Dairy Production, Quality Control and Marketing System in SAARC Countries

SAARC Agriculture Centre
Dairy Production, Quality Control and Marketing System in SAARC Countries
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Foreword

SAARC Agriculture Centre (SAC) has initiated a program on “Dairy Production, Quality Control and Marketing System in SAARC Countries” during 2010 and requested the respective member states to nominate focal point expert on the above subject to prepare the country status report. Centre received six country status reports prepared by focal point experts from six member states namely, Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka. Latter on these country reports were discussed in details in a consultation meeting organized by the Centre in collaboration with National Dairy Research Institute (NDRI), Karnal, Haryana, India during 25-26 May 2011. Main purpose of this program is to review the existing dairy production system in the SAARC countries; compare the dairy diversity among the member countries; identify the strength and weakness of the present scenario in the member states and recommend measures for improving the existing production system in individual member countries to address the need of 21st century.

It is well known fact that SAARC Member states have large population of cattle and buffalo, but in most of the countries the dairy production is far below their national requirement mainly due to low productivity. The quality Control of dairy products, marketing system and strengthening of value chain development is very important for the SAARC countries. Sharing of knowledge, experience and recommendations on dairy production, quality control and marketing system in SAARC countries would help the planners, policy makers, extension workers and farmers to enhance quantity as well as quality dairy production in the region.

The dairy sector in the South Asian countries of Buhtan, Bangladesh, India, Nepal, Pakistan and Sri Lanka is in general characterised by small-scale, widely dispersed and unorganised milch animal holders; low productivity; lack of assured year-round remunerative producer price for milk; inadequate basic infrastructure for provision of production inputs and services, and for procurement, transportation, processing and marketing of milk; and lack of professional management. Other important characteristics of the dairy sector in these countries are the predominance of mixed crop–livestock farms and the fact that most of the milch animals are fed on crop by-products and residues, which have a very low production cost. In addition, dairy development policies and programmes followed in these countries, including those relating to foreign trade, are not congenial to promoting sustainable and equitable dairy development.

Low productivity of milch animals is a serious constraint to dairy development in the region. This is due mostly to low genetic potential of the milch animals, inadequate and inappropriate feeding and animal health care. The productivity of dairy animals in the region could be increased substantially through crossbreeding of the low yielding nondescript cows with high yielding selected indigenous purebreds or suitable exotic breeds in a phased manner and by better feeding, disease control and management. The cattle breeding policy should also provide for the production of good quality bullocks to meet the draft power requirement of agriculture. Upgrading of nondescript buffalo through selective breeding with high yielding purebreds should be given a high priority in all areas where buffalo are well
adapted to the agro climatic conditions. While fixing procurement price, producers interest should receive the utmost attention. The producer price should at least cover the long-run average cost of milk production and provide a reasonable mark-up.

On the whole, the smallholder dairy sector has high potential to be a dependable source of livelihood for the vast majority of rural poor in the South Asian countries. The AMUL model of small-scale dairy production and marketing, as evolved and refined over the last 50 years in India, offers an appropriate strategy for promoting sustainable, equitable and gender-sensitive smallholder dairy development in not only South Asian countries but also in all other developing countries of the world. The model needs to be replicated in these countries, with adaptations being made to suit the peculiar conditions of each specific country.

The new world trade regime ushered in by the World Trade Organization (WTO) poses several challenges and opens up many opportunities for smallholder milk producers in South Asian countries. There is need for these countries to enhance their competitive economic advantage in dairy products in terms of both quality and cost. Furthermore, it is high time that the South Asian governments formulated and announced comprehensive dairy development policies for each of their countries keeping in mind to harmonise it as far possible within the region. These should form an integral part of their national development policies and due consideration should be given to their direct and indirect effects on other sub-sectors of the economy and vice versa.

I strongly believe that if recommendations emerged out of the consultation meeting are adopted by the member states, there are enormous opportunities to increase quantity as well as quality dairy production in the region and to achieve the target, it is imperative to concentrate on increasing productivity of cows rather than increasing their numbers. I think we can deserve and exchange our genetic resource, technology for better intervention.

Dr. Abul Kalam Azad
Director
SAARC Agriculture Centre
Executive Summary

Between one third and half of the world’s poor population live in South Asia and many of them rely on dairy farming for a part of their livelihood. Even though South Asia is one of the world’s major milk producing regions - with India having become the world leader in milk production in 1998 - milk production remains predominantly a smallholder business. In this study we tried to give a comparative overview of dairy industry of six South Asian countries (Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka) with respect to dairy production, quality control and marketing system.

This publication presents an overview of the structure and performance of the dairy sector in six selected South Asian countries, namely, Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. SAARC Agriculture Centre (SAC) has initiated a program on “Dairy Production, Quality Control and Marketing System in SAARC Countries” during 2010 and requested the respective member states to nominate focal point expert on the above subject to prepare the country status report. Centre received six country status reports prepared by focal point experts from six member states namely, Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka. Latter on these country reports were discussed in details in a consultation meeting organized by the Centre in collaboration with National Dairy Research Institute (NDRI), Karnal, Haryana, India during 25-26 May 2011. Main purpose of this program is to review the existing dairy production system in the SAARC countries; compare the dairy diversity among the member countries; identify the strength and weakness of the present scenario in the member states and recommend measures for improving the existing production system in individual member countries to address the need of 21st century. These country status reports are being summarised here, whereas recommendations coming out of the consultation meeting are summarised in a separate chapter.

Bangladesh

Dairying is an important economic activity in Bangladesh that provides supplementary income, employment and nutrition to about 3.6 million households. Unlike fisheries, dairying is labour intensive. A farm with two lactating cows generates 4,080 hours of labour opportunities every year.

Even though per capita milk consumption is low in Bangladesh, domestic production is still insufficient to meet existing demand. In the formal market, 87% milk is imported. The sector’s growth rate remains far behind that of the neighbouring countries (2.05% against 4.1% in India and 4.9% in Pakistan). The reasons for such modest growth rate are lack of good policy, insufficient data on the sector to formulate good policy, lack of political commitment and less attention and insufficient budget allocation (only 0.3% of national budget) leading to poor attraction of private investments to the sector.

About 7% of the total milk produced goes to the formal market. Bangladesh Milk Producers' Cooperative Union Ltd. (BMPCUL) has the largest share comprising 49%. Aarong and PRAN have the second (25%) and third share (11%), respectively. Pasteurised liquid milk, powder milk, UHT milk, ice cream, rasmalai, butter and ghee are the main milk and milk products marketed by the formal sector in Bangladesh.
Coordination among actors in the value chain (farmers, traders, processors and service providers) is very weak leading the chain very long with a significant degree of mistrust among participants. This increases cost and reduces competitiveness. In Bangladesh, dairies sold Pasteurised packet milk at US$0.44/litre against US$0.29–0.31/litre in India in 2006. Primary producers in Bangladesh only get about 50% of the consumers' price; in contrast, Indian producers get paid with 74% of the consumers' price. Due to ensured market in Sirajganj and Pabna by the BMPCUL, the milk production cost was much lower (US$18.9/100 litres) than that of the rest of the country (US$ 31.5 - 35.1/100 litres). The cost of milk production in Bangladesh is higher than that of India and Pakistan (US$15/100 litres).

Informal sectors handle the largest share of the milk (78%) produced in Bangladesh and market traditional products. Other than curds, the popular sweetmeats are Rasogolla, Chamchams, Rossomalai, Sandesh, Kalagam.

Bangladesh dairy industry depends on crop residues (30.66 million MT per year) and by-products and cut-and-carry green fodder (2.9 million MT per year). Crop residues commonly available are rice straws, wheat straws, maize stovers, sugar cane tops and other crop thrash. The by-products are wheat bran, rice polish, pulse husks and oil cakes. About 2.9 million MT by-products are produced in the country but only 0.97 million ton is available to feed cattle against a requirement of 2.8 million MT to produce 5.6 million MT milk. The rest of the by-product is used in the poultry (50%) and fisheries (20%).

The number of AI done in Bangladesh was 3.21 million in 2009, Department of Livestock Services (DLS) did 2.5 million, BRAC did 713 thousand and BMPCUL did 75 thousand. About 40% of the cattle breeding are covered by AI.

Two major types of cattle dominate the Bangladesh dairy industry. Crossbred cattle constitute about 20% and are mainly produced by breeding local non-descript zebu cows and heifers predominantly with Holstein Friesian and Sahiwal bulls. The most potential local cattle although not described as breed are Red Chittagong Cattle (RCC), Pabna Milking Cattle (PMC) and North Bengal Gray (NBG).

The buffaloes of Bangladesh are mostly river type although swamp type exists. Indigenous buffaloes are low yielding, but are stout draft animals. These animals can be the foundation for a high yielding milk buffaloes through breeding up with dairy breeds and have an increased milk and meat production of about 0.25 million MT and 40,000 MT per year respectively.

There is no incentive for quality milk supply because individual milk testing is not carried out at the procurement and farmers are paid a flat rate. Adulteration is common leading to a low fat and or SNF (solid not fat) percentage in milk. Measuring sets are not certified by the statutory authority and sets for measuring milk below 500 ml are not available, though supplies below 500 ml are accepted. Quality control of fresh milk and finished products are far behind consumers’ expectations in terms of food safety and sanitation. Consequently consumers are getting inclined to imported milk and milk products. Quality control measures include only taking a lactometer reading, which reflects the osmolarity and can easily be manipulated. Farmers neither get a price incentive for milk with
low bacterial load nor get any benefit of bringing milk quickly after milking to the chilling station, the latter practice would reduce bacterial load in milk.

Following recommendations are made to address the constraints and boost dairy development in Bangladesh.

♦ Government of Bangladesh should institutionalise the recently formed Bangladesh Dairy Development Council (BDDC).

♦ Government of Bangladesh should strengthen the BSTI capacity by establishing a standard laboratory and manning it properly to watch the quality of market milk.

♦ The Department of Livestock Services (DLS) veterinary services should be made regulatory. The services should be directed towards ensuring food safety and sanitation and phytosanitary measures as per SPS Agreements.

♦ The DLS shall establish an epidemiological unit with its coverage up to all the Upazilla and port of entries to the country. It should be equipped with a disease diagnosis laboratory certified by OIE.

♦ The DLS should establish and manage a laboratory of international standards to quality control of feeds, drugs, vaccines, breeding materials and other biologicals to be used as inputs to the dairy industry, in the line OIE.

♦ The DLS should phase out leaving its production veterinary services, vaccine production and artificial insemination to the private sectors.

♦ The annual budget allocation for the development of livestock should be at least 50% of the contribution it make to the national GDP.

♦ Milk processing industries should as soon as possible introduce milk fat and SNF percent testing of individual producers’ milk at the society level and reset its pricing on the basis of fat and SNF percentage.

♦ The processing industries should finance a research project to test the fat and SNF percent of milk collected directly from the cow’s udder covering good number of all possible breeds available all over the country. This will help dairy processors setting realistic SNF percentage at the society level.

♦ BMPCUL Management Board should concentrate mostly on the market expansion and leave technical issues like employment and procurement on the professional executives.

♦ The government share should be gradually tapered off and the BMPCUL should be given the liberty of running independently.

♦ BMPCUL should gradually leave the chilling tank ownership as much as possible to the dairy cooperative societies. This will help cooling milk promptly and thereby ensure better quality.

♦ NGOs and private milk processors should help organise smallholder producers in the form of registered societies or association and immediately give up the current practice of employing milk collection agents.

♦ NGOs and private milk processors should be in partner with an on-farm veterinary and AI service providers to link them with the producers’ societies.

♦ NGOs and private milk processors should encourage producers’ societies own the farm cooling tank. This will not only reduce their (industry) capital investment but also strengthen producers’ participation. The producers down the road will receive a larger portion of the consumers’ price.
Bhutan

Livestock rearing forms an essential component of the Bhutanese farming system with an estimated 90% of the population rearing livestock. The production systems in the country is largely determined by the variation in agro-ecological conditions with migratory herding of yaks in the high altitude regions, sedentary rearing of exotic breeds such as Jersey and Brown Swiss to systems where cattle are reared mainly for manure and draught power.

In keeping with the policies of the government for poverty reduction, the livestock sector albeit with setbacks and hindrances is identified as having an important role to play to achieve the goal within the 10th FYP (2008 – 2013). Accordingly the National Policy for Dairy Development addresses the constraints faced and identifies the major interventions to be made. The Jersey and Brown Swiss will be maintained as the principle dairy breeds with 50% crosses in remote and small holder production areas and crosses of higher blood level in peri-urban areas based on the managerial capacity of the farmers. Dairy potential areas have been identified along with the encouragement for formation of farmers groups. Furthermore, intensification of breeding activities through the establishment of AI centres, mobile AI, estrus synchronization and Contract Bull Production Programme (CBPP) is being carried out. Cattle feed and fodder resources are being strengthened through integration of pasture with horticulture and supply of free pasture seeds and fodder saplings to farmers as well as the promotion of winter fodder.

The native breed of the country known as Nublang has a relatively low yield with 393 L/lactation while cross bred cattle have a higher yield with 658 L/lactation for Brown Swiss crosses and 852 L/lactation for jersey cross. The cross bred animals produces a higher yield of 2300 L/lactation for Brown Swiss and 2440 L/lactation for jersey in government farms. The jersey cattle contribute to 42% of the total milk production from the 15% of the cattle population while the local cattle contribute to 32% of the milk production from the 50% of the cattle population. Cattle population trends show that the numbers of exotic breeds are on the increase but a reduction in the size of local herds is not evident. This is due to religious sentiment that discourages the slaughter of animals.

The milk production system in the country is classified as traditional, transitional and progressive. Farmers in the traditional system still practice migration of herds to follow availability of fodder, while the transitional farmers are shifting from the migratory system to a sedentary system through cross breeding with exotic breeds and construction of permanent cow sheds. The progressive farmers are either the progressive Brown Swiss with majority of the herd comprised of Brown Swiss cattle or the progressive jersey with their herd comprised of jersey cattle. These farmers practice stall feeding and have access to improved pasture. Farmers are also bought together to form dairy farmers groups as a means of increased income and milk production. Currently 31 organized dairy farmers groups exist. The dairy groups are supported through the construction of MCCs, MPUs, provision of training and supply of dairy equipments.

