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The State of Pakistan's Dairy Sector: An Assessment

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While there is a plethora of research documenting a multitude of dimensions of the crop sector of Pakistan, the virtual absence of meaningful economic analysis of the dairy economy is surprising. No serious attempt has been made in the past to clarify the micro-level potential of this sector to impact rural economy. This paper is a pioneering attempt to provide an objective assessment of the state of Pakistan's dairy and to point out areas of further research. The paper analyses some core issues, highlights the potential of this sector, and recommends the measures to be adopted towards such a goal.

1. INTRODUCTION

The macroeconomic importance of the dairy sector for Pakistan's economy, in general, and for the rural economy, in particular, cannot be overemphasised. While the contribution of agriculture to Pakistan's gross domestic product (GDP) is declining over time, it still stands at 23 percent. Of that, the livestock sector contributes 49 percent of the value addition in the agriculture sector, and about 11.4 percent to Pakistan's GDP, which is higher than the contribution made by the entire crops sector (10.9 percent) of the country. Net foreign exchange earnings from livestock were to the tune of Rs 53 billion in 2000-01, which is about 12 percent of the export earning for that year.

The role of livestock sector in the rural economy of Pakistan can also be gauged from the fact that 30–35 million rural population of the country engaged in raising livestock (small herds) derives 30–40 percent of their income from this sector. Within the livestock sector, milk is the largest and the most important single commodity. Despite the fact that the dairy sector in Pakistan faces major problems, and is not performing even close to its potential, Pakistan is the 6th largest producer

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of milk in the world. In terms of market value, milk production contributes more to the GDP of the country than any single major crop.

Yet, despite its clear importance the dairy sector in Pakistan has failed to attract its due importance from the policy-makers. Pakistan not only has very low milk yield per animal but also has poor animal stock. Its dairy sector mostly operates on non-commercial basis in the unorganised sector while the organised sector processes only a small fraction of total milk production of the country. Despite being one of the largest producers of milk in the world, Pakistan still imports powdered milk to meet the domestic demand.[1]

While there is a plethora of research documenting a multitude of dimensions of the crop sector of Pakistan, there is virtual absence of meaningful economic analysis of the dairy economy that is surprising. For example, no serious attempt has been made to clarify the micro-level potential of this sector in creating an impact on rural economy ranging from increasing indigenous milk production and its efficient distribution, economies of scale and scope of dairying, income generating capacities of the dairying households, to questions concerning objectives related to poverty alleviation.

This paper aims at providing an objective assessment of the state of Pakistan's dairy in the light of available evidence and points out areas where more detailed research work is needed. This review revolves around a key question: can the current status quo be helpful in bringing about a marked change in increasing indigenous milk production and its efficient distribution? The paper analyses some core issues and highlights the potentials, and recommends measures that could be adopted.

In Section 2, we provide a brief overview of the historical policy context of the dairy sector in Pakistan. Section 3 characterises milk production systems in Pakistan while Section 4 gives trends and projection on prices, production and consumption of fresh and ultra-high temperature (UHT) milk. Section 5 discusses implications of industry projections for the dairy economy as well as the outlook for this sector in the near future while the last section concludes the study and makes recommendations.

2. DAIRY POLICIES, MARKET FORCES, AND THE IMPACT ON DAIRY DEVELOPMENT

It comes out clearly from an historical review of the past dairy policies in Pakistan that policy-makers never had faith in the development of the dairy sector. For example, a cursory look at the Five-Year Plans shows that the policy interventions for dairy development were very few and far between, which also reflects in the poor showing of milk yields per animal, and in the way milk supply

[1]Pakistan's annual imports of powdered milk are about 25,000 tonnes, which costs around US$ 380 millions. Importing powdered milk becomes more lucrative when prices fall in the international market, which naturally influences the volume of imports.

channels are currently organised. In this section, we present a preliminary review of Pakistan's dairy development policies in an historical perspective, and highlight the role played by the market forces in creating incentives for higher milk production by subsistence and market oriented milk farmers in the country. This review is organised around two basic questions:

- Were past policy interventions successful in turning around the dairy sector?
- What role, if any, did market forces play in dairy sector development in the past?

Dairy Sector in the Policy Context

The planners in Pakistan have always been more concerned about development of the crop sector than dairying in the agriculture economy of the country. After independence, the livestock population in Pakistan significantly deteriorated due to (a) good stock was taken away by evacuees, (b) indiscriminate slaughter of animals by incoming refugees, (c) dry cows and buffaloes brought from rural areas by milk dealers for supply of milk in urban areas were slaughtered at the end of lactation period, and (d) increased demand for meat due to growth of population and incomes. Urban areas faced acute shortages of milk and dairy products. The planners faced a policy dilemma of how to increase draught power and milk production simultaneously. Efforts were made to improve stock of cattle by breeding of indigenous animals, but output of improved stocks was inadequate to make a dent on the dwindling supplies of improved cattle and buffaloes in the country.

The First Five-Year Plan (1955–60) recognises the importance of improving breeding centres, operating more hospitals, dispensaries and mobile dispensaries to check spread of contagious diseases for animals, in addition to providing for research on increasing supplies of feed and fodder, and starting pilot schemes for artificial insemination for improvement of cattle [Pakistan (1957)]. The First Plan was very specific in removing *gujar* (a cast of milkmen) colonies from cities like Lahore to outskirts and in recommending milk supply schemes for Karachi and Lahore on a pilot basis. Under the scheme government was to buy milk from *gawalas* (milkmen) residing in *gujar* colonies and supply pasteurised milk in sealed bottles through registered milk depots. To reduce adulteration in milk, the Plan recommended testing of milk for purity. The Plan also suggested that most of the milk would be produced in villages near the cities where small farmers would specialise in dairying by keeping half dozen or more cows, produce their own feed and organise themselves in to cooperatives for assembling, transport and even processing of milk.

Soon it became clear that the First Plan, which articulated the problems at hand quite well proved to be too ambitious in their implementation as compared to the Plan target. The question of how to improve milk production capacity remained un-addressed even in the Second Five-Year Plan (1960–65), which experienced major policy shift toward development of the large-scale manufacturing sector. Hence there was very little planned effort, if any, for the development of the dairy sector.[2] In the Third Five-Year Plan (1965–70) there was a renewed emphasis on agriculture development with the help of the seed-fertiliser-water technologies (the Green Revolution technologies) for higher yields in the crop sector. However, the dairying sector went into oblivion. The milk supply schemes envisaged in the First Plan for Karachi and Lahore first became operational in Karachi in 1965. With the support from UNICEF (United Nations Children's Fund), in later part of sixties, subsidised milk was made available in Karachi to low-income families and school children. This plant had to be shut down in 1980 after running in deficit for fifteen consecutive years. Similarly, the Pilot Milk Supply Project in Lahore also went into production in 1967, but like the project in Karachi this project also failed to receive the patronage of successive governments and hence was abandoned.[3]

Milk processing industry got a boost as part of the development of the manufacturing sector in the country somewhere between sixties and seventies, when the private sector established 23 milk pasteurisation and sterilisation plants around three big cities, e.g., Karachi, Lahore, and twin cities of Rawalpindi and Islamabad [Anjum, *et al.* (1989)]. These plants relied on supplies of skim milk powder coming under the auspices of the World Food Programme, which was recombined and pasteurised before being sold to consumers. These plants failed mainly due to weak acceptance of the recombined milk by consumers and its short shelf life [Anjum, *et al.* (1989)]. In other words, inadequate supplies of fresh milk to milk processing industry proved to be the major hurdle in their success.

