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 KPK is also below the benchmark, respectively. Around 86% population in the age group of 10 to 14 years 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.

[65]*We calculate the national dietary intake patterns based on desirable dietary patterns in the light of recommendations of Food and Agriculture Organization.*

[67]*For details on how the government arrived at the benchmark of 2350 calories, see Cheema (2005).*

Table 7.2: Head Count Of Caloric Poverty By Age Groups

	Urban			Province			Total
Age group	Urban	Rural	Punjab	Sindh	KPK	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: LUMS Survey of Dairy Households in Rural Punjab, 2005 & 2014
Note: We measure caloric poverty 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. We compare each household's per day per adult equivalent calories with the poverty line and calculate head count ratio for those who are unable to consume 2350 calories per day per adult equivalent (see, Haughton and Khandker, 2009).

Table 7.3 shows that Pakistan would need PKR 64 billion per day to bridge this nutritional gap, which is huge. Of this, PKR 39 billion per day would be required for rural population below the benchmark and PKR 24 billion per day for urban population. Punjab province would require PKR 36.72 billion or 59% of total funds, followed by Sindh PKR 16.29 billion, KPK PKR 7.0 billion and then Balochistan PKR 2.2 billion. The highest amount would be required to bridge nutritional gaps of 15-25 year olds (PKR 14.93 billion per day) and 26 – 50 year olds (PKR 15.43 billion per day).

Figure 7.1: Head Count Of Caloric Poverty By Region And Age Groups

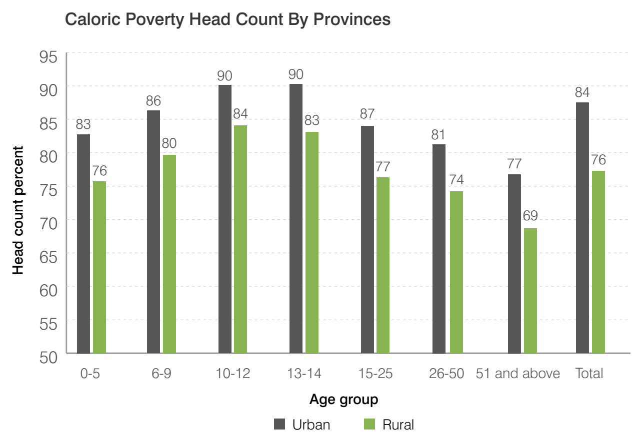
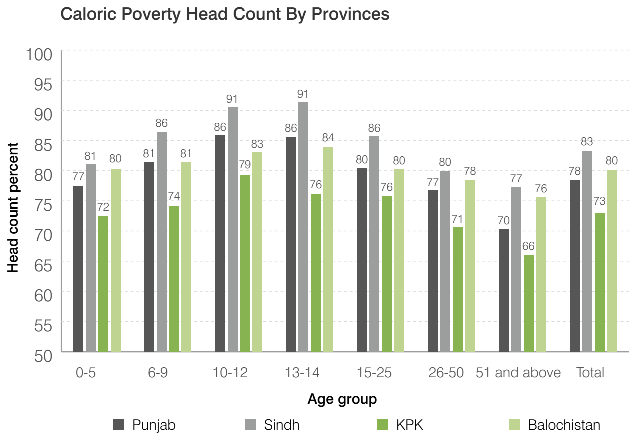


Table 7.3: Total Daily Caloric Poverty Deficit By Age Groups

	Urban			Province			Total
Age group	Urban	Rural	Punjab	Sindh	KPK	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: We measure daily caloric poverty deficit 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).

Figure 7.2: Head Count Of Caloric Poverty By Provinces And Age Groups



7.4 Deficit in Per Capita Milk Consumption and Milk Poverty

Milk is an important source of calcium; however, packed milk adds certain vitamins. Nutritional experts do not offer specific recommendation for the minimum quantity of milk consumption 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 2350 calories. Based on data of PSLM-HIES 2011-12 we find that 750 households were consuming exactly 2350 calories. We calculate per capital milk consumption of the households and use it as benchmark requirement for all households in the survey. Those who were consuming less than this benchmark are termed as below milk poverty line. We measure the requirement in liters of milk per capita.

Table 7.4 shows milk poverty lines used for urban and rural areas across provinces based on households at the 2,350-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 KPK. 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 7.5 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 KPK 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 7.6 presents deficit in daily milk consumption in national, urban/rural and provincial 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 7.3). Bridging the milk poverty gap at the national level would require around PKR 275 billion per annum.[67] 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 KPK and only 0.16 million liters in Balochistan (also see Figure 7.4).

Table 7.4: 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
KPK Urban	0.224
KPK Rural	0.176
Balochistan Urban	0.082
Balochistan Rural	0.098
National Average	**0.296**

Note: We calculate milk poverty line 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. Identifying these households, we take their average per capita milk consumption and term it as milk poverty line. We consider only consumption of fresh and packed milk quantity. Quantities of powdered milk, yogurt and other dairy products are not included to work out the milk poverty line.

[67] This is evaluated at the average price of PKR 60 per liter for loose milk in 2014-15 prices.

Table 7.5: Milk Poverty Head Count By Regions And Provinces

	Urban		Province				Total
Age group	Urban	Rural	Punjab	Sindh	KPK	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 7.4 (for poverty headcount see, Haughton and Khandker, 2009).

Table 7.6: Daily Milk Poverty Deficit

	Urban		Province				Total
Age group	Urban	Rural	Punjab	Sindh	KPK	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: We measure daily milk poverty deficit as the average normalized shortfall with respect to the milk poverty line set in Table 3.4 by age groups, also known as the poverty gap measure (see, Haughton and Khandker, 2009).

Figure 7.3: Head Count Of Milk Poverty

Milk Poverty Head Count By Regions

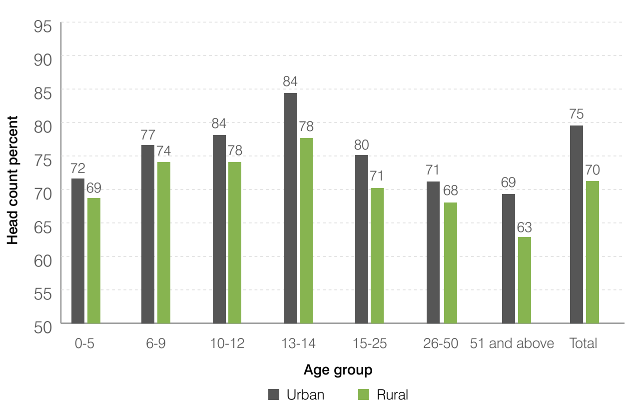
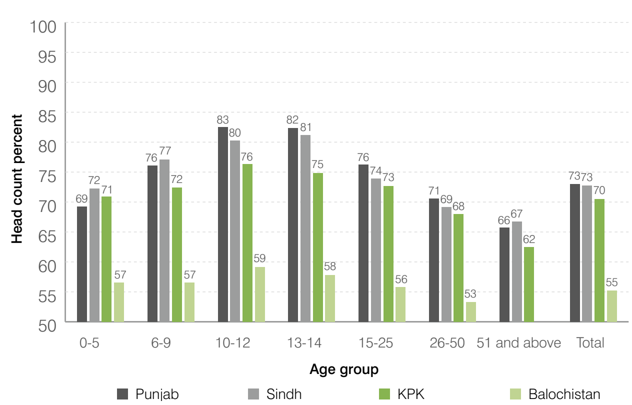


Figure 7.4: Head Count Of Milk Poverty By Provinces

Milk Poverty Head Count By Provinces



7.5 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, the econometric problems of endogeneity between children's nutritional/health status and schooling outcomes have marred attempts to find a causal relationship between nutrition and schooling.

Some researchers assert that nutrition/health is endogenous to schooling because the household makes investment decisions regarding schooling and health simultaneously (Alderman et al (2001), Handa and Peterman (2007), Aubery (2012), and Khanam (2014).[68] However, Grira (2004) disagrees while pointing out 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 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 that 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 also need control variables because they can cause endogeneity between these two variables (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.[69] 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.[70]

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[71]) 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, malnutrition substantially affects school progress once a child enrolls in school. 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).[72] 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.[73]

[68]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.

[69]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). The model captures price shocks by including current prices and geographical dummies to capture long run differences in expected prices.*

[70]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.

[71]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.

[72]The dichotomous grade attainment variable was constructed using schooling-over-age (SAGE) which is a continuous variable. This measures school attainment over age, and considers late enrollment.

[73]Khanam (2014) instrumented child health using mother and father's height, which are good indicators of the genetic endowment of the child, and are uncorrelated with schooling outcomes.

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 an 8.9% increase according to the average score" (Aubery, 2012). Other studies that find a 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 Guatemala. 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.[74]

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

7.6 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 provides empirical evidence on the impact of milk calories on school attendance in Pakistan by eliciting the human capital model of determinants of schooling.
To evaluate the determinants of schooling and child labor, the researchers use market demand and supply factors as explanatory variables (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 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. For the empirical framework, our motivation comes from 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

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

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

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

[74] *They instrument height for age z-score with mother's height and health prices.*

The dependent variable, I_i^* measures child school attendance for 4 to 17 year olds. This binary choice variable equals one if child was attending school at the time of interview and equals zero otherwise. Moreover, X_i represents a vector of individual and household control variables; X_i controls for spatial variation captured by district and province dummy variables; and u_i is the error term. This specification is a reduced form model, which reflects the supply and demand for child schooling. We obtain the coefficient estimates from the maximum likelihood estimation procedure. Table 7.7 presents definition of dependent and explanatory variables while Table 7.8 shows summary statistics.

Table 7.8 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 7.9. Table 7.8 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. Moreover, 10.5% boys and 8.1% girls have working mothers, 16.3% boys and 15.2% girls have literate mothers whereas average size of the household is 8.3 members. Also, note that 33.6% children have less than 5 year old sibling; 89.4% have siblings of 6 to 17 year olds and 8.1% have a female head of the household. In addition, 8.4% households 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 in agriculture sector. The summary statistics also reveals that 43% children in the sample come from Punjab, 23% from Sindh, 22% from KPK and 12% from Balochistan.

Table 7.10 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. 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

Table 7.7: Definition Of Dependent And Explanatory Variables

Variable name	Definition
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 milk-calories per day	Per capital milk-calories per day, 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 sibling.
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 employed in agricultural sector and 0 otherwise.
Head employed in mining	Dummy equals 1 if head employed in mining sector and 0 otherwise.
Head employed in manufacturing	Dummy equals 1 if head employed in manufacturing sector and 0 otherwise.
Head employed in electricity/gas	Dummy equals 1 if head employed in electricity/gas sector and 0 otherwise.
Head employed in construction	Dummy equals 1 if head employed in construction sector and 0 otherwise.
Head employed in wholesale trade	Dummy equals 1 if head employed in wholesale trade sector and 0 otherwise.
Head employed in transport & storage	Dummy equals 1 if head employed in transport and storage sector, and 0 otherwise.
Head employed in financial services	Dummy equals 1 if head employed in financial services sector and 0 otherwise.
Head employed in social services	Dummy equals 1 if head 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 7.8: 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
KPK	0.222	0.415	0	1
Balochistan	0.116	0.320	0	1
District fixed-effects	yes	--	--	--
Sample size	26870	--	--	--

Table 7.9: 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 7.10 Effects Of Milk Calories Consumed On School Attendance

Variable	Full sample	Std. Dev.
	(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]
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. We estimate the model with the probit maximum likelihood method corrected for heteroscedasticity.

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 7.10 suggest that holding all else as 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).

7.7 Impact Of Dairy Consumption On Nutritional Status Of Children In Pakistan

7.7.1 Introduction

Malnutrition remains a significant health issue in Pakistan where stunting, underweight and wasting rates in children under-five are not only high but have consistently increased over the past 40 years. The National Nutrition Surveys show that the wasting rates in Pakistan have increased from 8.6% in 1977, 11% in 1985, 14.3% in 2001 to 15.1% in 2011 (Spielman et al., 2016). The National Nutrition Survey data also reveals that in 2001, 41.6% children were stunted and 31.5% were underweight. In 2011, the proportion of stunted children has increased to 43.7% while the proportion of underweight children has remained the same (GoP, n.d.). These stunting rates are third highest in the world, which have longer-term implications on an individual's life. Stunted children are "less healthy, have lower cognitive ability, and earn less as adults" (Jayachandran and Pande, 2017). The prevalence of stunting and wasting is also high in Punjab where 34% of under-five children are stunted, 34% are underweight and 18% are wasted (UNICEF, 2016).

The persistence of child undernutrition in Pakistan appears to be due to a wide range of factors, most relating to uncertain access to enough food and inappropriate dietary practices. Other related factors may be poverty, low education of parents, lack of sanitation, short birth intervals and mothers' health indicators, among others. Few studies have examined the impact of dietary diversity on malnutrition of children aged 6 – 35 months; however, no study has examined the impact of dairy consumption on nutritional status of children.

We investigate the impact of dairy consumption (milk, yoghurt and cheese) on stunting, underweight and wasting of children aged zero – 35 months. Exclusive breastfeeding for children aged zero – 6 months[75] and transition from exclusive breastfeeding to complementary feeding during the weaning period for children aged 6 – 35 months is critical in a child's life. For children aged 6 – 35 months, the WHO recommends consumption of four or more food groups from seven food groups (including dairy products) for a balanced and nutritious food.[76] To disentangle the impact of dairy consumption from other food groups, we unbundle the seven food groups and take dairy products as an individual variable. The remaining six food groups are bundled where we consider food balanced and nutritious if children aged 6 – 35 months receive food from three or more food groups. We construct adequate food groups variable, which equals 1 if children under 6 months of age are exclusively breastfed

[75]Infants should be exclusively breastfed (receive only breast milk) for first six months of a child's life to achieve optimal and healthy growth. Exclusive breastfeeding means giving no other food or drink (including water), except breast milk. However, it allows children to receive oral rehydration salts (ORS), drops and syrups for vitamins, minerals and medicines. Exclusive breastfeeding provides natural protection form infections and diarrhea.

[76]The 7 recommended food groups are grains, roots and tubers; legumes and nuts; dairy products (milk, yogurt, cheese); flesh foods (meat, fish, poultry and liver/organ meats); eggs; vitamin-a rich fruits and vegetables; and other fruits and vegetables.

and children aged 6 – 35 months receive food from three or more food groups.

For this analysis, we use three anthropometric z-score cut-off points based on growth standards for under-five children published by the World Health Organization (WHO) Global Database on Child Growth and Malnutrition. The empirical analysis uses data of Punjab Multiple Indicators Cluster Survey (MICS) for 2013-14. We apply a multivariate logistic regression analysis adjusted for cluster and survey weights to identify the predictors of stunting, underweight and wasting measured by z-scores.

Stunting, or low height-for-age z-score, measures long-term index about chronic under-nutrition reflecting the past outcomes. Underweight, or low weight-for-age z-score, is an index that measures acute and chronic undernutrition. Wasting, or low weight-for-height z-score, is a short-term measure of nutritional status since it usually occurs due to recent nutritional deficiency due to prevalence of disease. We extract data from Punjab MICS 2013-14, which is the only district and rural-urban representative household survey containing information on anthropometric measures. Its sample comes from the master sample maintained by the Pakistan Bureau of Statistics, Government of Pakistan, Islamabad based on population census 1998. MICS contains data on height-for-age z-score, weight-for-age z-score and weight-for-height z-score from the median of WHO reference population.

The empirical estimates are based on data of 15,723 children aged 0 – 35 months taken from Punjab MICS 2013-14. Children whose height-for-age, weight-for-age, or weight-for-height z-scores are more than two standard deviations below (-2SD) the median of the reference population are classified as stunted, underweight, and wasted, respectively.

The dependent variables are binary taken as incidence of stunting (yes=1, no=0), underweight (yes=1, no=0) and wasting (yes=1, no=0) in children aged 0 – 35 months. Based on UNICEF's Conceptual Framework for Malnutrition, we classify independent variables into four categories: (1) child health and caring practices; (2) proximate determinants; (3) socioeconomic and demographic factors; and (4) environmental factors (UNICEF, 2013). Table 7.11 provides definition of all the variables.

7.7.2 Risk Factors For Malnutrition Of Children Aged 0 – 35 Months

We investigate the risk factors for malnutrition of children by child health and caring practices, selected proximate determinants, socioeconomic and demographic factors and environmental factors. We estimate multivariate logistic regressions and determine the adjusted risk of the independent variables by calculating the odds ratios (OR) with 95% confidence intervals. An odds ratio of more than one suggests positive correlation between the probability of malnutrition and the explanatory variables while an odds ratio of less than one indicates negative correlation. The odds ratio of one indicates that no correlation exists between the independent and dependent variable.

Impact Of Dairy Consumption On Stunting, Underweight And Wasting:

Table 7.12 shows that after controlling for all other covariates, the effect of dairy consumption on stunting and underweight remains large and statistically highly significant. Holding other things as constant, children who consume dairy are 0.825 times or 17.5% less likely to be stunted and 0.886 times or 11.4% less likely to be underweight. However, dairy consumption has no significant association with wasting rates of children aged zero – 35 months. These results

Table 7.11: Definition Of Variables

Variables	Definition
Child health & caring practices	
Dairy consumption	Dummy equals 1, if child consumed milk yoghurt, chees in last 24 hours, and 0 otherwise.
Adequate food groups	Dummy equals 1, if (a) child is < 6 months old and exclusively breastfed; and (b) Child age is 6 – 35 months and consumed >=3 food groups yesterday, 0 otherwise. We divide dietary intake into 6 food groups. We take seventh food group, dairy product consumption, as an independent variable.
Currently breastfeeding, 0 – 35 months old	Dummy equals 1, if (a) child's age is less than 24 months and child is still being breastfed, and (b) child's age is greater than or equal to 24 months and child is not being breastfed, 0 otherwise.
Infant formula	Dummy equals 1, if child consumed infant formula yesterday, 0 otherwise.

Proximate determinants	
Age of child (36 age dummy)	
Less than one month	Dummy equals 1, if child age is less than one month, 0 otherwise.
One month	Dummy equals 1, if child age is one month, 0 otherwise.
Two months	Dummy equals 1, if child age is two months, 0 otherwise.
⋮	
Thirty-five months	Dummy equals 1, if child age is 35 months, 0 otherwise.
Sex of child	
Child is male	Dummy equals 1, if child is male, 0 otherwise.
Child is female	Dummy equals 1, if child is female, 0 otherwise.
Birth interval	
No previous birth	Dummy equals I, if child has no previous siblings, 0 otherwise.
Birth interval is <24 months	Dummy equals 1, if birth interval is < 24 months, 0 otherwise.
Birth interval is >=24 months	Dummy equals 1, if birth interval is >=24 months, 0 otherwise.
Mother's age at child birth	
<20 years at birth of this child	Dummy equals 1, if mother was <20 years when this child was born, 0 otherwise.
20-29 years at birth of this child	Dummy equals 1, if mother was 20-29 years old when this child was born, 0 otherwise.
30-39 years at birth of this child	Dummy equals 1, if mother was 30-39 years old when this child was born, 0 otherwise.
40+ years at birth of this child	Dummy equals 1, if mother was 40+ years old when this child was born, 0 otherwise.
Socio-economic & demographic factors	
Mother's education	
Illiterate	Dummy equals 1, if mother is illiterate, 0 otherwise.
Primary or middle	Dummy equals 1, if mother's education is primary or middle, 0 otherwise.
Secondary or higher	Dummy equals 1, if mother's education is secondary or higher, 0 otherwise.
Wealth quintiles	
Poorest	Dummy equals 1, if household falls in the lowest wealth quintile, 0 otherwise.
Poor	Dummy equals 1, if household falls in second wealth quintile, 0 otherwise.
Middle	Dummy equals 1, if household falls in middle wealth quintile, 0 otherwise.
Rich	Dummy equals 1, if household falls in fourth wealth quintile, 0 otherwise.
Richest	Dummy equals 1, if household falls in highest wealth quintile, 0 otherwise.
Environmental factors	
Location of residence	
Region is urban	Dummy equals 1, if household is in urban area, 0 otherwise.
Region is rural	Dummy equals 1, if household is in rural area, 0 otherwise.
Hygienic toilet	Dummy equals 1, if toilet facility is flush or pit latrine, 0 otherwise.
Districts (36 dummy variables)	
Bahawalpur	Dummy equals 1, if district of residence is Bahawalpur, 0 otherwise.
⋮	
Mianwali	Dummy equals 1, if district of residence is Mianwali, 0 otherwise.