The NCAH functions as the apex body for all matters related to animal health and is supported by the Dzongkhag Veterinary Hospitals, Regional Livestock Development Centres, Satellite laboratories, Regional Veterinary Laboratories and a Vaccine production centre. Common infectious diseases in the country such as FMD, HS, BQ and respiratory diseases are controlled through mass vaccination. Parasite infestation is also a major
economic disease for milk production and periodic deworming is advocated along with regular fecal sampling.

The cattle breed improvement programme in the country is coordinated by the NLBP supported by the Dzongkhag Livestock Offices, Central farms and Units and the RLDC. Breed improvement is carried out by AI where feasible or through the supply of breeding bulls to areas where AI is not feasible.

The use of feed resources varies according to the agro-ecological conditions and the most common resources available are forest grazing, cultivated fodder and crop residues. Additionally improved pastures, fodder trees, fodder crops and concentrate feed mixtures are also important feed resources.

The majority of dairy products are imported from India and a smaller quantity overseas. The BDAL with a capacity of 20,000 LPD produces UHT toned and double toned milk in tetra brik aseptic packages and another dairy processing plant with a production capacity of 6600 LPH is soon to be established by a private company. The government also supports dairy processing plant with a mini dairy plant established for the production of pasteurized whole milk to cater to the milk demand in Thimphu. Even smaller cheese processing units, producing Gouda type cheese are established.

The milk production of the country is largely converted into butter and cheese. High altitude regions produce a hard variety of cheese known as Chugo and fermented cheese known as Phelu and Zoethey that are allowed to naturally ferment. Milk is also marketed as fresh milk when sold in urban centres and areas with easy access to market.

The supply of milk is subject to basic quality tests for milk supplied by dairy groups and the Dzongkhag Livestock Offices are also involved in imparting training on hygienic milk production. Additionally BAFRA monitors the quality of local and imported products.

Dairy products produced by farmers and dairy groups are marketed through three channels; products are delivered directly to consumers by the producers, products are sold to middlemen or traders who then markets it to consumers and producers deliver products to MCCs or MPUs, then to retailers and finally to consumers. The first system is followed by farmers following the traditional production system, while the other two are applicable to established dairy groups.

The enhancement of dairy production in Bhutan requires

- the intensification of the cross breeding program, as the jersey cross bred population is the main milk producer accounting for 42% of the milk production,
- the training of educated farmers/ school drop-outs interested take up the business in the community to provide uninterrupted AI services in the extension
- the initiation of crossbred heifer production scheme for distribution to farmers in dairy potential areas
- the strengthening of contract bull production programme and forming Breeders’ Association with the contract breeders at different level who shall share with the govt. the responsibilities of breed improvement programme
• instituting rigorous selection programme among nublang, yak and buffalo herds to supplement milk production as well as provide draught power to sustain agriculture
• identification of dairy production potential belts in every Dzongkhags, in which cross breeding will gear towards production of improved breeds only
• encourage buffalo production in southern belt
• improving fodder availability through development of feed resources that require less land and exploration of possibilities for integrating growing of fodder within the existing farming systems, rather than emphasizing pasture development. For serious dairy farmers willing to allocate land for growing fodder, the development of a feed garden incorporating grass, legumes, and fodder trees presents great potential for increasing fodder production.
• need to conduct nationwide market survey on the size, preference, seasonality of consumption etc to help identifying the most potential products to be produced. Furthermore, a comprehensive planned marketing strategy needs to be developed addressing issues such as production of products based on market demand and maintaining a consistent supply of products.

India

Dairying has been one of the livelihood options for many rural poor, especially for landless, marginal and small farmers in countries of South Asian Association for Regional Cooperation (SAARC). In India, presently over 120 million rural families are engaged in dairying. Dairying is an effective tool for rural development, employment and sustained income and it acts as an insurance against several odds. Dairy development in SAARC countries, especially in India is phenomenal mainly owing to the dedicated efforts of National Dairy Development Board (NDDB), Indian Council of Agricultural Research (ICAR) and milk federations. India is the largest milk producer in the world and is growing at 4% per annum. Among the agricultural product, milk is the major contributor to national GDP. Despite of the best efforts to improve dairy production in countries like India, the per capita availability of milk is lower than 246 gram per day against the world’s average of 285 grams per day. The average production of Indian milch animals is only about 987 kg per lactation as against the world’s average of 2308 kg. This low productivity is mainly due to low genetic potential, shortage of quality feed and fodder and lower health status of animals. The per capita milk production and consumption in India are 82.4 and 81.2 kg / annum respectively.

The production system in India is almost similar in SAARC region, with crop residues forming the major feed resource base. Buffalo has been the mainstay in contributing significantly towards total milk production, particularly in India and Pakistan and in recent years the total share of milk production has significantly increased.

The demand of milk in India is steadily increasing, particularly among the urban population, low and middle income households. It is essential to make dairying remunerative occupation by reducing the cost of production and making selling price attractive. The major input that adds to the cost of milk production (65-70%) is the feed and in the recent times the feed costs have risen 2-3 times, and hence it becomes necessary to address this issue with greater emphasis.
India has huge livestock population with 185 million cattle, 98 million buffaloes, 124 million goats, 61 million sheep. Out of the total livestock in the country, around 38.2 per cent are cattle, 20.2 per cent are buffaloes, 12.7 per cent are sheep and 25.6 per cent are goats. All other animals are 3.3 per cent of the total livestock population. The composition of livestock population in broad groups like bovine (cattle and buffaloes), ovine (sheep and goats), however, has changed over the last five decades. Cattle population that had increasing until 1992 has started declining and between 1992 and 2003, it declined by 9 per cent. The decline in the cattle population is confined to indigenous stock that comprised 87 per cent of the total cattle population in 2003. The number of indigenous cattle declined by 15 per cent, while that of the crossbred increased by 62 per cent. Within the indigenous stock, decline was drastic for males (22%). The main reasons for decline in indigenous-cattle population are: increasing substitution of draught animals with mechanical power and low milk yield. The buffalo population has increased from 43 million in 1951 to 98 million in 2003. There has been a small decrease in total bovines in the country by 1.9 per cent between 1992 and 2003. Total ovine population has increased from 86 million in 1951 to 185 million in 2003. The number of goats increased from 47 million in 1951 to 124 million in 2003. The population of sheep increased from 39 million in 1951 to 61 million in 2003.

In India, some 70% of the cows and 60% of the buffalo are nondescript and have very low productivity. To convert this huge population of low producing milch animals into high yielding milch animals, India needs a sound breeding policy. The breeding policy needs to consist of: (i) selective breeding of Indian dairy cattle for milk production; (ii) upgrading of the nondescript Indian cattle through breeding with selected Indian donors; (iii) selective breeding of the major buffalo breeds for milk production; and (iv) upgrading of nondescript and minor breeds of buffalo through breeding with the Murrah buffalo breed. Crossbreeding, as a tool to improve the quality of milch animals, is a time-tested technique in the country. However, organised breeding operations, mainly artificial insemination services under the government departments, reach only about 20% of the breeding animals among cattle and <5% of the buffalo. Proof of the success of crossbreeding as a strategy is the growing number of crossbred animals; numbers are increasing at the phenomenal rate of almost 10% per annum and 80% of the crossbred milch animals are held by the landless, marginal and smallholder producers.

According to the National Sample Survey Organisation (NSSO) in India, the average monthly private consumption expenditure of households on milk and milk products (1993–94) was 9.5% of total expenditure for households in rural areas and 9.8% in urban areas, and it had been rising steadily over the years (NSSO 1998). It was second in magnitude only to the expenditure incurred on cereals. Furthermore, the demand forecasts for milk at a GDP growth rate of 4% for 2010 and 2020 have been worked out to be 95.6 and 126 million tonnes, respectively, while at a GDP growth rate of 7% for the same period the forecasts are 122 and 182.8 million tonnes, respectively. As the expenditure elasticity of demand for milk and milk products for the lower income class in India is well over two, the rising per capita incomes for that class will sustain the current increasing trend in their demand.

Some 45% of milk produced in India is consumed as liquid milk. The bulk of it is traded through traditional channels, comprising several tiers of private milk vendors, contractors and mini dairies. Only about 16 million litres of milk are processed and packaged. Out of this, 13.5 million litres is processed in the co-operative sector and 2.5 million litres by over
300 million private sector operators. A large percentage of the milk handled by the private sector is substandard and often unhygienic, as quality and hygiene standards are seldom enforced in the private sector.

As regards exports of dairy products, India has made its presence felt in world markets. It regularly exports milk products and long-life milk to countries in West Asia, South-East Asia, South Asia and North America. The Gujarat Co-operative Milk Marketing Federation (GCMMF), which is the biggest food sector enterprise in India, is the major exporter of dairy products. In 1999, it exported about 1.7 thousand tonnes of milk powder, 400 million tonnes of ghee, 100 million tonnes of table butter, 25 million tonnes of cheese and about 100 million tonnes of other products valued at 466 million Indian rupees. This constituted almost 80% of all exports in that year. During the same year, imports of dairy products into the country amounted to some 17,252 million tonnes of skimmed milk powder and 5224 t of butter oil.

Scientific developments in the field of genetically engineering are the harbinger of value addition to the dairy products and bring about radical industrial changes of the future. This technology is in its infancy but holds promise of improving the quality and quantity of food production that will reap rich benefits as knowledge accumulates and new discoveries support practical applications. Biotechnological developments have led to the production of innovative range of dairy foods, where cultured cells could be incorporated through suitably prepared microbial cell concentrates, thus bypassing the fermentation process entirely. Cheese as a potential carrier for probiotical cultures and as a natural source of biological peptides, is a fascinating area for technological development. Current R&D is directed to develop advanced GM foods with antimicrobial and protective factors of milk such as lysozyme, lactoperoxidase, lactoferrin and vitamin binding proteins. Biotechnological developments in the bio preservation of these valuable foods are proving to be a boon in their bio-safety. Scope is also indicated for the application of biotechnology for the development of the range of dairy foods, which would meet the special health and nutritional requirements of athletes and during geriatric period.

A comprehensive approach in addressing the issues concerning dairy production and processing in terms of livestock improvement, feed management veterinary health care, quality of produce, marketing infrastructure, forward and backward linkages, involving Public-Private-Partnership is essential to take the dairy sector to higher pedestal amongst the SAARC countries.

For promoting further development, a pragmatic policy is essential which would facilitate interaction between R&D Institutions as well as development of requisite human resource to deal with the challenges of future.

**Nepal**

Nepal is predominantly an agricultural country. More than 65% of populations are involved in agriculture sector, which provides about 38% to the Gross Domestic Products (GDP) of the country. Livestock is an integral and important component of mixed farming system in Nepal. The sector shares about one third of the Agricultural Gross Domestic Products (AGDP) of the country. The dairy sub sector is the most important component of livestock sector and contributes almost two third (63%) of the livestock GDP shares. The
sector not only contributes in national GDP, but also ensures flow of money from urban to rural sectors. Above 100,000 dairy farmers deliver milk, with a large number engaged in the milk processing industry in both rural and urban areas. Similarly, thousands of people are engaged in production and marketing of indigenous dairy products like Ghee, Hard Cheese and Khoa. Cattle and buffaloes are the major dairy species in the country and yak (nak) to some extent in the high mountain region. Almost three fourth and one half of the households in Nepal keep cattle and buffaloes respectively. Despite larger cattle population, the buffalo contributes around 71% of the annual milk production and only rest 29% by cattle. This is mainly due to extremely low productivity of non-descript indigenous cattle as compared to the productivity of buffaloes. Buffaloes are also being kept for meat whereas the contribution of yak and their crossbred in the high Himalayan region as pack animals is also substantial. The yak cheese is a unique product, which has great potential for export. The dairy sector is gradually emerging as commercial/semi commercial enterprise particularly in the peri urban areas of the country.

The dairy is the gradual emerging sector having great potential in employment and income generation with significant contribution in the national economy. The demand for fluid milk is increasing tremendously due to establishment of private dairy industries in the country, increasing urban population and increasing consumption. Further expansion of sector in the days to come can be expected due to current gap in supply and demand situation. The established dairy industries are presently running at less than half of their capacity. The per capita availability and consumption of milk is less (51 L) than the required amount. In such scenario, the market force has attracted the population towards dairy animal farming and milk processing industries establishment. The young generations seeking employment abroad are also gradually attracted towards dairy sector. To meet increasing demand for fluid milk and milk products and to substitute import of milk products, the sector has been prioritised from the government also. There also exist the potential for export, if become competitive in production cost and address the quality issues in future.

However, there exist some challenges which need to be overcome by consolidated and concrete efforts from all concerned stakeholders for flourishing of the sector in future.

Some of the major challenges and issues for dairy development in the country are

- Poor genetic potential of indigenous dairy animals
- Higher cost of production
- Scattered production- higher collection cost
- Lack of appropriate insurance policies
- Diseases
- Feed quality and cost
- Hygienic milk production related with trade and human health (SPS measures)
- Infertility of crossbred animals
- Policy regarding animals with diseases (TB, Brucellosis etc.) and infertility problem
- Price control system
- Low investment from public sector
- Environmental issues – methane gas emission from dairy animals

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In the present context of global climate change, livestock production being blamed for green house gas emission and country having already high number of cattle and buffaloes, it is imperative that increasing the productivity rather than the number of animals is absolute necessary. The policy makers in the country have to rethink regarding the current development of import of Haryana cattle from India.

The Dairy Policy has been recently endorsed by the government with the vision of:
- Increasing employment and minimize poverty
- Developing qualitative and competitive dairy business among public, private and co-operative dairy sector
- Availing sufficient amount of high quality milk and milk products for consumers
- Developing National economy in multiple way

Pakistan

On the whole, the milk production systems in Pakistan are Low Input-Low Output system. Five production systems are generally recognized. Rural smallholders subsistence milk production system is the dominant system. It involves the largest number of farmers and produces the bulk of the total milk produced mainly from buffaloes. This is followed by smallholders market oriented production system. These have more milch animals per household and have better overall management. Rural commercial milk production system is a fairly new production system that started in the 1980s. This has larger herds of 40 or more mainly buffaloes and has the best management system with highest milk yield per animal. Peri urban milk production system started first around the city of Karachi to meet the increasing demand for fresh milk. Over the years, this system has spread to all the cities and large towns of the country. In Karachi alone there is an estimated 1.4 million dairy animals mainly buffaloes. There is no real cooperative milk production system in Pakistan. These are based on associations or groups. The system is growing but very slowly.

The entire livestock production including dairy production is in the private sector but all the services like training, research and extension services are the responsibility of the government. All the provinces provide animal health and production services through their Livestock and Dairy Development Departments. However, in spite of the name the focus of these departments are still on animal health activities. Even for animal health, the approach to the service is clinic based where the sick animals are expected to be brought to receive the service.

