5

Smallholder Dairy Farming in Nepal:
Characteristics, Constraints, and Development Opportunities

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Chapter 5

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CONTEXT

Livestock is an integral component of farming systems in Nepal; it contributes about 12.8% to the total national gross domestic product (GDP) and 31.5% to the agricultural GDP. It is estimated that the livestock share of agricultural GDP will reach 45% by the end of 20 years of the Agricultural Perspective Plan (APP) programme, that is by fiscal year 2014/15. The major components of livestock GDP are milk and milk products from buffalo and cattle (32.7% and 24.7% respectively). At present, the total annual milk production of Nepal is just over one million tonnes (70% from buffalo and 30% from cattle). Based on this figure, the per capita milk consumption over the country is about 48 l/year or approximately 130 ml per day. The average growth rate of milk production from 1985 to 1995 was 2.4%, and the population growth rate 2.9%. This gap is likely to increase in the future unless serious efforts are made to improve dairy production and marketing. In this chapter, we discuss the current characteristics of the dairy sector, its constraints, and opportunities for development.

STUDY SITES AND METHODOLOGY

A milkshed approach was taken to select three case study areas all with milk supply schemes (MSSs), namely Biratnagar, Kathmandu, and Pokhara, located in the eastern, central, and western regions, respectively. Two or three chilling centres were selected in each case study area, and in each of the selected chilling centre areas, six to eight groups of smallholder dairy farmers (between four and seven farmers in each group; three to four groups from valley/river basin farming areas and three to four from upland sloping agricultural land areas) and some key informants were interviewed using rapid appraisal techniques with a semi-structured interview and a prestructured questionnare cum checklist to obtain information and data on issues related to production, consumption, and marketing.

The Nepal Living Standard Survey (NLSS) at household level, conducted by the Central Bureau of Statistics (CBS) with support from the World Bank, was used for consumer and demand studies. This survey provides detailed information (quantities and costs) on household consumption of purchased and home-produced milk and milk products (milk, condensed milk, baby milk, curd, ghee, and other milk products).

DAIRY PRODUCTION SYSTEMS

Table 5.1 summarises the characteristics of the smallholder dairy production systems in the different study areas. Cows are the dominant dairy animals in the eastern hills and buffalo in the central and western hills. Animal herd size differs from region to region and ranges from 1 to 4 dairy animals per household. Stall feeding of dairy animals is common across the region.

Table 5.1: **Characteristics of the main dairy production systems prevailing in the three case study areas**

	Eastern Hills	Central Hills	Western Hills
Important species	Cows	Buffalo, cows (ratio 3:1)	Buffalo, cows (ratio 4:1)
Important breeds	Jersey/ Holstein crosses	Murrah cross buffalo, Jersey cross cows	Murrah cross buffalo (50% of buffalo)
Average herd size	3.4 (< 2 dairy cows)	3	4-5 (2.5 dairy animals)
Normal feed (daily, per head of dairy animal)	25 kg green grass (rainy season), 5 kg crop residues, 2.24 kg concentrate	30 kg grass in the rainy season; 12-15 kg of fodder leaves in winter; total 15-30% nutrients from concentrates	Green grass in rainy season, rice straw/ maize stovers, tree fodder leaves 1.5 kg home-made concentrate during lactation; 200- 700 kg commercial feed purchased per year
Feeding system	Stall feeding	Stall feeding	Stall feeding
Reproductive performance			
Age at first calving	28 months	3-4 years for improved buffalo, 5 years for native buffalo	4 years for local buffalo, 2.5 years for cross-bred cows, 4 years for local cows
Milk productivity	8.37 l/ day, 2660 l/ lactation	5.2 l/ day for Murrah buffalo, 3.5 l/ day for native buffalo (1590-1920 l/ lactation)	3.5 l / day for local buffalo, 4.7 l/ day for Murrah buffalo, 6.3 l/ day for crossbred cattle
Calving interval	13 months	14-15 months	NA
Lactation period	315 days	305 days	NA

SPECIES AND BREEDS OF DAIRY ANIMALS

Major milking animal breeds

There are about 7 million cattle and 3.5 million buffalo in the country. The hill region has the highest number of both cattle and buffalo. The Eastern Development Region

(EDR) has the highest cattle population (1,703,000) and the Far Western Development Region (FWDR) the lowest (940,000). The buffalo population is highest in the Western Development Region (WDR) followed by the Central Development Region (CDR). Although the cattle population is dominant in most of Nepal, there are more buffalo in the middle mountains of the CDR and WDR. The total population of cattle in the country increased from about 6.5 million in 1991/92 to about 7 million in 1998/99 with an average annual growth rate of just over 1%; and the buffalo population from about 3.3 million in 1991/92 to about 3.5 million in 1998/99, with an average annual growth rate of about 0.6%

The type of cattle found in Nepal varies according to the agroecological zone and also between east and west. The dominant breeds are the indigenous Zebu breeds (*Bos indicus*). There are also some improved cattle breeds – the result of the cattle improvement programmes being implemented by the Department of Agricultural Development (DAD) both by natural service using upgraded bulls and by artificial insemination. The main breeds being used are Brown Swiss in the upper Mid Hills, Jersey and Holstein in the Mid Hills, and Haryana and Sahiwal in the Terai. A buffalo improvement programme is also being implemented by DAD using the Murrah breed through both natural service and artificial insemination.

Trends in the dairy animal population

Despite large cattle and buffalo populations, the proportion of dairy animals has remained low, indicating a large number of 'unproductive' animals. Only 12% and 26% of cattle and buffalo, respectively, produce milk. The disposal of unproductive cattle is difficult, mainly because of religious beliefs.