Table 7.12: Determinants Of Stunting, Underweight & Wasting In Children Aged 0 – 35 Months, Punjab

	Odds ratios		
VARIABLES	Stunting	Underweight	Wasting
Child Health & Caring Practices:			
Dairy consumption (if child consumed milk, yoghurt, cheese in last 24 hours) (yes=1, no=0)	0.825*** (0.753 - 0.905)	0.886*** (0.809 - 0.970)	1.074 (0.968 - 1.192)
Adequate food groups (yes=1 if consumed >=3 food groups, no=0)	0.707*** (0.640 - 0.780)	0.730*** (0.662 - 0.804)	0.888** (0.793 - 0.993)
Currently breastfeeding (yes=1, no=0)	0.883** (0.798 - 0.976)	0.899** (0.819 - 0.987)	0.848*** (0.762 - 0.945)
Infant formula (yes=1, no=0)	1.289** (1.000 - 1.660)	1.258* (0.997 - 1.587)	1.108 (0.874 - 1.404)
Proximate Determinants:			
Child is female (yes=1, no=0)	0.829*** (0.771 - 0.892)	0.859*** (0.799 - 0.923)	0.805*** (0.744 - 0.871)
No previous birth (yes=1, no=0)	0.735*** (0.666 - 0.812)	0.779*** (0.711 - 0.854)	0.847*** (0.763 - 0.940)
Birth interval is <24 months (yes=1, no=0)	1.423*** (1.275 - 1.588)	1.281*** (1.152 - 1.424)	1.043 (0.923 - 1.177)
Mother's age at child birth 20-29 years (yes=1, no=0)	0.694*** (0.579 - 0.833)	0.800** (0.673 - 0.952)	1.010 (0.827 - 1.233)
Mother's age at child birth 30-39 years (yes=1, no=0)	0.619*** (0.509 - 0.753)	0.759*** (0.632 - 0.912)	1.047 (0.847 - 1.295)
Mother's age at child birth 40+ (yes=1, no=0)	0.656*** (0.507 - 0.851)	0.679*** (0.534 - 0.864)	1.052 (0.794 - 1.394)
35 child age dummies included	Yes	Yes	Yes
Socioeconomic & Demographic Factors:			
Mother's education primary or middle (yes=1, no=0)	0.842*** (0.765 - 0.926)	0.847*** (0.773 - 0.929)	0.912* (0.823 - 1.011)
Mother's education secondary or higher (yes=1, no=0)	0.565*** (0.494 - 0.647)	0.574*** (0.508 - 0.648)	0.736*** (0.643 - 0.843)
Wealth quintile – poorest	3.375*** (2.735 - 4.165)	2.588*** (2.119 - 3.161)	1.779*** (1.431 - 2.212)
Wealth quintile – poor	2.518*** (2.109 - 3.005)	2.021*** (1.711 - 2.387)	1.487*** (1.244 - 1.777)
Wealth quintile – middle	1.883*** (1.602 - 2.214)	1.745*** (1.503 - 2.025)	1.474*** (1.253 - 1.735)
Wealth quintile – rich	1.495*** (1.283 - 1.742)	1.455*** (1.268 - 1.669)	1.299*** (1.124 - 1.501)

Environmental Factors:			
Region is rural (yes=1, no=0)	0.937 (0.846 - 1.038)	0.871*** (0.788 - 0.963)	0.776*** (0.697 - 0.864)
Hygienic toilet (yes=1, no=0)	0.993 (0.871 - 1.132)	0.861** (0.760 - 0.976)	0.853** (0.741 - 0.983)
District fixed effects	YES		
Observations	15,723	15,723	15,723
Pseudo R-squared	0.0978	0.0637	0.0422

Note: Coefficient estimates come from a logistic regression, controlling for child age and district fixed-effects. Other variables included, but not reported, are child is female, two birth order variables, three mother age at child birth variables, took infant formula yesterday, adequate food groups, two mother education dummy, four wealth quintile variables, region is rural and hygienic toilet. Robust standard errors correct for clustering at the primary sampling unit. Numbers in parenthesis are odds ratio at 95% confidence interval. Asterisks denote statistical significance. *** p<0.01, ** P<0.05, * P<0.1.

show that children who do not consume dairy products are relatively at a higher risk of being malnourished than children who do consume dairy products.

We also find that if non-breastfed children consume dairy products, the risk of stunting significantly declines by 0.674 times or 32.6%, the risk of underweight declines by 0.614 times or 38.6% and the risk of wasting declines by 0.863 times or 13.7%, relative to children who are not breastfed and who do not consume dairy (Table 7.13). In other words, dairy products are more strongly associated with underweight and stunting of non-breastfed children, adjusting its effects for other covariates including other food groups. Thus, if children are not currently being breastfed then they must consume dairy products rather than switching solely to family foods. It implies that children under the age of six months who are not being breastfed would be better off if they substitute breastfeeding with dairy products while adopting complementary child feeding practices in children aged 6 – 35 months. These children must consume four or more food groups from amongst seven recommended food groups for balanced and nutritious food. Dairy consumption is one of the seven food groups, which has strong effect on nutritional status of children, independent of other food groups. This is a most pertinent short-term factor to act upon, through effective campaigns,

Table 7.13: Interaction Terms Between Currently Breastfed And Dairy Consumption

	Adjusted odds ratio at 95% confidence interval		
VARIABLES	Stunting	Underweight	Wasting
Dairy consumption (if child consumed milk, yoghurt, cheese in last 24 hours) (yes=1, no=0)	0.674*** (0.521 - 0.871)	0.614*** (0.478 - 0.789)	0.863 (0.659 - 1.130)
Currently breastfeeding (yes=1, no=0)	0.720** (0.555 - 0.934)	0.624*** (0.486 - 0.801)	0.682*** (0.518 - 0.898)
CBF x Dairy consumption	1.266* (0.957 - 1.675)	1.522*** (1.164 - 1.991)	1.285* (0.960 - 1.719)
Observations	15,723	15,723	15,723
Pseudo R-squared	0.0980	0.0642	0.0424

Note: Coefficient estimates come from a logistic regression, controlling for child age and district fixed-effects. Other variables included, but not reported, are child is female, two birth order variables, three mother age at child birth variables, took infant formula yesterday, adequate food groups, two mother education dummy, four wealth quintile variables, region is rural and hygienic toilet. Robust standard errors correct for clustering at the primary sampling unit. Numbers in parenthesis are odds ratio at 95% confidence interval. Asterisks denote statistical significance. *** p<0.01, ** P<0.05, * P<0.1.

with support from Lady Health Workers in severely affected regions.

Our results also suggest that if dairy consuming children are also currently breastfed, the effect on stunting and underweight is statistically significant (Table 7.13). Among dairy consuming children, the odds of stunting decline by 14.7% (0.674*1.266=0.873 or 14.7%) while the odds of underweight decline by (0.614*1.522=0.934 or 7%) if children are also currently breastfed.

Impact Of Other Risk Factors And Confounders:

Holding all else as constant, the risk of stunting, underweight and wasting is significantly lower in girls relative to boys. For example, Table 7.12, columns 1 to 3, shows that, as compared with boys, girls have 17.1% lower risk (0.829 – 1 = – 0.171) of stunting, 14.1% lower risk of underweight and 19.5% lower risk of wasting. Increased risk of undernutrition in boys may be associated with the fact that boys engage in physical activities much more than girls thus consuming enormous amounts of energy whereas, in contrast, girls generally stay at home and require much less energy. Generally, these results are in line with findings from other developing countries such as Nigeria (Akombi et al., 2017), Northern Ghana (Ali et al., 2017), India (Fenske et al., 2013) and South Africa (Faber et al., 2010).

Our results also support that previous birth interval has a strong association with stunting and underweight. Holding other things as constant, previous birth interval of less than 24 months increases the risk of stunting by 1.423 times, or 42.3% and of underweight by 1.281 times, or 28.1%, compared with children who have birth interval of more than 24 months. However, first-born children have 26.5% lower risk of stunting, 22.1% lower risk of underweight and 15.3% lower risk of wasting.

Mother's age at the time of birth is negatively and significantly associated with both stunting and underweight, controlling for all other factors. Compared with mothers who are less than 20 year old at childbirth, the risk of stunting is respectively 30.6%, 38.1% and 34.4% lower for age at childbirth of 20 – 29 years, 30 – 39 years and 40+ years. Moreover, the risk of underweight is respectively 20%, 24.1% and 32.1% lower for mother age at childbirth of 20 – 29 years, 30 – 39 years and 40+ years.

The determinants for child health and caring practices show that currently breastfeeding children have significantly lower risk of stunting, underweight and wasting. Estimates in Table 7.12 confirm that currently breastfed children have nearly 12% lower risk of stunting, 10.1% lower risk of underweight and 15.2% lower risk of wasting, as compared with children who are not currently breastfed.

Feeding practices such as regular use of infant formula is statistically significantly associated with stunting and underweight of children in our sample. The adjusted odds in Table 7.12 show that regular use of infant formula milk increases the odds of both stunting and underweight by 1.3 times relative to children who are not using infant formula. The use of contaminated drinking water in infant formula could be a major factor behind the association between infant formula and under nutrition of children through occurrence of diarrhea and fever. For example, a recent World Bank report on Pakistan notes that:

Households in poorer districts rely more on hand pumps, which fetch water from shallow depth rather than deeper drilling, leading to higher levels of "contamination through seepage of human excreta from nearby toilets and fecal waste dumping sites" and where a "combination of hand pumps and pit latrines substantially increases water contamination" (World Bank, 2018).

Table 7.14 reveals that among children who are not currently breastfed, infant formula consumption increases the odds of stunting by 1.735 times relative to those who are not consuming infant formula. Among children who are not consuming formula milk, the odds of stunting, underweight and wasting are 0.896 times, 0.901 times and 0.848 times lower for currently breastfed children compared with children who are not currently breastfed. Table 7.14 also reveals that among breastfed children, the risk of stunting is 0.566 times lower or 43.4%, the risk of underweight is 0.843 times lower or 15.7% and the risk of wasting is 0.857 times lower or 14.3% if they are consuming infant formula versus children who are not consuming infant formula. Thus, the practice of combining breastfeeding with infant formula is a much preferred option than consumption of infant formula only.

Table 7.14: Interaction Terms Between Currently Breastfed And Infant Formula

	Adjusted odds ratio at 95% confidence interval		
Variables	Stunting	Underweight	Wasting
Currently breastfeeding (yes=1, no=0)	0.896** (0.809 - 0.992)	0.901** (0.820 - 0.991)	0.848*** (0.760 - 0.946)
Infant formula (yes=1, no=0)	1.735*** (1.158 - 2.598)	1.314 (0.899 - 1.922)	1.100 (0.734 - 1.648)
CBF x Infant formula	0.621* (0.377 - 1.021)	0.936 (0.586 - 1.493)	1.011 (0.613 - 1.668)
Observations	15,723	15,723	15,723
Pseudo R-squared	0.0980	0.0637	0.0422

Note: Coefficient estimates come from a logistic regression, controlling for child age and district fixed-effects. Other variables included, but not reported, are child is female, two birth order variables, three mother age at child birth variables, dairy consumption, adequate food groups, two mother education dummy, four wealth quintile variables, region is rural and hygienic toilet. Robust standard errors correct for clustering at the primary sampling unit. Numbers in parenthesis are odds ratio at 95% confidence interval. Asterisks denote statistical significance. *** p<0.01, ** P<0.05, * P<0.1.

Adequate food groups variable, which equals 1 if children under 6 months of age are exclusively breastfed and children aged 6 – 35 months receive food from three or more food groups. The adjusted odds ratio shows that children who consume adequate food groups are 29.3% less likely to be stunted, 27% less likely to be underweight and 11.2% less likely to be wasted relative children who were not exclusively breastfed or consumed less than three food groups. Thus, lack of adequate food in children aged 0 – 35 months appears to be a major cause of undernutrition.

Our results also confirm that educated mothers significantly reduce the risk of malnutrition. We find that children born to educated mothers have significantly lower risk of stunting, underweight and wasting. Mother's education being primary/middle and secondary/higher significantly lowers the risk of stunting respectively by 16% and 44%, underweight by 15.3% and 42.6%, and wasting by 8.8% and 26.4%, compared with children of illiterate mothers. It is well known that educated mothers are expected to utilize health facilities better, e.g., pre-natal and post-natal care, they have much better understanding of child hygiene, diseases and the importance of dietary diversity in children including the importance of dairy consumption in children. These findings on the positive role of mother's education on child nutrition are corroborated by other studies carried out in Pakistan (Mahmood, 2001; Garcia and Alderman, 1990), Nigeria (Akombi et al., 2017), Bangladesh (Rayhan and Khan, 2006) and Northern Ethiopia (Yalew et al., 2014).

Another noteworthy feature of this study is the strong association established between wealth quintile and malnutrition of children. The results establish this relationship as the odds of stunting, underweight and wasting monotonically decrease with increase in wealth quintile of the household (Table 7.12). For example, controlling for all other factors, the odds of stunting are respectively 3.37 times and 2.74 times higher for children in the poorest 20% and poor 20% households, compared with the richest 20% households. Similarly, the odds of underweight and wasting are respectively 2.6 times and 1.8 times higher for children in the poorest 20% households relative to the richest 20% households. Other studies that have established strong association between wealth inequality and undernutrition of children have been carried out in Pakistan (Alderman et al., 1990), Oman (Alasfoor et al., 2007) and Ethiopia (Wolde et al., 2015), among others.

Contrary to expectations, rural children relative to urban children are at much lower risk of undernutrition. The determinants of environmental factors reveal that rural children have 12.9% lower risk of underweight and 22.4% lower risk of wasting relative to urban children. However, location being rural/urban has statistically insignificant impact on stunting. Empirical evidence from other countries generally contrasts with these results (see, Akombi et al., 2017; Kandala, 2011, among others).

Likewise, children who have access to hygienic toilet have 13.9% lower risk of underweight and 14.7% lower risk of wasting, compared with children who do not have access to hygienic toilet. However, no risk of stunting was associated with presence of hygienic toilets in the household since the estimates were statistically insignificant. Poor association between access to hygienic toilet and stunting may be attributed to the fact that community level sanitation behavior is more important than household having access to hygienic toilet. For example, Ahmed (2018) have found that "children living in communities with poor sanitation are likely to be shorter and that high rates of open defecation in these communities explains, in part, the shorter stature of the children" in Punjab and Sindh. He further notes that "exposure to fecal pathogens causes diarrhea and inflammation of the small intestine, thereby reducing nutrient absorption and hampering normal growth" (Ahmed, 2018). A recent World Bank report also corroborates that poor sanitation facilities in Pakistan are responsible for stunting of children (World Bank, 2018).

Whereas this analysis relies on a comprehensive set of covariates, we cannot rule out the residual confounding from unmeasured predictor variables. For example, no survey accurately measures access to clean drinking water. The researchers frequently used piped water variable as a proxy for clean drinking water, but the evidence from the World Bank report (2018) suggests that the piped water is not always safe for drinking. We tried piped water as one of the independent variables, but excluded it because it was statistically insignificant. Antenatal care, delivery in hospital, assisted delivery, mothers received tetanus shot are other proximate determinants excluded from the analysis due to its non-reporting for children aged 6 – 35 months. Other child health and caring practices variables tried in the regression, but excluded from the final analysis, as they were statistically insignificant, are child completely vaccinated, diarrhea and fever in the last two weeks.

7.8 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. We summarize the key findings 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 can 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, eliminating nutritional gap in protein energy, iodine deficiency and iron deficiency 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 included.

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 KPK 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 PKR 64 billion per day to bridge this nutritional gap, of

which PKR 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 or 4.57 billion liters per annum, which is equal to 10% of total milk currently available for human consumption. To bridge the gap in milk consumption would require PKR 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.

Sixth, 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 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. 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. Seventh, children who do not consume dairy products are relatively at a higher risk of being malnourished than those who consume dairy products. Our results suggest that children aged 0 – 35 months who consume dairy products are 18% less likely to be stunted and 11% less likely to be underweight; however, dairy consumption has no significant association with wasting of children.

Last, if children under the age of six were not exclusively breastfed, then they would be better off if they substitute breastfeeding with dairy products rather than switching to family foods. Our results show that dairy consumption by non-breastfed children lowers the risk of stunting by 33%, the risk of underweight by 39% and risk of wasting by 14%.

HOW SALES TAX ON PACKED MILK **AND MILK PRODUCTS AFFECTS WELFARE?**

8.1 Introduction

As part of measures to increase tax to GDP ratio, the Federal Board of Revenue (FBR) is keenly searching for ways and means to raise tax revenue. Until June 2016, a zero-rating regime was in place on all direct materials used by the milk processing industry. Refunds were admissible on indirect materials used at the rate of 17%. These materials included fuel, electricity, packing, spare parts, lubricants, etc. However, in practice these refunds never materialized. Over the years, accumulation of these refunds had led to serious problems for some big players due to questions on their balance sheets because their receivables did not go well with the good accounting practices in the eyes of their shareholders.

Even more fundamental problem associated with this policy was that it imposed an input tax of 6% on those dairy processing units who were tax compliant. Non-tax compliant units who did not pay their due taxes on indirect materials got undue cost advantages. In this way, non-refund of the input tax served as a distortionary measure penalizing tax compliant units for paying taxes while favoring non-tax compliant units.

Independent of these concerns, the government decided to abolish sales tax zero-rating status through finance acts 2015-16 and 2016-17, and have since imposed reduced rate sales tax at 10% on goods, e.g., concentrated (powder) milk, cream, yogurt, cheese, butter, whey while they have categorized UHT and fat filled milk exempt under the Sales Tax Act 1990 (Sarfraz and Abbasi, 2017).

The Pakistan Dairy Association demands restoration of zero rated tax regime because due to the withdrawal of zero rated facility, the gap between processed milk and loose milk price has got bigger leading to drop in sales of processed milk (Sarfraz and Abbasi, 2017). The dairy sector has also sought the withdrawal of 10% sales tax on milk products.

Despite the concerns of the Pakistan Dairy Association and the firm position taken by the Federal Board of Revenue (FBR) against restoration of zero rated sales tax regime, no comprehensive and independent assessment exists on how imposition of an output tax on packed milk and milk products affects welfare including government revenue, producer surplus and consumer surplus.

The economic literature guides us that the final incidence of indirect taxes depends on the relative elasticity of demand and supply curves. If demand curve is elastic and supply curve is inelastic then the incidence of the sales tax disproportionately falls on producers. However, if demand curve is inelastic and supply curve is elastic then the incidence disproportionately falls on consumers. We can do the tax incidence analysis 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.