Livestock production that includes milk production is still a family operation in which men, women and even children participate. But women have crucially important role in the agro-livestock production system. However, their contribution to the rural economy has neither been fully recognized nor documented until recently. The dominant role of women in livestock/dairy production is now being increasingly recognized. In two recent studies women were found to be involved in all the 10 livestock related activities with dominant role in 3 activities on a national basis. Women spent 3.5 hours/day in livestock activities compared with 2.0 hours/day by men. Another study revealed that women performed exclusively 12 livestock activities compared to only 5 activities performed by men.
By and large, the milk collection, preservation and transportation system is the same for both the traditional and the formal sectors. Primarily, milk is collected by a group of middle men called Katcha Dodhies from thousands of smallholders from the farm gate in small quantities (50-150 liters) who sells it to Pucca Dodhies located on main roads. The latter collects milk from several Katcha Dodhies and sells it to whole salers who in turn supply it to retailers/vendors in the cities. The Pucca Dodhies may also supply it directly to the dairy companies or others who may convert it to some indigenous dairy products mainly khoa. This is the overall system. But in some areas there may be more than two middle men. The most common preservation system is to add ice particularly during hot summer months.

The following recommendations are proposed for the effective dairy production, quality control and marketing system in Pakistan:

- Strategies for dairy development
- Action plan for dairy development

Strategies for Dairy Development:
Following are the recommended strategies for the dairy development:

i. Increase public sector investment in education, research and development in the dairy sector
ii. Provide policy support for the dairy development including de-regulation of milk prices
iii. Attract private sector investment particularly in hygienic production and collection of milk and cool chain for milk marketing.
iv. Restructure organizations that provide livestock/dairy services.
v. Organize small farmers into milk production and marketing groups/associations.
vi. Encourage value addition in the dairy industry
vii. Improve credit availability and terms of credit

Action Plan for Dairy Development:

i) Enhance productivity of livestock resources through training of livestock farmers, development of better technologies, scientific farming methods and improved management practices
ii) Improve milk marketing system through establishing cool chain and quality control
iii) Organize a massive on hands training program for technicians in all aspects of milk production and processing jointly with the relevant universities, public sector training institutes and the dairy industry
iv) Ensure easily accessible and affordable credit for livestock farmers especially landless livestock farmers
v) Promote import substitution of livestock and products
vi) Rationalize taxes/tariff on milk and dairy products
vii) Ensure availability of extension services at the door of the farmers
viii) Provide a level playing field for the local dairy industry to compete with the subsidized imported dairy products
ix) Encourage value addition in dairy industry
x) Improve consumer safety
xi) Reorient public sector institutions on following lines:

- Government livestock farms to be used for production of superior germplasm.
- Phased privatization of livestock extension services
- Strengthen existing livestock R&D institutions and establishment of new livestock production research institutes in the provinces.
- Ensure allocation of funds for livestock commensurate with its contribution to Agriculture GDP

Sri Lanka

The GDP per capita in Sri Lanka is US$ 551, which is the highest among the six asian countries reviewed. The average per capita expenditure on milk was generally low, particularly in the rural areas. The average expenditure on milk and milk products incurred by a spending unit was 3.3%. Presently, the country is facing serious economic problems including under-nutrition (>30), underemployment (>40%), unemployment (approximately 8.9%), and inequality of food security. The dairy sector holds high promise as a means of alleviating these problems.

Dairy farming is mainly a smallholder dominated mixed farming system in Sri Lanka. The agricultural sector’s contribution to the GDP is 20.7%, while that of livestock to the agricultural GDP is 8.0%. The formal dairy sector contributes 11% of the livestock GDP and beef production a further 15%. The average per capita availability of cow milk is 22.33 g/day and buffalo milk 9.86 g/day as compared with a minimum requirement of 164.38 g/day for milk and milk products in the country. The growth rate of the local dairy industry over the last decade has been estimated at around 2.5%, whilst the projected market growth rate is 5.2%.

Over 90% of the dairy farms are small holdings having less than 1 acre of land or many do not have any land at all and depend on the communal lands for feeding their animals. The dairy production and the management systems varied according to the resources available and the general farming activities in different agro climatic regions of the country. The management systems can be either intensive, semi intensive or extensive while semi intensive and extensive systems are widespread and intensive system of management is being promoted at present by the DAP&H. However, dairy production is mainly integrated with agriculture in every part of the country.

Cattle and buffalo populations in the country are scanty and discrete. According to the 2007 livestock statistics, the total neat cattle and buffalo populations are 1.2 million and 0.3 million respectively. They are distributed in different agro climatic regions of the country. The animal population in the country has reduced substantially during the last few years and the trend is continuing at present too.

As far as the natural resources, infrastructure facilities including animal resources, technology, trained human resources and the government policies are concern, Sri Lanka has an enormous potential for dairy development within the country. However, the achievement in the country since inception of the milk industry (early 1950s) is negligible and extremely average low productivity of the animals itself provide a strong evidence for that effect.
Furthermore, the constraints listed above have been the same for last few decades and nothing substantial has happened with all the planning and activities carried out in the dairy sector in the country. Therefore, it clearly shows that there is a urgent need to change the approach and the policies that are adapted in view of improving dairy industry to achieve at least 50% self sufficiency in milk production by 2015 as expected by the government. Since each and every constraints mentioned above are linked to the dairy industry the common solutions that could be applied to overcome them are suggest below.

i) Strengthening the farmer organizations
ii) Genetic improvement of animals through organize breeding strategies
iii) Make AI service more effective and efficient
iv) Promote innovative approach to marketing of milk
v) Promote commercial dairying
vi) Farmer participatory research approach
vii) Make dairying competitive

India’s AMUL model of dairy development: A boon for smallholders

The AMUL model of small-scale dairy production and marketing, as evolved and refined over the last 50 years in India, offers an appropriate strategy for promoting sustainable, equitable and gender-sensitive smallholder dairy development, not only in South Asian countries but also in many other developing countries of the world. The salient features of the AMUL model include: (1) a single commodity approach; (2) a three-tier organizational structure; (3) producer-elected leadership and decentralized decision making; (4) employment of professional managers and technicians; (5) accountability of professional managers, technicians and other employees to the member-producers through their elected leaders; (6) provision of all necessary inputs and services to member-producers at reasonable, often subsidized rates; (7) integration of production, procurement, processing and marketing functions; (8) continuous and concurrent audit; (9) cash payment to producers for their milk—daily or weekly; and (10) contribution to village amenities.

The Anand Pattern Dairy Co-operatives (APDCs) provide their members with a complete package of inputs and services necessary for enhancing milk production. The package includes animal health care through both regular as well as emergency visits by veterinary doctors, AI, balanced cattle feed, improved fodder seeds, and extension education and training. More importantly, the APDCs provide a year-round and assured market for the producers’ milk at a remunerative price.

In summary, the AMUL model is producer-oriented, people-centred and holistic. It emphasizes the integrated development of all the important facets of the dairy industry, namely: production, procurement, processing, pricing, marketing, training and management. Moreover, it advocates the use of appropriate technical, economic and institutional instruments to promote smallholder dairy development.
Challenges and opportunities for small livestock holders under the new world trade regime

All the selected South Asian countries are signatories to the agreement that led to the establishment of the WTO and therefore, are obliged to follow the dictates of the new world trade regime spearheaded by the WTO. The new regime concerning dairy products became effective on 1 July 1995. Liberalisation of world trade in dairy products under the new trade regime poses new challenges and has opened up new export opportunities for the dairy industry in South Asian countries. There is need for these countries to enhance their competitive economic advantage in dairy products, in terms of both quality and cost, and to enhance their credibility in international markets. The role of governments in these countries should be to direct, co-ordinate and regulate the activities of various organisations engaged in dairy development, to establish and maintain a level playing field for all stakeholders and to create and maintain a congenial socio-economic, institutional and political environment for smallholder dairy development through appropriate policies and programmes.

The new trade regime is not expected to affect the overall world trade in milk and milk products. However, there will be some redistribution in terms of regions of origin and destination. It is expected that the decreased volume of subsidised exports of dairy products from several developed countries will be offset, to some extent, by increased export from countries like India, which do not subsidise their exports of dairy products.

In order to benefit from the new trade opportunities, India and other South Asian countries will need to set and enforce high quality standards for various dairy products through an independent non-governmental authority and to improve the basic infrastructure (particularly the ports) and the air transport system. They will also need to improve their competitive advantage in milk production by improving milk yields to reduce the per litre cost of production and by improving the quality of their products by adopting the latest processing and packaging technologies and professional management. Compliance with phytosanitary specifications will also be necessary in order to increase the export of dairy products. A general switch to higher-value dairy products consequent upon increased access to high-priced markets in developed countries is also likely to occur.

In today's context, trade between neighbours is the harbinger of goodwill and economic uplift. In this context, the South Asian Preferential Trade Arrangement (SAPTA), which became operational in December 1995, is a welcome and significant development. It aims to facilitate trade among South Asian countries through preferential tariffs. The South Asian countries have identified a substantial number of commodities for preferential trading among themselves. Previously, they used to import/export some of these commodities indirectly from their neighbours through distant third parties. Besides the preferential tariff, the other gain to South Asian trade from SAPTA should be a drastic reduction in transportation costs. It is hoped that following SAPTA, trade in dairy products among South Asian countries will usher in an era of prosperity in the region.

Conclusions

The dairy sector in the South Asian countries of Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka is characterised by small-scale, scattered and unorganised milch animal
holders; low productivity; inadequate and inappropriate animal feeding and health care; lack of assured year-round remunerative producer price for milk; inadequate basic infrastructure for provision of production inputs and services; inadequate basic infrastructure for procurement, transportation, processing and marketing of milk; and lack of professional management. Other important characteristics of the dairy sector are the predominance of mixed crop–livestock farms and the fact that most of the milch animals are fed on crop by-products and residues, which have very low opportunity costs. Additionally, dairy development policies and programmes followed in these countries, including those relating to foreign trade are not congenial to the promotion of sustainable and equitable dairy development.

Low productivity of milch animals is a serious constraint to dairy development in all the countries under review. The productivity of dairy animals in the six selected countries could be increased by crossbreeding the low yielding nondescript cows with high yielding selected indigenous purebreds or suitable exotic breeds in a phased manner. The cattle breeding policy should not only focus on milk yield but should also provide for the production of good quality bullocks to meet the draft power requirement of agriculture. Upgrading of nondescript buffalo through selective breeding with high yielding purebreds, such as Murrah, Mehsani or Nili Ravi, should be given high priority in all areas where buffalo are well adapted to the agro-climatic conditions.

While fixing procurement price, producers’ interests should receive the utmost attention. The producer price should at least cover the long-run average cost of milk production and provide a reasonable mark-up. Studies on cost of milk production and its financial viability should be initiated by the Departments of Animal Husbandry or the Dairy Development Boards/Corporations in the selected countries. Such research need to be carried out in all the major agro-climatic zones and should be repeated at regular intervals of approximately three years to determine whether milk production is profitable and to furnish an objective basis for fixing producer price of milk. The studies may be entrusted to reputed universities/research organisations operating in the regions selected for the studies.

Despite all the problems it faces, the dairy sector holds high promise as a dependable source of livelihood for the vast majority of the rural poor in the South Asian countries. The AMUL model of small-scale dairy production and marketing, as evolved and refined over the last 50 years or so in India, holds high promise for smallholder dairy development in these countries. The model needs to be replicated in all the South Asian countries with adaptations made to suit the specific conditions of the countries concerned.

Liberalisation of world trade in dairy products under the new trade regime of the WTO poses new challenges and has opened up new export opportunities for the dairy industry in South Asian countries. These countries need to enhance their competitive economic advantage in dairy products, in terms of both quality and cost, and to enhance their credibility in international markets. The role of governments in these countries should be to direct, coordinate and regulate the activities of various organisations engaged in dairy development, to establish and maintain a level playing field for all stakeholders and to create and maintain a congenial socio-economic, institutional and political environment for smallholder dairy development. There is need for each South Asian government to formulate and announce a comprehensive dairy development policy for their country. Such policy should be an integral
part of their national development policy and due consideration should be given to its direct and indirect effects on other subsectors of the economy and vice-versa.

In the past, management has been the key factor in the success of smallholder dairying. This is evidenced by the experiences of AMUL, Operation Flood and many other successful dairy development projects. The future of smallholder dairying will also rely on the continued adaptation of management techniques to suite markets, environments and socio-economic conditions. Managing dairy plants and cattle feed factories is not the business of the government; it is better left to professional managers who are employees of the milk cooperatives and hence are accountable to their member milk producers.

Integration of dairy farming with crop production systems in South Asia is a special feature of smallholder dairying, which is not understood widely in dairy monoculture production systems. An integrated crop–dairy production system model indicates the incremental benefits in the form of draft power, meat and a range of other products provided through dairying as an adjunct to crops and productive use of crop by-products and residues, both of which have very low opportunity costs. Furthermore, milk production is less vulnerable to weather-induced risks than crop production and hence serves as an informal means of insurance for milk producers.
Dairy Production, Quality Control and Marketing System in Bangladesh

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EXECUTIVE SUMMARY

Dairying is an important economic activity in Bangladesh that provides supplementary income, employment and nutrition to about 3.6 million households. Unlike fisheries, dairying is labour intensive. A farm with two lactating cows generates 4,080 hours of labour opportunities every year.

Even though per capita milk consumption is low in Bangladesh (11.2 litres against 85 litres in India during 2004-2005), domestic production is still insufficient to meet existing demand. In the formal market, 87% milk is imported. The sector’s growth rate remains far behind that of the neighbouring countries (2.05% against 4.1% in India and 4.9% in Pakistan). The reasons for such modest growth rate are lack of good policy, insufficient data on the sector to formulate good policy, lack of political commitment and less attention and insufficient budget allocation (only 0.3% of national budget) leading to poor attraction of private investments to the sector.

About 7% of the total milk produced goes to the formal market. Bangladesh Milk Producers' Cooperative Union Ltd. (BMPCUL) has the largest share comprising 49%. Aarong and PRAN have the second (25%) and third share (11%), respectively. Pasteurised liquid milk, powder milk, UHT milk, ice cream, rasmalai, butter and ghee are the main milk and milk products marketed by the formal sector in Bangladesh.