There was a renewed interest in the milk processing industry in late-seventies and early-eighties when policy support was provided by the government in the form of exemptions in income tax, duty free import of machinery and equipment, and availability of domestic and foreign currency financing [Pakistan (1990)]. The success of Packages Limited in ultra-high temperature (UHT) treated milk in late seventies also attracted other players into the field. Moreover, the UHT treated milk received a successful introduction in this period when the Tetra Pak Pakistan Limited started producing aseptic packaging material for the UHT treated milk. Several UHT plants were set up in eighties while many others were sanctioned leading to growth

[2]This can be verified from the planning documents such as Pakistan (1966).

[3]Lahore Milk Plant has been revived after it was taken over by the Idara-i-Kissan, a farmer's organisation, and currently it has a processing capacity of 300,000 litres a day of pasteurised milk. Similarly, Karachi Milk Plant was also revived when the Idara-i-Kissan took over its control in November 2002.

in the capacity. However, the growth in demand for processed milk was not forthcoming at least in the short run. Hence, due to operating below their variable costs, most of these plants were shut or could not get started. In effect, these developments could not make headway in creating productive capacity of milk in the country or its distribution through the organised sector. As SMEDA (2000) notes, "milk production at the farm level remains the weakest link of the dairy industry in Pakistan" due to which steady supply of fresh milk at economical prices could not be ensured.

In the late eighties, the policy focus envisaged increasing production of livestock products by establishing large scale private corporate enterprises while the role of government was reduced to research on animal breeding, nutrition and creating conducive environment for encouraging private investment in this sector [Pakistan (1990)]. However, despite numerous incentives the same could not make headway. Other than making claims, successive governments in the period of nineties have not initiated any tangible policy for the improvement of the dairy sector.

Role of Market Forces in Dairy Sector Development

Historically, the milk economy of Pakistan cannot be divorced from the crop production sector where traditionally bullocks provided draught power and milk production came as a by-product. Therefore, the constraints or opportunities affecting the dairy sector today have to be found in the internal dynamics of the agriculture proper.

Needless to say that the important role played by draught animals in rural economy in pre-Green Revolution period kept the production of high quality bullocks at the centre stage in animal husbandry practices. Milk production from cattle in this production relation had but only a secondary importance while buffalo was used as a specialist dairy animal. However, in rice growing areas there was always a comparative advantage in using buffalo bulls or even buffaloes for draught power than the bullocks. Therefore, it is not surprising to find a huge concentration of buffaloes than cows in rice growing areas of Pakistan. The spread of buffaloes to other parts can be explained by the preference for buffalo milk in peoples' diet.

In pre-Green Revolution period feed resources were widespread because landlords used to produce green fodder to sustain work animals as part of agriculture economy. In this period, the land tenancy or share cropping relationship was such that typically tenants used to own bullocks while the landlords used to spare land for fodder production for their own animals and the animals maintained by the tenants. However, with the popularisation of the Green Revolution technologies the traditional landlord-tenant relationship was disturbed because the landlords who now provided better seeds (i.e., high yielding varieties) and purchased fertiliser (i.e., chemical fertilisers) claimed higher shares from the produce than the conventional

sharing of crop yields. Even on large tracts of land where in pre-Green Revolution period self-cultivation was not technically feasible with bullock technology was now made possible with the introduction of tractors and tractor-driven implements. Empirical literature shows that tractors are a substitute for animal labour.[4] This is because tractors can be employed for similar agricultural operations that are done by bullocks, e.g., seed bed preparation, harvesting and transportation. The availability of tractor technology on subsidised prices in late sixties and early seventies initiated a gradual replacement of bullocks and male buffaloes with tractors. The fear of land reforms and consequent grabbing of the land by tenants in early 1970s further augmented this process in early to mid-seventies.

Eventually, in post-Green Revolution period tractors have drastically replaced bullocks and male buffaloes for transportation purposes while most of the bullocks that were traditionally used for seed bed preparation and harvesting have also been replaced by tractors paving the way for gradual phasing-out of the work animals, making cows getting the centre-stage. For instance, there was 34 percent decline in the number of bullocks for work between 1986 and 1996 [Pakistan (1998)]. Hence surplus stock of work animals, mainly bullocks, has been culled over time where they had lived their utility. Since the production of work animals had been the first priority of farm households in the rural economy, it should not come as a surprise that the remaining stocks of cows mainly belong to work breeds. It is only a recent phenomenon that milk production has assumed key significance in rural areas where genetic constraint of milking animals is increasingly being felt.

With the burgeoning urbanisation and income growth, there is commercialisation of milk production in Pakistan whereby milk-processing industry has made inroads through better transportation networks and modern storage facilities. The recent economic stimulus provided by processing units, through collection of milk from subsistence and commercial farmers located in remote rural areas, has the potential of setting-in a process of changed management. In the short-run this may take the form of changing the variable factors of production (such as feeding practices) while in the long run it may involve such decisions as the optimal farm sizes based on the economies of scale. The synergies coming from mixed-farming practices could promote economies of scope that could help in simultaneously maximising milk production and crop yields. In this way, the farmers could economise on animal and land assets to maximise profits. However, these inter-relationships have not been thoroughly examined by analysts and hence they offer a fertile area for future research. However, it must be emphasised that due to the inter-relationships between dairy and crop production, agricultural development policies aimed at transforming the rural economy cannot succeed, not anymore, by neglecting the dairy sector. However, progress within the dairy sector largely hinges on the potential of enhancing milk production in the country, which is discussed in Section 3.

[4]See, for instance, Ali and Parikh (1992).

3. CHARACTERISTICS OF MILK PRODUCTION SYSTEMS IN PAKISTAN

The milk production system currently prevailing in Pakistan can be characterised by their location, herd size, feeding practices and marketing opportunities. These production systems based on rural and urban areas offer immense potential for rapid growth in indigenous milk production from their current lower milk yields by improving upon animal management and feeding practices in the short-run and by bringing about a marked improvement in the animal stocks in the long-run. For illustrative purposes, we distinguish here three milk production systems in Pakistan and highlight their main characteristics.

Rural Milk Production Systems

In rural areas of Pakistan, both subsistence and market oriented milk production systems are rampant. A most common age-old practice for rural families was to keep milching animals to meet family's subsistence needs of milk and milk products whereby excess milk was converted in to butter or ghee for home consumption. At that time there was very little demand, if any, for commercial milk production within the village. However, with burgeoning urbanisation a vast market for milk and ghee gradually developed in most parts of Pakistan, which encouraged commercial milk production by subsistence as well as market oriented dairying households.