The total population of milking animals (comprising cows and buffalo) in the country increased from about 1.4 million in 1984/1985 to about 1.7 million in 1998/99 with an average annual growth rate of 1.8%. Milking animals are mostly concentrated in the hills (58% of the country's total milking population). The Terai region has experienced the highest growth rate in milking animal population and the mountains the lowest. Among the regions, the average annual growth rate was highest in the FWDR and lowest in the Mid Western Development Region (MWDR).

The proportion of cows in the total milking animal population of the country remained at just under half over the period 1984-1998. The proportion is highest in the mountains (57%), followed by the Terai (52%), and then the hills (45%). Across the development regions, the proportion is highest in the MWDR (59%) and lowest in the WDR (34%). The proportion remained virtually unchanged between 1984/85 and 1998/99 across all ecological and development regions of the country (Table 5.2). The proportion of crossbred dairy cows in the country is reported to be around 2% of the total dairy cow population.

Table 5.2 **Proportion of cows in the total milking animal population**

	Mountain	Hill	Terai	EDR	CDR	WDR	MWDR	FWDR	Overall
1984/85	61.6	46.2	52.5	59.1	50.2	33.4	58.5	53.7	49.8
1998/99	56.7	44.6	51.6	55.5	45.8	34.4	59.1	51.6	48.0
Average annual growth rate (%)	-0.59	-0.25	-0.12	-0.45	-0.65	0.20	0.08	-0.29	0.25

Source: Agricultural Statistics Division, Ministry of Agriculture, His Majesty's Government of Nepal (HMGN)

In the eastern hills, the average number of livestock per sampled household was 3.4. The number of dairy cows owned by the farmers did not exceed two. The smallholders manage their herds in order to maintain a steady supply of milk. Dairy animals are predominantly improved crossbred cows, which give on average 8.4 l of milk per day (2,659 l/ lactation period), calve at an early age, and have shorter calving intervals (Table 5.1).

In the central hills, the majority of the dairy farmers in the selected milkshed area raised Murrah cross buffalo, a few kept Jersey cross and local cows. Once a cow is dry, it is exchanged immediately for a milking buffalo. Buffalo traders have reached each and every corner of the study area to sell Murrah cross buffalo brought from India. These traders sell milking Murrah cross buffalo at NRs* 20,000-30,000 each. The average milk yield per day is about 5.2 l for Murrah cross and 3.5 l for native buffalo. The milk yield per lactation of 305 days varied from 1,590 l to 1,920 l at different locations. The average milk yield of local cows was much lower.

In the western hills, the dominant dairy species is buffalo (local and Murrah cross) followed by crossbred cows (mostly Jersey cross but also Holstein, and in some cases, both breeds mixed). Local cattle were not reared as dairy animals.

The average numbers of livestock per household were 4.7 and 5.4 livestock units in lowland and upland areas respectively, with an average holding of about 2.5 dairy animals per household. The ratio of buffalo to cows ranged from 4:1 in the lower areas to 1:1 in the cooperatives located in the higher areas. Fifty per cent of the buffalo were Murrah crossbred.

The productivity of the crossbred animals (cattle or buffalo) was not significantly higher than that of the local buffalo. This indicates clearly that despite the potential, the productivity of the crossbred buffalo could not be raised in the absence of adequate nutrition and health care management. The difference in yield between the Murrah cross buffalo and the local buffalo was also marginal. The higher yield in the Murrah cross buffalo was at the cost of higher feed intake.

ANIMAL FEED RESOURCES AND NATURAL RESOURCE MANAGEMENT

Animal feed

Several animal feed improvement projects have been implemented in the past. In 1985, the Integrated Livestock Development Programme was implemented by the Department of Livestock Services (DLS) in 35 districts and in 1989, this programme was extended to 11 more districts. In 1992, the Hill Leasehold Forestry and Forage Development Project was implemented in 12 districts. The implementation of these projects over the past decades has resulted in available rangeland of 17 million ha, which is 12% of the total land area delineated in the Land Reform and Mapping Project of 1986. Estimates indicate that available rangeland supplies only 36% of the total food requirement of the livestock in the country (Mathema and Joshi 2000). Experience further reveals that while past initiatives in fodder development in Nepal have had some success in areas that were accessible by vehicles, programmes have not been successful in most of the poorly accessible hill and mountain areas. The present area of rangeland is thus inadequate not only to meet the current deficit but also to meet the demand of the increasing livestock population in the future.

* NRs 68.00 = US$1 (in 2000)

Eastern hills

Unlike other districts, the link between common property resources (CPRs) and livestock in the study area was weak due to the lack of availability of grass and fodder. All animals were stall fed and the planting of grasses, shrubs, and fodder trees on private land was quite common.

Grass, which is mostly used in the rainy season, makes a significant contribution to livestock feed; it is collected from private land specially leased for grass. Interestingly, 20% of the farmers in the study area have leased land for grass.

Concentrates and high-quality feeds are given in the morning and evening during milking. Grain by-products such as rice and wheat bran, oil cake, maize flour, and salt are fed to dairy animals throughout the year. A cow was fed an average of 25 kg of green grass, 5 kg of dry grass, and 2.24 kg of concentrates per day.

The main calving season for cows in the area is November to February. There is an acute shortage of green forage throughout the year, except during the wet season from July to October. The net deficit periods of good quality forage are November to December and April to June.

Central hills

Crop by-products like rice straw and maize stovers were the main feed for dairy animals in the lowland parts of the central hills study area. In the upland areas animals are fed tree fodder and grass collected from government forests and the diet is supplemented with rice bran and maize stovers. All animals were stall fed.