Coordination among actors in the value chain (farmers, traders, processors and service providers) is very week leading the chain very long with a significant degree of mistrust among participants. This increases cost and reduces competitiveness. In Bangladesh, dairies sold Pasteurised packet milk at US$0.44/litre against US$0.29–0.31/litre in India in 2006. Primary producers in Bangladesh only get about 50% of the consumers' price; in contrast, Indian producers get paid with 74% of the consumers' price.

Due to ensured market in Sirajganj and Pabna by the BMPCUL, the milk production cost was much lower (US$18.9/100 litres) than that of the rest of the country (US$ 31.5 - 35.1/100 litres). The cost of milk production in Bangladesh is higher than that of India and Pakistan (US$15/100 litres).

Informal sectors handle the largest share of the milk (78%) produced in Bangladesh and market traditional products. Other than curds, the popular sweetmeats are Rasogolla, Chamchams, Rossomalai, Sandesh, Kalagam.

Bangladesh dairy industry depends on crop residues (30.66 million MT per year) and byproducts and cut-and-carry green fodder (2.9 million MT per year). Crop residues commonly available are rice straws, wheat straws, maize, stovers, sugar cane tops and other crop trash. The by-products are wheat bran, rice polish, pulse husks and oil cakes. About 2.9 million MT by-products are produced in the country but only 0.97 million ton is available to feed cattle against a requirement of 2.8 million MT to produce 5.6 million MT milk. The rest of the by-product is used in the poultry (50%) and fisheries (20%).
The number of AI done in Bangladesh was 3.21 million in 2009, Department of Livestock Services (DLS) did 2.5 million, BRAC did 713 thousand and BMPCUL did 75 thousand. About 40% of the cattle breeding are covered by AI.

Two major types of cattle dominate the Bangladesh dairy industry. Crossbred cattle constitute about 20% and are mainly produced by breeding local non-descript zebu cows and heifers predominantly with Holstein Friesian and Sahiwal bulls. The most potential local cattle although not described as breed are Red Chittagong Cattle (RCC), Pabna Milking Cattle (PMC) and North Bengal Gray (NBG).

The buffaloes of Bangladesh are mostly river type although swamp type exists. Indigenous buffaloes are low yielding, but are stout draft animals. These animals can be the foundation for a high yielding milk buffaloes through breeding up with dairy breeds and have an increased milk and meat production of about 0.25 million MT and 40,000 MT per year respectively.

There is no incentive for quality milk supply because individual milk testing is not carried out at the procurement and farmers are paid a flat rate. Adulteration is common leading to a low fat and or SNF (solid not fat) percentage in milk. Measuring sets are not certified by the statutory authority and sets for measuring milk below 500 ml are not available, though supplies below 500 ml are accepted. Quality control of fresh milk and finished products are far behind consumers’ expectations in terms of food safety and sanitation. Consequently consumers are getting inclined to imported milk and milk products. Quality control measures include only taking a lactometer reading, which reflects the osmolarity and can easily be manipulated. Farmers neither get a price incentive for milk with low bacterial load nor get any benefit of bringing milk quickly after milking to the chilling station, the latter practice would reduce bacterial load in milk.

Following recommendations are made to address the constraints and boost dairy development in the country.

♦ Government of Bangladesh (GoB) should institutionalise the recently formed Bangladesh Dairy Development Council (BDDC) man it accordingly, allocate budget and specify its roles of business.
♦ GoB should strengthen the BSTI capacity by establishing a standard laboratory and manning it properly to watch the quality of market milk.
♦ The DLS veterinary services should be made regulatory. The services should be directed towards ensuring food safety and sanitation and phytosanitary measures as per SPS Agreements.
♦ The DLS shall establish an epidemiological unit with its coverage up to all the Upazilla and port of entries to the country. It should be equipped with a disease diagnosis laboratory certified by OIE.
♦ The DLS should establish and manage a laboratory of international standards to quality control of feeds, drugs, vaccines, breeding materials and other biologicals to be used as inputs to the dairy industry, in the line OIE.

♦ The DLS should phase out leaving its production veterinary services, vaccine production and artificial insemination to the private sectors.

♦ The annual budget allocation for the development of livestock should be at least 50% of the contribution it make to the national GDP.

♦ Milk processing industries should as soon as possible introduce milk fat and SNF percent testing of individual producers’ milk at the society level and reset its pricing on the basis of fat and SNF percentage.

♦ The processing industries should finance a research project to test the fat and SNF percent of milk collected directly from the cow’s udder covering good number of all possible breeds available all over the country. This will help dairy processors setting realistic SNF percentage at the society level.

♦ BMPCUL Management Board should concentrate mostly on the market expansion and leave technical issues like employment and procurement on the professional executives.

♦ The government share should be gradually tapered off and the BMPCUL should be given the liberty of running independently.

♦ BMPCUL should gradually leave the chilling tank ownership as much as possible to the dairy cooperative societies. This will help cooling milk promptly and thereby ensure better quality.

♦ NGOs and private milk processors should help organise smallholder producers in the form of registered societies or association and immediately give up the current practice of employing milk collection agents.

♦ NGOs and private milk processors should be in partner with an on-farm veterinary and AI service providers to link them with the producers’ societies.

♦ NGOs and private milk processors should encourage producers’ societies own the farm cooling tank. This will not only reduce their (industry) capital investment but also strengthen producers’ participation. The producers down the road will receive a larger portion of the consumers’ price.
1. **INTRODUCTION**

Dairying is an important economic activity in Bangladesh that provides supplementary income, employment and nutrition to about 3.6 million households. Even though the increase in per capita milk consumption has been slow, domestic production is still insufficient to meet existing demand. Costs of fresh milk production are high due to low yields of animals and high feed costs. Processing costs are higher than that in neighbouring countries and technology uptake has been minimal. Given the situation, cattle rearing and milk production has the potential if constraints are addressed to be the lead animal agriculture in Bangladesh.

Employment opportunity is an important development agenda of Bangladesh. Dairying generates both on-farm and off-farm employments. Bangladesh is having an annual growth rate of about 6%. The sixth five years plan has been targeted to achieve an economic growth rate of 8%. This means people's purchase power will increase and their consumption habit will change towards having more food of animal origin in the menu. Bangladesh needs to increase milk production many folds to meet the domestic demand of milk. Else the country will turn to a chronic milk-import dependent one if the issue is not addressed now. Major issues are to increase production in one hand and decrease number of animals on the other hand to reduce pressure on the land because the agricultural land is getting reduced every year at a 1% rate. Bangladesh dairy industry should be based on the crop residues and milling byproduct as the major cattle feed. Milk production needs integrated with the cropping. There is an urgent need of technology development to address these issues and to reduce milk production cost and keep the industry competitive in the regional and global context. Average milk yields per cow in Bangladesh are equivalent to about 0.7 tonnes per year, which is lower than the average yields in India (1.2 tonnes per cow per year) or Pakistan (1.1 tonnes per cow per year). In contrast, per cow yields in Australia, New Zealand and Denmark are about 5.2, 3.7 and 7.8 tonnes per year, respectively (Anon 2008). Shamsuddin *et al.* (2006; 2007) reported that the dairy industry of Bangladesh would be competitive with neighbouring countries if per cow average milk production could be raised to 7 litres per day.

1.1 **Background**

The dairy industry of Bangladesh poses a big gap between the requirement and domestic production. The country produced 2.68 million metric tons (MT) milk in 2006 against a requirement of 13.70 million MT (250 ml per day for 150 million people). The sector’s growth rate remains far behind that of the neighbouring countries (2.05% against 4.1% in India and 4.9% in Pakistan). The reasons for such modest growth rate are lack of good policy, insufficient data on the sector to formulate good policy, lack of political commitment and less attention and insufficient budget allocation leading to poor attraction of private investments to the sector, to mention a few. Less than 0.3% of the national budget was allocated to livestock during the current fiscal year.
Average annual per capita milk consumption in Bangladesh has increased over the last decade (from 10.45 liters in 1995–96 to 11.2 liters in 2004–05) but remains very low compared with regional consumption levels (for example, 85 liters per capita in India). According to HIES data, total milk consumption grew by about 3 percent per year between 1995-96 and 2004-05. Bangladesh produces only 20% of the milk required. That small amount of milk has not been canalised to the formal market, in particular to meet the urban demands. Only 5% of the locally produced milk is handled by the formal sector. Consequently, Bangladesh heavily relies on powder milk import (0.613 million MT liquid milk equivalents in 2005) in exchange of the valuable foreign currency. Liquid milk collected from producers in Bangladesh holds only 13% share of the organised market.

Informal sectors handle the largest share of the milk produced in Bangladesh through traditional product and direct sell to the consumers. Many of the traditional products in the form of sweetmeat and curds of various kinds are popular to the consumers. There is always an argument whether the traditional products are reducing the availability of liquid milk in the market. However, to be in the line of consumers’ taste and social context, these products deserve attention to be modernised for large scale production.

Dairying has been proved to be a powerful tool to reduce rural poverty in India. Initiatives in the form of milk pockets have made visible success in Bangladesh, which if coordinated could easily make national impacts. Dairy is labour intensive and require less land than does crop cultivation and fisheries. In a small dairy farm with two lactating cows, 4,080 hours of labour opportunities are created every year. Moreover, non-farm activities like trading feeds and forages, drugs, breeding materials, farm equipment, milk carrying from farms to the chilling centres and rural transport generate substantial amount of income in the rural community.

Up until the early 1990s Milk Vita used to be the only formal sector that processed and marketed milk from the producers of Bangladesh. Milk Vita is the trade name of a government cooperative – Bangladesh Milk Producers’ Cooperative Union Ltd. (BMPCUL). Liberalization and market reforms in the 1990s along with increasing demand for milk and milk products accompanying per capita income growth and urbanization and improvements in infrastructure have brought about greater private sector participation in the dairy sector. However, much of the potential of the dairy industry in Bangladesh remained unexplored with regard to input and service delivery to farm activities and involvement of industries in post harvest processing and marketing of milk.

Currently the dairy industry in Bangladesh faces complex challenges which prevent it from taking advantage of emerging opportunities. Coordination among actors in the value chain (farmers, traders, processors and service providers) is very weak, these chains tend to be very long and create a significant degree of mistrust among participants increasing cost and reducing competitiveness. Consequently, the desired margin of
consumers’ price is not going back to the producers. Primary producers in Bangladesh only get about 50% of the consumers' price; in contrast Indian producers get paid with 74% of the consumers' price. Post-harvest management systems are poor despite the existence of technical solutions. Modernization of technology is also needed. There is little importance given to quality control and standards among participants in the value chain. Institutes for quality control and standards do exist; however, their activities are not always visible.

1.2 Objectives
This document focuses on the (i) evaluation of different milk production systems; (ii) evaluation of different models of dairy processing and marketing systems in Bangladesh; (iii) identification of opportunities and constraints to the development and growth of the dairy industry; and (iv) formulation of recommendations for promoting sustainable growth in the sector.

2. MILK PRODUCTION SYSTEM

Shamsuddin and Rahman (2009) described the production system, supply and value chain of the dairy industry in Bangladesh. Bangladesh had 24.5 million cattle and 0.9 million buffaloes with 10.0 million lactating animals (3.5 million crossbred cows). Shamsuddin et al. (2006) calculated costs of milk production under various management conditions in four regions of Bangladesh drawing on data from 1,440 dairy farms. The production cost averaged from US$ 31.5 - 35.1/100 litres for producers who were not members of BMPCUL, but BMPCUL costs in Sirajganj and Pabna were only about US$18.9/100 litres (Table 1). The cost of milk production is generally higher than that of India and Pakistan, which are reportedly below US$15/100 litres (Hemme et al., 2004).

Table 1. Average expenses (*US$) to produce 100 litres of milk in the four regions of Bangladesh with the range in brackets

<table>
<thead>
<tr>
<th>Cost of milk production</th>
<th>Mymensingh</th>
<th>Khulna-Satkhira</th>
<th>Sirajgonj-Pabna</th>
<th>Chittagong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health care</td>
<td>0.07 (0.0-0.6)(^a)</td>
<td>0.4 (0.1-3.1)(^b)</td>
<td>0.2 (0.0-1.7)(^c)</td>
<td>0.5 (0.02-2.4)(^a)</td>
</tr>
<tr>
<td>Feed</td>
<td>21.1 (5.0-67.2)(^a)</td>
<td>22.1 (5.9-81.7)(^a)</td>
<td>13.8 (4.6-52.6)(^c)</td>
<td>20.0 (5.0-78.4)(^b)</td>
</tr>
<tr>
<td>Labour</td>
<td>13.4 (0.9-75.9)(^a)</td>
<td>8.3 (0.4-53.9)(^b)</td>
<td>4.4 (0.6-23.9)(^c)</td>
<td>13.3 (1.2-63.2)(^a)</td>
</tr>
<tr>
<td>Housing</td>
<td>0.5 (0.03-1.8)(^b)</td>
<td>0.7 (0.02-5.9)(^a)</td>
<td>0.5 (0.03-2.7)(^b)</td>
<td>0.8 (0.04-4.7)(^c)</td>
</tr>
<tr>
<td>Total</td>
<td>35.1 (6.9-109.0)(^a)</td>
<td>31.5 (7.6-106.9)(^b)</td>
<td>18.9 (5.8-66.7)(^c)</td>
<td>34.6 (7.7-119.3)(^a)</td>
</tr>
</tbody>
</table>

*1 US$= taka 58
\(^a,b,c\)= Figures with different superscript letters in the same row differ from each other (p<0.01).

Source: Shamsuddin et al., 2006.
High costs of fresh milk production are due to low yields and high feed costs. For example, feed costs as a percentage of income from milk varies from 67 - 92% in the unorganized sectors of Chittagong, Mymensingh and Khulna-Satkhira (Shamsuddin et al., 2006). Average yields are only 2.0 litres per cow per day, although there are regional variations. Among commercial dairy farmers, average milk production ranges from 3.5 litres per day in Mymensingh to 7.2 litres per day in Sirajgonj (Shamsuddin et al., 2006). Average milk yields per cow in Bangladesh are equivalent to about 0.7 tonnes per year, which is lower than the average yields in India (1.2 tonnes per cow per year) or Pakistan (1.1 tonnes per cow per year). In contrast, per cow yields in Australia, New Zealand and Denmark are about 5.2, 3.7 and 7.8 tonnes per year, respectively (Anon 2008). Shamsuddin et al. (2006; 2007) reported that the dairy industry of Bangladesh would be competitive with neighbouring countries if per cow average milk production could be raised to 7 litres per day.