The subsistence dairying households in Pakistan keep buffaloes and cows in smaller herd sizes while market oriented households keep larger herd sizes for commercial milk production. Up to 43 percent of the dairying households in Pakistan still operate under conditions of subsistence by maintaining herd sizes of one to two while another 27 to 28 percent of the households operate under conditions of near subsistence where the herd sizes range from three to four animals (Table 1). The rest

Table 1

Herd Size by Household, 1996

Herd Size	Household Owning Cattle (%)	Household Owning Buffaloes (%)
1-2	42.05	43.47
3-4	27.48	28.67
5-6	13.85	10.03
7-10	10.74	9.78
11-15	3.46	3.32
16-20	1.18	0.98
21-30	0.77	0.50
31-50	0.33	0.18
51 or more	0.14	0.07

Source: Authors' calculations based on Pakistan (1998), Vol. 1, Table 8.

of the dairying households appear to be maintaining larger herd sizes of cattle and buffaloes located in rural and urban areas that operate essentially for commercial supply of milk.

The subsistence or near subsistence dairying households mostly consist of small farmers, tenants or landless labourers. These dairying households have very high stakes in dairy production because dairy income supplements their other income from farming or agricultural labour. Therefore, smallholder dairying is seen as a tool of raising effective incomes of these impoverished rural households. Interventions in dairy economy aimed at benefiting these impoverished classes involve high returns from a policy standpoint.

Because buffalo milk is richer in composition as compared with cow milk, consumers and dairy milk plants prefer it.[5] About 66 percent of the milk available for human consumption is buffalo milk, 31.4 percent is cow milk and about 2.4 percent is goat and sheep milk [Pakistan (2001)]. Due to higher demand for buffalo milk it sells at a higher price than the cow milk.[6] Higher butter fat content in buffalo milk makes it attractive to milk processing units, which are located in irrigated areas of Punjab where milk production largely depends on buffaloes.[7]

Poor management and feeding of animals is one of the key characteristics responsible for lower milk yields in Pakistan. Artificial insemination can be extremely useful for breeding of cattle and buffaloes, but the farmers in Pakistan are still not inclined to accept this method for various reasons. The fact is that only 4 percent to 4.5 percent of dairying households in Pakistan use artificial insemination (see Table 2) in buffaloes and cows with a slight edge to farmers in North West Frontier Province (NWFP) over all other provinces. Artificial insemination facilities have either not been introduced in many parts of Pakistan or this service is not available nearby to be used at the time of need.

Similarly, proper feeding of animals is important for improving the livestock industry. Even though animal feeding practices in Pakistan are successful in simply maintaining or achieving lower milk yields, they are simply devoid of achieving higher milk yields from the milking animals. For instance, we show in Table 3 that

[5]Except for higher butterfat content in buffalo milk, buffalo and cow milk have very similar composition. For example, buffalo milk has 87.2 percent water, 6.5 to 8 percent fat, 3.6 percent protein, 5.5 percent lactose (milk sugar) and 0.8 percent ash while the cow milk consists of 87.2 percent water, 3.7 to 4.6 percent fat, 3.5 percent protein, 4.9 percent lactose and 0.7 percent ash. Higher sugar content in buffalo milk is another reason for people's preference for buffalo milk.

[6]Buffalo is part of rural production system in Asia for over 5000 years used for milk, draft power, meat and hides. Currently there are 153 million buffalo in several Asian countries. For a detailed review of the role of buffalo in economic and social fabric, in particular, of the small and landless rural poor in Asia. [see Nanda and Nakao (2003)].

[7]According to the *Livestock Census, 1996*, from the total buffaloes in Pakistan 64 percent are located in Punjab while 28 percent are located in Sindh. However, the distribution of cattle is more diverse with 46 percent in Punjab, 27 percent in Sindh, 21 percent in NWFP and 6 percent in Balochistan [Pakistan (1998)].

Table 2

Percentage of Households Reporting Artificial Inseminations, 1996

	Buffaloes	Cows
Pakistan	4.41	5.01
Punjab	5.61	6.54
Sindh	1.28	0.53
NWFP	6.52	7.62
Balochistan	0.74	3.91

Source: Pakistan (1998), Table18.

Table 3

Sources of Feed by Size of Herd, 1996

	Only Stall-feeding (%)		Only Grazing (%)		Both Stall-feeding and Grazing (%)	
	Cattle	Buffaloes	Cattle	Buffaloes	Cattle	Buffaloes
Pakistan	31.9	48.2	8.7	6.3	59.4	45.5
Herd Size						
1-2	50.3	66.2	3.9	3.3	45.8	30.5
3-4	43.5	59.8	4.5	4.0	52.0	36.2
5-6	37.1	53.7	5.7	4.8	57.2	41.5
7-10	32.6	47.3	7.4	6.0	60.0	46.7
11-15	27.4	39.7	9.9	7.6	62.7	52.7
16-20	22.4	33.3	12.7	8.6	64.9	58.1
21-30	17.1	27.9	14.4	11.0	68.5	61.1
31-50	13.8	24.6	17.2	14.7	69.0	60.7
51 or more	9.7	42.1	22.2	8.0	68.1	49.9

Source: Authors' calculations based on Pakistan (1998), Vol. 1, Table 21.

most dairy farmers in Pakistan combine stall-feeding with grazing while grazing only option is practiced on very few farms. Most common feeding regimes for rural subsistence farmers involve stall-feeding or combining stall-feeding with grazing. They commonly feed their animals on grasses and herbs, with forages gathered from uncultivated lands, crop residues and low quality roughages. The amount of concentrate or higher-grade green fodder fed to these animals is often small, which is one of the main reasons for very low yields in rural milk production system. Ironically, most dairy farmers with large herd sizes combine stall-feeding with grazing. This is shown in Table 3 where stall-feeding-cum-grazing practice dramatically increases in large herd sizes.

Needless to say that large ruminants such as buffaloes and cows are known as excellent converters of low-quality forages, roughages, grasses and herbs, crop residues, and crop by-products into milk, which is a complete food. But these feeding plans do not offer a balanced food regime required by the milking animals for higher milk yield. General experience shows that only balanced feeding of animals can bring about 30 percent increase in milk yield per animal. Abundant supply of molasses at cheaper rates in the country can be used as concentrate in animal feed to raise milk yields. Moreover, use of clean but abundant drinking water can also play an important role in raising milk yields.

The negative impact of conventional feeding practices is further augmented during summer months when grasses and herbs rapidly dry out. Moreover, high temperatures also limit animal's ability to digest enough food. Therefore, due to lesser food intake than desirable, milk production drops significantly during summer.[8] The nutritional quality of animal feed is crucial for milk production during lactation and farmers have very little awareness about correct feeding plan for their animals. As a consequence, per lactation milk production in Pakistan is very low.

A key feature of subsistence milk economy is division of labour in the family whereby dairying is a task for women. Local traditions mainly determine the role actually played by women, which differ enormously across regions. In some regions, women in addition to women husbandry are responsible for marketing of milk and ghee while in others women only do activities within their home. However, the role of women in more market oriented dairy farming is limited, if any, because they traditionally depend on males for carrying out various dairy related tasks.