Dairy farmers have become more conscious about feed. Improved grass crops have been observed in farmers' fields, and native grasses like amriso, nigalo, siru (*Imperata cylendrica),* khar (*Andropogan* spp.), and banso (*Setaria pallidesesca*) are also used in large quantities. On average every household in the study area collected about 30 kg of grass per day per adult animal in the rainy and autumn seasons (for six months).

In lowland areas, the cutting of tree fodder in government forests is prohibited. In the upland areas, many farmers collected 25-30 kg of fodder leaves on alternate days during spring and winter, and some dairy farmers went far from their villages (6 hrs walk) to bring tree fodder (a load of 50-60 kg). The most common fodder species in order of farmers' preference were *Leucaena leucocephala*, *Artocarpus lakoocha*, *Ficus hispida*, *Ficus roxburghii*, *Premna integrifolia*, *Morus alba*, *Litsea polyantha*, *Eriobotrya elliptica*, *Ficus nemoralis*, and *Ficus lacoor*.

The farmers mix about 2 kg of rice bran with beverage by-products and feed this to the lactating animals. Concentrate feeding practices varied from location to location.

Normally, one standard livestock unit (SLU) should be provided with 5.09 kg total digestible nutrient (TDN) per day; about 66% of this TDN requirement should be met from roughage and 34% from concentrate feed. The feed resources in terms of TDN were sufficient in two of the three chilling centre areas and slightly deficit in the third. Between 13% and 33% of TDN was estimated to come from concentrate feed.

Western hills

Dairy animals were stall fed throughout the year. The composition of the forage varies according to season, depending on what is available. Only a few farmers raising

crossbred cattle cultivate forage (oats) during the winter months as a green supplement. The type and proportion of feed resources available were similar in the higher and lower areas.

The majority of the forage was home grown; the contribution from the forest was only 3-14% (according to the season). This figure is lower than the national average, perhaps reflecting the close proximity of the dairy animals to market areas where forest resources are less. The homestead grass production was minimal during the winter months and animals were fed almost exclusively on crop by-products and tree fodder.

Rice straw was the main crop by-product during the winter and maize stovers in the rainy season. Various species of fodder tree are cultivated by farmers, but the most popular are badhar, bans, khanyu, koiralo, kutmiro, and ginderi.

Concentrate feed was mostly home made and based on cereal grains (maize, rice, and rice bran in different combinations). Lactating dairy animals were given about 1.5 kg of home-made concentrate feed per day during the lactation period. Commercial feed was only purchased by farmers rearing crossbred cows. Some of the farmers rearing crossbred cattle also bought wheat bran in addition to concentrate feed and mixed it with equal amounts of maize or rice grain before feeding it to the animals. The amount of commercial feed purchased per year ranged from 200 kg in the inaccessible areas to 700 kg in the accessible areas. The costs of concentrate feed varied with supplier and area within the range of 12-15 NRs/kg.

LIVESTOCK HEALTH SERVICES

Animal health and diseases

The most common communicable diseases of animals in Nepal are peste des petits ruminants (PPR), rinderpest, foot-and-mouth disease (FMD), rabies, brucellosis, haemorrhagic septicaemia, black leg disease, anthrax, mastitis, and fasciolosis (liver fluke) (Mathema and Joshi 2000). Some animals, especially in the eastern and central hills, are also affected by contagious diseases such as black quarter and red water. Mastitis is an increasing problem in crossbred cows. Internal parasites like liver fluke and roundworm are quite widespread in all the districts. These parasites affect young and adult animals equally. In the western hills mortality from the diseases was not reported to be very high: 0.23% and 4.85% from liver fluke and FMD respectively, in affected cattle and buffalo.

Poor feed has also reduced reproductive performance in dairy animals. In the past, breeding improvement programmes have been undertaken to introduce Jersey, Holstein, Brown Swiss, and Murrah into native cattle and buffalo. However, because of poor diet, the upgraded dairy animals have not performed well.

Treatment

Efforts have been made to improve animal health services with the establishment of several veterinary hospitals which include various specialised divisions and sections. The government veterinary section was established in 1961, the biological product division in 1967, and the infectious disease and parasite control division in 1981. In addition, to support the different sectors of the veterinary service, a disease investigation and parasite control project was started in 1968, a rabies control project in 1981, and a national foot-and-mouth disease control project in 1983. Veterinary services

in Nepal are largely provided by the government sector with little or no encouragement given to the involvement of the private sector. Veterinary services are only sought when the animals are clinically ill. Animal health services are mainly provided by veterinary hospitals, livestock service centres (LSCs), and livestock service sub-centres in nearby villages. About 50% of the farmers in the study were satisfied with the level of services they obtained from these centres. The unavailability of technicians at the centres, high service charges for treatment, and unfair distribution of medicines were the major complaints. Village animal health workers and private practitioners also provide some animal health services.

Although the farmers in most areas reported drenching twice a year against liver fluke, they had little knowledge about correct drenching timing. Preventive vaccinations were not carried out in any of the areas, but vaccinations were carried out during disease outbreaks. The farmers in the western hills were willing to pay for the veterinary care provided to their animals; the average cost of animal treatment was NRs 350 per household per year.

MARKETING OF DAIRY PRODUCTS

Milk marketing and market structure

The market structure for dairy products may be separated into three segments: the rural or informal component, the urban or formal component, and the export market component. The rural component of dairy marketing comprises the over 90% of farm households with dairy animals where most of the milk produced is consumed within the households either in the form of fresh milk (usually boiled) or in the form of traditional dairy products. Some products are traded directly with consumers (raw milk) or through traditional collecting agents for consumption in urban areas or export to India. In the urban component of dairy marketing, most of the dairy products consumed in households and at restaurants and hotels are purchased from rural producers through several market networks. Milk-marketing agents include both private dairies and Dairy Development Cooperation (DDC) supported outlets. In some smaller cities, some households may also produce, consume, and sell dairy products. Fresh and pasteurised milk, yoghurt, cream, butter, ghee, cheese, and ice-cream are the main products of both the private and the public dairy industries.