2.1 Smallholder dairying

Smallholder dairy farms in Bangladesh are of different kinds. These vary from one to two low producing local cows that produce 1 litre or less milk per cow per day under extensive management to one to two crossbred cows that produce 4 to 5 litre milk per cow per day, under semi-intensive management. Small scale dairying is a family enterprise in Bangladesh. Although specific data are not available, a considerable number of dairy farms are owned by women. Many of them are widows or left by the husband. The Box 1 describes one of such dairy producers at Sulpha village of Sherpur Upazilla of the District Bogra (Author's own observation, 2006). The production in such farms grows rapidly if milk marketing and productivity veterinary services are made available. Figures 1 and 2 show examples in Satkhira, where productivity veterinary services have been introduced the Community-based Dairy Veterinary Foundation (CDVF) through farmers groups and associations and at the same time milk marketing has been ensured by installations of chilling plants by a dairy processor. During April 2008, a farmers association has been established with 150 farmers that produced only 2.0 tonnes milk. During May 2010, four associations are functioning with 2,956 farmers that produce 345 tonnes of milk.

2.2 Periurban milk production

Periurban farms have grown mostly in and around metropolitan cities and district head quarters. Majority of the farms have five to ten lactating cows but some have up to 30 cows. In exceptional cases, farms as big as with 300 crossbred cows are available in metropolitan cities, e.g. in Chittagong. The cows are mostly crossbred. Each one of periurban crossbred cows produces 8 to 15 litre milk per day under intensive management.

Periurban farms are responsive to technology. The CDVF has been continuing a programme of delivering productivity veterinary services through farmers groups and
association in Potia Upazilla of the Chittagong district since 2002. At the beginning, there were 70 farmers producing about 1500 litres of milk per day. Currently, the programme involves 270 farm families who collectively produce about 15,000 litres per day. In addition, the farmers association bargains milk price with the sweetmeat industries; earlier, farmers used to be exploited by the middlemen and sweetmeat producers. Now that the productivity veterinary service and AI are available and the associations bargain a good milk price, both numbers of dairy farmers and per farm milk production have increased.

**Figure 1. Milk production sharply increased in the Community-based Dairy Veterinary Foundation operated area in Satkhira from April 2008 to May 2010**

**Figure 2. Number of members of the Community-based Dairy Veterinary Foundation in Satkhira from April 2008 to May 2010**
2.3 Dairying through co-operatives

Bangladesh Milk Producers’ Cooperative Union (BMPCU) Ltd was registered in 1965, covering the entire country as its area of operation. There are 1836 primary milk producers’ cooperative societies affiliated to the Union. The Union has 3 dairy plants of (Baghabari, Tekerhat and Dhaka) and 28 chilling centres with 300,000 litres total capacity. The Union collects about 250,000 litres of milk daily; 160,000 litres is sold as liquid milk and the balance is converted to various products like milk powder, butter, ghee, cream, curd, ice cream, rashomalai, chocobar, for examples.

Milk is procured through primary milk producers’ cooperative societies and collections are made in the morning and afternoon. Union transports milk to the plant and payment is made every seven days, on the basis of percentage of fat to the society. Society makes payment to its members every seven days.

Cooperative farmers use river basins, particularly in Sirajganj, for grazing their cattle together. The system is commonly called Bathan and is an age old practice. Milk Union has taken such land on a long lease from the government for grazing the cattle of its member societies. The land is available for grazing for about six months (January-June). Leguminous fodder crops like khesari kalai (Lathyrus sativus) and mati kalai (Fasciola mungo) are cultivated and the cattle are left for grazing on the land. After this grass is over, the land is fertilized and irrigated and local grass (Cynodon dactylon) comes up very well. Animals graze on this grass. Some farmers grow Napier and maize on the Bathan land. In one Bathan there will be 100-150 animals and 35-40 such Bathans are maintained in the river bed land. Cattle graze throughout the day. Milking is done at the Bathan and milk is transported by boat and or tractor to the Milk Vita dairy. Veterinary and AI services are available at the Bathan.

3. Dairy Animal Health Care and Breeding Services

Recently, DLS reviewed the constraints that limit accessibility of farmers to the veterinary services (National Livestock Policy 2007). These are (i) limited coverage of animal health care by the DLS, (ii) lack of quality control of vaccines, drugs, feeds and breeding materials, (iii) lack of regular disease control programme, (iv) weak epidemiological unit in the DLS for disease surveillance and poor linkage of disease investigation with the surveillance system, (v) lack of regulations designated to veterinary public health and food hygiene, (v) absence of continuing education for veterinarians and animal health workers, (vi) inadequate supports for veterinary research, (vii) absence of quarantine services and lack of information on market promotion and opportunities for private veterinary and AI services. The latter would stimulate young veterinarians to come forward into the private services.

It has been demonstrated by the author that an on-farm veterinary service incurs a net farmers’ benefit of Tk. 20.00 per cow per day. The BMPCU Ltd. charge Tk. 1.00 per
litre to deliver veterinary services at the society centres. The CDVF charge the same amount of money and delivers both productivity and emergency veterinary services on-farm.

Vaccines for the diseases of trans-boundary and zoonotic importance should be procured and distributed by the public sector and the vaccines for production limiting diseases should be dealt privately.

The breeding programme must have a clear direction towards achieving the national production goal. If the milk production grows at 6%, a real tough job, the per capita milk availability in 2025 will be 120 ml against an expected 1.6% population growth rate (Figure 3). Based on the current breeding practices, which only support a national average of 2.0 litre milk per cow per day, Bangladesh will require 26 million lactating cows leading to 65 million total cattle. The land of this country can not support that many animals. We need a breeding policy to achieve a population of 5.2 million lactating cows (13 million total cattle) with a national herd average production of 3000 kg milk per lactation per cow. Such dairy industry will require 1.3 million acres of cultivable land for fodder cultivation, which is 4% of the available cultivable land in Bangladesh. This job is not impossible. Pakistan’s current national herd average is 3000 milk per lactation. Many herds in India are getting that level of production. In Baghabarighat milk shed area of BMPCU Ltd, the 20% best herds produce in average 9.0 litres milk per cow per day with a lactation length of 282 days (estimated 2538 litre per lactation). Based on these, the national breeding policy 2007 has set a target of achieving a certain level of milk production in defined time frame. However, progress in implementation of the national breeding policy 2007 has not been visible.

![Graph showing estimated per capita milk availability in 2025 at different growth rates of milk production and population](image_url)

**Figure 3. Estimated per capita milk availability in 2025 at different growth rate of milk production and population**
4. **Feed Industry, Dairy Animal Nutrition and Production**

All livestock production in Bangladesh, across all species, except poultry, depends on crop residues and by-products and cut-and-carry green fodder. Crop residues commonly available are rice straws, wheat straws, maize, stovers, sugar cane tops and other crop thrash. The by-products are wheat bran, rice polish, pulse husks and oil cakes. Concentrate feed items are mostly imported. There are small feed plants, but feeding of compounded feed to cattle is not very popular. There are no permanent pastures or extensive grazing lands except in the bathan where animals can graze about six months a year.

Natural grasses, weeds from cropped areas, bushes and shrubs from private land, fallow lands, cultivable waste land and road side grasses constitute the sources of green fodder along with tethered grazing on community lands and road sides. Cultivated perennial fodder grass Napier, seasonal crops like cowpea and other pulses mainly grown on cultivated land and crop borders and in the paddy field after paddy harvest or as relay crops also provide sources of green forages for animal feeding. Fodder cultivation is practiced in the milk sheds like Baghabarighat, Satkhira and Chittagong. The amount of green forage available for ruminant feeding in Bangladesh is about 2.29 million MT per annum (Table 2).

**Table 2. Estimated green fodder available in Bangladesh**

<table>
<thead>
<tr>
<th>Land classification</th>
<th>Area Available hectare</th>
<th>Green Fodder mt @ 2 mt/ ha</th>
<th>Available Million mt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural waste</td>
<td>309,312</td>
<td>618,623</td>
<td>0.62</td>
</tr>
<tr>
<td>Current fallow</td>
<td>387,449</td>
<td>774,899</td>
<td>0.77</td>
</tr>
<tr>
<td>Crop borders:10% of NCA</td>
<td>803,441</td>
<td>803,441*</td>
<td>0.80</td>
</tr>
<tr>
<td>Badoi/ Rabi fodder Production</td>
<td></td>
<td>97,975</td>
<td>0.10</td>
</tr>
<tr>
<td>Total</td>
<td>2,294,939</td>
<td></td>
<td>2.29</td>
</tr>
</tbody>
</table>

*Source: Land classification and Area: Year Book of Agricultural Statistics BBS 2004
Yields: Study Estimates; * @1 mt/ ha; NCA: Net Cropped Area; mt= metric tonnes. Estimated by E. Madhavan 2006, personal communication*

Crop residues constitute the source of dry matter intake by ruminants in Bangladesh, rice straw constituting the most abundant among them. The estimate of crop residues is based on crop production data as crop residues accrue in proportion to the quantity of grain or seed output. The ratio used is the standards developed by S.K. Ranjan, ICAR (India), in 1991. The total dry fodder available is some 30.66 million MT (Table 3).
Table 3. Estimates of dry fodder originated from crop residues in Bangladesh

<table>
<thead>
<tr>
<th>Crop production</th>
<th>Grain production million mt</th>
<th>Grain to crop residues ratio</th>
<th>Straw or stovers million mt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>26.19</td>
<td>1:1</td>
<td>26.19</td>
</tr>
<tr>
<td>Wheat</td>
<td>1.25</td>
<td>1:1.3</td>
<td>1.63</td>
</tr>
<tr>
<td>Maize*</td>
<td>0.24</td>
<td>1:4</td>
<td>0.97</td>
</tr>
<tr>
<td>Pulses*</td>
<td>0.33</td>
<td>1:4</td>
<td>1.33</td>
</tr>
<tr>
<td>Oil Seeds*</td>
<td>0.27</td>
<td>1:2</td>
<td>0.54</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>30.66</td>
</tr>
</tbody>
</table>

Note: *Crop residues of these crops are edible only if chopped into small pieces by chaff cutters, Estimated by E. Madhavan 2006, personal communication

Milling by-products and small quantities of grains constitute the concentrate feed for cattle in Bangladesh. Available by-products are brans, husks and oil cakes. Broken rice, maize and wheat constitute the grains for concentrate mixture. The use of concentrate feed is usually restricted to milking cows and its extent depends on the commercial viability of dairy farming and access to milk marketing. Calves, growing stock and dry animals normally do not receive any concentrate feed and survive mostly on dry fodder and green forage and tethered grazing. Concentrate feeds are fed mostly to milking animals. Almost all farmers make their own feed mixes.

5. DAIRY BREED AND THEIR PRODUCTION PERFORMANCE

Two major types of cattle dominate the Bangladesh dairy industry. Crossbred cattle constitute about 20% and are mainly produced by breeding local non-descript zebu cows and heifers predominantly with Holstein Friesian and Sahiwal bulls. Holstein Friesian bulls or semen brought into the country are mostly from Europe and Sahiwal are from Pakistan and India. A substantial number of bulls and semen straws were also brought from Australia and Canada. A small proportion of crossbred cattle were produced until 1990 by breeding local cows with Jersey bulls. Recently, BMPCU Ltd. re-introduced Jersey bull semen for AI in their areas of operation. Although local cattle have never been described as specific breeds, three types of cattle are considered to have the potential to develop into breeds, and some research in this area have been initiated. The most potential is with Red Chittagong Cattle which are small animals, mature females only weigh 150 - 200 kg and mature bulls weigh up to 450 kg. With good feeding and health care, these cows could produce 800 - 1000 kg milk/240 - 260 day lactation. Other potential cattle are Pabna Milking Cattle, North Bengal Gray and Deshi. The PMC cattle, found in the Pabna and Sirajganj Districts, are as big as Sahiwal cattle. The NBG cattle are smaller than PMC, with mature females weighing 200-250 kg and bulls 350-400 kg.
The buffaloes of Bangladesh are mostly river type although swamp type exists. Indigenous buffaloes are low yielding, but are stout draft animals. However, with the increasing trend to farm mechanization, the demand for these buffaloes as work animals is shrinking. Nevertheless, they constitute a very important natural resource as the foundation for a high yielding milk buffalo population through breeding up with dairy breeds. Bangladesh can, through these buffaloes, have an increased milk production of about 0.25 million tones/year and increased meat output of about 40,000 tonnes.

6. Quality Control in the Dairy Industry

Because individual milk testing is not carried out at the procurement level, farmers are paid a flat rate. Thus, there is no incentive for quality milk supply. Adulteration is common and as a result fat and or SNF (solid not fat) percentage in milk is low. Skim milk powder often has to be added to milk to make up the low SNF levels to meet the legal standard set for pasteurized liquid milk. Measuring sets for measuring milk below 500 ml are not supplied, though supplies below 500 ml are accepted and recorded. Further, the measuring sets used at the collection centre are not stamped by the statutory authority.

Legal standards for milk and milk products are fixed by the Bangladesh Standards and Testing Institution (BSTI). The standard for liquid milk was 3.5 percent fat and 8.2 percent SNF till 1977. Thereafter, it was revised to 3.5 percent fat and 8.0 percent SNF because of low levels of SNF problems reported by the dairies. The low SNF is largely on account of milk being not tested at the collection points which resulted in adulteration of milk with water. It was not a right decision to lower the SNF percentage to 8.0 as it has only resulted in further fall in SNF levels. A survey should be conducted by a technical body to find out the actual SNF level in cows' milk and on the basis of the findings, SNF standards may be fixed. The statutory authorities should check the quality of milk and milk products periodically throughout the value chain to prevent adulteration. It is time that efforts should be made to introduce quality consciousness with reference to chemical and microbiological standards (for adhering to sanitary and phytosanitary standards), right from the stage of milk production.

It is essential to develop appropriate systems for ensuring quality and safety of the end products like standardized milk, skim milk powder, whole milk powder, butter, ghee, traditional milk-based sweets and any other dairy products.

6.1 Input supply and service delivery

A participatory rural appraisal conducted in four districts with considerable dairy activities showed that the dairying requires feed and forage, veterinary and breeding services and bank loan as major inputs (Shamsuddin et al., 2007). A big gap exists in Bangladesh between the requirement and production of concentrate feeds for cattle.
Most of the milling by-products used as cattle feed in the name of concentrates are of poor quality in terms of digestibility, crude protein and energy content. This byproduct in the ration of a crossbred dairy cow often does not support its production potentials. Due to the crossbreeding activities of the last three decades, the crossbred cows did not only increase in number but also graded to almost Holstein in many cases. These cows would require a diet with real grain-based concentrates to support their genetic potential for milk production.