City and Peri-urban Milk Production

The oldest form of milk supply in urban areas consists of animal population of cities, which was (and still is) kept in stables in the outskirts of cities and towns. In other cities, small-scale *dodhis* (milkmen) used to transport fresh milk to urban consumers on foot or on bicycles from peri-urban areas, which still persists in more or less the same form. However, with rapid urbanisation the municipal limits of growing towns and cities are extended, which brought most of these stables inside main cities. Civic authorities of few metropolitan cities (e.g., Karachi, Lahore and Rawalpindi) have made concerted efforts to remove dairy animals from city limits leading to establishment of *Gawala* Colonies around urban areas. In other cities, buffalo and cow herds are still kept on stables gathered over the urban area. Some urban families also keep a large ruminant milch animal (e.g., buffalo or cow) in their streets, garages, or backyards to obtain guaranteed supply of fresh and unadulterated milk.

[8]Based on a survey of 55 small herds in rural Punjab, Anjum, *et al.* (1989) have reported that milk production of buffaloes at 215.4 kg. in high month (January-February) was 88 percent higher if compared with milk production of 114.6 kg. in low month (May-June).

By keeping buffaloes and cows in or near cities on a large or small scale the city and peri-urban milk producers exploit a key feature of this commercial system of shortening the distance between production units and final consumers that helps in considerably lowering the risk of milk spoilage. The large market for fresh milk in big cities such as Karachi, Lahore, Rawalpindi and Islamabad is the main attraction for city and peri-urban milk producers who fetch relatively higher prices of milk, face lower transportation costs, but bear relatively higher cost of feeding the milching animals. Milk is often sold on the spot by units located in cities to guarantee fresh and unadulterated milk. More often, city and peri-urban milk producers supply milk to consumers on the doorstep. Few producers also sell milk to city milk shops or sweet shops (*halwais*).

City and peri-urban animals are kept in herd sizes that vary from 6 to more than 50. They are often fed on stall-feeding with expensive fodder and concentrates.[9] Therefore, dairy animals in this production system are bought shortly before or after calving for greater milk yields while non-lactating or dry animals are sent back to rural areas or are sold to the butcher. The establishment of numerous markets for dairy animals around most big cities and towns facilitate this process.

Commercial Dairy Farming

This involves keeping larger herd sizes usually about 30 or more animals where production depends on modern feeding practices with wheat and rice straw, purchased concentrates, green feeds such as *barseem*, sorghum and maize, and other agricultural by-products. They often take full advantage of available breeding practices, e.g., artificial insemination, to improve their herd quality. Some of them have also installed their own pasteurisation or processing equipment. Due to superior feeding and management practices, yearly milk yield per animal in these production units is relatively higher.[10] However, the share of such farms in total milk production is very low.

In sum, we need primary level research to address the above questions, but given the potential of the sector, it would be important to research and address the above mentioned concerns. This obviously raises the question of how production and consumption decisions are influenced by real prices of fresh and processed milk, to which we turn in Section 4.

[9]To economise on cost of feeding, milch animals (especially those kept in the city) are often paraded through the city streets and roads in the morning in many small cities and towns to take them to suburbs for grazing on public lands, along canals or rivers, and along the roadside and brought back in the afternoon.

[10]Yearly milk production per buffalo in commercial farms was 2518 kg. as compared with 2460 kg. in peri-urban, 2060 kg. in rural market oriented, and only 1200 kg. in rural subsistence units [Anjum, *et al.* (1989)].

4. PRICES, PRODUCTION, AND CONSUMPTION OF MILK: TRENDS AND PROJECTIONS

The growth prospects for the dairy sector in Pakistan largely depend on the pattern of real prices, which in turn are influenced by production and consumption of fresh and processed milk. In this section, we evaluate past trends and make projections for the future on prices, production and consumption of fresh and UHT milk with the objective to provide direction and pace of future change, assuming that the current status quo in policy is maintained.

The ARIMA Model

To make future projection for various time-series, we use the Autoregressive Integrated Moving Average (ARIMA) model, which gives forecasted values after making the desirable time-series stationary [Pindyck and Rubinfeld (1998)]. It is well known that the non-stationary series can be modeled as ARIMA with various lags. To illustrate, the modeling of time series through the ARIMA model is based on three steps:

(1) Modeling of stationary series.
(2) Identification and estimation.
(3) Diagnostic check and forecasting.

To determine whether the series is non-stationary at the level the Augmented Dicky-Fuller (ADF) test is conducted. This test is applied after taking the first difference and in some cases by taking the second difference. Then a cursory inspection of the declining autocorrelation and the partial autocorrelation function of the series ensure that the series is stationary. Once the stationary nature of the series is ensured, the series is modeled depending on its autocorrelation and partial autocorrelation function's spikes at various lags.[11] After determining the possible lags, the final step is executed by looking at the residuals of the estimated equation, i.e., ARIMA (p, d, q).[12]

Fresh and UHT Milk Prices: Trends and Projections

The nominal price series of fresh and UHT milk reported in Table 4 shows consistent year to year increase, which can be misleading unless it is deflated. To illustrate, we show in Table 4 that nominal price of fresh milk consistently increased from 1972 to 2004 while real price of fresh milk either declined or remained constant after 1976-77. More recently, real price of fresh milk has decreased by about 2

[11]This was accomplished by determining possible lags, such as AR (p), MA (q), and ARIMA (p, d, q).

[12]If these residuals are not white noise, then the new specification is tried. When the process discussed above is complete, the future forecasting is made for the future time-period.

Table 4

Nominal and Real Price of Fresh and UHT Milk

Year	GDP Deflator	Nominal Price of Fresh Milk (Rs Litre)	Real Price of Fresh Milk (Rs Litre)	Nominal Price of UHT Milk (Rs Litre)	Real Price of UHT Milk (Rs Litre)
1971-72	10.37	1.26	12.15	–	–
1972-73	12.01	1.39	11.57	–	–
1973-74	14.88	1.80	12.09	–	–
1974-75	18.20	2.40	13.18	–	–
1975-76	20.39	2.71	13.28	–	–
1976-77	22.57	3.03	13.42	–	–
1977-78	24.61	3.11	12.64	–	–
1978-79	25.96	3.22	12.40	–	–
1979-80	28.68	3.48	12.13	–	–
1980-81	31.78	3.77	11.86	–	–
1981-82	34.76	4.20	12.08	–	–
1982-83	36.60	4.64	12.68	–	–
1983-84	40.13	4.95	12.33	–	–
1984-85	41.95	5.53	13.18	–	–
1985-86	43.33	5.68	13.11	–	–
1986-87	45.29	5.85	12.92	–	–
1987-88	49.65	6.08	12.25	–	–
1988-89	53.91	6.47	12.00	–	–
1989-90	57.38	7.14	12.44	–	–
1990-91	64.88	7.71	11.88	–	–
1991-92	71.42	8.82	12.35	–	–
1992-93	77.61	9.90	12.76	–	–
1993-94	87.59	11.07	12.64	–	–
1994-95	100.00	12.18	12.18	25.00	25.00
1995-96	108.04	13.67	12.65	25.55	23.65
1996-97	122.46	15.12	12.35	25.66	20.95
1997-98	131.84	16.27	12.34	25.66	19.46
1998-99	139.68	17.71	12.68	29.33	20.99
1999-00	144.03	17.91	12.43	30.00	20.83
2000-01	151.01	18.21	12.06	30.00	19.87
2001-02	158.03	19.80	12.53	30.00	18.98
2002-03	164.46	21.44	13.04	31.00	18.84
2003-04	175.58	23.13	13.17	32.00	18.22

Sources: Pakistan (2000, 2002, 2004).