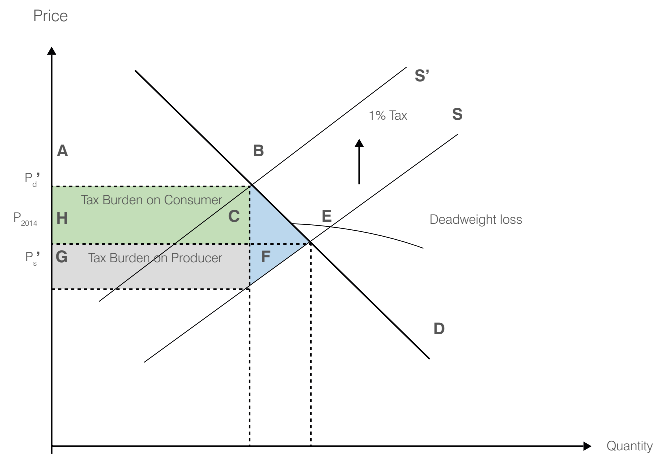
In this chapter, we ask a more fundamental question. How imposing sales tax on packed milk and milk products affects welfare? The answer to this question is tricky simply because sales tax is an indirect tax, which may have far-reaching implications on the welfare of milk consumers and dairy farms producing milk depending upon the incidence of the tax. We conduct the partial equilibrium analysis to figure out the incidence of tax on packed milk and milk products. We use elasticity of demand and supply of packed milk to map market demand and supply functions 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.

Section 8.2 presents a theoretical perspective on incidence of tax while in Section 8.3 we estimate the market demand for dairy products. Section 8.4 is on supply elasticity of dairy products. Finally, Section 8.5 examines the long run and short run welfare implications of imposition of sales tax on the dairy processing industry.

8.2. A Theoretical Perspective On The Incidence Of Tax

Figure 8.1 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. Therefore, 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.[77] 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.[78]

Figure 8.1: Tax Incidence On Producers, Consumers, And Society



We use the coordinates of new and old market equilibrium 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.

In Figure 8.1, the area of the rectangle ABFG represents total tax revenue for collection. 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.

To conclude, this section, tax revenue is the area of rectangle ABFG, deadweight loss is the areas of triangle BEF, change in consumer surplus is the area of trapezoid ABEH, and change in producer surplus is the area of trapezoid EFGH.

[77] This equilibrium point, E, marks the price and amount of milk produced and consumed in the year 2014. We label these coordinates on the graph as P_{2014} and Q_{2014} respectively. The Foresight Research panel survey indicates that the average price of milk in 2014 was PKR 93.55/liter. We found from industry sources that the quantity of milk produced and consumed in 2014 was 1854 million liters.

[78] The new market equilibrium, B, has the coordinates P_d' and $_Q$'.

8.3. Estimating Market Demand For Dairy Products

We assume that budgetary constraints restrict consumer demand for goods and services, which are interlinked. To portray the linkages between prices and incomes on demand for these goods and services, we apply the Stone's model of simultaneous demand equations to estimate the demand function for packed milk and other goods.

The model is estimated by employing a unique panel data shared by a market research firm namely, Foresight Research. This household panel consists of four-year data of 7700 households, from 2011 to 2014.[79] The 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 Annex-A.

We group household per capita consumption into four categories, viz., packed milk; fresh milk; all food and beverages other than milk; and a composite commodity variable including apparel, textile, footwear, housing, utilities, education, health, transportation, communication, cleaning, personal hygiene, recreation, and entertainment. We simultaneously estimate the demand functions for the four categories listed above by the Stones model. Table 8.1 reports the estimates of compensated elasticity along with their standard errors.

Table 8.1 reveals that all own price elasticities bear negative signs (as expected) and their magnitudes are reasonable. 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.[80] We find that the intercept was 206,657,957.

[79]We obtain this data set from 'Foresight Research' based in Karachi. The Foresight Research collects monthly and annual expenditure data from households.

[80]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 liters 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.

Table 8.1: 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 in parenthesis.
***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

8.4. Estimating Supply Elasticity Of Packed Milk

In the next step, we also estimate supply elasticity of packed milk. 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. Annex-B provides a brief explanation of the econometric model specification. 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.

The variable inputs include diverse 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'.[81] The remaining fodder types (wheat straw and concentrate) are grouped together to form another composite input.[82] The fixed inputs in our production process include electricity, and initial investments in animal capital, sheds, and yards. We consider electricity as a fixed input in the short run because there is no significant variation in prices. Annex-B presents the estimation results. 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 longer-run. We use this elasticity to calculate the slope and intercept of the output supply function.[83] Our calculations reveal that the slope of the supply curve for packed milk is 15617, which confirms that the supply curve is upward sloping.[84] Moreover, the calculations further show that the intercept is 64,583,479.

8.5. 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 angles. As noted above, the demand for milk is relatively inelastic (with elasticity of 0.828, or less than one) and the supply is relatively elastic (with elasticity of 3.23, or more than one); supply elasticity is almost four

[81]Combining Rabi, kharif, and roughages and grass into one input makes empirical sense because their prices are in rupees per acre. We compute the price of this composite input (known as green fodder) by share weighting the price of each of the individual types of fodder.

[82]Combining wheat straw and concentrate into one input makes empirical sense because their prices are in rupees per 40 kg. We calculate this composite input by share weighting the price of each of the individual types of fodder.

[83]Annex-B explains calculations for the price elasticity of supply of milk, and the slope and intercept of the supply function.

[84]This slope was computed using price in PKR per million liter and quantity in million liters (we converted the price of milk from rupees per liter to rupees per million liters for convenience). The resulting tax revenues, deadweight loss, and changes in consumer and producer surplus are calculated in PKR, and reported in PKR billion in the finalized tables.

times that of the demand elasticity of milk. However, recent estimates suggest that short run supply elasticity of milk production is inelastic. For example, Wasim (2005) finds that the short run supply price elasticity of milk is only 0.258. This figure is small, compared to our long run elasticity estimate reported above. In the case of increased price of milk, producers will choose to produce more milk to reap higher profits. However, 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 longer-run.

The remainder consists of two subsections. Section 5.1 discusses the long run implications of imposing a sales tax on the dairy sector. Section 5.2 analyzes the short run consequences of imposing a sales tax on dairy products.

8.5.1 Tax Incidence Analysis For Packed Milk
Long Run Tax Incidence Analysis:

In this section, we use the long run milk price elasticity estimates to compute the impact of sales tax on tax revenue, deadweight loss, producer's surplus and consumer's surplus. In general, the long run estimates show that increase in sales tax significantly increases tax revenue, but the efficiency losses (due to deadweight loss, loss in producer and consumer surplus) exceeds the gains in tax revenue. Figure 8.2(a) to 8.2(d) depict this where the curves show the long run sales tax incidence for years 2015 to 2017 (see also, Annex-C, Table C8.1 to C8.3).

More specifically, Figure 8.2(a) maps the relationship between tax revenue and tax rate to show that as tax rate increases, tax revenue rises proportionally. A 1% sales tax yields a tax revenue of PKR 3.38 billion in 2015, PKR 3.81 billion in 2016, and PKR 3.65 billion in 2017. Likewise, a sales tax of 10% earns PKR 31.26 billion in 2015, PKR 35.24 billion in 2016, and PKR 33.79 billion in 2017. While this may serve as an incentive to the government to levy a high sales tax on packed milk, but it would be important to consider its welfare implications.[85]

We note that while increasing sales tax rate proportionately increases tax revenue, Figure 8.2 (b) indicates that deadweight loss to society increases more than proportionately for every additional percentage point increase in tax.[86]Other measures of tax incidence used are producer[87] and consumer[88] surplus.

Figure 8.2(c) plots the relationship between change in producer surplus[89] and the tax rate. The imposition of 1% sales tax reduces producer surplus by PKR 0.69 billion in 2015, PKR 0.78 billion in 2016, and PKR 0.75 billion in 2017. Increasing this tax rate to 10%, producer surplus decreases by PKR 6.66 billion in 2015, PKR 7.51 billion in 2016, and PKR 7.2 billion in 2017. In other words, as the tax rate increases, the tax burden on producer increases.

Similarly, Figure 8.2(d) shows the relationship between change in consumer surplus and the tax rate. Imposing a sales tax of 1% reduces consumer surplus by PKR 2.70 billion in 2015, PKR 3.05 billion in 2016, and PKR 2.92 billion in 2017. Increasing the tax rate to 10%, consumer surplus decreases by PKR 26.01 billion in 2015, PKR 29.32 billion in 2016, and PKR 28.11 billion in 2017.

Comparing the changes in producer and consumer surplus leads us to conclude that in the longer-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 producer surplus. Our estimates suggest that at sales tax rate of 5% (10%), the FBR would have earned a total tax revenue of PKR 17.65 billion (PKR 33.79 billion) in 2017. However, the efficiency loss to society would amount to PKR 18.42 billion (PKR 36.83 billion). Therefore, we conclude that imposing sales tax on the dairy sector would yield higher tax revenues, but efficiency losses to producers and consumers would be higher than gains in tax revenue.

[85]A sales tax levy forces producers and consumers to change preferences leading to misallocation of resources (efficiency loss, i.e., deadweight loss) since aggregate production and consumption fall below the optimal level.
86For instance, suppose that an initial tax rate of 5% is imposed, which will lead to deadweight loss of PKR 0.38 billion in 2017. If the tax rate increases from 5% to 6%, the deadweight loss would increase by approximately PKR 0.17 billion in 2017.

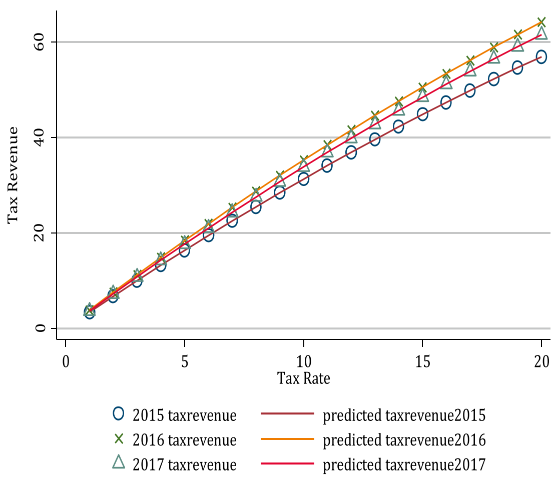
[87]We define the producer surplus, a measure of producer welfare, as the difference between what producer is willing to supply and the actual amount received when s/he makes the transaction. Imposing a sales tax on dairy products decreases producer surplus in two ways. Firstly, it exerts a tax burden on producers. Secondly, it incurs efficiency loss to producers in the form of unemployment and reduced profits for rural subsistence dairy farms.

[88]We define consumer surplus, a measure of consumer welfare, as the difference between what consumers are willing and able to pay and what they pay. Like producer surplus, levying a sales tax on dairy sector decreases consumer surplus in two ways: it exerts a tax burden on consumers; and it incurs efficiency losses to consumers.

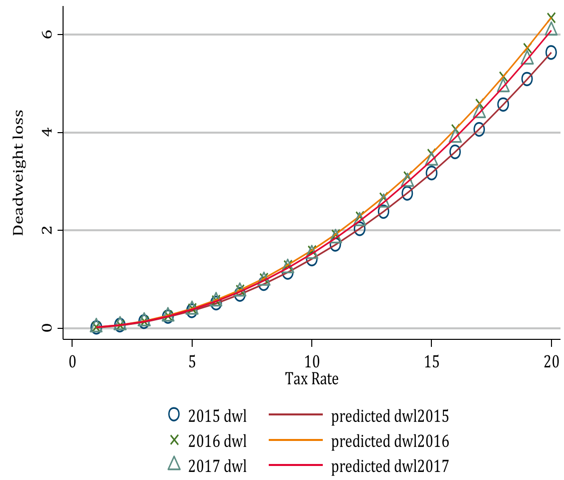
[89]Note that this is aggregate producer surplus for the dairy industry, and includes all milk-producing agents (processing companies, rural small holders, and corporate dairy farms).

Figure 8.2: Long Run Impact Of Sales Tax On Packed Milk

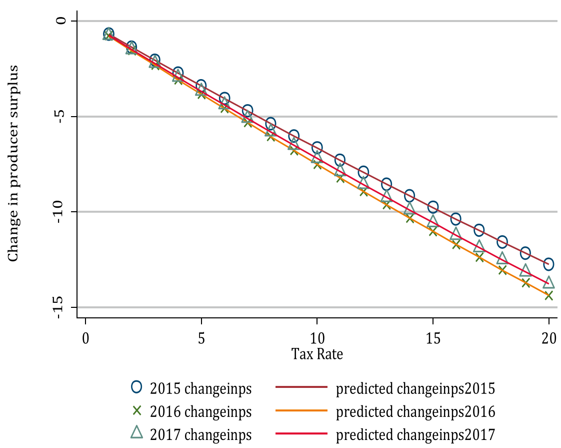
(a) Impact On Tax Revenue



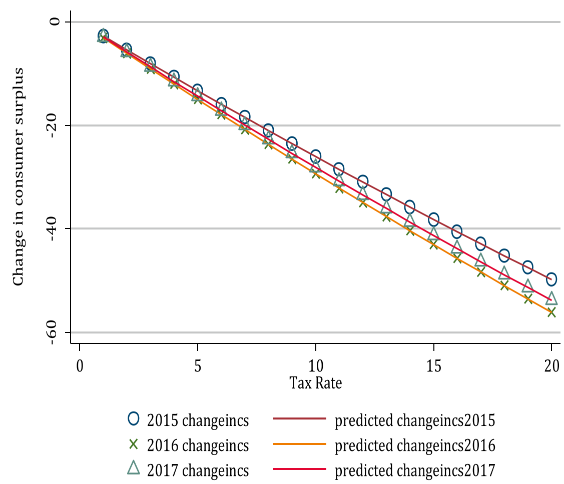
(b) Impact On Deadweight Loss



(c) Impact On Producer Surplus



(d) Impact On Consumer Surplus



Short-Run Tax Incidence Analysis For Packed Milk

Next, we conduct short-run tax incidence analysis for packed milk by deploying short run estimate of supply price elasticity of milk.[90] Figure 8.3(a) to (c) present the results (also see, Annex-C, Tables C8.4 to C8.6). Figure 8.3(a) shows that a 1% sales tax earns tax revenue of PKR 11.32 billion in 2015, PKR 12.76 billion in 2016, and PKR 12.23 billion in 2017. Imposing a tax rate of 10% yields approximately PKR 104.67 billion in 2015, PKR 117.99 billion in 2016, and PKR 113.12 billion in 2017.

Tax revenue in the short run is much higher if compared with the tax revenues in the longer-run. However, as dairy producers alter their milk supply and adjust to new market equilibrium in the longer-run, the average tax revenue earned from each percent increase in sales tax will fall. This move might increase tax revenue but will also incur a deadweight loss on society and exert a tax burden on both producers and consumers. The results in Figure 8.3(b) indicate that as the sales tax rate increases, the deadweight loss to society increases more than proportionately.[91] The deadweight loss at each tax rate is much higher in the short run than in the longer-run.

---

[90]Following Wasim (2005), we take short-run price elasticity as 0.258.

[91]Suppose we impose an initial tax rate of 5% on the industry. This will result in a deadweight loss of PKR 1.27 billion in 2017. If we increase the tax rate from 5% to 6%, the deadweight loss would increase by PKR 0.57 billion in 2017.

Figure 8.3(c) shows that as the tax rate increases, the producer surplus decreases linearly. The imposition of 1% sales tax reduces producer surplus by PKR 8.66 billion in 2015, PKR 9.76 billion in 2016, and PKR 9.36 billion in 2017 and for 10% sales tax producer surplus decreases by PKR 83.38 billion in 2015, PKR 93.99 billion in 2016, and PKR 90.11 billion in 2017. These figures suggest that, in the short run, for every one-percentage point increase in tax rate, producer surplus decreases by PKR 8.30 billion in 2015, PKR 9.35 billion in 2016, and PKR 8.97 billion in 2017. In the longer-run, however, producer surplus decreases by only PKR 0.66 billion in 2015, PKR 0.75 billion in 2016, and PKR 0.72 billion in 2017 on average.

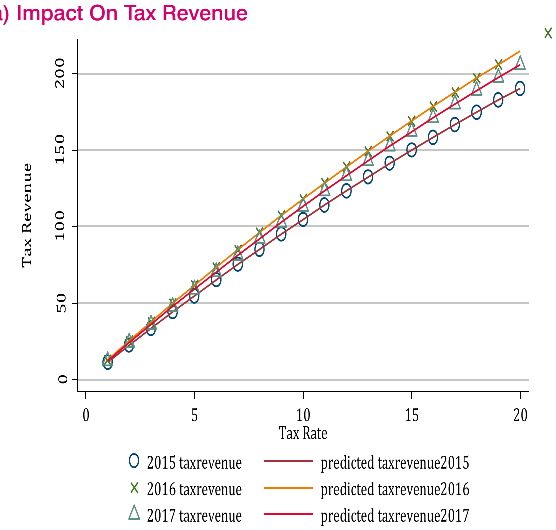
In net terms, total tax revenue falls short of loss in total welfare, measured by deadweight loss, consumer and producer surplus. The estimates show that at 5% (10%) sales tax, the FBR would earn total tax revenue of PKR 10.78 billion (PKR 33.79 billion) in the short run. Total deadweight loss to society and change in consumer and producer welfare (or surplus) amounts to PKR 18.42 billion and PKR 36.83% at sales tax rates of 5% and 10%, respectively, which is higher than the total tax revenue collected at these tax rates. In sum, we find that short run increase in sales tax leads to a large increase in tax revenue, but, as in the long run analysis, the efficiency loss to producers, consumers and society would far exceed the gains in tax revenue.

8.5.2 Welfare Analysis Of Imposing Sales Tax On Processed Milk Products

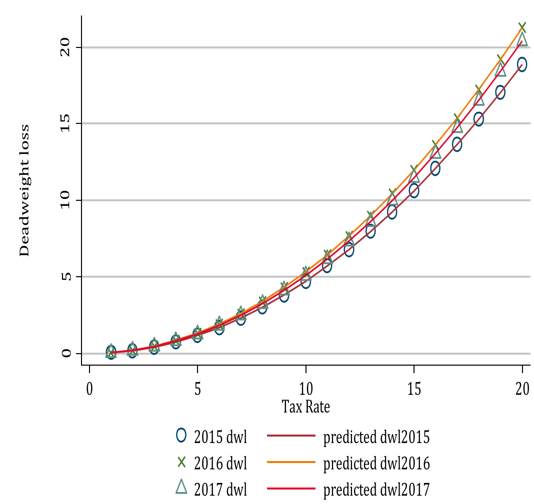
In this section, we extend the welfare analysis of imposition of sales tax on different packed or processed milk products. Specifically, it discusses the impact of sales tax on three sub-categories of packed or processed milk: ambient white milk,[92] tea creamers, and dairy drinks & beverages. We use the long run and short run price elasticities of demand and supply for packed milk,[93] 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.