Artificial insemination (AI) service in Bangladesh is largely in the hand of the Department of Livestock Services (DLS) – a government organisation. The number of AI made in Bangladesh was 3.21 million in 2009, of which 2.5 million were made by the DLS. BRAC, an NGO, did 713 thousand AIs and BMPCUL did 75 thousand inseminations in 2009. About 40% of the cattle breeding are covered by AI. The conception rate of DLS AI services is about 50%. The BRAC AI services have claims a conception rate of 55-60%; however, the source was not published data. Although the conception rate can be regarded good, the genetic potential of the bull used in Bangladesh AI services are unknown. The situation is same in DLS and BRAC. DLS selects their bulls from the national dairy herd at Savar and from contact farmers all over the country. BRAC also selects their bulls from the private farmers. In both cases, these are crossbred bulls, which have generated mostly from the DLS AI programmes. The national dairy herd has an average production of about 5 L milk per cow per day. The lactation information of the private bull mothers are mostly the one given by the farmers. No milk recording from the bull station side is made and the situation is the same for the DLS and the BRAC. BMPCUL often imports bull calves from abroad. None of the AI service providers have the information on the progeny performance of the bull they use to produce semen.

The Department of Livestock Services (DLS) has extended its service coverage network up to Upazilla, the fourth tire in the administrative hierarchy in Bangladesh. The DLS veterinary service delivery strength includes 464 Upazilla Veterinary Hospital, 63 District Veterinary Hospital/District Diagnostic Laboratory, 1 Central Veterinary Hospital, 7 Regional Field Diseases Investigation Laboratory, and 1 Central Disease Investigation Laboratory. With this strength, Bangladesh has one veterinarian for 9,098 cattle, 444 buffaloes, 88,292 poultry and ducks and 8,652 small ruminants. The veterinary services are mostly in DLS’s hand. The DLS veterinarians work on-station. The on-station service cost very little to the farmer. However, to take that service, the farmers have to carry their animals to the Upazilla Veterinary Hospital, which in some cases could be as far as 20 to 30 km. Many farmers are reluctant to bring their animals to enjoy the on-station DLS veterinary services. They will seek services from unskilled, unregistered practitioners with variable results. The other choice is to pay a heavy charge to the on-station veterinarian and get the service on-farm. Moreover, mostly the sick animals get the treatment. Minimum services exist for the prevention of disease, although
a benefit of US $ 8.5 per cow per month was achieved after delivering a preventive veterinary service on farm (author's own findings).

6.2 Milk purchase from producers by the processors

Thirteen organisations handle liquid milk processing, product making and marketing in the formal sector (Table 4). About 7% of the total milk produced goes to the formal market. BMPCUL has the largest share comprising 49%. Aaaron and PRAN have the second (25%) and third share (11%), respectively. Pasteurised liquid milk, powder milk, UHT milk, ice cream, rasmalai, butter and ghee are the main milk and milk products marketed by the formal sector in Bangladesh.

Table 4. Volume of processed milk by different dairy companies

<table>
<thead>
<tr>
<th>Companies</th>
<th>Daily Collection (,000 litres)</th>
<th>Market share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMPCU Ltd.</td>
<td>250</td>
<td>49</td>
</tr>
<tr>
<td>BRAC-dairy</td>
<td>130</td>
<td>25</td>
</tr>
<tr>
<td>Pran dairy</td>
<td>55</td>
<td>11</td>
</tr>
<tr>
<td>Amomilk</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Bikrampur Dairy</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Ultra- Shelaida Dairy</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Aftab dairy</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>Tulip dairy</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Grameen / CLDDP</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Grameen-Danone</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>Rangpur dairy</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Akij dairy</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Savar dairy</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: Updated from Raha, 2009

6.3 Quality control in the traditional dairy sectors

The quality control is almost lacking in the traditional sector where middlemen buy milk from the producers and sell to gosh (traditional dairy product maker). The gosh pays the middleman based on the amount of chhana (Fat+SNF+calcium) and or cream produced from the milk. Unhygienic transportation without maintaining cold chain and water adulteration are possible sources of microbial contaminations. Addition of additives to prevent microbial growth contaminates milk with chemicals, which often are health hazardous.
6.4 Poor quality control limits the development of the dairy industry

Quality control of fresh milk and finished products are far behind consumers’ expectations in terms of food safety and sanitation. Consequently consumers are getting inclined to imported milk and milk products. The taste of Pasteurised cold milk and any dairy product depends on the quality of original fresh milk used as raw materials. Poor quality milk often with heavy bacterial load taste bad and therefore the consumers develop apathy to the locally produced Pasteurised milk and other dairy products. The overall investment climate including the problem of unfair means, poor law and order situation, severe infrastructure bottle necks and poor performance of the financial sector also affected private sector investments in the dairy industry and the performance of firms in the sector.

6.5 Factors that discourage producing quality milk

The current payment of milk price based on the fat percentage and lactometer reading discourages primary producers selling milk to formal processors. For instances, if the fat percentage is high, it is likely that the lactometer reading will be low in the same milk. The lactometer reading reflects the osmolarity, which can easily be manipulated. The payment should have been made on the basis of fat and SNF, the latter is very sensitive to addition of water. Currently a bonus is paid to the farmer at the end of the year on the basis of the amount of milk the farmer has given to the processor. This means, if a farmer had given milk with higher fat and SNF but smaller volume to the processor, he/she would get less amount of bonus than the farmer who gave low fat and SNF containing milk at a higher volume. There is no price incentive for milk with low bacterial load. Farmers do not get any benefit of bringing milk quickly after milking. Longer the time milk stays at the hot and humid temperature higher will be the bacterial load, which deteriorates the taste and flavour of milk.

7. Milk Collection, Preservation and Transportation

In addition to 7% milk processed by the organized sector, 15% is consumed by producer families and 78% goes to the traditional sector (Anon., 2008; Raha, 2008). Locally produced liquid milk is only 13% of the formal market with rest (87%) consisting of imported milk powder. Overhead costs in milk processing appear to be higher in Bangladesh dairies than in India (Anon, 2008). In Bangladesh, dairies sold milk at US$0.44/litre, after reducing the fat content to 3.5%, in 2006. In that year, Indian dairies sold processed pouch milk of similar quality at US$0.29–0.31/litre. Higher costs in Bangladesh appear to be due to lower volumes of milk processed and higher overhead costs. Increasing the milk processing industry size, increasing industry efficiency, adjusting industry profit margins and directing a larger share of profit to producers will help expand market size. Introduction of bulk vending for milk distribution would reduce overheads in packaging and distribution, and milk sold through bulk vending can be lower priced.
8. Milk Marketing

The milk marketing system in Bangladesh is widely diversified. The existing marketing systems are categorized into the traditional (informal) milk marketing system and formal marketing system.

8.1 Milk Supply Chain

Milk from the producer follows several channels to reach the processors’ industries or consumers directly. The detailed of the supply channels are shown in Figures 4 and 5. Farmers that belong to BMPCUL or to the CDVF require the fewest steps (1 to 3) to deliver milk to the processors or consumers. The rural farmers who do not have access to belong to the cooperatives require the largest number (up to 5) and most complicated pathway to sell their milk.

![Milk Supply Chain Diagram](image)

Figure 4: Milk supply chain – organized sectors
8.2 Value-added products

The organized sector markets pasteurized and pouch liquid milk, ultra heat treated packaged liquid milk, condensed canned milk, ice cream, yogurt and sweetmeats. Other products of this sector are butter, ghee and a small amount of cheese.

The traditional sector produces a variety of sweetmeats, curd and milk-based drinks, as well as cottage cheese and ghee. The history of traditional dairy products in the Indian Subcontinent is very old, since Vedic times about five thousand years ago. The followings are the key sweetmeats available in Bangladesh:

- Rasogolla is a famed chhana-based sweetmeat of Bengal, made from cows milk curd, which is kneaded into small balls that are boiled in clarified sugar syrup. The finished product is either of soft body or spongy syrup structure.
- Chamchams are round oval-shaped structures made of chhana, which are gently heated in clarified sugar syrup to a light brown colour.
- Rossomalai consists of small balls made of freshly prepared chhana and sugar syrup where the balls are heated gently and added to malai, the latter is prepared by boiling milk to light brown colour.
- Sandesh is prepared by heating the mixture of freshly prepared chhana and ground sugar on a slow fire to a soft structure with fine and uniform grains. Monda is a specialized sondesh, developed in the District of Mymensingh more than two hundred years ago. Kachagolla is a variety of sondesh, which contains more moisture than monda and classical sondesh. Sondesh has the lowest water content among the three types.
• Kalagam is a specialized type of sweetmeat consisting of chhana, sugar and wheat flour. In this case, oval balls of mostly chhana and flour are gently heated to dark brown before placing in sugar syrup.

9. CONCLUSIONS AND RECOMMENDATIONS

Bangladesh has a big gap between the amount of milk production and requirement. The gap will be widening in future if the low growth rate in milk production continues against the current trend of population growth, increase in GDP and urbanisation. Bangladesh heavily relies on milk powder imports and this dependent will be larger in the coming years if growth in milk production is not repositioned at a higher rates. Bangladesh has opportunities to increase the growth rate and support a much larger dairy industry than the existing ones. However, several constraints have been identified that need to be overcome. Recommendations are made to address the constraints and boost dairy development in the country.

• Government of Bangladesh (GoB) should institutionalise the recently formed Bangladesh Dairy Development Council (BDDC) man it accordingly allocate and specify its roles of business.
• GoB should strengthen the BSTI capacity by establishing a standard laboratory and manning it properly to watch the quality of market milk in terms of fat and SNF percentages, and bacterial load and drug residues.
• The DLS veterinary services should be made regulatory. It should be responsible for public goods and prevention, control and eradication of communicable diseases and diseases of public health and trans-boundary importance. The services should be directed towards ensuring food safety and sanitation and phytosanitary measures as per SPS Agreements.
• The DLS shall establish an epidemiological unit with its coverage up to all the Upazilla and port of entries to the country. It should be headed by a Director and be equipped with a disease diagnosis laboratory certified by OIE.
• The DLS should establish and manage a laboratory of international standards to quality control of feeds, drugs, vaccines, breeding materials and other biologicals to be used as inputs to the dairy industry, in the line OIE.
• The DLS should phase out leaving its production veterinary services, vaccine production and artificial insemination to the private sectors.
• The annual budget allocation for the development of livestock should be at least 50% of the contribution it make to the national GDP.
• Milk processing industries should as soon as possible introduce milk fat and SNF percent testing of individual producers’ milk at the society level and reset its pricing on the basis of fat and SNF percentage. Such practice will be an incentive
to quality milk producers. Strict quality control of raw milk will be a great incentive on the value addition of finished products.

- The processing industries should finance a research project to test the fat and SNF percent of milk collected directly from the cow’s udder covering good number of all possible breeds available all over the country. This will help dairy processors setting realistic SNF percentage at the society level.

- BMPCUL Management Board should concentrate mostly on the market expansion and leave technical issues like employment and procurement on the professional executives.

- The government share should be gradually tapered off and the BMPCUL should be given the liberty of running independently.

- BMPCUL should gradually leave the chilling tank ownership as much as possible to the dairy cooperative societies. This will help cooling milk promptly and thereby ensure better quality.

- NGOs and private milk processors should help organise smallholder producers in the form of registered societies or association and immediately give up the current practice of employing milk collection agents.

- NGOs and private milk processors should be in partner with an on-farm veterinary and AI service providers to link them with the producers’ societies.

- NGOs and private milk processors should encourage producers’ societies own the farm cooling tank. This will not only reduce their (industry) capital investment but also strengthen producers’ participation. The producers down the road will receive a larger portion of the consumers’ price.
10. REFERENCES


**ACRONYMS AND ABBREVIATIONS**

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Artificial Insemination</td>
</tr>
<tr>
<td>BDDC</td>
<td>Bangladesh Dairy Development Council</td>
</tr>
<tr>
<td>BMPCUL</td>
<td>Bangladesh Milk Producer’s cooperative Union Limited</td>
</tr>
<tr>
<td>BRAC</td>
<td>Building Resources Across Community</td>
</tr>
<tr>
<td>BSTI</td>
<td>Bangladesh Standard Testing Institute</td>
</tr>
<tr>
<td>CDVF</td>
<td>Community based Dairy Veterinary Foundation</td>
</tr>
<tr>
<td>DLS</td>
<td>Department of Livestock Services</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GOB</td>
<td>Government of Bangladesh</td>
</tr>
<tr>
<td>HIES</td>
<td>Household Income and Expenditure Survey</td>
</tr>
<tr>
<td>Milk vita</td>
<td>The trade name of Bangladesh Milk Producers Cooperative Union Limited</td>
</tr>
<tr>
<td>MT</td>
<td>Metric Ton</td>
</tr>
<tr>
<td>NBG</td>
<td>North Bengal Gray</td>
</tr>
<tr>
<td>NGO</td>
<td>Non Government Organization</td>
</tr>
<tr>
<td>OIE</td>
<td>World Organization for Animal Health</td>
</tr>
<tr>
<td>PMC</td>
<td>Pabna Milking Cow</td>
</tr>
<tr>
<td>PRAN</td>
<td>Programme for Rural Advancement Nationally</td>
</tr>
<tr>
<td>RCC</td>
<td>Red Chittagong Cattle</td>
</tr>
<tr>
<td>SNF</td>
<td>Solid Not Fat</td>
</tr>
<tr>
<td>SPS</td>
<td>Sanitary and Phytosanitary</td>
</tr>
<tr>
<td>UHT</td>
<td>Ultra Heat Treated</td>
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Dairy Production, Quality Control and Marketing System in Bhutan

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EXECUTIVE SUMMARY

Livestock rearing forms an essential component of the Bhutanese farming system with an estimated 90% of the population rearing livestock. The production systems in the country is largely determined by the variation in agro-ecological conditions with migratory herding of yaks in the high altitude regions, sedentary rearing of exotic breeds such as Jersey and Brown Swiss to systems where cattle are reared mainly for manure and draught power.