Notes: (a) The base year is 1994-95 = 100.

(b) For consistency, the base year of the GDP deflator was changed from 1980-81 to 1994-95.

(c) Data on nominal price of UHT milk was obtained from industry sources.

– Indicates that data were not available.

percent from Rs 12.76 to Rs 12.53 in the period from 1992-93 to 2001-02. Table 4 also reports price time series for UHT processed milk and shows that nominal price of UHT milk registered significant increase from 1994-95 to 2003-04 while its deflated price consistently declined. How milk processing industry has been able to sustain this shock? The answer largely depends on the nature of productivity growth in the industry. Even though we have no direct evidence on the nature of productivity growth in milk processing industry, we conjecture that productivity may have increased in this period due to economies of scale and scope in these years.

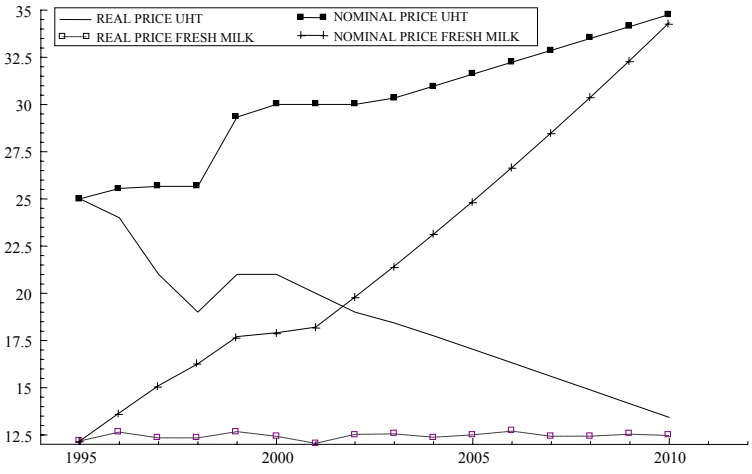
We also note that the gap between nominal and real price of fresh and UHT milk is narrowing over time. This is clearly shown in Table 5 and Figure 1[13] where

Table 5

Price Projections for Fresh and UHT Milk with ARIMA Model

Year	Nominal Price of Fresh Milk (Rs Litre)	Real Price of Fresh Milk (Rs Litre)	Nominal Price of UHT Milk (Rs Litre)	Real Price of UHT Milk (Rs Litre)
2004-05	24.87	12.51	32.20	17.04
2005-06	26.66	12.70	32.24	16.32
2006-07	28.51	12.43	32.87	15.59
2007-08	30.40	12.44	33.50	14.87
2008-09	32.34	12.54	34.13	14.15
2009-10	34.33	12.47	34.76	13.43

Fig. 1. Actual and Projected Prices of Fresh and Processed Milk.



[13]For ease of presentation, we report only the later half of a fiscal year in the horizontal-axis in this and all subsequent figures. For instance, FY1994-95 is reported only as 1995.

we report actual and projected price of fresh and UHT milk until 2009-10. It can be seen that the gap between real price of fresh and UHT milk significantly closes down by the year 2009-10. It indicates that a continuation of this trend may lead to shutting down of some of the high cost milk plants in the near future.

Milk Production: Past Trends and Future Projections

Next we use historical time-series data reported in Table 6 to review trends in fresh and UHT milk production. In this regard, first we use data from 1971-72 to 2003-04 to estimate a time trend for fresh milk production. This time trend is estimated by employing an exponential function of the form $y_F = 5877e^{0.0504t}$, where y_F is for fresh milk production and t depicts the year. The estimated parameters are highly statistically significant (t-statistics is 27.0 and 32.8, respectively), while the overall explanatory power of the model is very high since $R^2 = 0.98$. These results indicate that annual growth rate of fresh milk production from 1971-72 to 2003-04 is over 5 percent per annum. However, it conceals varying growth rates across different time periods. This is shown in Figure 2 where we plot actual and fitted values of fresh milk production from 1971-72 to 2003-04. Despite overall smoothness of the predicted (solid) line in Figure 2, the differential in growth rates across various time periods becomes obvious when we look at the actual data points depicted by the dotted line. It clearly shows that annual growth rate of fresh milk production is lower in pre-1981-85 period if compared with the period from 1984-85 to 1993-94. However, we notice an upward jump in fresh milk production in 1995-96, which is followed by a relatively lower annual growth in fresh milk production. We conjecture that this upward jump may be explained by inter-censual data errors coming from the *Livestock Census*. However, slower growth in later period may be explained by poor supply response of dairy farmers due to falling real price of fresh milk.

Production of UHT milk grows at a higher annual rate of 15.12 percent per annum from 1994-95 to 2003-04. We observe monthly fluctuations in supply of UHT milk but the overall fit is again exponential. More specifically, based on monthly data obtained from processed milk industry from 1995 to 2004 we estimate an exponential function given by $y_H = 6.03e^{0.012558t}$, where y_H indicates production of processed milk, while t indicates month. We find that both the parameter estimates are highly statistically significant with t-statistics of 17.29 and 15.29, respectively, while the overall explanatory power of the model is high, measured by adjusted $R^2 = 0.73$. The estimated parameters reveal an overall monthly growth rate of 1.26 percent per annum or an annual growth rate of 15.12 percent. The observed trend is also shown in Figure 3 where the vertical axis measures sale of UHT processed milk in millions of litres while the horizontal axis measures time in months. The solid line is the fitted trend line while the dots show the actual monthly observations.

Table 6

Actual Production of Fresh and UHT Milk

Year	Supply of Fresh Milk (Million Litres)	Supply of UHT Milk (Million Litres)
1971-72	6180.799	–
1972-73	6500.379	–
1973-74	6836.484	–
1974-75	7189.967	–
1975-76	7561.726	–
1976-77	7952.708	–
1977-78	8363.906	–
1978-79	8796.365	–
1979-80	9251.184	–
1980-81	9729.520	–
1981-82	10232.59	–
1982-83	10761.67	–
1983-84	11318.10	–
1984-85	11903.31	–
1985-86	12518.77	–
1986-87	13166.06	–
1987-88	13846.82	–
1988-89	14562.77	–
1989-90	15315.75	–
1990-91	16107.65	–
1991-92	16940.51	–
1992-93	17816.42	–
1993-94	18737.62	–
1994-95	19706.46	78.63
1995-96	20725.39	91.42
1996-97	21797.00	106.29
1997-98	22924.03	123.58
1998-99	24109.32	143.68
1999-00	25566.00	167.04
2000-01	26284.00	194.22
2001-02	27031.00	225.81
2002-03	27811.00	262.53
2003-04	28624.00	305.23

Sources: Pakistan (2000, 2004).