The production figures for dairy products of the DDC (the figures for the private sector are not available) indicate that the market is growing. Some high-value products like dried milk, cheese, and ice cream are also imported for sale in addition to the locally produced dairy products.

The public sector

The DDC was established in July 1969 under the Corporation Act of 1964 to consolidate formal dairy development activities. A network of milk collection and chilling centres was established that feed into 'milk supply schemes' (MSS) to form the so-called national milk grid. Currently there are five MSSs, in Kathmandu, Biratnagar, Hetauda, Pokhara, and Lumbini, and a cheese production scheme under the Dairy Product Production and Marketing Scheme.

Milk producer associations (MPAs) manage the milk collection centres and have expanded their operations in recent years. The DDC supports the MPAs with management and accounting assistance. A fixed commission is also provided to MPAs

on the basis of the solid content of the milk they supply to the chilling centres. The commission covers not only the marketing cost involved in the collection and transport of milk, but also the overheads for the operations of their cooperative institutions.

Pasteurised milk is sold in half-litre plastic packs. Milk is distributed by trucks to milk booths and shops, and most sales take place in the morning. The booths are privately operated and receive a commission from the DDC, while the shops are owned and operated by the DDC itself. As of 1998, there were 400 booths, 11 shops, and 2 dealers operating under the DDC.

There are currently 12 cheese production centres (of which 6 are located in the high mountains) operating in different parts of the country. These cheese production centres collect milk from the network of 25 milk producer cooperative associations.

The growth in the number of chilling centres and cooperatives over a six-year period (1992/93 to 1997/98) is summarised in Table 5.3. The catchment areas of the milk collection centres located in different parts of the country cover a total of 39 hill and Terai districts. The supply of milk in the Kathmandu MSS originates from nine highland districts, in Biratnagar from seven districts (three highland), in Hetauda from five districts (one highland), in Pokhara from seven hill districts, and in Lumbini from eight districts (one hill). Some 60 million litres was collected by the DDC in 1998, about 5% of the total milk production in the country. Out of all the DDC milk factories, the one in Kathmandu collects and processes the most milk. Between 1992/93 and 1997/98, the total milk collection from all the centres increased by 74%, an average annual growth rate of 12%.

Table 5.3: **Total number of chilling centres and cooperatives**

	Chilling Centres	Cooperatives
1992/93	37	696
1997/98	45	939
Growth rates (% per annum)	4.0	6.2

There is, however, a seasonal fluctuation in the milk supply from the rural areas. During the peak season supply is greater than demand, whereas in other seasons the supply of milk is inadequate. To overcome this situation, the DDC has established a milk powder factory with technical assistance from the government of Denmark. This factory has helped substitute more than 50% of the powder milk imported by the DDC from abroad for producing liquid milk during the lean season.

Private dairies

Many large and small dairies have been established in the private sector. The Nepal Dairy was the first dairy established in Kathmandu, followed by the Himalayan Dairy of Lalitpur. Currently, the Sita Ram Gokul Dairy in Kathmandu has the biggest milk processing facility (100,000 l/day) among the private dairies. Most of the private dairies are situated in the CDR and clustered in and around Kathmandu. Notable private dairies outside Kathmandu are the Namo in Dharan, the Ram Janaki in Janakpur, the Jai Ganesh in Chitwan, the Pan/Panthi in Pokhara, the Pandav-Pabitra in Butwal, the Gurudev in Nepalgunj, and the Western Himalaya Dairy near Mahendrangar. The processing facilities and working conditions in these private dairies vary widely from simple cream separator dairies to well-established dairies with a collection network and processing facilities. Cheese industries have also been established in the private sector.

The private dairies have distribution and sales systems similar to those of the DDC, with booths located in urban areas as well as direct sales from their plants. Some dairies compete with the DDC on milk routes and secure quality milk by paying a premium price. The small private dairies pay contractors to collect their milk and some have their own dairy farms. It is believed that about 35% of the market share is controlled by private dairies.

Eastern hills

The main marketing channels in the eastern region are

(1) producers – MPAs – DDC
(2) producers – vendors – semi-urban/urban consumers
(3) producers – semi-urban consumers
(4) producers – urban consumers.

In the study area itself, the milk was sold directly to the MPAs who supplied it to the DDC chilling centres. About 80% of the total milk produced in the area was sold in the market. Even local consumers who want to purchase milk for home consumption have to purchase milk from the MPAs. All the private sector cheese factories in the study area also collected milk from the MPAs with the exception of Neelam Cheese Factory, which collected a very small amount of milk directly from the farmers. The private sector was unable to collect milk.

The highway passing through the milkshed helped greatly in the transportation of milk to various market centres.

Central hills

The milk produced by the farmers in the central hills milkshed area was either sold to the chilling centre of the DDC direct or through milk producers' cooperatives (MPCs) and contractors, or sold to teashops, restaurants, and house-to-house. Some was sold in the form of milk products (for example, ghee, butter, and cream)

The price paid to cooperative members was based on fat and solid–not–fat content. The majority of farmers in the study were willing to sell milk to the DDC for a standard and reliable price, although the price paid was NRs 0.10 per litre less than by private dairies. Only 4 of the 29 dairy farmers sold milk to restaurants for a high price.