Figure 8.3: Short Run Impact Of Sales Tax On Packed Milk

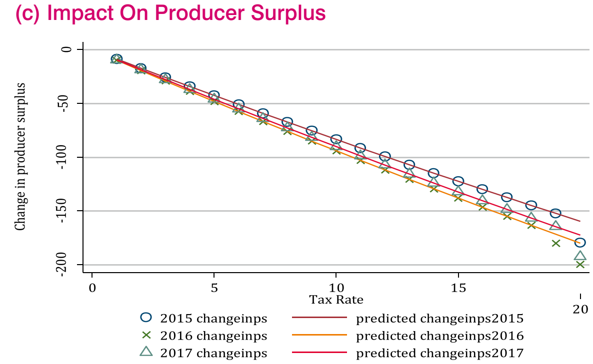
(a) Impact On Tax Revenue



(b) Impact On Deadweight Loss



(c) Impact On Producer Surplus



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

[93] *Note that we use the same price elasticity of demand and supply, which encompasses all packed or processed milk produced and consumed. However, 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.*

Long Run Impact On Ambient White Milk

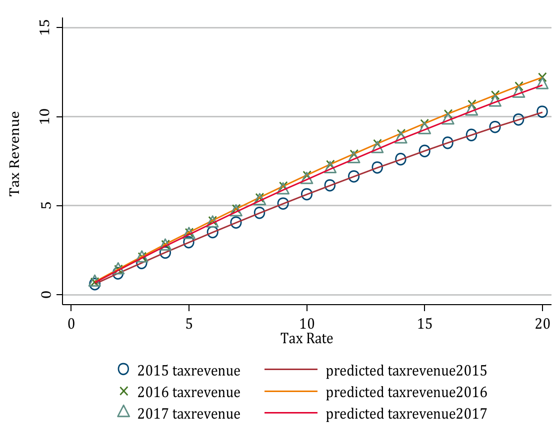
Figure 8.4(a) maps the relationship between tax revenue and tax rate (for details, see Annex-C, Tables C8.7 to C8.9). The estimates suggest that, on average, for every one-percentage point increase in tax rate, tax revenues go up by PKR 0.56 billion in 2015, PKR 0.67 billion in 2016, and PKR 0.64 billion in 2017. While increasing sales tax rate increases tax revenue proportionally, the deadweight loss to society increases more than proportionately (Figure 8.4(b)), as illustrated below.[94]

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 farms and to consumers in the form of reduced nutrient intake from milk. In keeping with this, Figure 8.4(c) shows that as tax rate increases, producer surplus decreases linearly and for a one percentage point increase in tax rate, producer surplus decreases by PKR 0.12 billion in 2015, PKR 0.142 billion in 2016, and PKR 0.137 billion in 2017. Similarly, Figure 8.4(d) demonstrates that for a one percentage point increase in tax rate, consumer surplus decreases by PKR 0.47 billion in 2015, PKR 0.56 billion in 2016, and PKR 0.54 billion in 2017.

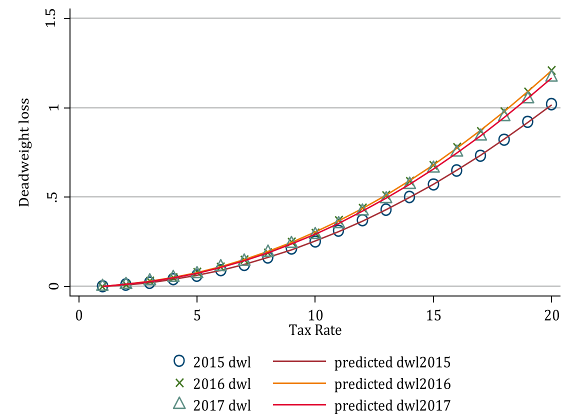
Note that the impact of imposing a sales tax is higher on consumers than on producers, indicating that consumers fare worse in the longer-run with a sales tax on ambient white milk. Finally, it is important to note that while tax revenues rise for every percentage point increase in tax, the combined decrease in producer and consumer surplus exceeds this amount even before we account for the deadweight loss to society.

Figure 8.4: Long Run Impact Of Imposing Sales Tax On Ambient White Milk

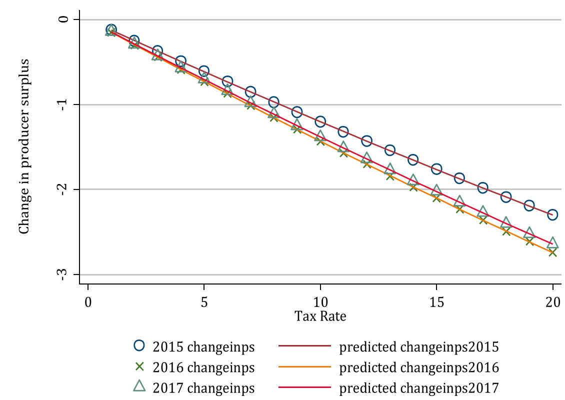
(a) Impact On Tax Revenue



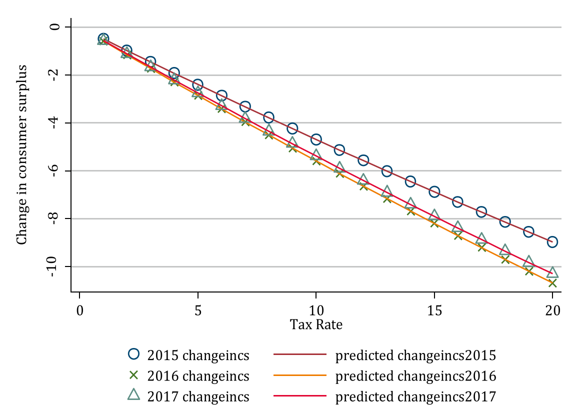
(b) Impact On Deadweight Loss



(c) Impact On Producer Surplus



(d) Impact On Consumer Surplus



[94]Suppose we impose an initial tax rate of 7%, which will result in a deadweight loss of PKR 0.14 billion in 2017. If we increase the tax rate from 7% to 8%, the deadweight loss would increase roughly by PKR 0.05 billion in 2017. If we further increase the tax rate from 8% to 9%, the deadweight loss would increase by PKR 0.05 billion in 2017.

Short Run Impact On Ambient White Milk

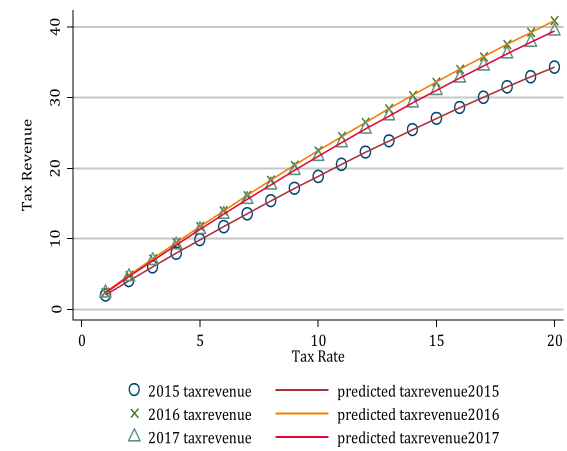
Using the short run estimate of price elasticity of milk supply, Figure 8.5(a) to (c) present the results. Figure 8.5(a) reveals that every percentage point increase in tax rate on ambient white milk increases tax revenues by PKR 1.87 billion in 2015, PKR 2.23 billion in 2016, and PKR 2.15 billion in 2017 (for detailed results, see Annex-C, Tables C8.10 to C8.12). That is, the increase in tax revenues in the short-run is higher, compared to the long run. However, a comparison of Figures 8.4(b) and 5(b) indicates that the deadweight loss to society is also much higher in the short run[95] and that it increases at a faster rate in the short run as tax rate increases. Similarly, in the short run, producer surplus decreases by approximately PKR 1.50 billion in 2015, PKR 1.78 billion in 2016, and PKR 1.72 billion in 2017 for a one-percentage point rise in tax rate as depicted in Figure 8.5(c).

The change in consumer surplus because of change in sales tax rates 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. Nevertheless, what is important to note in this scenario is that in the short run, producers fare worse than consumers do: for a one-percentage point increase in tax rate, producer surplus decreases far more than consumer surplus. Finally, it is worth noting that a percentage point increase in the tax rate imposed on ambient white milk increases tax revenues far less than the combined decrease in producer and consumer surplus as well as the deadweight loss to society.

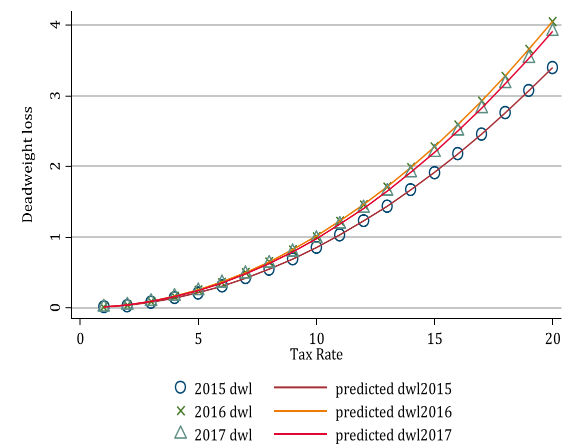
In sum, on average, imposing a sales tax on ambient white milk incurs higher efficiency losses to society than the amount of tax revenue it generates in both the long run and the short run. Consumers suffer more in the longer-run because preferences remain unaltered. In comparison, producers endure the most of the tax burden in the short run and fare better in the longer-run. This is because, in the longer-run, they can alter their milk supply in response to the imposition of sales tax.

Figure 8.5: Short Run Impact Of Imposing Sales Tax On Ambient White Milk

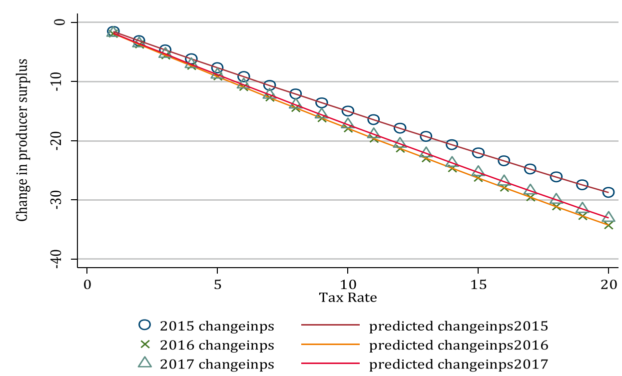
(a) Impact On Tax Revenue



(b) Impact On Deadweight Loss



(c) Impact On Producer Surplus



[95] *Imposing an initial tax rate of 7% on ambient white milk results in a deadweight loss of PKR 0.48 billion in 2017 in the short run. In the long run, however, deadweight loss amounts to only PKR 0.14 billion in 2017. If the tax rate is increased from 7% to 8% the deadweight loss would increase by PKR 0.15 billion in 2017 in the short run; whereas our calculations show that it would increase by only PKR 0.05 billion in 2017 in the long run.*

Long Run Impact On Tea Creamers:

We now turn to the long run effects of imposing a sales tax on tea creamers. The results from our calculations are presented in Figure 8.6 (for detailed results, see Annex-C, Tables C8.13 to C8.15). As depicted in Figure 8.6(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 PKR 1.132 billion in 2015, PKR 1.30 billion in 2016, and PKR 1.129 billion in 2017.

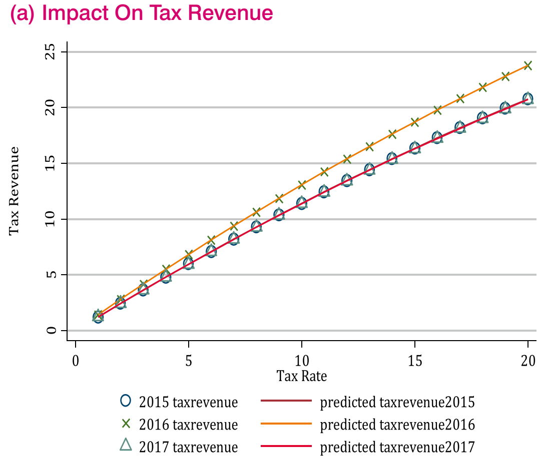
Figure 8.6(b) shows a non-linear graphical trend between deadweight loss to society and tax rate; the deadweight loss increases more than proportionately for every additional percentage point increase in tax. This essentially means that higher taxes impose greater efficiency losses on society compared to lower tax rates.[96] 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 (see above), the deadweight loss to society at each tax rate is also higher for tea creamers compared to ambient milk.

Figure 8.6(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 1 percentage point, producer surplus decreases by roughly PKR 0.242 billion in 2015 and 2017, and PKR 0.276 billion in 2016; whereas consumer surplus decreases by PKR 0.946 billion in 2015, PKR 1.08 billion in 2016, and PKR 0.944 billion in 2017. This indicates that in the markets for tea creamers, consumers are worse off in the longer-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.

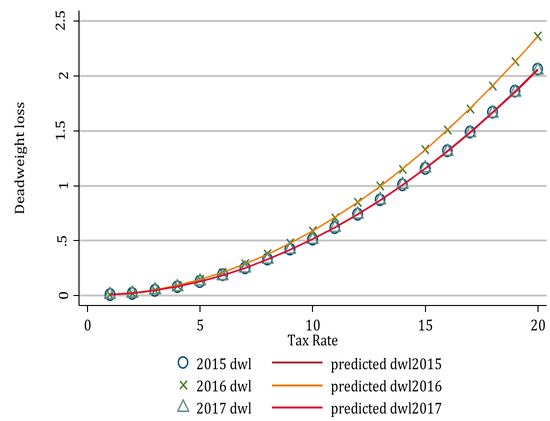
In addition, it is worthwhile to note that while tax revenues rise for every percentage point increase in sales tax on tea creamers, the combined decrease in producer and consumer surplus. When we add the deadweight loss to society to this change in producer and consumer surplus, we find that the losses 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 relative to ambient white milk. Note, however 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.

Figure 8.6: Long Run Impact Of Sales Tax On Tea Creamers

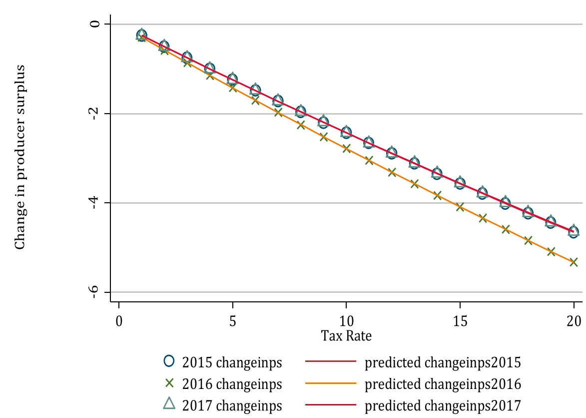
(a) Impact On Tax Revenue



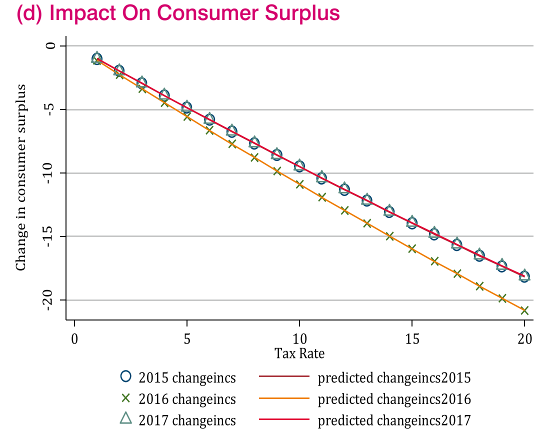
(b) Impact On Deadweight Loss



(c) Impact On Producer Surplus



(d) Impact On Consumer Surplus



[96] If an initial tax rate of 7% is imposed on tea creamers, it will result in a deadweight loss of PKR 0.25 billion in 2015 and 2017, and PKR 0.29 billion in 2016. If the tax rate is increased from 7% to 8%, the deadweight loss would increase by PKR 0.08 billion in 2015 and 2017, and PKR 0.09 billion in 2016, and PKR billion in 2017. If the tax rate were further increased from 8% to 9%, the deadweight loss would increase by PKR 0.09 billion in 2015 and 2017, and PKR 0.10 billion in 2016.

Short Run Impact On Tea Creamers:

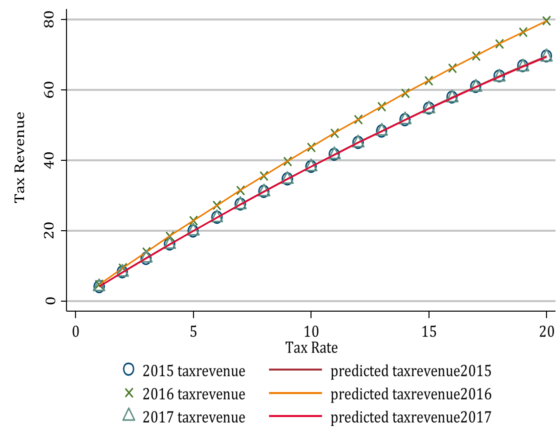
Figure 8.7(a) to (c) report the results from our calculations for the short run tax incidence on producers and consumers (for detailed results, see Annex-C, Tables C8.16 to C8.18). Figure 8.7(a) indicates that as the tax rate increases, tax revenues also rise linearly. According to the data, every percentage point increase in tax rate on tea creamers increases tax revenues by PKR 3.79 billion in 2015, PKR 4.34 billion in 2016, and PKR 3.78 billion in 2017 in the short run. Figure 8.7(b) shows the all too familiar trend between deadweight loss and tax rate: as tax rate increases, deadweight loss increases non-linearly. A comparison of Figure 8.6(b) and 8.7(b) shows that deadweight loss to society is also much higher in the short run[97] and that it increases at a faster rate in the short run as tax rate increases.

Similarly, in the short run, producer surplus decreases by approximately PKR 3.03 billion in 2015, PKR 3.47 billion in 2016, and PKR 3.02 billion in 2017 for a one-percentage point rise in tax rate as depicted in Figure 8.7(c). The change in consumer surplus, because of changes in sales tax rate, remains constant over the long run and short run.[98] Also, it is important to note that in the short run, producers fare worse than consumers since producer surplus falls much more than consumer surplus owing to increase in sales tax rates.

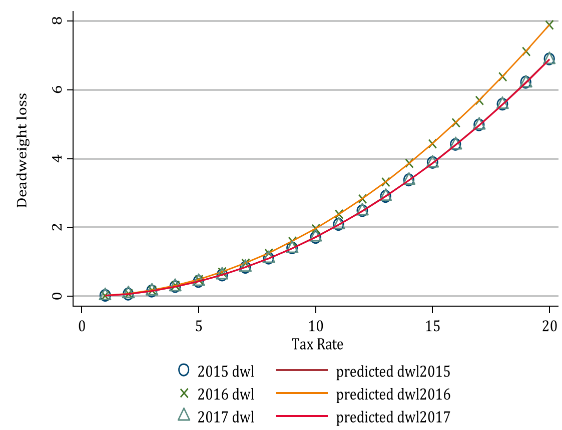
It is also worth noting that a percentage point increase in the tax rate imposed on tea creamers increases tax revenues far less than the combined decrease in producer and consumer surplus as well as the deadweight loss to society. Therefore, on average, imposing a sales tax on tea creamers incurs higher efficiency losses to society than the amount of tax revenue it generates in both the long run and the short run. Tax collection in the long run affects the consumers more. In comparison, producers endure the most of the tax burden in the short run and fare better in the long run.

Figure 8.7: Short Run Impact Of Sales Tax On Tea Creamers

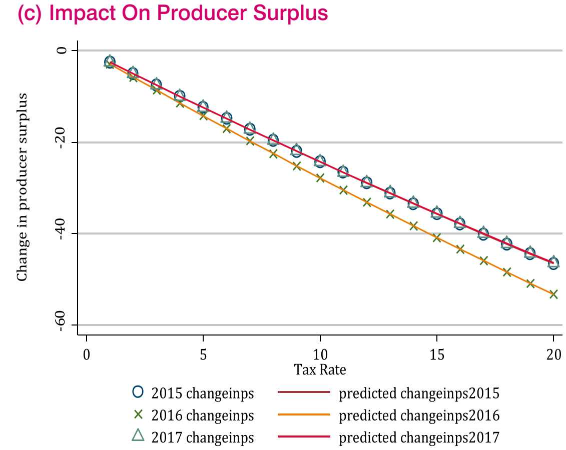
(a) Impact On Tax Revenue



(b) Impact On Deadweight Loss



(c) Impact On Producer Surplus



[97]First, imposing an initial tax rate of 7% on tea creamers results in a deadweight loss of PKR 0.84 billion in 2015 and 2017, and PKR 0.97 billion in 2016 in the short run (see, Annex-C, Tables C9.16 to C9.18). In the longer run, however, the deadweight loss amounts to only PKR 0.25 billion in 2015 and 2017, and PKR 0.29 billion in 2016 (see, Annex-C, Tables C9.13 to C9.15). Second, if the tax rate were increased from 7% to 8%, in the short-run, the deadweight loss would increase by PKR 0.26 billion in 2015 and 2017, and PKR 0.29 billion in 2016 (Annex-C, Tables C9.16 to C9.18). Our calculations also show that in the longer run, it would increase by only PKR 0.08 billion in 2015 and 2017, and PKR 0.09 billion in 2016 (Annex-C, Tables C9.13 to C9.15).