In keeping with the policies of the RGoB for poverty reduction, the livestock sector albeit with setbacks and hindrances is identified as having an important role to play to achieve the goal within the 10th FYP (2008 – 2013). Accordingly the National Policy for Dairy Development addresses the constraints faced and identifies the major interventions to be made. The Jersey and Brown Swiss will be maintained as the principle dairy breeds with 50% crosses in remote and small holder production areas and crosses of higher blood level in peri-urban areas based on the managerial capacity of the farmers. Dairy potential areas have been identified along with the encouragement for formation of farmers groups. Furthermore, intensification of breeding activities through the establishment of AI centres, mobile AI, estrus synchronization and CBPP is being carried out. Cattle feed and fodder resources are being strengthened through integration of pasture with horticulture and supply of free pasture seeds and fodder saplings to farmers as well as the promotion of winter fodder.

The native breed of the country known as Nublang has a relatively low yield with 393 L/lactation while cross bred cattle have a higher yield with 658 L/lactation for Brown Swiss crosses and 852 L/lactation for jersey cross. The cross bred animals produces a higher yield of 2300 L/lactation for Brown Swiss and 2440 L/lactation for jersey in government farms. The jersey cattle contribute to 42% of the total milk production from the 15% of the cattle population while the local cattle contribute to 32% of the milk production from the 50% of the cattle population. Cattle population trends show that the numbers of exotic breeds are on the increase but a reduction in the size of local herds is not evident. This is due to religious sentiment that discourages the slaughter of animals.

The milk production system in the country is classified as traditional, transitional and progressive. Farmers in the traditional system still practice migration of herds to follow availability of fodder, while the transitional farmers are shifting from the migratory system to a sedentary system through cross breeding with exotic breeds and construction of permanent cow sheds. The progressive farmers are either the progressive Brown Swiss with majority of the herd comprised of Brown Swiss cattle or the progressive jersey with their herd comprised of jersey cattle. These farmers practice stall feeding and have access to improved pasture. Farmers are also bought together to form dairy farmers groups as a means of increased income and milk production. Currently 31
organized dairy farmers groups exist. The dairy groups are supported through the construction of MCCs, MPUs, provision of training and supply of dairy equipments.

The NCAH functions as the apex body for all matters related to animal health and is supported by the Dzongkhag Veterinary Hospitals, Regional Livestock Development Centres, Satellite laboratories, Regional Veterinary Laboratories and a Vaccine production centre. Common infectious diseases in the country such as FMD, HS, BQ and respiratory diseases are controlled through mass vaccination. Parasite infestation is also a major economic disease for milk production and periodic deworming is advocated along with regular fecal sampling.

The cattle breed improvement programme in the country is coordinated by the NLBP supported by the Dzongkhag Livestock Offices, Central farms and Units and the RLDC. Breed improvement is carried out by AI where feasible or through the supply of breeding bulls to areas where AI is not feasible.

The use of feed resources varies according to the agro-ecological conditions and the most common resources available are forest grazing, cultivated fodder and crop residues. Additionally improved pastures, fodder trees, fodder crops and concentrate feed mixtures are also important feed resources.

The majority of dairy products are imported from India and a smaller quantity overseas. The BDAL with a capacity of 20,000 LPD produces UHT toned and double toned milk in tetra brig aseptic packages and another dairy processing plant with a production capacity of 6600 LPH is soon to be established by a private company. The government also supports dairy processing plant with a mini dairy plant established for the production of pasteurized whole milk to cater to the milk demand in Thimphu. Even smaller cheese processing units, producing Gouda type cheese are established.

The milk production of the country is largely converted into butter and cheese. High altitude regions produce a hard variety of cheese known as Chugo and fermented cheese known as Phelu and Zoethey that are allowed to naturally ferment. Milk is also marketed as fresh milk when sold in urban centres and areas with easy access to market.

The supply of milk is subject to basic quality tests for milk supplied by dairy groups and the Dzongkhag Livestock Offices are also involved in imparting training on hygienic milk production. Additionally BAFRA monitors the quality of local and imported products.

Dairy products produced by farmers and dairy groups are marketed through three channels; products are delivered directly to consumers by the producers, products are sold to middlemen or traders who then markets it to consumers and producers deliver products to MCCs or MPUs, then to retailers and finally to consumers. The first system is followed by farmers following the traditional production system, while the other two are applicable to established dairy groups.
1. INTRODUCTION

Bhutan is a small landlocked Kingdom located in the eastern Himalayas between latitudes 26° 40’ and 28° 20’ north and longitude 88° 45’ and 92° 7’ east. The country has an area of 38,394 square kilometers (National Statistical Bureau, 2009) bordered by China to the North and the Indian states of Sikkim, West Bengal, Assam and Arunachal Pradesh to the west, south and east.

Bhutan has 20 Dzongkhags, with 205 Geogs and a population of 683,402 (NSB, 2009). It is characterized by a great diversity of environments with high rugged mountains and deep networks of valleys, ravines and depressions earmarking watercourses, drainage basins, waterfalls, human settlements, glacial lakes and moraines (MoAF, 2002). The elevation of the country begins from 100 meters above sea level (masl) in the south to more than 7550 masl in the north and can be classified into different agro-ecological zones; the southern foothills, inner Himalayas and the high Himalayas determined by altitude, rainfall and topography.

Livestock and associated farming systems differ from one agro-ecological zone (Annexure 1) to the other and is largely a subsistence farming system. It is estimated that approximately 70% of the population are engaged in agriculture and over 90% of the population rear livestock (MoAF).

1.1. Background

Livestock is an essential part of the Bhutanese farming system with a range of livestock production systems dictated by the large variation in environmental conditions, ranging from the high altitude transhumance yak-sheep system to systems where animals are used for draft and manure only. Livestock has also traditionally been a measure of wealth, families with larger numbers of cattle were considered wealthier. Cattle are the most numerous livestock available and constitute approximately 79.5% of the total ruminant population. The local cattle population including Mithun (*Bos frontalis*) accounts for 80% of the population and the rest comprised of improved breeds such as the Jersey and Brown Swiss (Livestock Statistics, 2008).

The production system for Yaks involves the annual migration of herds from alpine rangelands (approx. 5000 masl) to low land winter pastures (approx. 2500 masl) due to the shortage of pasture and the inhospitable conditions in the high altitude regions during winter.

Many local cattle herds at altitudes between 2500 – 3000 masl also follow the seasonal migrating pattern. This is attributed to the unavailability of winter fodder and the need to safeguard the cattle from extreme cold weather (Ura K, 2001). Animals with higher exotic inheritance are not adapted to the migration pattern and are mostly reared around the family home and normally stall fed and grazed on improved pasture fields along with concentrate and crop residues.
The guiding philosophy in the development of the country is centered on Gross National Happiness (GNH) rather than Gross Domestic Product (GDP). Development through GNH follows the four pillars of sustainable and equitable economic growth, conservation and sustainable use of the environment, preservation and promotion of cultural heritage and good governance.

The Royal Government of Bhutan (RGoB) in its 10th Five Year Plan (FYP) from 2008 – 2013 has set the overall goal of poverty reduction with the intent of reducing the proportion of population living below the poverty line (Planning Commission Secretariat, 2006). The strategies framed to achieve this are through rural development, balanced development at the regional and local levels, private sector development and infrastructure development.

The Renewable Natural Resource (RNR) sector is seen as instrumental in the reduction of rural poverty as it is still the main source of livelihood for about 69% of the local population. It contributes 26% of the GDP of which 8% comes from livestock and 7% from forestry (RMA, 2005). Within the RNR sector, livestock sub-sector has important role in boosting rural economy and alleviating poverty.

However, enhancing livestock production is not without its setbacks. The smallholder livestock production system, traditionally low input husbandry practices with periodic migration, low productivity from existing livestock breeds, conservative attitudes towards modern farming methods, insufficient feed and fodder-especially during lean season that results in reduction of yield, disease outbreaks and social taboo to cull unproductive animals are some of the hindrances.

The domestic milk production in 2008 was estimated at 22,882.59 MT (Livestock Statistics, DoL 2008). A substantial portion of the local dairy products requirements are met through imports from neighbouring India and overseas (Figure 1).

![Dairy Product Import (MT)](image-url)

*Figure 1: Dairy product Import (Source: Bhutan Trade Statistics)*
The import of dairy products are dominated by the imports of powdered milk with an average of 1,352 MT imported over 2006 – 2008. This could be attributed to the limited availability and short shelf life of fresh milk that promotes the purchase and consumption of powdered milk. Additionally, in regions that have limited accessibility, the use of powdered milk is preferred due to their longer shelf life and ease of transportation. The import of liquid milk is however showing a steady decline with increased domestic milk production. No local dairy processing plants are engaged in the production of powdered milk, mainly due to the limited supply of milk as a raw material.

1.2. Objectives of the Study

The objectives of the study are to share knowledge and information among SAARC countries on

- Current scenario of dairy production in Bhutan
- Support in milk production, processing and marketing
- Quality control measures adopted

2. National Policy for Dairy Development

The national policy for dairy development in Bhutan focuses on;

- Maintaining Jersey and Brown Swiss as principle dairy breeds and the choice of breeds offered to farmers without restricting the geographical barrier for breeds except to the original breeding tract of native siri breed called Nublang. The siri cattle are the base population for cross breeding with other dairy breeds. However, sizable population of native cattle shall be maintained (Livestock Breeding policy, 2007)
- formation of dairy farmers’ group in dairy potential areas and provide support in group form in construction of milk collection centre, establishment of milk processing unit and marketing as well as subsidy support in dairy sheds construction
- strengthening AI services in the country via establishment of AI centres wherever feasible and estrus synchronization in dairy potential areas. Imported progeny tested semen shall be used in areas identified for source of breeding bull procurement such as govt. run nucleus farms and Contract bull production programmes (CBPP), whereas locally produced frozen semen shall be used in other areas
- procurement of breeding bulls as per set criteria and supply free of cost inclusive of transportation to the communities where AI is not feasible
- use of government fallow land for community pasture development
• Encourage buffalo production in the southern belt and improve Yak husbandry practices among yak herders in the north
• integration of pasture establishment with horticulture and supply of free pasture seeds and fodder saplings to farmers
• provide free animal health services

The Dairy Development Division of the Department of Livestock is spearheading the development of the dairy sector into commercially viable enterprise in the country through involvement of private entrepreneurs under Public-Private Partnership (PPP). Concerted efforts have been made to increase domestic milk production and eventually achieve the substitution of imports.

A long term Masterplan for the development of the dairy sector in the country is currently being formulated. For dairy production intensification the policy documents on livestock subsidy, Public – private partnership and revolving fund have been formulated.

Additionally, the Accelerated Bhutan Socio-economic Development (ABSD) plan formulated by the McKinsey & Company recruited by the RGoB for accelerating the socio-economic development of the country has also identified the development of the dairy sector as a potential means of achieving the goal. In collaboration with the DoL, a total of 8 dzongkhags has been identified for increasing the milk production of the country to 150,000 liters by 2013. The majority of the production is to be supplied to the upcoming Zimdra Foods Pvt Ltd that has the capacity to absorb the entire milk production of the 8 dzongkhags. Work plans till 2013 in consultation with the involved dzongkhags has been formulated and are in the initial stages of implementation.

3. DAIRY ANIMALS/BREEDS AND THEIR PERFORMANCE

The animals existing in the country as dairy breeds are Nublang, Mithun cross, Jersey pure and cross, Brown Swiss pure and cross, yak and buffaloes.

Nublang is found throughout the country. Although a poor milk producer, this breed has survived over centuries as a result of its adaptability to different agro-ecological systems, its disease resistance, and its usefulness as a draught animal. Siri are used as the base stock for developing composite breeds with breeds like Jersey, Brown Swiss, and Mithun. The Mithun crossbreeds are more common in the lower temperate and subtropical regions (150-2,600m); the Mithun males are popular as draught animals and the females because they have a higher fat content in their milk. Brown Swiss crossbreeds are found in the higher altitudes of the temperate region, whereas Jerseys are more prevalent in the lower temperate and subtropical regions of the country. Yaks are found in alpine regions of the country. A small number of Swamp crossbreeds and improved buffalo (mainly Murrah) are also found in the southern belts.
The introduction of exotic crossbred animals has led to the reduction in the size of the herd in the dairy potential areas and an increasing percentage of the sedentary system with higher milk productivity per animal.

A steadily increasing trend in the exotic high productive animals such as Jersey cross and Brown Swiss cross can be seen over the years (figure 2). However, this has not lead to a decrease in the population of local breeds predominantly due to Buddhist sentiments against the slaughter of animals.

![Figure 2: Cattle population trend (2006 – 2008) by breed (Livestock Statistics 2008)](image)

The distribution of the local cattle as in annexure 2 is predominantly centered around the southern and eastern regions of the country, with the southern Dzongkhag of Samtse having the overall highest population with 32,435 and Trashigang having the highest population of 15,669 in the east. The Jersey cross cattle are distributed throughout the country with Trashigang having the highest population with 7,543 while Gasa in the north has the lowest with 108. This is attributed to the fact that the northern regions of the country are mostly engaged in the rearing of yaks as can be seen from the dominance of yaks in Thimphu, Trashigang and Gasa. The distribution of Brown Swiss is more restricted in Bumthang and nearby dzongkhags due to the breeding barrier imposed by the government, which has since been lifted.

The milk production of the local cattle are relatively low with a yield of 393 liters per lactation while crossbred cattle have a higher yield with 1299 L/ lactation on average for the Brown Swiss Cross and 1479L/ lactation for the Jersey cross at the small holder farmers’ level. The average performance of the exotic breeds in CBPP farms produces a yield of 2165 L/lactation for Brown Swiss and 2755 L/lactation for Jersey pure.
Nevertheless, the average production of siri cattle at National Nublang Breeding farm, Tashiyangphu is 3.8L/ day (Rai and Chungsila, 2010).

The milk production categorized on breed of animal present in the country along with their average milk yield (Av. MY), lactation length and total milk production in kilograms inclusive of household consumption and product diversification is illustrated in table 1 and figure 3.