However, the DDC's purchasing policy was not regular, and the introduction of 'milk holidays' (when no milk is accepted) is posing problems for the smallholder dairy farmers. 'Milk holidays' were introduced because production during the wet season was considerably higher than the DDC's handling capacity. There are limited alternative outlets, particularly for farmers far away from towns, so on some days farmers faced difficulties in disposing of their milk. Milk holidays twice a month are common from the month of August, and later in the year they are practised weekly until the end of January.

Western hills

Farmers in the case study area in the western hills preferred to sell their milk direct to the market or teashops because the open market price of fresh milk was about 20-25% higher than the price given by the milk collection centre and cooperatives, and there is little consideration given in the open market to the quality of the milk. Thus in the areas with access to markets and teashops, only a third of the milk was sold to the dairy

and milk collection centres, and two-thirds through informal markets (teashops, private dairies, and direct to consumers).

Overall farmers who have enough labour sell their milk directly on the open market, and those without labour sell to the dairy collection centres. Milk is mostly transported from the collection to the chilling centres through contracted hired porters. Wage rates varied among the areas from NRs 50 to NRs 60 per day.

MILK SUPPLY AND DEMAND

Although the population density of dairy cattle in Nepal is high, milk productivity is low due to poor feeding, breeding, and management practices. On average, the annual production of milk from cattle and buffalo is only about 386 and 827 l per animal respectively. Nepal's total milk production in 1998/99 was 1,073,000t of which about 70% (774,000t) was from buffalo and the rest (329,000t) from cattle. The Western Development Region produced the highest quantity of milk (281,000t), and the MWDR the lowest (121,000t) (Table 5.4).

Milk production increased from 1984 to 1998/99 at an average annual rate of 2.6%; the annual growth rate from 1991 to 1998 was around 3%. Milk production in the mountains showed a declining trend (negative growth rate of 3.7%) from 1984 to 1998, whereas both hill and Terai regions showed a positive growth rate (Table 5.4).

Table 5.4: **Trends in total milk production (t)**

	Hill	Mountain	Terai	CDR	EDR	FWDR	MWDR	WDR	Overall
1984/85	391	148	206	220	153	89	140	144	745
1998/99	605	88	380	294	242	127	125	285	1073
Average annual growth rate (%)	3.16	-3.67	4.49	2.10	3.33	2.61	-0.80	5.00	2.64

Source: Agriculture Statistics Division, Ministry of Agriculture, HMGN

This milk consumption in the country was estimated from the NLSS data (1996). All units have been standardised into litres. The different sources of supply (purchased, home produced, quantity received in kind) were aggregated to obtain the total quantity consumed by households. It is worth noting that unlike the information on quantity of purchased and home-produced milk and milk products, milk and milk products received in kind are all reported as monetary values in this source. The quantity of milk consumed was derived by dividing the total value of milk received in kind by prices reported for purchased milk.

The distribution of the households purchasing milk and milk products is reported by region, and consumption estimates made for milk and milk products among rural and urban households and for different sectors. Regression equations were estimated from the NLSS data to derive demand elasticity (price and income) for milk and ghee for urban and rural consumers. The estimated income elasticity parameters were used to forecast the milk demand.

Purchase of milk and milk products

Nearly 66% of urban households purchased milk compared to about 23% of rural households, reflecting that many rural households have dairy animals. In the country

as a whole, only 26% of households purchased milk from the market. In both urban and rural areas, the proportions of milk buyers vary greatly among development regions, with the CDR having the largest proportion, followed by the WDR. The number of milk buyers decreased from south to north.

The proportion of households buying milk increased consistently with increasing household income. This relationship is more marked in urban Nepal than in rural Nepal. For example, about 79% of urban households in the highest income group purchase milk, but only 2% in the lowest income group.

In urban Nepal, about 4% and 5% of households purchased baby milk powder and condensed milk, respectively. The corresponding figures in rural Nepal are less than 1%. The percentage of households purchasing ghee was 38% in urban Nepal and 24% in rural Nepal with an average of 25% over the country as a whole. Curd was purchased by roughly 28% of the households in urban areas compared to just 11% in rural Nepal.

Annual consumption pattern

Milk

The average annual per capita consumption of milk (purchased + home produced + received in kind) estimated from the NLSS survey statistics was about 27 l across Nepal (about 5 ml per day) with the consumption rate higher in urban areas (38 l) than in rural areas (26 l). The per capita milk + milk product consumption was only slightly higher at 29 l per year. Across the development regions, the per capita milk consumption was highest in the WDR (34 l) followed by the CDR (29 l).

The comparable figures reported in New ERA (1990) range from 49 to 68 l per person per year in urban areas; the value calculated on the assumption that all milk in Nepal is consumed in country is also about 48 l. In a more recent study by Nepal Rastra Bank (1999) for urban Nepal, the average annual per capita consumption of fresh and dairy milk was reported to be about 26 l and 11.4 l respectively, a total of 37 l. Annual per capita consumption of milk in developing countries is about 40 kg (approximately 40 l) (Staal and Jabbar 2000) [in western countries 60-160 kg, CDIC 2002, ed].

Three-quarters of the milk consumed in urban areas is purchased, whereas the rural milk demand is met primarily through home production.

Ghee

The estimated average annual per capita consumption of ghee (purchased + home produced + received in kind) is about 0.94 l, 1.0 l in urban areas and 0.93 l in rural areas. This is fairly close to the per capita consumption of 0.7 l reported by the Nepal Rastra Bank for urban Nepal. The per capita ghee consumption was highest in the FWDR (1.36 l) and lowest in the CDR. The bulk of the ghee consumed in rural areas is home produced while in urban areas the bulk is purchased. Per capita consumption of other milk products such as condensed milk, baby milk powder, and curd is low, even in urban Nepal.