[98]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.

Long Run Impact On Dairy Drinks And Beverages:

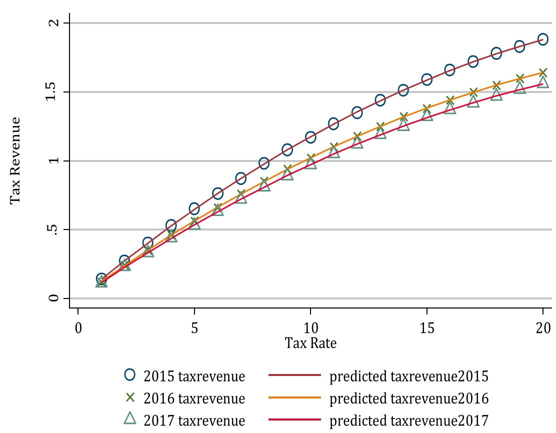
Next, we compute the long run tax incidence for dairy drinks & beverages by using (a) hypothetical value[99] for price elasticity of demand, (b) the reported[100] short run price elasticity of supply for milk, and (c) the price and quantity of dairy drinks & beverages. The results are in Figure 8.8(a) to (d) and Annex-C, Tables C8.19 to C8.21). 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 roughly 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.

As indicated by Figure 8.8(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 PKR 0.11 billion in 2015, PKR 0.10 billion in 2016, and PKR 0.095 billion in 2017. Figure 8.8(b) reveals the usual non-linear graphical trend between deadweight loss and tax rate: as before deadweight loss to society increases more than proportionately for every additional percentage point increase in tax.[101] This means that higher tax rates impose greater efficiency losses on society compared to lower tax rates. Figures 8.8(c) and (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 PKR 0.084 billion in 2015, PKR 0.073 billion in 2016, and PKR 0.070 billion in 2017 whereas producer surplus decreases by only PKR 0.043 billion in 2015, PKR 0.038 billion in 2016, and PKR 0.036 billion in 2017.

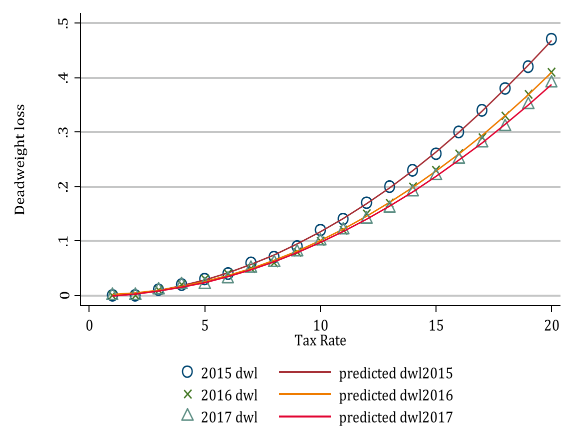
What is interesting to note here is that, according to the data, the tax revenue and the combined decrease in producer and consumer surplus are roughly equal. However, when we compute the difference between welfare gain (revenue earned through tax collection) and welfare loss (deadweight loss to society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

Figure 8.8: Long Run Impact Of Sales Tax On Dairy Drinks And Beverages

(a) Impact On Tax Revenue



(b) Impact On Deadweight Loss



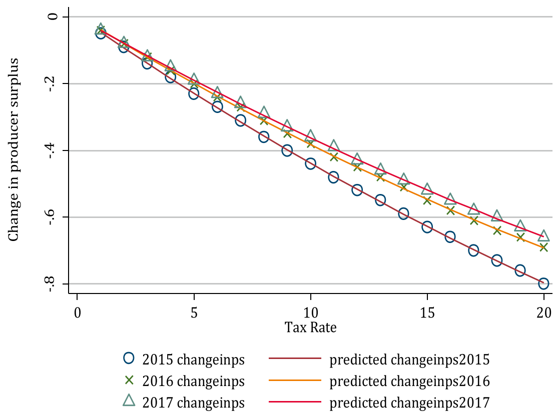
---

[99] Previously, we have used price elasticity of demand = - 0.827 in all our calculations. We now assume that price elasticity of demand is twice this value for dairy drinks and beverages because we expect the demand for dairy drinks and beverages to be more price elastic compared to the other categories.

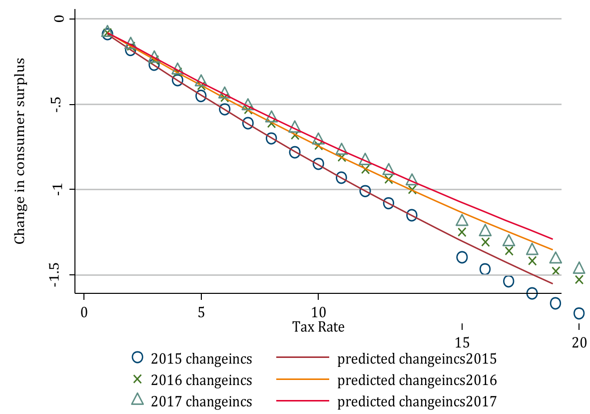
[100] Reported by Wasim, 2005.

[101] If an initial tax rate of 7% is imposed on dairy drinks & beverages, it will result in a deadweight loss of PKR 0.06 billion in 2015, and PKR 0.05 billion in 2016 and 2017. Increasing the tax rate from 7% to 8%, the deadweight loss would increase by PKR 0.01 billion in all three years. Further increasing the tax rate from 8% to 9%, the deadweight loss would increase by PKR 0.02 billion again in all 3 years.

(c) Impact On Producer Surplus



(d) Impact On Consumer Surplus



Short Run Impact On Dairy Drinks And Beverages:

Finally, to compute the tax incidence of dairy drinks and beverages in the short run, we use a short run price elasticity of milk supply (as reported by Wasim, 2005), and the price and quantity of dairy drinks and beverages produced and consumed. Here again, we assume a hypothetical value for price elasticity of demand for dairy drinks.[102] The results are in Figure 8.9(a) to (c) and Annex-C, Tables C8.22 to C8.24.

Figure 8.9(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 PKR 0.56 billion in 2015, PKR 0.49 billion in 2016, and PKR 0.46 billion in 2017. Figure 8.9(b) shows the characteristic non-linear graph of deadweight loss to society against tax rate. Our results show that at tax rate of 7%, the resulting deadweight loss is PKR 0.28 billion in 2015, PKR 0.24 billion in 2016, and PKR 0.23 billion in 2017. If the tax rate is increased from 7% to 8%, the deadweight loss would increase by PKR 0.09 billion in 2015, and PKR 0.08 billion in 2016, and PKR 0.07 billion in 2017. If this tax rate was further increased from 8% to 9%, the deadweight loss would increase by PKR 0.09 billion in 2015, and PKR 0.08 billion in 2016 and 2017. That is, the incremental change in deadweight loss from each percent increase in tax rate is also increasing for dairy drinks and beverages.[103]

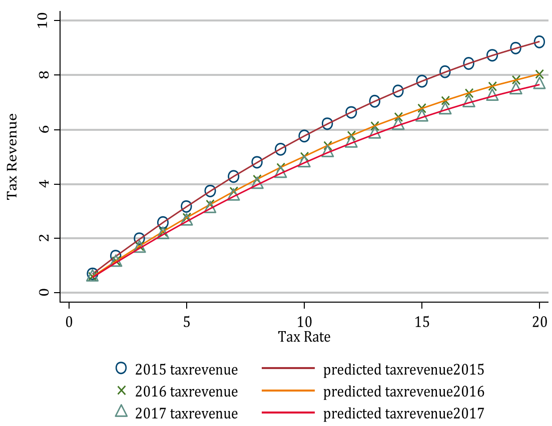
However, the deadweight loss to society, and decrease in producer and consumer surplus are also the highest when we impose sales tax on tea creamers and least when we impose sales tax on dairy drinks and beverages.

Addressing producer and consumer surplus, Figures 8.9(c) and 8(d) show a linear relationship between the producer surplus and the 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 PKR 0.54 billion for 2015, PKR 0.47 billion for 2016, and PKR 0.45 billion for 2017; and consumer surplus decreases by only PKR 0.084 billion for 2015, PKR 0.073 billion for 2016, and PKR 0.070 billion for 2017. Note that the change in consumer surplus remains constant over the long run and short run since consumer preferences remain unchanged. Additionally, producer surplus changes more significantly in the short run compared to the long run for dairy drinks and beverages. As with the other two categories of packed milk products, producers bear most of the tax burden in the short-run. In the longer run, producers alter their milk supply function and consumers bear the burden.

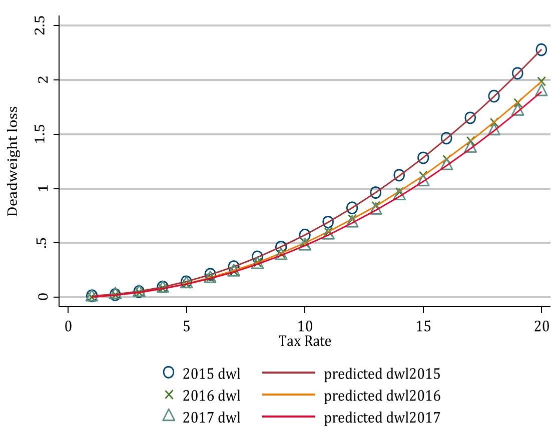
[102] We now assume that price elasticity of demand is equal to –1.654.
[103] When a sales tax is imposed in 2017 ranging from 1% to 20%, short run deadweight loss to society ranges from zero to PKR 3.91 billion for ambient white milk, PKR 0.02 billion to PKR 6.88 billion for tea creamers, and from zero to PKR 1.89 billion for dairy drinks and beverages.

Figure 8.9: Short Run Impact Of Sales Tax On Dairy Drinks And Beverages

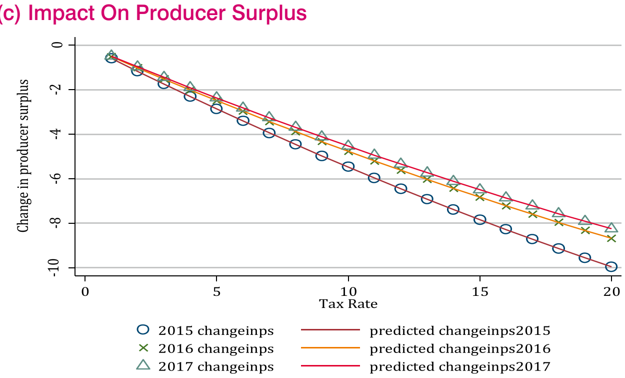
(a) Impact On Tax Revenue



(b) Impact On Deadweight Loss



(c) Impact On Producer Surplus



Comparison Of The Effects Of Sales Tax On Sub-Categories Of Packed Milk

We analyzed the long run and short run effects of imposing sales tax on different sub-categories of packed or processed milk, namely, ambient white milk, tea creamers, and dairy drinks & beverages. Our analysis suggests that imposing sales tax on processed milk products yields high tax revenues, but the resulting welfare loss to society is higher than the revenue generated via taxation. As shown above, 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 is deadweight loss to society.

Our long run estimates for 2017 indicate that imposing 5% sales tax, tax revenue generated on tea creamers is highest (PKR 9.95 billion), revenue generated by ambient white milk is second highest (PKR 3.38 billion), and tax revenue generated by dairy drinks & beverages is the lowest (PKR 0.53 billion). It is worth noting, however, that the deadweight loss with 5% tax rate is also the highest for tea creamers (PKR 0.13 billion), followed by ambient white milk (PKR 0.07 billion), and the lowest for dairy drinks & beverages (PKR 0.02 billion). Imposing sales tax of 1% to 20% in 2017, the longer run deadweight loss to society ranges from zero to PKR 1.17 billion for ambient white milk (see Annex-C, Table C8.9); PKR 0.01 billion to PKR 2.79 billion for tea creamers (see Annex-C, Table C8.15); and zero to PKR 0.39 billion for dairy drinks and beverages (see Annex-C, Table C8.21).

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 sales tax of 10% in 2017, producer surplus decreases by approximately PKR 0.51 billion for tea creamers, PKR 0.29 billion for ambient white milk, and PKR 0.1 billion for dairy drinks & beverages. Similarly, for 10% sales tax rate, consumer surplus decreases by PKR 9.48 billion for tea creamers, PKR 5.39 billion for ambient white milk, and PKR 0.71 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. Adding society's deadweight loss to the welfare loss to producers and consumers, average gap between welfare loss and welfare gain widens, leaving a net welfare loss for all the three categories.

Our short run estimates show a similar trend in tax revenue and welfare loss. As before, imposing a sales tax on tea creamers still yields the highest tax revenue, deadweight loss, and decline in producer welfare whereas imposing a sales tax on dairy drinks and beverages yields the lowest tax revenue and welfare loss. However, the magnitude of the gain and loss is much higher in the short run compared to the long run. More specifically, for sales tax rate of 5%, tax revenue generated from tea creamers is PKR 19.92 billion, from ambient white milk is PKR 11.32 billion, and from dairy drinks & beverages is PKR 2.62 billion. Deadweight loss to society is also higher in the short run compared to the long run for each of these categories.[104] Consumer surplus remains unaltered in the short run since it depends upon consumer demand, not market supply.[105]However, there is a notable change in producer surplus in the short run: at 5% increase in sales tax rate in 2017 decreases producer surplus by PKR 15.51 billion for tea creamers, PKR 8.82 billion for ambient white milk, and PKR 2.37 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 can alter their milk supply in response to the imposition of a sales tax or changes in sales tax rate.

8.6 Conclusions

In this Chapter, we conducted partial equilibrium analysis to study welfare implications of the imposition of sales tax on packed milk and processed milk products. Our results suggest that in the long run, a sales tax at the rate of 1% and 10% in 2017 yields tax revenue of PKR 3.65 billion and 33.79 billion, respectively. While this may be alluring to the FBR, they should see it 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 the society in the form of deadweight loss. The long run deadweight loss to society would increase more than proportionately for additional increase in the tax rate. Every one-percentage point increase in tax rate decreases producer surplus by 0.75 billion. We observe a similar trend in the case of consumer surplus; a 1% sales tax would reduce consumer surplus by PKR 2.92 billion. These figures suggest that for every one-percentage point increase in tax rate, consumer surplus would decrease incrementally. To put it differently, these results imply that as tax rate increases, the tax burden on consumer increases. Changes in producer and consumer surplus lead us to conclude that in the long run tax burden imposed on consumers is higher than burden on producers. We show that at sales tax rate of 10% in 2017, tax revenue would be 33.79 billion. In the same period, however, the efficiency loss to society would amount to PKR 36.83 billion. Therefore, we conclude that imposing sales tax on the dairy sector would yield higher tax revenues, but efficiency losses to producers and consumers would be higher than gains in tax revenue.

The short run analysis, on the other hand, suggests that tax revenue collection would be much higher. In the short run, a tax rate of 1% (10%) would yield tax revenue of PKR 12.23 billion (PKR 113.12 billion) in 2017; the efficiency losses to society would be PKR 0.05 billion (PKR 5.10 billion); producer surplus would fall by PKR 9.36 billion (PKR 90.11 billion), and consumer surplus would fall by PKR 2.92 billion (PKR 28.11 billion). At 1% (10%) sales tax in 2017, total deadweight loss and decrease in consumer and producer would amounts to PKR 12.33 billion (123.32 billion), which is higher than the total tax revenue collected. 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 Annex-C, Tables C8.9, C8.15, and C8.21). While lowering output would help processors minimize their losses from new tax, it would also lower dairy farmers' profits. Moreover, farmers would 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.

[104]When we impose sales tax of 1% to 20% in 2017, the short run deadweight loss to society ranges from PKR 0.01 billion to PKR 3.91 billion for ambient white milk (see, Annex-C, Table C9.12). Moreover, the short run deadweight loss goes to PKR 0.02 billion to PKR 6.88 billion for tea creamers (see, Annex-C, Table A9.18), and zero to PKR 1.89 billion for dairy drinks and beverages (see, Annex-C, Table C9.24).
[105]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.

Annex-A: Demand Curve Estimation

Budgetary constraints restrict consumer demand for commodities, which is 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.

We give our basic econometric model as follows:

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

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

(A8-1)

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[106], 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, we use the actual prices of the commodities in 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.[107] For the same reason, we have constructed quantity indices[108] rather than using the actual quantities of the commodities in our analysis.

We use the results from our estimation to compute the slope of the demand function, $\frac{dP^d}{dQ^d}$ 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, $\bar{P}^d$ and $\bar{Q}^d$ are the average price of milk and average quantity of milk consumed. We find the slope and intercept of the demand curve by plugging in the relevant values.

---

[106] *We use the consumer price index (CPI) to normalize per capita income and commodity prices. We obtain CPI from Monthly Statistical Bulletins published by the Pakistan Bureau of Statistics.*

[107] *The Monthly Statistical Bulletin contains a general CPI as well as indices for specific expenditure categories. For instance, these publications contain a separate index for clothing & footwear, a separate index for housing & utilities, etc. 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 CPI.*

[108] *We added household expenditure on all the items within the composite commodity. We convert the sum of these expenditures into an expenditure index. To obtain the quantity index for the composite commodity, we divided its expenditure index by its price index.*

[109] *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.*

Annex-B: Supply Curve Estimation

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. We specify our basic econometric model by the following system of equations:

$$\ln\Pi = \alpha_0 + \sum_i \alpha_i lnW_i + \alpha_q lnP_q + ß_z\, lnZ + \frac{1}{2}\sum_j \sum_i \gamma_{ij} lnW_i lnW_j + \frac{1}{2}\gamma_{qq}\, lnP_q^2 + \frac{1}{2}ß_{zz}\, lnZ^2 + \sum_i \gamma_{iq} lnW_i lnP_q + \sum_i \rho_{zi} lnZ lnW_i + \rho_{zq} lnZ lnP_q + \varepsilon_i \quad \text{(B8-1)}$$

Share Equations

$$S_i = \alpha_i + \sum_j \gamma_{ij} lnW_j + \gamma_{iq} lnP_q + \rho_{zi} lnZ + \mu_i \quad \text{(B8-2)}$$

$$S_q = \alpha_q + \sum_j \gamma_{iq} lnW_j + \gamma_{qq} lnP_q + \rho_{zq} lnZ + \mu_i \quad \text{(B8-3)}$$

where, Π is the restricted profit or returns to family labor derived as total revenue minus total costs of variable inputs.[109] W_i is the price of the i^{th} 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 ,$(S_i = \frac{P_i X_i}{\Pi})$ and Sq is the share of revenue in restricted profits . $(S_q = \frac{P_q X_q}{\Pi})$

We impose constant returns to scale in our model such that the linear terms in the translog profit function (i.e. B8.1), $\sum_i \alpha_i$ 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. B8.2 and B8.3)), $\sum_j \gamma_{ij}$ equals 0. In addition, we impose cross equation symmetry restrictions 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. Table B8.1 reports the results from this estimation.