Notes: Data on supply of UHT milk was obtained from industry sources.

– Indicates that data were not available.

Fig. 2. Actual and Predicted Production of Fresh Milk.

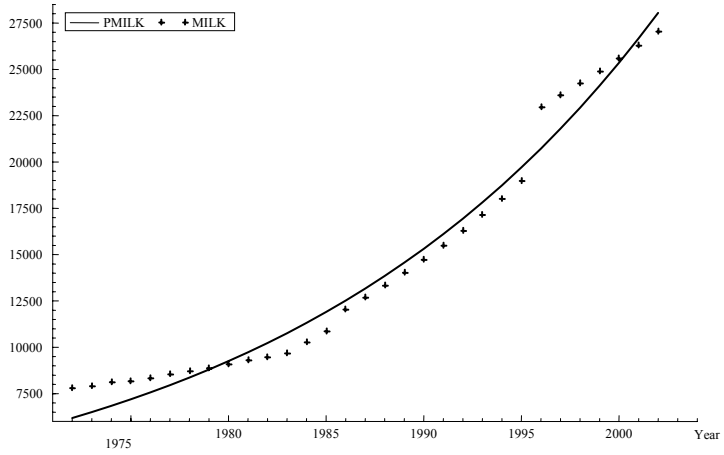
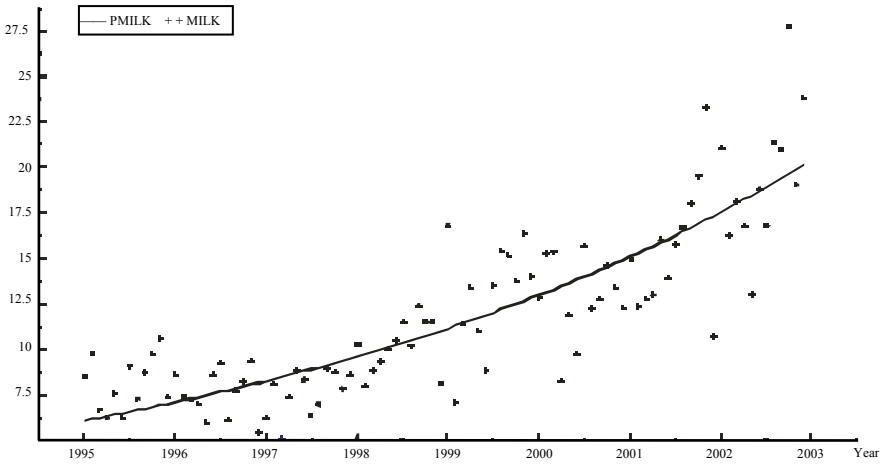


Fig. 3. Actual and Projected Production of UHT Processed Milk.



Next we estimate the ARIMA model to project supply of fresh milk by using past trend of fresh milk production from 1971-72 to 2003-04. Our estimates show that projected supply of fresh milk is 31.42 billion litres in 2004-05, which reaches 42 billion litres in 2009-10. The predicted supply of fresh milk is given in Table 7 and Figure 4. Solid line in the graph shows the predicted/projected production of fresh milk. The in-sample values for actual production and projected production being reasonably close to each other indicate the reliability of our projected production from 2002-03 to 2009-10.

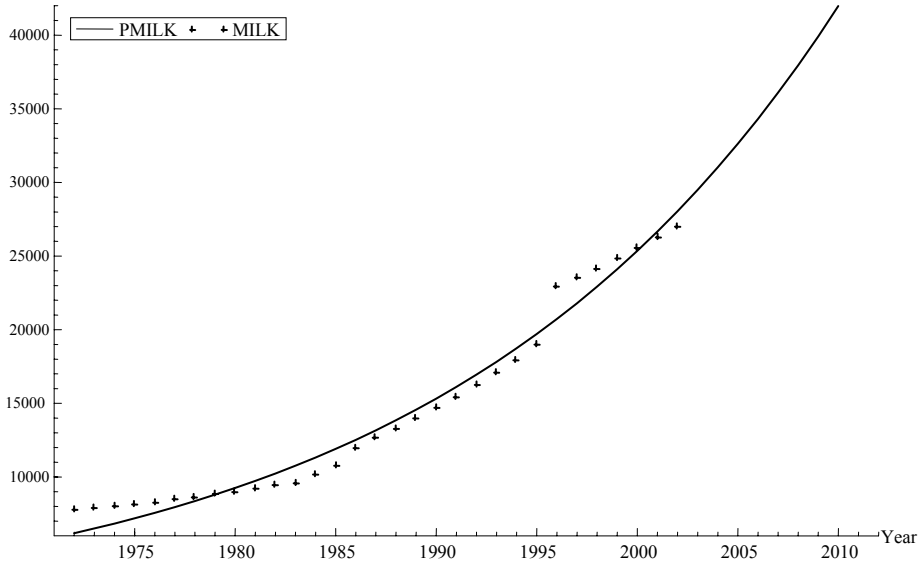
Table 7

Predicted Supply of Fresh and UHT Milk

Year	Supply of Fresh Milk (Million Litres)	Supply of UHT Milk (Million Litres)
2004-05	29882.92	354.87
2005-06	31211.81	412.59
2006-07	32504.91	479.70
2007-08	33805.10	557.72
2008-09	35495.25	648.43
2009-10	37669.75	753.89

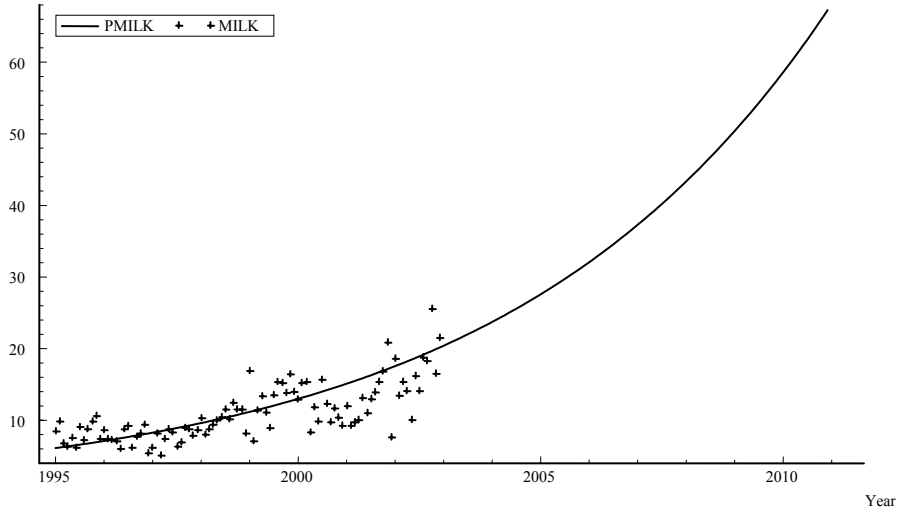
Notes: The projected values reported in this table were obtained by the ARIMA model.