Milk and milk product expenditure

The per capita annual value of purchased and home-produced milk (including that received in kind) was estimated to be NRs 604 in urban areas and NRs 362 in rural areas, with an average of NRs 380 in the country overall. The annual per capita value of

ghee was estimated to be NRs 119 in the country overall, and higher in urban areas (NRs 139) than in rural areas (NRs 117).

The total annual per capita value of all consumed milk and milk products was estimated to be NRs 514 overall, NRs 812 in urban Nepal and NRs 491 in rural Nepal.

Milk and milk product expenditure (value) represented 5% and 7% of total household expenditure in urban areas and rural areas respectively, with an average of 6% in the country overall, about 11% and 10% of the total annual food budget. The level of household milk consumption and the proportion of total household expenditure increased with increasing income.

The per capita milk expenditure increased with increasing income, with a wide gap in consumption levels between households belonging to the top and bottom expenditure classes. The mean per capita expenditure of the top 10% of households in urban areas (NRs 1,153) was almost 2.5 times that of the bottom 10% (NRs 477); in rural areas the difference between the top and bottom 10% of households was much smaller. Similarly the top 10% of households in urban areas accounted for about 60% of total expenditure on milk and milk products and the bottom 70% account for less than 5%. The disparity was less in rural areas: the bottom 40% of households and the top 10% each accounted for about 16% of the total expenditure on milk and milk products.

Estimated milk demand functions

Milk demand functions were estimated using the NLSS data. The price elasticity of milk is expected to be negative and numerically less than one because milk is a necessity and, according to the law of demand, the demand for necessities falls as their price increases. Likewise, income elasticity is expected to be positive, as is the case with all necessities (as income rises so does the amount purchased). Usually, income elasticity estimates from cross-sectional data are higher than estimates from time-series data, because cross-sectional data reflect that families have had time to make necessary adjustments over time with respect to changes in their incomes.

Milk demand is assumed to be a function of milk price, household income, and family size. Different functional forms can be used to estimate demand functions. Two types of functional forms (linear and double-log linear) were estimated. The annual purchase of milk (in litres) was regressed with the average milk price, household income, and household size. A set of dummy variables was included to capture the variation in milk consumption across regions (Terai, hills, mountains) and the source of supply (purchased compared with home-produced).

The results of the double log model were better than those of the linear regression model in all cases (rural, urban, Nepal total). As expected, the regression coefficients were negative for price elasticity and positive for income elasticity and were significant in all equations estimated (six in total, Table 5.5). The results indicate that over 40% of the variation in milk consumption can be explained by the variables included in the double-log model. The results also indicated that milk demand in the Terai is significantly lower than in the hill and mountain regions.

The sign and magnitude of the price elasticity confirmed that milk is a necessity. The estimated overall price elasticity of milk demand of -0.35 is comparable with the price elasticity parameters estimated by New ERA (1990) for Kathmandu (-0.33) and by the Agricultural Project Service Centre (APROSC) (-0.51) using time-series data.

The positive income elasticity also confirmed that milk is a necessity. The income elasticity was higher in urban areas (0.87) than in rural areas (0.78). The estimated values for income elasticity of milk demand for urban Nepal seem fairly close to the earlier estimates of the APROSC and New ERA studies. The widely used income elasticity parameter for milk demand at national level for the Agricultural Perspective Plan is 1.0.

Table 5.5: **Coefficient of ordinary milk demand function**

Item	New Era (1990)	APROSC (1986)	Present Study (2000)		
			Urban	Rural	Whole country
Price elasticity	-0.35*	-0.51	-0.21	-0.38	-0.35
Income elasticity	0.31**	0.56	0.87	0.78	0.79

Source: New Era (1990) and APROSC (1995)

* a 10% increase in price would lead to a 3.5% decrease in demand
** a 10% increase in household income would lead to a 3.1% increase in demand

Projected supply and demand of milk in Nepal

Estimates of projected milk supply and demand were made based on assumptions about growth rates of the population, incomes, and income elasticity of milk demand until 2015. Most of the demand for milk is in urban areas where approximately 15% of the population currently lives and where average income and population growth rate are higher than in rural areas.

Two different scenarios for growth rate of per capita milk demand were used, with annual per capita real GDP growth rates of 0.5% (Scenario 1) and 1% (Scenario 2) and the income elasticity coefficients shown in Table 5.5. The population growth rates in rural and urban areas were taken as 1.53% and 7.1% from official estimates.

The projected levels of milk demand in relation to supply were calculated over a 15-year period from 2000-2015. The results are shown in Tables 5.6 and 5.7 for the present level of consumption (Table 5.6) and a postulated higher annual per capita level of consumption of 40 l in rural areas and 50 l in urban areas (Table 5.7).

The current per capita consumption of milk in urban areas (38 l) is 1.46 times higher than in rural areas (26 l). The average income and population growth in urban areas is much higher than in rural areas. Under the real per capita income growth scenario 1, the projected demand for milk in urban areas is expected to rise to 1,221 million litres by 2015 from 115 million litres in 1999. In rural areas, the projected demand for milk would rise to about 1,076 million litres by 2015 from 638 million litres in 1999. Put another way, projected demand of milk in urban areas is expected to rise at an annual rate of about 16% compared to an annual rate of about 3% in rural areas (Table 5.6).

The results indicate that at present consumption levels projected milk production will be able to meet the milk demand for the next 12 years, and that from 2012 onwards the country will experience a net deficit in milk supply unless there is an additional 3% growth rate in production. If per capita consumption is assumed to be higher (Table 5.7) the country will experience an increasing net deficit over the whole period under both scenarios for milk production growth rates. Overall the estimates range from a surplus of 429 million l in 2015 in the best case scenario, to a deficit of 1,766 million litres in the worst case.