Table B8.1: Parameter Estimates Of The Translog Profit Function

Variables	$\ln\Pi$	S_1	S_q
	(1)	(2)	(3)
lnW_1	13.68*** (4.490)	-1.624** (0.684)	2.385*** (0.790)
lnP_q	-16.57*** (5.674)	2.385*** (0.790)	-3.463*** (1.051)
lnW_2	3.892* (2.275)	-0.442 (0.340)	1.108** (0.461)
lnZ	0.880 (2.380)	-0.319 (0.268)	-0.0298 (0.176)
$(lnW_1)^2$	-1.624** (0.684)		
$lnW_1 * lnP_Q$	2.385*** (0.790)		
$lnW_1 * lnW_C$	-0.442 (0.340)		
$lnW_1 *$ lnZ	-0.319 (0.268)		
$(lnPQ)^2$	-3.463*** (1.051)		

$\ln P_Q * \ln W_2$	1.108** (0.461)		
$\ln P_Q * \ln Z$	-0.0298 (0.176)		
$(\ln W_2)^2$	-0.618* (0.337)		
$\ln W_2 * \ln Z$	-0.0486 (0.209)		
$\ln Z * \ln Z$	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 W_2 is the price of wheat straw and concentrate. P_q 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.

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[110], and P^s and Q^s are the values of price of output supplied and quantity of output supplied in 2014, respectively.

[110] *We obtain this figure from our estimation.*

Annex-C: Estimation Results

Table C8.1: LR Sales Tax Incidence On Tax Revenue, Deadweight Loss, Producers And Consumers, 2015

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	3.38	0.01	-0.69	-2.70
2	6.70	0.06	-1.38	-5.38
3	9.97	0.13	-2.06	-8.04
4	13.18	0.23	-2.73	-10.67
5	16.34	0.35	-3.40	-13.29
6	19.43	0.51	-4.06	-15.88
7	22.48	0.69	-4.72	-18.44
8	25.46	0.90	-5.37	-20.99
9	28.39	1.14	-6.02	-23.51
10	31.26	1.41	-6.66	-26.01
11	34.08	1.71	-7.29	-28.49
12	36.84	2.03	-7.92	-30.94
13	39.54	2.38	-8.55	-33.38
14	42.19	2.76	-9.16	-35.79
15	44.78	3.17	-9.77	-38.18
16	47.31	3.61	-10.38	-40.54
17	49.79	4.07	-10.98	-42.88
18	52.21	4.57	-11.57	-45.20
19	54.58	5.09	-12.16	-47.50
20	56.89	5.64	-12.75	-49.78

Note: These computations are from long run price elasticity of demand of -0.827 and supply of 2.23. Average price of packed milk (PKR 13,367) was a share-weighted average computed from 56 brands produced by 17 companies. Total volume consumed is 2029.93 million liters.

Table C8.2: LR Sales Tax Incidence On Tax Revenue, Deadweight Loss, Producers And Consumers, 2016

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	3.81	0.02	-0.78	-3.05
2	7.56	0.06	-1.55	-6.07
3	11.24	0.14	-2.32	-9.06
4	14.86	0.25	-3.08	-12.03
5	18.41	0.40	-3.83	-14.98
6	21.91	0.57	-4.58	-17.90
7	25.34	0.78	-5.32	-20.79
8	28.70	1.02	-6.06	-23.66
9	32.00	1.29	-6.79	-26.50
10	35.24	1.59	-7.51	-29.32
11	38.42	1.92	-8.22	-32.12
12	41.53	2.29	-8.93	-34.88
13	44.57	2.68	-9.63	-37.63
14	47.56	3.11	-10.33	-40.34
15	50.48	3.57	-11.02	-43.03
16	53.34	4.07	-11.70	-45.70
17	56.13	4.59	-12.38	-48.34
18	58.86	5.15	-13.05	-50.96
19	61.53	5.73	-13.71	-53.55
20	64.13	6.35	-14.37	-56.12

Note: These computations are from long run price elasticity of demand of -0.827 and supply of 2.23. Average price of packed milk (PKR 147.25/liter) was a share-weighted average computed from 53 brands produced by 17 companies. Total volume of sales is 2077.16 million liters.

Table C8.3: LR Sales Tax Incidence On Tax Revenue, Deadweight Loss, Producers And Consumers, 2017

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	3.65	0.02	-0.75	-2.92
2	7.24	0.06	-1.49	-5.82
3	10.78	0.14	-2.22	-8.69
4	14.25	0.24	-2.95	-11.54
5	17.65	0.38	-3.68	-14.36
6	21.00	0.55	-4.39	-17.16
7	24.29	0.75	-5.10	-19.93
8	27.52	0.97	-5.81	-22.68
9	30.68	1.23	-6.51	-25.41
10	33.79	1.52	-7.20	-28.11
11	36.83	1.84	-7.88	-30.79
12	39.81	2.19	-8.56	-33.44
13	42.73	2.57	-9.24	-36.07
14	45.60	2.99	-9.90	-38.68
15	48.40	3.43	-10.56	-41.26
16	51.13	3.90	-11.22	-43.82
17	53.81	4.40	-11.87	-46.35
18	56.43	4.93	-12.51	-48.86
19	58.99	5.50	-13.14	-51.34
20	61.48	6.09	-13.77	-53.80

Note: These computations are from long run price elasticity of demand of -0.827 and supply of 2.23. Average price of packed milk (PKR 150.23/liter) was a share-weighted average computed from 52 brands produced by 17 companies. Total volume of sales is 1951.92 million liters.

Table C8.4: SR Sales Tax Incidence On Tax Revenue, Deadweight Loss, Producers And Consumers, 2015

Sales tax rate (%)	Tax revenue (PKR billion)	Deadweight loss (PKR billion)	Change in producer surplus (PKR billion)	Change in consumer surplus (PKR billion)
1	11.32	0.05	-8.66	-2.70
2	22.44	0.19	-17.25	-5.38
3	33.38	0.42	-25.77	-8.04
4	44.13	0.75	-34.21	-10.67
5	54.69	1.18	-42.59	-13.29
6	65.07	1.70	-50.89	-15.88
7	75.25	2.31	-59.12	-18.44
8	85.25	3.02	-67.28	-20.99
9	95.05	3.82	-75.36	-23.51
10	104.67	4.72	-83.38	-26.01
11	114.10	5.71	-91.32	-28.49
12	123.34	6.79	-99.19	-30.94
13	132.39	7.97	-106.99	-33.38
14	141.25	9.25	-114.71	-35.79
15	149.93	10.62	-122.37	-38.18
16	158.41	12.08	-129.95	-40.54
17	166.71	13.64	-137.46	-42.88
18	174.82	15.29	-144.90	-45.20
19	182.74	17.03	-152.27	-47.50
20	190.47	18.87	-159.56	-49.78

Note: The computations in this table were performed using price elasticity of demand and short run price elasticity of supply (-0.827 and 0.258, respectively), and average price of packed milk and total volume consumed and sold during 2015. The average price of packed milk in 2015 was PKR 133.67/liter, and total volume of sales was 2029.93 million liters. We obtain the average price of packed milk using price information provided by Tetra Pak for 56 brands of packed milk produced by 17 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for different sub-categories of packed milk for 2015. Average prices for ambient white milk, tea creamers, and dairy drinks/beverages were first calculated using this information. These prices were then used in conjunction with the corresponding sales volumes for each sub-category to compute a share-weighted average of the price of packed milk

Table C8.5: SR Sales Tax Incidence On Tax Revenue, Deadweight Loss, Producers And Consumers, 2016

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	12.76	0.05	-9.76	-3.05
2	25.30	0.21	-19.45	-6.07
3	37.63	0.48	-29.05	-9.06
4	49.75	0.85	-38.57	-12.03
5	61.66	1.33	-48.01	-14.98
6	73.35	1.91	-57.37	-17.90
7	84.83	2.61	-66.64	-20.79
8	96.10	3.40	-75.84	-23.66
9	107.15	4.31	-84.96	-26.50
10	117.99	5.32	-93.99	-29.32
11	128.62	6.44	-102.94	-32.12
12	139.04	7.66	-111.82	-34.88
13	149.24	8.99	-120.61	-37.63
14	159.23	10.43	-129.32	-40.34
15	169.01	11.97	-137.95	-43.03
16	178.58	13.62	-146.49	-45.70
17	187.93	15.37	-154.96	-48.34
18	197.07	17.23	-163.35	-50.96
19	206.00	19.20	-171.65	-53.55
20	214.71	21.28	-179.87	-56.12

Note: The computations in this table were performed using price elasticity of demand and short run price elasticity of supply (-0.827 and 0.258, respectively), and average price of packed milk and total volume consumed and sold during 2016. The average price of packed milk in 2016 was PKR 147.25/liter, and total volume of sales was 2077.16 million liters. We obtain the average price of packed milk using price information provided by Tetra Pak for 53 brands of packed milk produced by 17 companies in Pakistan for the year 2016. Tetra Pak also provided annual sales volumes for different sub-categories of packed milk for 2016.

Table C8.6: SR Sales Tax Incidence On Tax Revenue, Deadweight Loss, Producers And Consumers, 2017

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	12.23	0.05	-9.36	-2.92
2	24.26	0.20	-18.64	-5.82
3	36.08	0.46	-27.85	-8.69
4	47.70	0.82	-36.98	-11.54
5	59.11	1.27	-46.03	-14.36
6	70.32	1.84	-55.00	-17.16
7	81.33	2.50	-63.89	-19.93
8	92.13	3.26	-72.71	-22.68
9	102.73	4.13	-81.45	-25.41
10	113.12	5.10	-90.11	-28.11
11	123.31	6.17	-98.69	-30.79
12	133.30	7.34	-107.20	-33.44
13	143.08	8.62	-115.63	-36.07
14	152.66	9.99	-123.98	-38.68
15	162.04	11.47	-132.25	-41.26
16	171.21	13.05	-140.45	-43.82
17	180.17	14.74	-148.56	-46.35
18	188.94	16.52	-156.60	-48.86
19	197.49	18.41	-164.56	-51.34
20	205.85	20.40	-172.45	-53.80

Note: The computations in this table were performed using price elasticity of demand and short run price elasticity of supply (-0.827 and 0.258, respectively), and average price of packed milk and total volume consumed and sold during 2017. The average price of packed milk in 2017 was PKR 150.23/liter, and total volume of sales was 1951.92 million liters. We obtain the average price of packed milk using price information provided by Tetra Pak for 52 brands of packed milk produced by 17 companies in Pakistan for the year 2017. Tetra Pak also provided annual sales volumes for different sub-categories of packed milk for 2017.

Table C8.7: LR Incidence Of Sales Tax For Ambient White Milk In 2015

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	0.61	0.00	-0.12	-0.49
2	1.21	0.01	-0.25	-0.97
3	1.80	0.02	-0.37	-1.45
4	2.38	0.04	-0.49	-1.92
5	2.95	0.06	-0.61	-2.40
6	3.50	0.09	-0.73	-2.86
7	4.05	0.12	-0.85	-3.33
8	4.59	0.16	-0.97	-3.78
9	5.12	0.21	-1.09	-4.24
10	5.64	0.25	-1.20	-4.69
11	6.14	0.31	-1.32	-5.14
12	6.64	0.37	-1.43	-5.58
13	7.13	0.43	-1.54	-6.02
14	7.61	0.50	-1.65	-6.45
15	8.07	0.57	-1.76	-6.88
16	8.53	0.65	-1.87	-7.31
17	8.98	0.73	-1.98	-7.73
18	9.41	0.82	-2.09	-8.15
19	9.84	0.92	-2.19	-8.57
20	10.26	1.02	-2.30	-8.98

Note: The computations in this table were performed using price elasticity of demand and short run price elasticity of supply (-0.827 and 0.258, respectively), and average price of packed milk and total volume consumed and sold during 2016. The average price of packed milk in 2016 was PKR 147.25/liter, and total volume of sales was 2077.16 million liters. We obtain the average price of packed milk using price information provided by Tetra Pak for 53 brands of packed milk produced by 17 companies in Pakistan for the year 2016. Tetra Pak also provided annual sales volumes for different sub-categories of packed milk for 2016.

Table C8.8: LR Incidence Of Sales Tax For Ambient White Milk In 2016

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	0.73	0.00	-0.15	-0.58
2	1.44	0.01	-0.30	-1.16
3	2.14	0.03	-0.44	-1.73
4	2.83	0.05	-0.59	-2.29
5	3.51	0.08	-0.73	-2.85
6	4.17	0.11	-0.87	-3.41
7	4.83	0.15	-1.01	-3.96
8	5.47	0.19	-1.15	-4.51
9	6.10	0.25	-1.29	-5.05
10	6.72	0.30	-1.43	-5.59
11	7.32	0.37	-1.57	-6.12
12	7.91	0.44	-1.70	-6.65
13	8.49	0.51	-1.84	-7.17
14	9.06	0.59	-1.97	-7.69
15	9.62	0.68	-2.10	-8.20
16	10.16	0.78	-2.23	-8.71
17	10.70	0.87	-2.36	-9.21
18	11.22	0.98	-2.49	-9.71
19	11.72	1.09	-2.61	-10.20
20	12.22	1.21	-2.74	-10.69

Note: The computations in this table were performed using long run price elasticity of demand and supply (-0.827 and 3.23, respectively), and average price and total volume consumed and sold of ambient white milk during 2016. The average price of ambient white milk in 2016 was PKR 118.52/liter, and total volume of sales was 491.8 million liters. We compute the average price of ambient milk using price information provided by Tetra Pak for 30 brands of ambient milk produced by 15 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for ambient white milk for 2015.

Table C8.9: LR Incidence Of Sales Tax For Ambient White Milk In 2017

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	0.70	0.00	-0.14	-0.56
2	1.39	0.01	-0.29	-1.11
3	2.06	0.03	-0.43	-1.66
4	2.73	0.05	-0.57	-2.21
5	3.38	0.07	-0.70	-2.75
6	4.02	0.11	-0.84	-3.29
7	4.65	0.14	-0.98	-3.82
8	5.27	0.19	-1.11	-4.35
9	5.88	0.24	-1.25	-4.87
10	6.47	0.29	-1.38	-5.39
11	7.06	0.35	-1.51	-5.90
12	7.63	0.42	-1.64	-6.41
13	8.19	0.49	-1.77	-6.91
14	8.74	0.57	-1.90	-7.41
15	9.27	0.66	-2.02	-7.90
16	9.80	0.75	-2.15	-8.39
17	10.31	0.84	-2.27	-8.88
18	10.81	0.95	-2.40	-9.36
19	11.30	1.05	-2.52	-9.84
20	11.78	1.17	-2.64	-10.31

Note: The computations in this table were performed using long run price elasticity of demand and supply (-0.827 and 3.23, respectively), and average price and total volume consumed and sold of ambient white milk during 2017. The average price of ambient white milk in 2017 was PKR 124.65/liter, and total volume of sales was 450.7 million liters. We compute the average price of ambient milk using price information provided by Tetra Pak for 30 brands of ambient milk produced by 15 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for ambient white milk for 2015.

Table C8.10: SR Incidence Of Sales Tax For Ambient White Milk In 2015

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	2.04	0.01	-1.56	-0.49
2	4.05	0.03	-3.11	-0.97
3	6.02	0.08	-4.65	-1.45
4	7.96	0.14	-6.17	-1.92
5	9.86	0.21	-7.68	-2.40
6	11.73	0.31	-9.18	-2.86
7	13.57	0.42	-10.66	-3.33
8	15.37	0.54	-12.13	-3.78
9	17.14	0.69	-13.59	-4.24
10	18.87	0.85	-15.03	-4.69
11	20.57	1.03	-16.47	-5.14
12	22.24	1.23	-17.88	-5.58
13	23.87	1.44	-19.29	-6.02
14	25.47	1.67	-20.68	-6.45
15	27.03	1.91	-22.06	-6.88
16	28.56	2.18	-23.43	-7.31
17	30.06	2.46	-24.79	-7.73
18	31.52	2.76	-26.13	-8.15
19	32.95	3.07	-27.46	-8.57
20	34.34	3.40	-28.77	-8.98

Note: The computations in this table were performed using price elasticity of demand and short run price elasticity of supply (-0.827 and 0.258, respectively), and average price and total volume consumed and sold of ambient white milk during 2015. The average price of ambient white milk in 2015 was PKR 110.71/liter, and total volume of sales was 441.9 million liters. We compute the average price of ambient milk using price information provided by Tetra Pak for 30 brands of ambient milk produced by 15 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for ambient white milk for 2015.

Table C8.11: SR Incidence Of Sales Tax For Ambient White Milk In 2016

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	2.43	0.01	-1.86	-0.58
2	4.82	0.04	-3.71	-1.16
3	7.17	0.09	-5.54	-1.73
4	9.48	0.16	-7.35	-2.29
5	11.75	0.25	-9.15	-2.85
6	13.98	0.36	-10.93	-3.41
7	16.17	0.50	-12.70	-3.96
8	18.31	0.65	-14.45	-4.51
9	20.42	0.82	-16.19	-5.05
10	22.49	1.01	-17.91	-5.59
11	24.51	1.23	-19.62	-6.12
12	26.50	1.46	-21.31	-6.65
13	28.44	1.71	-22.98	-7.17
14	30.35	1.99	-24.64	-7.69
15	32.21	2.28	-26.29	-8.20
16	34.03	2.59	-27.92	-8.71
17	35.81	2.93	-29.53	-9.21
18	37.56	3.28	-31.13	-9.71
19	39.26	3.66	-32.71	-10.20
20	40.92	4.05	-34.28	-10.69

Note: The computations in this table were performed using long run price elasticity of demand and supply (-0.827 and 3.23, respectively), and average price and total volume consumed and sold of ambient white milk during 2016. The average price of ambient white milk in 2016 was PKR 118.52/liter, and total volume of sales was 491.8 million liters. We compute the average price of ambient milk using price information provided by Tetra Pak for 30 brands of ambient milk produced by 15 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for ambient white milk for 2015.

Table C8.12: SR Run Incidence Of Sales Tax For Ambient White Milk In 2017

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	2.34	0.01	-1.79	-0.56
2	4.65	0.04	-3.57	-1.11
3	6.91	0.09	-5.34	-1.66
4	9.14	0.16	-7.08	-2.21
5	11.32	0.24	-8.82	-2.75
6	13.47	0.35	-10.54	-3.29
7	15.58	0.48	-12.24	-3.82
8	17.65	0.63	-13.93	-4.35
9	19.68	0.79	-15.60	-4.87
10	21.67	0.98	-17.26	-5.39
11	23.63	1.18	-18.91	-5.90
12	25.54	1.41	-20.54	-6.41
13	27.41	1.65	-22.15	-6.91
14	29.25	1.91	-23.75	-7.41
15	31.04	2.20	-25.34	-7.90
16	32.80	2.50	-26.91	-8.39
17	34.52	2.82	-28.46	-8.88
18	36.20	3.17	-30.00	-9.36
19	37.84	3.53	-31.53	-9.84
20	39.44	3.91	-33.04	-10.31

Note: The computations in this table were performed using long run price elasticity of demand and supply (-0.827 and 3.23, respectively), and average price and total volume consumed and sold of ambient white milk during 2017. The average price of ambient white milk in 2017 was PKR 124.65/liter, and total volume of sales was 450.7 million liters. We compute the average price of ambient milk using price information provided by Tetra Pak for 30 brands of ambient milk produced by 15 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for ambient white milk for 2015.