Fig. 4. Projected Supply of Fresh Milk.



The projected production of UHT processed milk is given in Table 7 and Figure 5, which is extended on the estimated exponential function given by $y_H = 6.03\ e^{0.012558t}$, where the estimated growth rate of processed milk is 1.26 percent per month or 15.12 percent per annum. Even though a growth rate of this magnitude is encouraging for milk processing industry, it captures a very small proportion of total milk production. Also other things being constant, real price of milk would be a crucial factor for future production of fresh as well as UHT milk.

Fig. 5. Projected Supply of UHT Processed Milk.



Projecting Future Consumption of Milk

Any good demand forecast must take into consideration three essential elements, namely: (1) previous growth trend in sales; (2) randomness in previous trend of prices and sales; and (3) key determinants of the demand. A most convenient method of obtaining such forecasts may simply be based on historical growth rates, which only cover the first element. Nonetheless, such forecasts neither accommodate randomness in market trends, nor take into account the determinants of consumer behaviour. An alternative method to this simple forecasting technique is the ARIMA model, which is a combination of an autoregressive part that accounts for randomness, and the moving average part that accounts for the historical growth rates. Even a simple ARIMA model fails to take into consideration the parameters of consumer demand model. Therefore, it is an improvement over the simple ARIMA model when we employ a forecasting technique, which integrates the empirical demand model with the simple ARIMA method. Here we employ this improved methodology to forecast demand for fresh and UHT milk.

The estimates of income-elasticity are obtained by specifying separate demand functions for fresh and processed milk in the following form:

Fresh Milk = *f* (Real price of fresh milk, Real per capita GNP),
UHT Milk = *f* (Real price of UHT milk, Real urban per capita GNP)

For the sake of convenience, we estimate these demand functions by using a double-log functional form, which provides direct estimate of price and income elasticity.

We use per capita gross national product (GNP) instead of GDP to capture the affects of remittances on the incomes of the population. The use of per capita GNP also helps us gauge joint impact of increase in population and income levels in the country. These demand functions are estimated by using the annual time-series data for fresh milk from 1971-72 to 2003-04 and monthly data from 1994-95 to 2003-04 for UHT processed milk. For these specifications, the parameter estimates can conveniently be interpreted as own-price and income elasticity.

We report parameter estimates of these demand functions separately for fresh milk and UHT milk in Table 8. We find that price elasticity of demand is statistically insignificant as shown by the *t*-statistics in the parenthesis. This is not surprising given small sample due to time-series annual data. The elasticity of demand with respect to real per capita income is found to be significantly elastic. These magnitudes make sense because fresh milk is considered a necessity. However, the elastic response of income depicted by the income elasticity may be explained by the

Table 8

Parameter Estimates of the Ordinary Least Square Regressions

	Demand for Fresh Milk	Demand for UHT Milk
Variable	Parameter	Parameter
Constant	−1.55**	−2.18
	(−2.03)	(− 0.97)
Real Price of Fresh Milk	−0.87	−2.47**
	(−1.06)	(−7.40)
Real per Capita GNP	1.74**	–
	(11.82)	
Real per Capita Urban GNP	–	5.63**
		(3.07)
F-statistic	73.27	38.10
Adjusted-R^2	0.83	0.44
Number of Observations	33	120

Notes: (a) The demand function for UHT milk is based on monthly data. Since GNP data is not reported on a monthly basis, we have used an approximation and converted yearly GNP into monthly observations. To obtain this series, first we divide yearly growth rate with twelve (to get monthly growth rate) and then extend the series on this constant growth rate and obtain a cumulative series of monthly GNP.

(b) Separate data on urban GNP is also not available from published sources. Therefore, we use a proxy measure for per capita urban GNP by dividing total GNP with urban population. In this way, we capture the trend by assuming that urban GNP grows at the same rate as national GNP. If actual urban GNP growth was faster than the national GNP, our income elasticity parameter for UHT milk may be on the higher side. But, our in-sample forecasts of the series are quite close to the actual indicating that the bias has little or no effect.

–Indicates that data were not available.

fact that the current per capita consumption is constrained by low per capita income and as per capita income rises, consumption of milk rises faster to fulfil basic caloric requirements. This result may be considered as a positive sign for the growth of the dairy sector because real per capita income in Pakistan is on the rise.

The estimates of demand function for UHT milk using monthly time series is also presented in Table 8. The elasticity estimates for UHT milk are price and per capita income elastic and highly statically significant, indicating an increasing share of UHT processing industry in the overall milk consumption in the economy where per capita milk consumption is projected to be rising and real UHT milk price is projected to be falling in future. Since the consumers of UHT milk belong to middle and higher income groups mostly residing in urban areas, rapid expansion of UHT milk consumption is expected with increasing urbanisation and rising per capita income and falling gap between the real prices of fresh and UHT milk. Based on our estimated demand functions for fresh and processed milk, we project future consumption levels of fresh and UHT milk from 2004-05 to 2009-10 and report them in Table 9 and Table 10.

Table 9

Projections of Fresh Milk Production and Consumption up to 2009-10

Year	Annual Production (Million Litres)	Annual Consumption (Million Litres)	Annual Deficit (Million Litres)
Average, 1971-72 to 2003-04	15498.15	15601.53	−103.38
2004-05	29882.92	31194.59	−1311.67
2005-06	31211.81	32532.09	−1320.28
2006-07	32504.91	33785.13	−1280.22
2007-08	33805.10	34929.54	−1124.43
2008-09	35495.25	36361.25	−866.00
2009-10	37669.75	38188.92	−519.17
Average, 2004-05 to 2009-10	33428.29	34498.70	−1170.41

Note: The projected values of fresh milk consumption and production are obtained from the ARIMA model.

Table 10

Projections of UHT Milk Production and Consumption up to 2009-10

Year	Annual Production (Million Litres)	Annual Consumption (Million Litres)	Annual Surplus (Million Litres)
Averages, 1994-5 to 2003-04	141.24	141.6	− 0.36
2004-05	354.87	280.56	74.31
2005-06	412.59	298.71	113.88
2006-07	479.70	317.1	162.6
2007-08	557.72	335.36	222.36
2008-09	648.43	353.71	294.72
2009-10	753.89	372.05	381.84
Average, 2004-05 to 2009-10	534.53	326.265	208.26

Note: The projected values of UHT milk consumption and production are obtained from the ARIMA model.

Future Projections and Deficit/Surplus in Fresh and UHT Milk

We present a comparison of the projections for fresh milk consumption and production in Table 10, which indicates that fresh milk production lags behind consumption. More specifically, if current production and consumption trends continue, fresh milk deficit in the country is projected to peak in 2005-06 at 1320.38 million litres before falling to 519 million litres in 2009-10. Similarly, we report our projections for the UHT milk in Table 10, which show that the dairy processing industry is expected to face surplus production in the near future. If the current trends in per capita income continue, this surplus is projected to rise from only 74.31 million litres per annum in 2004-05 to 381.84 million litres in 2009-10. Our in-sample comparison of annual average production and consumption (from 1995-96 – 2003-04) reveals only marginal differentials for fresh milk and UHT milk indicating, in other words, supply-demand equilibrium.