Table 5.6: **Projected supply and demand of milk based on present per capita consumption rates#**						
	1998/ 99	1999	2000	2005	2010	2015
Scenario 1: 0.5 % Real annual per capita GDP growth rate						
Total demand (million litres)						
Rural Nepal	614	638	663	797	943	1076
Urban Nepal	101	115	131	258	539	1221
Whole of Nepal	715	753	794	1055	1483	2297
Total milk supply (million litres)						
Milk production scenario A*	1073	1100	1140	1337	1579	1875
Milk production scenario B**	1073	1133	1197	1575	2072	2726
Supply-Demand Balance (million litres)						
Milk production scenario A*	357	347	347	282	96	-422
Milk production scenario B**	357	380	404	520	590	429
Scenario 2: 1% Real annual per capita GDP growth rate						
Total demand (million litres)						
Rural Nepal	614	641	669	825	1000	1169
Urban Nepal	101	116	132	267	570	1321
Whole of Nepal	715	757	801	1091	1570	2490
Total milk supply (million litres)						
Milk production scenario A*	1073	1100	1140	1337	1579	1875
Milk production scenario B**	1073	1133	1197	1575	2072	2726
Supply-demand balance (million litres)						
Milk production scenario A*	357	343	339	245	8	-615
Milk production scenario B**	357	377	396	484	502	236

\# Annual per capita consumption of 26 l in rural areas, 38 l in urban areas.
* Milking population (cows and buffalo) projected based on present population growth rate
** 3% increase over and above the present population growth rate of milking animals

CONSTRAINTS, OPPORTUNITIES, AND RESEARCH AND DEVELOPMENT ISSUES IN DAIRY PRODUCTION AND MARKETING

General problems and constraints

In Nepal, milk is produced by small farmers in rural areas, whereas much is consumed in the major urban areas, in particular Kathmandu Valley. In the absence of an assured market, the producers do not have an incentive to invest in good breeding stock, feeds, or veterinary medicines and services. Without these inputs, it is difficult to raise productivity and profits. Similarly, because of the low purchasing power of the consumers, the effective demand for milk locally is also low, necessitating transportation to major urban areas for marketing. At the same time the price the DDC pays to farmers does not match growing feed prices.

Poor feed base

The lack of availability of good quality forage is a major problem among smallholder farmers. This has made the dairy industry become more concentrate-based than forage-based. Commercially produced concentrates are expensive and their use increases the cost of milk production and reduces profits. In many parts of the study areas, finding adequate amounts of tree fodder is becoming a problem.

Table 5.7: **Projected supply and demand of milk based on higher per-capita consumption rates#**						
	1998/ 99	**1999**	**2000**	**2005**	**2010**	**2015**
Scenario 1: 0.5% Real annual per capita GDP growth rate						
Total demand (million litres)						
Rural Nepal	945	982	1020	1226	1451	1655
Urban Nepal	141	160	183	360	752	1703
Whole of Nepal	1086	1142	1202	1586	2203	3358
Total milk supply (million litres)						
Milk production scenario A*	1073	1100	1140	1337	1579	1875
Milk production scenario B**	1073	1133	1197	1575	2072	2726
Supply-demand balance (million litres)						
Milk production scenario A*	-13	-42	-62	-249	-625	-1483
Milk production scenario B**	-13	-9	-5	-11	-131	-632
Scenario 2: 1% Real annual per capita GDP growth rate						
Total demand (million litres)						
Rural Nepal	945	987	1030	1269	1539	1799
Urban Nepal	141	161	184	372	795	1843
Whole of Nepal	1086	1148	1214	1640	2334	3641
Total milk supply (million litres)						
Milk production scenario A*	1073	1100	1140	1337	1579	1875
Milk production scenario B**	1073	1133	1197	1575	2072	2726
Supply-demand balance (million litres)						
Milk production scenario A*	-13	-48	-74	-304	-756	-1766
Milk production scenario B**	-13	-14	-17	-65	-262	-915

\# Annual per capita consumption of 40 l in rural areas and 50 l in urban areas.
* Milking population (cows and buffalo) projected based on present population growth rate
** 3% increase over and above the present population growth rate of milking animals

Encouraging the private sector

The price paid by the government is not determined by market mechanisms and this creates difficulties for private entrepreneurs to compete effectively with the DDC. Although the private sector is not bound to follow the DDC's pricing policy, its prices act as a reference point for buyers. Consequently, private dairies are seen to operate and expand only in those market segments not reached by the DDC.

It would be desirable to devise ways for the private sector to use the under-used chilling centres of the DDC. This could be done by leasing out the chilling centre facilities to the private sector, by custom chilling milk collected by the private sector but guaranteed under contractual arrangements, or by handing over the operation and management of the facilities to private entrepreneurs or groups. The involvement of the private sector should also be encouraged for new chilling centres.

Milk holidays

The term 'milk holiday' was coined in 1991 when the DDC could not buy all the milk offered, and refers to days in the week when public or private dairy organisations do not buy milk from their regular suppliers (dairy farmers) (Upadhaya et al. 2000). The reasons may be limited consumer demand for the processed milk and milk products or

lack of processing or storage capacity of the dairy factory. The 'milk holiday' is announced in advance and can last for a day, several days, or even weeks.

Milk holidays are largely a phenomenon of the flush season (September to March) during which the supply of milk is four times greater than in the lean season (Upadhaya et al. 2000). The large seasonal difference in milk production in the country is attributed to short supply of green fodder and to buffalo, which calve during August to September; the calving season for cattle is more uniformly spread throughout the year. Despite higher efficiency and uniformity in milk production throughout the year from cattle, farmers prefer buffalo due to their greater immunity to disease, greater capacity to absorb roughage, low risk, and low investment, including their salvage value. Existing milk pricing systems also give higher value to buffalo milk (on a milk-fat basis) than to cow milk.