Table C8.13: LR Incidence Of Sales Tax For Tea Creamers In 2015

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	1.23	0.01	-0.25	-0.99
2	2.45	0.02	-0.50	-1.97
3	3.64	0.05	-0.75	-2.94
4	4.81	0.08	-1.00	-3.90
5	5.97	0.13	-1.24	-4.85
6	7.10	0.19	-1.48	-5.80
7	8.21	0.25	-1.72	-6.74
8	9.30	0.33	-1.96	-7.67
9	10.37	0.42	-2.20	-8.59
10	11.42	0.51	-2.43	-9.50
11	12.45	0.62	-2.66	-10.41
12	13.46	0.74	-2.89	-11.30
13	14.44	0.87	-3.12	-12.19
14	15.41	1.01	-3.35	-13.07
15	16.36	1.16	-3.57	-13.94
16	17.28	1.32	-3.79	-14.81
17	18.19	1.49	-4.01	-15.66
18	19.07	1.67	-4.23	-16.51
19	19.94	1.86	-4.44	-17.35
20	20.78	2.06	-4.66	-18.18

Note: The computations in this table were performed using long run price elasticity of demand and supply (-0.827 and 3.23, respectively), and average price and total volume consumed and sold of tea creamers during 2015. The average price of tea creamers in 2015 was PKR 151.23/liter, and total volume of sales was 655.3 million liters. We compute the average price of tea creamers using price information provided by Tetra Pak for 15 brands of tea creamers produced by 8 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for tea creamers for 2015.

Table C8.14: LR Incidence Of Sales Tax For Tea Creamers In 2016

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	1.41	0.01	-0.29	-1.13
2	2.80	0.02	-0.58	-2.25
3	4.17	0.05	-0.86	-3.36
4	5.51	0.09	-1.14	-4.46
5	6.83	0.15	-1.42	-5.55
6	8.13	0.21	-1.70	-6.64
7	9.40	0.29	-1.97	-7.71
8	10.65	0.38	-2.25	-8.78
9	11.87	0.48	-2.52	-9.83
10	13.07	0.59	-2.78	-10.88
11	14.25	0.71	-3.05	-11.91
12	15.40	0.85	-3.31	-12.94
13	16.53	1.00	-3.57	-13.96
14	17.64	1.15	-3.83	-14.96
15	18.72	1.33	-4.09	-15.96
16	19.78	1.51	-4.34	-16.95
17	20.82	1.70	-4.59	-17.93
18	21.83	1.91	-4.84	-18.90
19	22.82	2.13	-5.09	-19.86
20	23.78	2.36	-5.33	-20.81

Note: The computations in this table were performed using long run price elasticity of demand and supply (-0.827 and 3.23, respectively), and average price and total volume consumed and sold of tea creamers during 2016. The average price of tea creamers in 2016 was PKR 170.13/liter, and total volume of sales was 666.8 million liters. We compute the average price of tea creamers using price information provided by Tetra Pak for 15 brands of ambient milk produced by 7 companies in Pakistan for the year 2016. Tetra Pak also provided annual sales volumes for tea creamers for 2016.

Table C8.15: LR Incidence Of Sales Tax For Tea Creamers In 2017

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	1.23	0.01	-0.25	-0.98
2	2.44	0.02	-0.50	-1.96
3	3.63	0.05	-0.75	-2.93
4	4.80	0.08	-1.00	-3.89
5	5.95	0.13	-1.24	-4.84
6	7.08	0.18	-1.48	-5.78
7	8.19	0.25	-1.72	-6.72
8	9.27	0.33	-1.96	-7.65
9	10.34	0.42	-2.19	-8.56
10	11.39	0.51	-2.43	-9.48
11	12.41	0.62	-2.66	-10.38
12	13.42	0.74	-2.89	-11.27
13	14.40	0.87	-3.11	-12.16
14	15.37	1.01	-3.34	-13.04
15	16.31	1.16	-3.56	-13.91
16	17.24	1.31	-3.78	-14.77
17	18.14	1.48	-4.00	-15.62
18	19.02	1.66	-4.22	-16.47
19	19.88	1.85	-4.43	-17.30
20	20.72	2.05	-4.64	-18.13

Note: The computations in this table were performed using long run price elasticity of demand and supply (-0.827 and 3.23, respectively), and average price and total volume consumed and sold of tea creamers during 2017. The average price of tea creamers in 2017 was PKR 172.47/liter, and total volume of sales was 573.1 million liters. We compute the average price of tea creamers using price information provided by Tetra Pak for 15 brands of tea creamers produced by 7 companies in Pakistan for the year 2017. Tetra Pak also provided annual sales volumes for tea creamers for 2017.

Table C8.16: SR Incidence Of Sales Tax For Tea Creamers In 2015

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	4.13	0.02	-3.16	-0.99
2	8.20	0.07	-6.30	-1.97
3	12.19	0.16	-9.41	-2.94
4	16.12	0.28	-12.50	-3.90
5	19.98	0.43	-15.56	-4.85
6	23.77	0.62	-18.59	-5.80
7	27.49	0.84	-21.59	-6.74
8	31.14	1.10	-24.57	-7.67
9	34.72	1.40	-27.53	-8.59
10	38.23	1.72	-30.45	-9.50
11	41.68	2.09	-33.36	-10.41
12	45.05	2.48	-36.23	-11.30
13	48.36	2.91	-39.08	-12.19
14	51.59	3.38	-41.90	-13.07
15	54.76	3.88	-44.70	-13.94
16	57.86	4.41	-47.47	-14.81
17	60.89	4.98	-50.21	-15.66
18	63.85	5.58	-52.93	-16.51
19	66.75	6.22	-55.62	-17.35
20	69.57	6.89	-58.28	-18.18

Note: The computations in this table were performed using price elasticity of demand and short run price elasticity of supply (-0.827 and 0.258, respectively), and average price and total volume consumed and sold of tea creamers during 2015. The average price of tea creamers in 2015 was PKR 151.23/liter, and total volume of sales was 655.3 million liters. We compute the average price of tea creamers using price information provided by Tetra Pak for 15 brands of tea creamers produced by 8 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for tea creamers for 2015.

Table C8.17: SR Incidence Of Sales Tax For Tea Creamers In 2016

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	4.73	0.02	-3.62	-1.13
2	9.38	0.08	-7.21	-2.25
3	13.96	0.18	-10.77	-3.36
4	18.45	0.32	-14.30	-4.46
5	22.87	0.49	-17.81	-5.55
6	27.20	0.71	-21.28	-6.64
7	31.46	0.97	-24.72	-7.71
8	35.64	1.26	-28.13	-8.78
9	39.74	1.60	-31.51	-9.83
10	43.76	1.97	-34.86	-10.88
11	47.71	2.39	-38.18	-11.91
12	51.57	2.84	-41.47	-12.94
13	55.35	3.33	-44.73	-13.96
14	59.06	3.87	-47.96	-14.96
15	62.69	4.44	-51.16	-15.96
16	66.23	5.05	-54.33	-16.95
17	69.70	5.70	-57.47	-17.93
18	73.09	6.39	-60.58	-18.90
19	76.40	7.12	-63.66	-19.86
20	79.63	7.89	-66.71	-20.81

Note: The computations in this table were performed using price elasticity of demand and short run price elasticity of supply (-0.827 and 0.258, respectively), and average price and total volume consumed and sold of tea creamers during 2016. The average price of tea creamers in 2016 was PKR 170.13/liter, and total volume of sales was 666.8 million liters. We compute the average price of tea creamers using price information provided by Tetra Pak for 15 brands of ambient milk produced by 7 companies in Pakistan for the year 2016. Tetra Pak also provided annual sales volumes for tea creamers for 2016.

Table C8.18: SR Incidence Of Sales Tax For Tea Creamers In 2017

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	4.12	0.02	-3.16	-0.98
2	8.18	0.07	-6.28	-1.96
3	12.16	0.15	-9.39	-2.93
4	16.08	0.28	-12.46	-3.89
5	19.92	0.43	-15.51	-4.84
6	23.70	0.62	-18.54	-5.78
7	27.41	0.84	-21.54	-6.72
8	31.05	1.10	-24.51	-7.65
9	34.63	1.39	-27.45	-8.56
10	38.13	1.72	-30.37	-9.48
11	41.56	2.08	-33.27	-10.38
12	44.93	2.48	-36.13	-11.27
13	48.23	2.90	-38.97	-12.16
14	51.46	3.37	-41.79	-13.04
15	54.62	3.87	-44.58	-13.91
16	57.71	4.40	-47.34	-14.77
17	60.73	4.97	-50.07	-15.62
18	63.68	5.57	-52.78	-16.47
19	66.57	6.20	-55.47	-17.30
20	69.38	6.88	-58.12	-18.13

Note: The computations in this table were performed using price elasticity of demand and short run price elasticity of supply (-0.827 and 0.258, respectively), and average price and total volume consumed and sold of tea creamers during 2017. We find that the average price of tea creamers in 2017 was PKR 172.47/liter, and total volume of sales was 573.1 million liters. We compute the average price of tea creamers using price information provided by Tetra Pak for 15 brands of tea creamers produced by 7 companies in Pakistan for the year 2017. Tetra Pak also provided annual sales volumes for tea creamers for 2017.

Table C8.19: LR Incidence Of Sales Tax For Dairy Drinks & Beverages In 2015

Using Price Elasticity Of Demand= - 0.827 X 2

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	0.14	0.00	-0.05	-0.09
2	0.27	0.00	-0.09	-0.18
3	0.40	0.01	-0.14	-0.27
4	0.53	0.02	-0.18	-0.36
5	0.65	0.03	-0.23	-0.45
6	0.76	0.04	-0.27	-0.53
7	0.87	0.06	-0.31	-0.61
8	0.98	0.07	-0.36	-0.70
9	1.08	0.09	-0.40	-0.78
10	1.17	0.12	-0.44	-0.85
11	1.27	0.14	-0.48	-0.93
12	1.35	0.17	-0.52	-1.01
13	1.44	0.20	-0.55	-1.08
14	1.51	0.23	-0.59	-1.15
15	1.59	0.26	-0.63	-1.22
16	1.66	0.30	-0.66	-1.29
17	1.72	0.34	-0.70	-1.36
18	1.78	0.38	-0.73	-1.43
19	1.83	0.42	-0.76	-1.49
20	1.88	0.47	-0.80	-1.55

Note: The computations in this table were performed using price elasticity of demand and supply (-1.654 and 3.23, respectively), and average price and total volume consumed and sold of dairy drinks and beverages during 2015. We find that the average price of dairy drinks in 2015 was PKR 116.5/liter, and total volume of sales was 79.9 million liters. We compute the average price of dairy drinks & beverages using price information provided by Tetra Pak for 11 brands of tea creamers produced by 6 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for dairy drinks & beverages in 2015.

Table C8.20: LR Incidence Of Sales Tax For Dairy Drinks & Beverages In 2016

Using Price Elasticity Of Demand= - 0.827 X 2

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	0.12	0.00	-0.04	-0.08
2	0.24	0.00	-0.08	-0.16
3	0.35	0.01	-0.12	-0.24
4	0.46	0.02	-0.16	-0.31
5	0.56	0.03	-0.20	-0.39
6	0.66	0.04	-0.24	-0.46
7	0.76	0.05	-0.27	-0.53
8	0.85	0.06	-0.31	-0.61
9	0.94	0.08	-0.35	-0.68
10	1.02	0.10	-0.38	-0.74
11	1.10	0.12	-0.42	-0.81
12	1.18	0.15	-0.45	-0.88
13	1.25	0.17	-0.48	-0.94
14	1.32	0.20	-0.51	-1.00
15	1.38	0.23	-0.55	-1.07
16	1.44	0.26	-0.58	-1.13
17	1.50	0.29	-0.61	-1.18
18	1.55	0.33	-0.64	-1.24
19	1.60	0.37	-0.66	-1.30
20	1.64	0.41	-0.69	-1.35

Note: The computations in this table were performed using price elasticity of demand and supply (-1.654 and 3.23, respectively), and average price and total volume consumed and sold of dairy drinks and beverages during 2016. We find that the average price of dairy drinks in 2016 was PKR 129.3/liter, and total volume of sales was 62.7 million liters. We compute the average price of dairy drinks & beverages using price information provided by Tetra Pak for 10 brands of tea creamers produced by 8 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for dairy drinks & beverages in 2016.

Table C8.21: LR Incidence Of Sales Tax For Dairy Drinks & Beverages In 2017
Using Price Elasticity Of Demand= - 0.827 X 2

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	0.11	0.00	-0.04	-0.08
2	0.23	0.00	-0.08	-0.15
3	0.33	0.01	-0.12	-0.23
4	0.44	0.02	-0.15	-0.30
5	0.53	0.02	-0.19	-0.37
6	0.63	0.03	-0.23	-0.44
7	0.72	0.05	-0.26	-0.51
8	0.81	0.06	-0.29	-0.58
9	0.89	0.08	-0.33	-0.64
10	0.97	0.10	-0.36	-0.71
11	1.05	0.12	-0.39	-0.77
12	1.12	0.14	-0.43	-0.83
13	1.19	0.16	-0.46	-0.89
14	1.25	0.19	-0.49	-0.95
15	1.32	0.22	-0.52	-1.01
16	1.37	0.25	-0.55	-1.07
17	1.42	0.28	-0.58	-1.13
18	1.47	0.31	-0.60	-1.18
19	1.52	0.35	-0.63	-1.23
20	1.56	0.39	-0.66	-1.29

Note: The computations in this table were performed using price elasticity of demand and supply (-1.654 and 3.23, respectively), and average price and total volume consumed and sold of dairy drinks and beverages during 2017. We find that the average price of dairy drinks in 2017 was PKR 129.81/liter, and total volume of sales was 59.4 million liters. We compute the average price of dairy drinks & beverages using price information provided by Tetra Pak for 10 brands of tea creamers produced by 8 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for dairy drinks & beverages in 2016.

Table C8.22: SR Incidence Of Sales Tax For Dairy Drinks & Beverages In 2015
Using Price Elasticity Of Demand= - 0.827 X 2

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	0.68	0.01	0.59	0.09
2	1.33	0.02	1.17	0.18
3	1.97	0.05	1.75	0.27
4	2.58	0.09	2.31	0.36
5	3.16	0.14	2.86	0.45
6	3.73	0.21	3.40	0.53
7	4.27	0.28	3.94	0.61
8	4.79	0.37	4.46	0.70
9	5.28	0.46	4.97	0.78
10	5.76	0.57	5.47	0.85
11	6.21	0.69	5.97	0.93
12	6.63	0.82	6.45	1.01
13	7.04	0.96	6.92	1.08
14	7.42	1.12	7.39	1.15
15	7.78	1.28	7.84	1.22
16	8.12	1.46	8.28	1.29
17	8.43	1.65	8.72	1.36
18	8.72	1.85	9.14	1.43
19	8.99	2.06	9.56	1.49
20	9.23	2.28	9.96	1.55

Note: The computations in this table were performed using price elasticity of demand and supply (-1.654 and 3.23, respectively), and average price and total volume consumed and sold of dairy drinks & beverages during 2015. We find that the average price of dairy drinks in 2015 was PKR 116.5/liter, and total volume of sales was 79.9 million liters. We compute the average price of dairy drinks & beverages using price information provided by Tetra Pak for 11 brands of tea creamers produced by 6 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for dairy drinks & beverages in 2015.

Table C8.23: SR Incidence Of Sales Tax For Dairy Drinks & Beverages In 2016

Using Price Elasticity Of Demand= - 0.827 X 2

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	0.59	0.00	-0.52	-0.08
2	1.16	0.02	-1.02	-0.16
3	1.71	0.04	-1.52	-0.24
4	2.24	0.08	-2.01	-0.31
5	2.76	0.12	-2.49	-0.39
6	3.25	0.18	-2.96	-0.46
7	3.72	0.24	-3.43	-0.53
8	4.17	0.32	-3.88	-0.61
9	4.60	0.40	-4.33	-0.68
10	5.01	0.50	-4.77	-0.74
11	5.41	0.60	-5.20	-0.81
12	5.78	0.72	-5.62	-0.88
13	6.13	0.84	-6.03	-0.94
14	6.46	0.97	-6.43	-1.00
15	6.78	1.12	-6.83	-1.07
16	7.07	1.27	-7.22	-1.13
17	7.34	1.44	-7.59	-1.18
18	7.59	1.61	-7.96	-1.24
19	7.83	1.79	-8.32	-1.30
20	8.04	1.99	-8.68	-1.35

Note: The computations in this table were performed using price elasticity of demand and supply (-1.654 and 3.23, respectively), and average price and total volume consumed and sold of dairy drinks & beverages during 2016. We find that the average price of dairy drinks in 2016 was PKR 129.3/liter, and total volume of sales was 62.7 million liters. We compute the average price of dairy drinks & beverages using price information provided by Tetra Pak for 10 brands of tea creamers produced by 8 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for dairy drinks & beverages in 2016.

Table C8.24: SR Incidence Of Sales Tax For Dairy Drinks & Beverages In 2017
Using Price Elasticity Of Demand= - 0.827 X 2

Sales tax rate (%)	Tax revenue (PKR Billion)	Deadweight loss (PKR Billion)	Change in producer surplus (PKR Billion)	Change in consumer surplus (PKR Billion)
1	0.56	0.00	-0.49	-0.08
2	1.11	0.02	-0.97	-0.15
3	1.63	0.04	-1.45	-0.23
4	2.13	0.08	-1.91	-0.30
5	2.62	0.12	-2.37	-0.37
6	3.09	0.17	-2.82	-0.44
7	3.54	0.23	-3.26	-0.51
8	3.97	0.30	-3.69	-0.58
9	4.38	0.38	-4.12	-0.64
10	4.77	0.47	-4.53	-0.71
11	5.14	0.57	-4.94	-0.77
12	5.50	0.68	-5.34	-0.83
13	5.83	0.80	-5.74	-0.89
14	6.15	0.93	-6.12	-0.95
15	6.45	1.06	-6.50	-1.01
16	6.72	1.21	-6.86	-1.07
17	6.98	1.37	-7.22	-1.13
18	7.22	1.53	-7.57	-1.18
19	7.45	1.71	-7.92	-1.23
20	7.65	1.89	-8.25	-1.29

Note: The computations in this table were performed using price elasticity of demand and supply (-1.654 and 3.23, respectively), and average price and total volume consumed and sold of dairy drinks and beverages during 2017. We find that the average price of dairy drinks in 2017 was PKR 129.81/liter, and total volume of sales was 59.4 million liters. We compute the average price of dairy drinks & beverages using price information provided by Tetra Pak for 10 brands of tea creamers produced by 8 companies in Pakistan for the year 2015. Tetra Pak also provided annual sales volumes for dairy drinks & beverages in 2016.

CONCLUSIONS AND **RECOMMENDATIONS**

The basic point of this study was to explore the emergence of Pakistan's dairy sector by focusing on its achievements and constraints. The study notes that a vibrant dairy sector is essential for the welfare of millions of people associated with this sector and for economic growth and development in the country. Based on analysis of secondary data and empirical analysis on primary data, the following conclusions and recommendations stand out.

1. This study raises concerns on the quality of livestock census data. Chapter 2 identifies problems in livestock population and describes why average milk yield per animal data reported in livestock census is not realistic. More specifically, it notes that between 1996 and 2006, in some selected districts milk yield per dairy animal has increased at 20% per annum while in other districts growth in milk yield has exceeded 10% per annum, which is unrealistic. This is also in sharp contrast to our finding of TFP regress in the dairy sector of Punjab in recent years. Since the shares of agriculture and livestock also come from this data, ambiguities of this nature do not go well with the calculations of the GDP growth rates. The study recommends revisiting the sampling strategy of the livestock census data in its subsequent rounds.

2. A related concern arises when the study makes comparison of milk supply and demand in the country. The study finds 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, the study recommends to the Pakistan Bureau of Statistics, Islamabad and the Government of Pakistan to revisit on their data collection tools for the Pakistan Livestock Census and ensure better monitoring and supervision so that we arrive at the true numbers. The dairy industry and its major stakeholders would eagerly await the outcome of the new livestock census.