Our projections indicate net deficit in fresh milk market and net surplus in UHT milk market from 2004-05 to 2009-10. Average annual deficit of fresh milk is projected at 1170.41 million litres while average annual surplus of UHT milk is projected at 208.26 million litres. These results indicate that if the current status quo in government policy continues milk processing industry may face challenges lying ahead.

5. INDUSTRY PROJECTIONS AND DAIRY SECTOR OUTLOOK

In the previous section, our finding of a stagnant or falling real price of fresh milk during the past ten years is alarming. Falling real price of fresh milk can elicit

two types of responses from dairy farmers: (1) they may be discouraged to make investment for improvement in their existing stocks; and (2) an increase in real price of beef relative to the price of fresh milk can motivate dairy farmers to reap immediate profits by getting rid of their existing stocks of milking animals for slaughter.

It needs to be realised that in Pakistan same animal breeds are used for milk and meat production. Recent scare of mad-cow disease in major meat importing Middle Eastern countries has, not only, led to a surge in export demand for meat from Pakistan, but has also fueled a sharp increase in retail price of beef in local markets. With rising real price of milking animals and constant real price of fresh milk, there is a strong possibility that farmers, especially those residing in non-milk producing areas, may have started selling their surplus stock of milking animals for profit. If this is indeed the case, the existing growth rate of milk production might not be sustainable in the long run. May be for the same reason, the Government of Pakistan has allowed import of beef from India at a low tariff rate of 5 percent in November 2004.

Our projections in Section 4 also indicate that if current trends in production and consumption of fresh milk continue, Pakistan may face a large deficit in fresh milk supplies. The deficits observed in fresh milk supplies may be partially filled by surpluses in UHT milk, which seems very likely in the face of converging real prices of UHT and fresh milk.

Unlike other major milk producing countries in the European Union (EU) and the North America where generous farm subsidies are provided to the dairy sector leading to dairy surpluses, there are no subsidies offered to the dairy sector in Pakistan. The fact remains that Pakistan is one of the few countries in the world, which truly enjoys comparative advantage in milk production, despite its very low milk yields per animal. This is evident from the relative farm gate price of fresh milk in Pakistan as compared with other major milk-producing nations in the world.[14]

At another level, productivity of milk animals in Pakistan is very low if compared with U.S.A., Germany and New Zealand. For example, one dairy animal in New Zealand produces milk equal to three dairy animals in Pakistan; in Germany one dairy animal produces milk equal to six dairy animals in Pakistan; and in U.S.A. one dairy animal produces milk equal to seven dairy animals in Pakistan [Garcia, *et al.* (2003)]. However, one dairy animal in India produces milk equal to only 60 percent of that produced by one dairy animal in Pakistan even after substantial improvement in Indian dairy sector [see, Garcia, *et al.* (2003)]. Even though average

[14]For instance, Garcia, *et al.* (2003) has recently calculated that farm-gate milk prices in leading milk producers of the world (e.g., Germany, U.S.A., New Zealand, and India) are higher than those prevailing in Pakistan. The most notable difference in farm-gate price of fresh milk with Pakistan is found in the U.S.A. and in Germany where farm-gate price is more than twice that of Pakistan. Similarly, the farm-gate price of fresh milk in India and New Zealand is respectively 53 percent and 40 percent higher than the farm-gate price paid in Pakistan.

milk yield per animal in Pakistan is low, targeted policies for improvement in these areas offer a great potential for rapid development of the dairy sector in Pakistan.

A sound dairy policy in Pakistan would, therefore, require steps that increase milk yields or productivity of milking animals, on the one part, and ensures a greater share (price incentives) to dairy farmers in retail prices of fresh milk, on the other part. Such measures gain more significance due to the central role played by dairy production and marketing system in poverty alleviation in the country. However, no serious attempt has yet been made to examine the nexus between dairy sector development and poverty alleviation.

6. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to provide a preliminary assessment of the state of Pakistan's dairy, explore the sector's potential in making impact on the dairy economy, and to recommend areas where more detailed research work is needed. We find that even though milk production systems prevailing in Pakistan are plagued by lower milk yields, they offer immense potential for growth in the short to long run. Marked changes in animal management and animal feeding practices, especially by small dairy farmers, can be instrumental in raising milk yields in the short run. However, to bring about improvements in the long run the farmers would need to make sustained efforts to improve their animal stocks, management systems, and production technologies.

Because most dairying households belong to subsistence or near subsistence category, they have high stakes in dairy production because dairy income often supplements farming or labour income. Therefore, attempts to enhance production of smallholder dairying not only are important for raising milk yield in the country; they could also become an effective tool of raising incomes of impoverished rural households. Successful interventions in this type of dairy farms could be the key for alleviating poverty in rural areas. Further research on production structure in dairying could enable us understand the structural changes needed in this sector.

It is not clear which dairy farm size has the greatest potential of growth? This key question needs thorough investigation. Moreover, there is a need to probe the interrelationships between crop production and dairy farming in the context of economies of scale and scope so that an optimal-mix between land and animal assets could be found to make dairying much more competitive.

Our projections show increasing deficits in fresh milk market and increasing surpluses in UHT milk market in the run up to 2009-10, which suggests that the industry should get ready to face challenges.

The analysis shows that Pakistan's milk yields are very low, and even simple management of feed (proper timing, proper mix and so on) can increase yield substantially. This requires intervention at two levels:

(a) The farmers need to have better knowledge of feed management. This can be done by involving milk plants and provincial livestock departments who can provide training and extension services to dairy farmers.

(b) The feed industry needs to be developed substantially to provide better quality animal feed at affordable prices. Currently we do not have sufficient supply of high quality nutrients and additives, especially in rural areas. A specific package needs to be developed with the help of the government and in partnership with the private sector that would facilitate and encourage the development of a modern feed industry. Further, the vast potential of using molasses as concentrate in animal feed also need to be taped.

We also find that the animal stock is of poor quality as well. So even though better feed will increase yield somewhat, to make the dairy sector commercially viable, the stock of animals needs to be improved substantially in the long run. Artificial insemination facilities have to be made widely available, and poor stock needs to be eliminated over time. These facilities need to be cheap enough to be in the reach of poor people who are planning on keeping small herds. One way of ensuring this is through provision of credit for better quality livestock only. Animal husbandry contributes 30-40 percent of income to households that keep animals, and it can contribute substantially in achieving goals concerning poverty alleviation. To exploit the potential in this area more fully we recommend (a) Zarai Tarakiati Bank, government micro-credit providers as well as non-governmental organisations (NGOs) in the area of micro-credit provision and rural poverty alleviation should focus on providing credit for rearing better quality stock; and (b) all of the above points are also essential for larger livestock farmers. Corporate farming cannot take off in Pakistan unless better feed and better stock are available, and credit providers are willing to provide credit to the area. In sum, the dairy sector needs a lot more research before we can understand it fully and then recommend a more comprehensive set of measures that would facilitate its development.

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