The import of cheap skimmed milk powder is cited as another key reason for milk holidays. The establishment of the Biratnagar skimmed powder plant in 1994 helped reduce the severity of the milk holiday for two years after which there was surplus production. Skimmed milk powder is entering the country at a price of less than NRs 100/kg, far less than even the production cost in Nepal (NRs 169/kg) (Upadhaya et al. 2000). Therefore, the plant in Biratnagar was unable to sell its products to the private sector, who are believed to have made extensive use of the imported product. The small scale of operation of private dairies in the country has been unable to alleviate the milk holiday problem.

One possible option for the surplus milk produced during the flush season in Nepal is to export it to neighbouring countries, if Nepal can provide products at cheaper prices. Since the flush production season in Nepal overlaps with that of India, this has not materialised. The only possibility for export of milk from Nepal to India is through milk producer associations, provided the public dairy milk procurement price is not set artificially high. The private dairies can also purchase such milk but it is extremely difficult for them to set a price independently of the DDC (Upadhaya et al. 2000).

Overall, milk holidays are becoming an annual phenomenon in Nepal. The available evidence indicates that this is mainly a result of the inability of the formal dairy organisations to sell milk and milk products (Upadhaya et al. 2000). Product diversification could be instrumental in increasing the demand for milk products if quality standards are maintained. A strong marketing drive together with quality improvement could increase market uptake.

Milk quality

The inability to maintain acceptable quality standards for milk has been an ongoing problem resulting in the rejection of inferior quality milk at collection centres and spoilage during transportation and processing. A number of factors are known to have caused this problem: a high bacterial count at farms due to improper washing of hand and pots, adulteration, and time taken for transportation between farms and collection centres (a maximum of 3.5 h is recommended), and between collection and processing (a maximum of 24 h is recommended).

Pricing

The DDC has had conflicting objectives of providing attractive prices to rural milk producers and supplying milk to urban consumers at the lowest possible price. The

availability of significant quantities of donated skimmed milk powder has encouraged the government to keep the consumer price from rising, at the expense of producer prices (ADB and APROSC 1993). While the donors have a clear agreement with the government regarding not using donated commodities for consumer subsidy, this has been largely circumvented in the past for the benefit of a consumer milk price subsidy in urban areas. Currently milk prices are fixed on a regular basis and reflect differences in transportation costs.

While the 10-year Dairy Development Plan (1990-2000) proposes that the DDC set its own price for milk based on commercial considerations, this has not yet materialised. Although the DDC has been responsible for formulating and executing pricing policy, in practice it has to obtain government approval before implementing any price change.

POLICY ISSUES AND IMPLICATIONS FOR DAIRY FARMING

There has been no clear long-term policy or concerted effort on the part of the government to perceive the dairy sub-sector as potentially rich in its comparative advantage to transform the rural economy. Existing policies and programmes are weak in addressing the number of problems faced by smallholder dairy farmers in different ecological settings.

Given the inability of the formal dairy organisation to handle the surplus milk during the flush season, the milk holiday is becoming an annual phenomenon for a large majority of smallholder dairy farmers and will continue to be so in future unless timely measures are taken to formulate and implement both short- and long-term plans and policies. The problem is compounded by weaknesses in existing national dairy policy that keep the producer price of milk constant across the seasons while at the same time allowing the import of cheap skimmed milk powder. Under the existing DDC-dominated price structure, there is little scope for adjusting market price according to seasonal fluctuations in price and consumption. Policy failure arises from the fact that while farmers are facing regular milk holidays consumers have not found the milk available in the market whenever they want to buy. This paradox suggests that there is a need for a substantial shift in policy and priority towards diversification of dairy products, through a strong marketing strategy together with quality improvement.

The DDC has been operating at a loss. Restructuring the operation and functions of the DDC with a view to making it a self-sustaining institution will have far-reaching implications for sustained improvement in the dairy sector. Success will also depend strongly on how well the government can mobilise the National Dairy Development Board (NDDB) to provide strategic direction to HMGN for planning, implementation, monitoring, and evaluation in the area of dairy development, thereby increasing the participation of the private sector and smallholders.

Dairy development should be an integral part of mountain community development. The national interest has always been guided by political interest in terms of where DDC coverage is increased, with little or no attention paid to the development of a minimum complementary infrastructure such as road and other support and input services that are important for sustained dairy development.

Currently, there is no established mechanism for monitoring and evaluating the milk producer cooperatives operating in different parts of the country. Such a system would have important implications for restructuring towards their sustainability.

In the past, most of the animal breeding development programmes have been supply driven with no attention being paid to the farmer's requirements from dairy development. Because the present area of rangeland is inadequate to meet the feed demand of the increasing livestock population, sustained improvement in dairy development will require a greater use of high-quality forage and purchased concentrates along with improved grassland. More emphasis on the farming of buffalo and crossbred cattle is also required.

The supply-and-demand projections based on the current state of technology and infrastructure have shown that the country is likely to experience a net deficit in milk supply in the future. The implication of a deficit in milk supply over the projected period is clear.

On the supply side, there is a need to increase the participation of a large number of smallholder dairy farmers in the formal market. To achieve this, restrictive policies and regulations must be relaxed. Also, measures need to be taken to reduce high transaction costs due to poor infrastructure and information systems and a poorly developed market for inputs and outputs. On the demand side, diversification of dairy products with emphasis on quality and a strong marketing drive will be important, along with proper analysis of consumer demand for dairy products.

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