3. Chapter 3 notes that the quality of feed fed to dairy stock directly affects milk yield and profitability of the dairy farms because fodder costs have a higher share in total cost. Therefore, if policy makers are interested in reducing milk production cost to the dairy farms, they must aim at reducing the cost of fodder. However, the feeding practices in vogue in the dairy sector are outdated leading to suboptimal results. Farmers will immensely benefit from awareness of the different ways in which they can alleviate fodder shortages and reduce fodder costs. Training on making good quality silage and access to silage preparation equipment can go a long way in helping the farmers. However, due to lack of demand, there is missing market for renting-out services of private equipment for silage making. These services may develop on their own when there is enough demand for the equipment in rural areas. However, medium and large-scale commercial dairy farms and some private market players are already renting out their excess capacity to small farmers. This activity is likely to pick up in the near future. The milk processing industry and the provincial governments can play their constructive role by providing awareness where the adoption rates are slow or non-existent.

Moreover, microfinance loans can also provide the capital to purchase fodder during peak seasons for silage making. Besides, there is an urgent need to increase productivity of fodder crops, providing access to quality seeds and improving agronomic practices in fodder crops. If farmers sow fodder crops at intervals within their respective seasons, they will be less vulnerable to variations in fodder availability. Help sessions and training to the dairy farms can get better crop management skills leading to lower fodder cost and increased profitability.

4. The analysis in Chapter 4 shows that the returns to an average smallholder dairy farm have significantly declined between 2005 and 2014. Moreover, the returns to the dairy farms selling to the milk processing industry have also drastically come down in recent years. It is more lucrative for the smallholder dairy farms to sell milk to the informal sector rather than to the processing industry, which was a much favored option back in 2005. The mechanized dairy cattle farms have a clear cost advantage on non-mechanized dairy farms; these dairy farms seem to cover all their costs and make profits.

5. In Chapter 5, the analysis of productivity growth on smallholder dairy farms shows that productivity of small dairy farms is declining at 1.42% per annum because they have failed to innovate. Both subsistence and landless dairy farms have performed better than their larger counterparts have because most subsistence farms employ family labor to collect roughages and grasses to feed their mulching 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. The dairy farms will have no incentive to make investments to increase productivity unless real farm gate price of milk is positive. The policy of liberal import of SMP and WM has hurt the interests of dairy producers due to declining real farm gate price of milk and falling total factor productivity. Due to heavy dairy subsidies prevalent in Europe and Ireland, mitigating measures are necessary to protect the long-term interests of the dairy producers by promoting a level playing field. To enhance productivity of the dairy sector, this study recommends strategies to promote genetic improvements through cross breeding of cattle with high yielding exotic breeds, which offers tremendous long-term potential of increasing milk yields at the farm level by three to four times. Moreover, this study recommends introduction of balanced feeding program for dairy animals using IT technology and computer software to advise dairy producers on their doorstep to achieve balanced ration for their lactating dairy animals. In addition, there are 2.5 million dairy farms with herd size of 10 or more who have the potential of adopting mechanical and electronic devices for enhancing their productivity including equipment for feed and fodder preparations, milking machines, among others. This study estimates that there is potential demand of around USD 8 to 9 billion for the dairy machinery in the country. Effective use of awareness schemes and training programs can help promote early adoption for enhancing productivity of these dairy farms.

6. The study shows in Chapter 6 that to promote growth of modern large scale 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, fine-tuning of this policy in line with the changing dynamics of this sector is required. Our investigation of the costs and returns to large commercial dairy farms, keeping purebred Holstein Frisian Australian dairy cows, shows that on a 1300 cattle dairy farm the 10-year average operating profit per farm, per cow and per liter of milk comes to PKR 96.4 million, PKR 45,763 and PKR 828. The operating profit is highest on 1300 cattle farm, followed by 500 cattle farm and then 300 cattle farm indicating presence of the economies of scale. In first few years of operations, the operating margins of these farms remain in the negative, but significantly increase in the later period. However, the 10-year margins are quite low at 11.3%, 4.6% and 0.3% for 1300 cattle, 500 cattle and 300 cattle farms, respectively. Thus, very large dairy

farms do not seem to be a viable option due to low rate of return and huge capital investment required, which most investors cannot afford. However, setting up of 100 cattle dairy farms in peri-urban areas of big cities appears to be a lucrative investment opportunity. The study shows that due to higher retail prices and huge demand for fresh milk in big cities the internal rate of return on a 100 cattle dairy farm in peri-urban areas comes to 11% and 19% at retail price of PKR 70 and PKR 80. The rate of return increases to 25% and 30% at retail prices of PKR 90 and PKR 100, respectively. After gaining maturity in 5th year of its operations, this average profit per cow comes to PKR 57,000 at milk price of PKR 70 per liter, which is nearly four-times higher than the profit per cow of a 300 cattle dairy farm.

7. In chapter 7, we focus on the economics of nutrition and we summarize its key findings below. First, adopting policies that help eliminate birth weight deficit in Pakistan can 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. 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% i.e., PKR 1,005 billion per annum. Third, 79% population in Pakistan consumes less than the recommended 2350 calories per day of which 84% population is from urban and 76% from rural areas. Moreover, 86% children of 10-14 years consume less than the recommended calories. It implies that Pakistan would need PKR 64 billion per day to bridge this nutritional gap, of which PKR 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 belongs to children in the age group of 10 to 14 years. To bridge the gap in milk consumption would require PKR 275 billion per annum. Fifth, evidence from Pakistan suggests that there is a positive effect of pre-school height-for-age Z-score on school enrollment for girls. Sixth, the direct relationship between per capita milk calories consumed on school attendance rate is positive. An increase in per capita daily milk calories by its sample mean increases the probability of school attendance by 0.95 percentage points. There is a huge gap between the present level of milk calories consumed and the desirable level. Seventh, children who do not consume dairy products are relatively at a higher risk of being malnourished than those who consume dairy products; children aged 0-35 months who consume dairy products are 18% less likely to be stunted and 11% less likely to be underweight. Last, if children under the age of six were not exclusively breastfed, they would be better off if they substitute breastfeeding with dairy products rather than switching to family foods. Dairy consumption by non-breastfed children lowers the risk of stunting by 33%, the risk of underweight by 39% and risk of wasting by 14%.

8. Finally, we recommend in Chapter 8 that there is a need to use sales tax policy wisely to create level playing field for different players. The FBR has abolished zero rating sales tax and imposed reduced rate sales tax at 10% on goods e.g., concentrated (powder) milk, cream, yogurt, cheese, butter, whey; however, they have categorized UHT and fat filled milk exempt. While some stakeholders demand restoration of the zero-rated regime and withdrawal of 10% sales tax on milk products, independent assessment of the impact of the revised policy does not exist. This study provides this assessment by using the partial equilibrium analysis to explore the incidence of tax on packed milk and milk products. The long-run analysis depicts that although, imposing sales tax on the dairy sector would yield higher tax revenues, yet efficiency losses to producers and consumers would outweight gains in tax revenue. The short-run analysis shows that tax revenue collection from an increase in tax rate would be relatively higher, but imposing an output or sales tax instead of an input tax will incur a higher net cost rather than gain in revenues. The study also notes that imposing sales tax on tea creamers, ambient white milk and dairy drinks & beverages, the change in milk supply would be substantial

REFERENCES

- Afzal, M. (2007). Livestock Development Policy, Livestock and Dairy Development Board, Ministry of Food, Agriculture and Livestock, Government of Pakistan, Islamabad.
- Afzal, M. (2008). Corporate Dairy Farming in Pakistan: Is there a Future? Pakistan Journal of Agricultural Sciences. 45(2), 250 – 253.
- Afzal, M. (2010). Re-Designing Smallhoder Dairy Production in Pakistan, Pakistan Veterinary Journal, 30(3), 187 – 190.
- Ahmad, M., T.N. Pasha (2009). Economics of Livestock Production in Various Ecological Zones of Punjab.
- Ahmed, M. Fakhar (2018). Sanitation and Child Stunting: Evidence from Two Multiple Indicator Cluster Surveys in Pakistan, MS Thesis, Department of Economics, Lahore University of Management Sciences, Lahore.
- Aigner, D., C.A.K. Lovell, P. Schmidt (1977). Formulation and estimation of stochastic frontier production function models. Journal of Econometrics, 6, 21–37.
- Akombi, B.J., Kingsley E. Agho, John J. Hall, Dafna Merom, Andre M Renzaho (2017). Multilevel Analysis of Factors Associated with Wasting and Underweight among Children Under-Five Years in Nigeria. Nutrients, 9(44), 3 – 17.
- Alasfoor, D., F. Delpeuch, A. Gartner, P. Traissac (2007). Determinants of Persistent Underweight among Children, Aged 6–35 Months, after Huge Economic Development and Improvements in Health Services in Oman. Journal of Health, Population and Nutrition, 25(3), 359 – 369.

- 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, H., Jere R. Behrman, V. Lavy, R. Menon (2001). Child Health and School Enrollment: A Longitudinal Analysis. Journal of Human Resources, 36(1), 185-205.
- Alderman, H., M. Garcia, Zeba A. Sathar (1990). Patterns and Determinants of Malnutrition in Children in Pakistan: Impact of Community. Pakistan Development Review (Papers and Proceedings), 28(4), 891 – 902.
- Ali, M., D. Byerlee (2002). Productivity Growth and Resource Degradation in Pakistan's Punjab: A Decomposition Analysis, Economic Development and Cultural Change, 50(4), 839 – 863.
- Ali, Z., M. Saaka, S.K. Kamwininaang, A.-R. Abizari, A.-G. Adams (2017). The effect of maternal and child factors on stunting, wasting and underweight among preschool children in Northern Ghana. BMC Nutrition, 3(1).
- 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.
- Ansari, N., R. Mehmood, H. Gazdar (2018). Analysing Pakistan's Modern Dairy Value-Chain Innovation, LANSA Working Paper Series, 29, 1 – 38.
- 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, F. (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., E. 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.
- Byerlee, D., T. Hussain, Eds. (1992). Farming Systems of Pakistan: Diagnosing Priorities for Agricultural Research. Vanguard Books, Lahore.
- 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.
- Chaudhry, M.G., M. Ahmad, G.M. Chaudhry (1999). Growth of Livestock Production in Pakistan: An Analysis, Pakistan Development Review, 38(4), Part II, 605 – 614.
- 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.
- Dost, M. (2003). Fodder Production for Peri-urban Dairies in Pakistan. Accessed on 19th January 2019. http://www.fao.org/ag/agp/agpc/doc/pasture/dost/fodderd ost.htm.
- Edmonds, E.V., N. Pavcnik (2005). The Effect of Trade Liberalization on Child Labour. Journal of International Economics, 65, 401–419.

- Faber, M., S.M. Hanekom, M.S. Lesiapeto, Jan du Plessis, M. C. Smuts (2010). Risk factors of poor anthropometric status in children under five years of age living in rural districts of the Eastern Cape and KwaZulu-Natal provinces, South Africa. South African Journal of Clinical Nutrition, 23, 202 – 207.
- 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. Food and Agriculture Organization, Rome.
- FAO (2012). Balanced feeding for improving livestock productivity – Increase in milk production and nutrient use efficiency and decrease in methane emission, FAO Animal Production and Health Paper No. 173. 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.
- Fenske, N., J. Burns, T. Hothorn, Eva A. Rehfuess (2013). Understanding Child Stunting in India: A Comprehensive Analysis of Socio-Economic, Nutritional and Environmental Determinants Using Additive Quantile Regression. PLOS One, 8(11).
- 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.

- 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).
- Gautam, R.S. D., V. Pathak (2010). Indian Dairy Sector: Time to Revisit Operation Flood, Livestock Science, 127, 164 – 175.
- Glewwe, P., H. 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.
- Godfrey, S.S., K. Behrendt, T.L. Nordblom, P.C. Wynn, A. Cowling, D.M. McGill, H.M. Warriach (2018). Dairying and Whole-farm Economics of Crop-livestock Farming Systems – Comparing Arid and Irrigated Districts of Punjab, Pakistan, Australian Farm Business Management Journal, 15, 1 – 18.
- Gomes-Neto, J.B., Eric A. Hanushek, R. H. Leite, R.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) (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.
- GoP (Government of Pakistan) (2018). Agriculture Statistics of Pakistan 2016-17. Ministry of National Food Security and Research, Islamabad.
- GoP (Government of Pakistan) (2018). Pakistan Economic Survey 2017-18, 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.
- 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.
- Habib, G., Muhammad Fatah Ullah, S. Javaid, M. Saleem (2016). Assessment of Feed Supply and Demand for Livestock in Pakistan, Journal of Agricultural Science and Technology, A6, 191 – 202.
- Handa, S., A. Peterman (2007). Child Health and School Enrollment: A Replication. Journal of Human Resources, 42(4), 863-880.
- Haq, S. (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.
- Iqbal, M., M. Ahmad (1999). As Assessment of Livestock Production Potential in Pakistan: Implications for Livestock Sector Policy, Pakistan Development Review, 38(4), Part II, 615 – 628.
- Jalil, H., H.U. Rehman, M.H. Sial, S.S Hussain (2009). Analysis of Milk Production System in Peri-Urba Areas of Lahore, Pakistan: A Case Study, Pakistan Economic and Social Review, 47(2), 229 – 242.
- Jayachandran, S., R. Pande (2017). Why are Indian Children So Short? The Role of Birth Order and Son Preference, American Economic Review, 107(9), 2600 – 2629.
- 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, M. (2013). Dairy Value Chain Assessment Final Report for Agribusiness Project, United States Agency for Internaional Development (USAID).
- Kambhampati, U.S., R. Rajan (2006). Economic Growth: A Panacea for Child Labour? World Development, 34, 426–445.
- Kandala, N.B., T.P. Madungu, J.B. Emina, K.P. Nzita, F.P. Cappuccio (2011). Malnutrition among Children Under the Age of Five in the Democratic Republic of Congo (DRC): Does Demographic Location Matter? BMC Public Health, 11, 261. DOI: 10.1186/1471-2458-11-261.
- Khan, J. K., A. Abbas, M. Naeem, M. M. Ayaz, S. Akhter (2013). Current Issues and Future Prospects of Dairy Sector in Pakistan, Science, Technology and Development, 32(2), 126 – 139.

- Khanam, R. (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.
- Nadeem, N., M.I. Javed, I. Hassan, W. Khurshid, A. Ali (2012). Total Factor Productivity Growth and Performance of Livestock Sector in Punjab, Pakistan, Journal of Agricultural Research, 50(2), 279 – 287.
- 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, M., M. 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.
- Pinckney, 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., K.S. Gorman, P.L. Engle, R. Martorell, J. Riviera (1993). Early Supplementary Feeding and Cognition. Monographs of the Society for Research in Child Development, 58, 235.
- Rayhan, M.I., M. S. H. Khan (2006). Factors Causing Malnutrition among Under Five Children in Bangladesh, Pakistan Journal of Nutrition, 5(6), 558 – 562.
- Riaz, K. (2008). A Case Study of Milk Processing: The Idara-e-Kissan Cooperative. Lahore Journal of Economics, 13(1), 87 – 128.
- Riaz, S., S. 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.
- 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.
- Sarfraz, S., Z. Abbasi (2017). MoF Reviewing Dairy Sector Proposals, Business Recorder, Islamabad, 24th May.
- Sarwar, M., M. A. Khan, Z. Iqbal (2002). Feed Resources for Livestock in Pakistan. International Journal of Agriculture and Biology, 4 (1): 186-92.
- 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.
- SBP (State Bank of Pakistan) (2018). Annual Report 2017-18, State of the Economy, State Bank of Pakistan, Karachi.
- 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.
- Seyyed, F., Abid A. Burki, H. Ashfaq (2018). Corporate Dairy Farm: Performance Evaluation & Feasibility Analysis, CRC Number 02-647-2018-1, Case Research Center, Lahore University of Management Sciences, Lahore.
- Shah, H., N. Akmal, M. Sharif (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, S.M., B.B. Christopher, A.A. Akinwumi (2002). Smallholder technical efficiency controlling for environmental production conditions. Journal of Development Economics, 69, 85–101.
- Spielman, David J., S.J. Malik, P. Dorosh, N. Ahmad (eds.) (2016). Agriculture and the Rural Economy in Pakistan: Issues, Outlooks, and Policy Priorities, University of Pennsylvania Press, Philadelphia (Published for the International Food Policy Research Institute).
- Tetra Pak Pakistan (n.d.). Fodder: Healthy Animals, Wealthy Farmers, Tetra Pak, Lahore
- UNICEF (2013). Improving Child Nutrition: The Achievable Imperative for Global Progress, United Nations Children Fund, New York, NY.
- 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.
- Wolde, M., Y. Berhan, A. Chala (2015). Determinants of underweight, stunting and wasting among schoolchildren. BMC Public Health, 15(8).
- Woodford, K. B. (2009). Devil in the Milk: Illness, Health and Politics of A1 and A2 Milk, Chelsea Green Publishing.
- World Bank (2018). When Water Becomes a Hazard: A Diagnostic Report on the State of Water Supply, Sanitation and Poverty in Pakistan and its Impact on Child Stunting. WASH Poverty Diagnostic Series, The World Bank, Washington, D.C.
- Yalew, B. M., F. Amsalu, D. Bikes (2014). Prevalence and Factors Associated with Stunting, Underweight and Wasting: A Community Based Cross Sectional Study among Children Age 6-59 Months at Lalibela Town, Northern Ethiopia. Journal of Nutritional Disorders and Therapy, 4(2), 1 – 16.
- 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.
- Younas, M. (2013). The Dairy Value Chain: A Promoter of Development and Employment in Pakistan. ICDD Working Papers (Paper No. 9).
- Zuberi, S., R. Mehmood, H. Gazdar (2016). Review of Agri-Food Value Chain Interventions Aimed at Enhancing Consumption of Nutritious Food by the Poor: Pakistan, LANSA Working Paper Series, 7, 1 – 48.

LIST OF **TABLES**

LIST OF **FIGURES**

ACRONYMS

-2SD	Two standard deviations below the median of the reference population
AI	Artificial Insemination
BMI	Body Mass Index
CBF	Currently breast feeding
CCD	Caves, Christensen and Diewert
CPI	Consumer Price Index
ctrl	Control
DEA	Data Envelopment Index
DEA	Data Envelopment Analysis
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
IFCN	International Farm Comparison Network
KLEMS	Capital, labor, energy, material and services
LUMS	Lahore University of Management Sciences
MICS	Multiple Indicators Cluster Survey
NDDB	National Dairy Development Board
OR	Odds ratios
ORS	Oral Rehydration Salts
PBS	Pakistan Bureau of Statistics
PECH	Pure Efficiency Change
PK	Pakistan
PKR	Pak Rupees
PMPIA	Pakistan Milk Powder Importers Association
PSLM	Pakistan Social and Living standards Measurement Survey
RFF	Return to Family Farm
SAGE	Schooling Over Age
SCM	Solid Corrected Milk
SCN	United Nations Standing Committee on Nutrition
SDSB	Suleman Dawood School of Business
SECH	Scale Efficiency Change
SLSP	Strengthening of Livestock Services Project
SMP	Skimmed Milk Powder
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
trt	Treatment
UHT	Ultra-High Temperature
UN	United Nations
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
VAT	Value Added Tax
WHO	World Health Organization
WM	Whey Milk Powder

LUMS

LAHORE UNIVERSITY OF MANAGEMENT SCIENCES

Sector "U" DHA, Lahore Cantt. 54792, Pakistan
Call: +92 - 42 - 111-11-LUMS (5867)
Fax: +92 - 42 - 3589 - 6559
www.lums.edu.pk