Table 1: Milk Production by species

<table>
<thead>
<tr>
<th>Category</th>
<th>In Milk</th>
<th>Av. MY</th>
<th>Lact. Length</th>
<th>Prod (Kgs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Cattle (Nublang)</td>
<td>35,543</td>
<td>1.50</td>
<td>240</td>
<td>12,795,480</td>
</tr>
<tr>
<td>Mithun Cross</td>
<td>10,209</td>
<td>2.00</td>
<td>240</td>
<td>4,900,320</td>
</tr>
<tr>
<td>Yak</td>
<td>13,319</td>
<td>0.82</td>
<td>240</td>
<td>2,876,904</td>
</tr>
<tr>
<td>Jersey Pure</td>
<td>239</td>
<td>9.10</td>
<td>305</td>
<td>663,345</td>
</tr>
<tr>
<td>Brown Swiss Pure</td>
<td>26</td>
<td>7.10</td>
<td>305</td>
<td>56,303</td>
</tr>
<tr>
<td>Jersey Cross</td>
<td>10,846</td>
<td>4.85</td>
<td>305</td>
<td>16,176,267</td>
</tr>
<tr>
<td>Brown Swiss Cross</td>
<td>1,211</td>
<td>4.26</td>
<td>305</td>
<td>1,573,452</td>
</tr>
<tr>
<td>Others</td>
<td>171</td>
<td>1.50</td>
<td>240</td>
<td>61,560</td>
</tr>
<tr>
<td>Total</td>
<td>71,564</td>
<td></td>
<td></td>
<td>39,103,631</td>
</tr>
</tbody>
</table>

Source: RNR RC Jakar, 2008

The highest contribution for the total milk production in the country comes from the Jersey cross cattle at 42% although they account for only 15% of the cattle population. The local cattle population accounts for 50% of the cattle but only contributes 32% to the total milk production. The Mithun cross cattle at 14% of the cattle population contributes...
12% to the milk production, while the yaks contribute 7% and the pure jerseys 2% due to their limited numbers.

The increase in the number of cross bred cattle is directly contributing to the increase in the production of dairy products.

The domestic production (figure 4) of liquid milk consumed as fresh has increased from 19,927.61 MT in 2005 to 22,882.59 MT in 2008. The production of butter and cheese is around 1,402 MT and 5,513 MT over the past four years. Approximately 13% of the domestic milk production is sold while 59% and 58% of the butter and cheese production are sold (Livestock Statistics 2005 – 2008).

![Domestic Production of Dairy Products (MT)](image)

*Figure 4: Domestic Production of Dairy Products (Source: Livestock Statistics 2005 – 2008)*

4. MILK PRODUCTION SYSTEMS

The milk production system in the country is largely subsistence based with an average household rearing about 2 – 3 cattle along with other livestock and crop production. There are no privately owned commercial dairy farms that cater to the supply of milk to the public while the government farms are mainly involved in the breed improvement of the cattle. The Department of Livestock, MoAF has initiated the formation of dairy groups whereby members of the group supply their milk to their respective MPUs for processing and marketing.

The production system in Bhutan is categorized into traditional, transitional and progressive systems (Dreville, 2007). In the traditional system farmers rear mostly local cattle and still practice migration of cattle to follow availability of fodder and marketing outlets for products. In these system, the milk produced is home consumed and the surplus is converted into butter and cheese. In the transitional system, farmer’s rear local breeds but have started to resort to cross breeding with exotic breeds. They are also
shifting from the migratory to sedentary system with the construction of permanent cow sheds and changed feeding practices. The progressive system is classified into progressive farmers rearing Brown Swiss and Jersey, where farmers have proper cow sheds and improved pastures (Dreville, 2007).

The formation of farmer groups are becoming increasingly popular with the rural populace as they begin to realise the benefits of working in groups. As such various groups have sprung across the country dealing in dairy products, fodder groups and marketing of products.

Currently there are 31 dairy farmers groups in existence (Annexure 3) that are differentiated by the type of activity they are involved in; Fresh Milk Marketing Group, Processing Group and Marketing Groups. The first group is involved in the collection and sale of fresh milk, the second in the collection of fresh milk and processing into local butter and local cheese and the third group in the collection and marketing of processed butter and local cheese from individual member households for collective marketing.

The operation and processing of products are either carried out by the group members themselves or by hired staff. The group activities are not restricted to the production and marketing of dairy products but are also involved in the sale of fertilizer and feed to group members. They have also established a savings fund that is deposited into a collective group account. The marketing groups will soon be transformed into a processing group for hygienic and consistency in quality of the products.

In addition to the revenue generation through the formation of farmers groups, the problems of labor shortage is also addressed and through the generation of employment in the groups, the rural-urban migration will be reduced. As per the framework of the cooperatives act 2001, high priority support for formation of cooperatives and associations bringing together communities, households and individuals with common interests, it is intended that such bodies will serve to bring together poor and marginal farmers for engaging in economically viable enterprises by pooling their resources as well as sharing the operational costs. They will be the embodiment of the Royal Government’s policies on decentralisation, people’s participation, privatisation, self-help and self-reliance (The Cooperatives Act of Bhutan, 2001).

As per the Livestock statistics, the domestic production of dairy products over the past 3 years is illustrated in figure 5.

The production of liquid milk has increased from 20,059MT in 2007 to 22,882MT in 2008. The production of datshi remains more or less stabilized while there is a decrease in the production of butter in 2008. This could be due to the increased sale of fresh liquid milk that limited the milk available for production of butter.

Further, the approach to enhance dairy production is aimed through vertical and horizontal increase of milk production. The vertical approach includes increase in milk production by increase in no. of improved cattle heads per households and increase in
productivity per cow through improved feeding and management. The horizontal approach aims at increasing the population of productive cattle through intensive crossbreeding with local cattle with exotic Jersey and Brown Swiss and increasing the number of dairy farmers group.

Figure 5. Dairy Production trend (Source: Livestock Statistics)

5. DAIRY ANIMAL HEALTH AND PRODUCTION SERVICES

Animal health is plays an important role in animal production. In turn animal health is influenced by factors such as disease resistance, nutrition, and the animals’ environment. The most common infectious diseases of cattle in Bhutan are foot and mouth disease (FMD), haemorrhagic septicaemia (HS), black quarter (BQ), and respiratory diseases. Control of diseases such as FMD, BQ, and HS are carried out through regular mass vaccination.

Parasite infestation is a major economic disease as it affects milk production to a considerable extent. Intestinal worm infestations and external parasite, mainly tick, infestation were the major problems in cattle. Infestation by liver fluke is very common in rice-growing areas while roundworm infestations are more widespread. Periodic deworming is advocated to control these parasites. Adequate veterinary services are provided to farmers for prevention of these infestations by the livestock extension centres.

Diseases that influence milk production are various reproductive disorders, nutritional deficiency diseases, and mastitis. The incidence of nutritional deficiency diseases has not been recorded. The incidence of sub-clinical mastitis in eastern Bhutan was found to be about 24% (Sharma et al. 1998).
Cattle health management is recognized as an important aspect of dairy production. Farmers ensure their cattle herds are vaccinated in time against all major and notifiable diseases. Animal health care services are provided by one veterinary hospital in each district and 136 livestock extension centres. These field services are supported by a national referral laboratory at National Centre for animal Health (NCAH), four regional veterinary laboratories at the Regional Livestock Development Centre (RLDC), satellite laboratories and a vaccine production centre. All the laboratories are reasonably established and well equipped to provide animal health services coordinated by NCAH.

The cattle breed improvement programme in the country is coordinated by the National Livestock Breeding Programme (NLBP). The two govt. farms for pure jersey and Brown Swiss serve as a model to farmers on dairy farm management. The govt. initiated Heifer production programme procures the excess heifers from farmers and are reared, impregnated and distributed to other farmers while the calf rearing centre procures the male calves that are burden a to dairy farmers and reared till breedable age. The bulls fit for breeding are sent for breeding in extension and unfit bulls are sent to slaughter houses.

The breed improvement programme is carried out by providing AI services in all feasible areas and supplying breeding bulls to the communities/areas where AI is not feasible. For the source of Jersey and Brown Swiss breeding bulls, CBPP had been initiated with the progressive farmers region wise and govt. farms are strengthened where progeny tested frozen semen are imported and used. In other extension areas, locally produced frozen semen from NLBP is supplied. In order to initiate selection programme the National Cattle Identification and Recording system had been initiated in govt. farms and CBPP areas. Besides, the NLBP also conducts cattle fertility campaign, estrous synchronization programme, and imparts training to the farmers on dairy management, record keeping, and group formation.

The programme while focusing on cross breeding programme for breed improvement to enhance dairy production is also responsible for conservation of native breeds in collaboration with National Biodiversity Centre. The improvement of native breeds’ performances selection programme have been initiated in ex-situ conservation farm and in Nublang original breeding tract.

6. **Dairy Animal Nutrition and Feed Industry**

The use of feed resources in the mixed farming system prevalent among the farmers in Bhutan is influenced by the cropping system, agro-ecological conditions, and the type of animal reared on farm. The most common feed resources available to farmers are forest, cultivated fodder, and crop residues. A survey in 1996 in the temperate regions of the country has shown that forest grazing are the most important feed resources (Table 5).
Feeding of hay in the winter months contributes substantially in areas where improved pasture is well established. Rice straw, barley straw, wheat straw, and maize stovers also contribute about 13% of the feed during the hungry-gap period (November to March). In areas where paddy is not grown, fallow field grazing seems to be the dominant feed resource in winter.

Table 5: Contribution of fodder resources to the national fodder requirement

<table>
<thead>
<tr>
<th>Fodder Source</th>
<th>Relative Contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest grazing</td>
<td>23</td>
</tr>
<tr>
<td>Natural grassland</td>
<td>38</td>
</tr>
<tr>
<td>Improved pasture</td>
<td>9</td>
</tr>
<tr>
<td>Fallow land</td>
<td>15</td>
</tr>
<tr>
<td>Fodder trees</td>
<td>15</td>
</tr>
<tr>
<td>Crop residues</td>
<td>13</td>
</tr>
</tbody>
</table>

Source: Roder et al., 1999

Cattle grazing on undergrowth and browsing several species of fodder shrubs in the forest provide about 20% of the fodder requirements for the cattle population in the country (Roder et al. 1999). Fodder tree branches are sometimes cut and carried to the homestead to be stall fed to milking cows or as a supplement to grazing, especially during the winter months.

The temperate regions of the country have the largest areas of improved pasture on a household basis with more than 0.2 ha per milking cow and this has been cited as the most important fodder source in the temperate areas (Roder et al. 1999). Improved fodder is mainly fed to milking cows, bulls, and growing cattle. Excess grass is cut and made into hay for winter feeding in these areas. In the temperate areas, improved pasture consists of a mixture of white clover, tall fescue, cocksfoot, and Italian rye grass while in the subtropical areas, green leaf desmodium, molasses grass, ruzi grass, and stylo are grown.

Traditionally, farmers grow small quantities of fodder crops that are fed primarily to milking cows and draught animals during the dry season. At an elevation of 2,500-4,000m, the most important fodder crops are turnips, radishes, and pumpkins. At high altitudes, individual households may cultivate up to 0.3 ha of turnips annually (Roder et al. 1999). At lower altitudes, maize is cultivated, to be fed to draught animals during rice transplantation. Wheat is cultivated in a range of production systems including the rice-based systems after the rice harvest. Oats, by virtue of higher biomass production, have partly replaced wheat as a winter fodder in the rice-growing areas of Thimphu, Paro, Wangdue, and Trongsa.
Fodder trees are important feed resources in many parts of Bhutan especially during the dry winter season. In fact, fodder trees were reported to be the most important fodder source in Punakha, Wangdue, Trongsa, Chukha, Zhemgang, Lhuntsi, and Mongar where between 76 and 100% of households have fodder trees with individual households owning between 1 and 1,015 trees (Tshering et al. 1997). At elevations above 2,000m the choice of fodder tree is limited.

Crop and agro-industrial residues account for a major portion of the feed requirement of cattle. Maize, wheat, and buckwheat straw are important winter feeds in the areas where they are grown, while rice straw is used by almost all farmers in rice-growing areas. Other important crop residues include inferior and broken grain, husks and chaff (by-products of milling). Residues from chang (local brew) production also provide an important feed for dairy cattle.

Commercial concentrate feed mixtures are supplied by the only private feed manufacturing plant located at Phuentsholing, with most of the ingredients being imported from India due to limited availability or the expensive nature of the raw materials locally. Concentrate feed is unaffordable for most traditional and transitional farmers. These farmers feed their cattle with concentrate mixture consisting of mustard oil cake, maize flour, chang residue, salt, kitchen waste (Phanchung et al., 2002) while progressive farmers depend on concentrate feed mixture.

7. **GENDER ROLE/GENDER DYNAMICS IN MILK PRODUCTION**

Since livestock farming is an important component of the rural livelihood, the activities for milk production are shared by family members. Roder et al. (1999) however states that the contribution of women are higher for activities related to milking, milk processing, feeding, feed preparation and fodder collection as men are more likely to engage in off farm work. This is illustrated in figure 6. Children also contribute to activities and play a significant role in the herding of cattle.
8. EDUCATION IN DAIRY AT PROFESSIONAL AND TECHNICAL LEVELS

The country is dependent on training institutions in India and overseas for education in dairy at both the professional and field levels. Technical level field staffs are trained at PTC+ in the Netherlands and these personnel are fielded in the dairy potential areas to supervise and provide trainings in the operation of MPUs. Additionally regular trainings on hygienic milking and dairy production are carried out by the DoL for both farmers and extension agents. Trainings on cheese making technology are also conducted with technical experts recruited from overseas.

9. RESEARCH AND DEVELOPMENT IN MILK PRODUCTION

The majority of the processing activities is carried on a small scale system and relies on the traditional methods of processing however the DoL has supported the growth of these small industries through the supply of milk processing equipments to enhance the quality and hygiene of dairy products. With the institution of dairy group formation, the volume of milk production has also shown a steady increase. Additionally the establishment of organized dairy groups and the institution of improved hygienic production methods have led to an increase in demand for dairy products due to higher product uniformity and better quality products. Trials are also initiated for the production of Swiss type cheese with yak milk at the individual household level as collective production is not feasible due to the long distance between the herds.

10. NUMBER OF DAIRY PROCESSING PLANTS

The Bhutan Dairy and Agro Products Limited (BDAL) through support by the Swed fund, Sweden has established the first Ultra High Temperature (UHT) milk plant in the country with a capacity of 80,000 liters of milk and fruit juices. The company currently produces and markets the “Duyul” brand of toned and double-toned UHT milk in 200ml and 1 liter Tetra Brix Aseptic packs and the “Dew Fresh” brand of fruit juices in 200ml packs. The BDAL is also HACCP certified.

Zimdra Foods Pvt. Ltd will be established by Zimdra Industries Pvt. Ltd with a production capacity of 6,600 Litres per hour Tetra Pak UHT plant for the manufacture of UHT milk, butter, yoghurt, flavored milk and fruit juices. The company will initially source 20% of the total milk requirement from Bhutan that will be further increased to 70%. The company will as such work in close collaboration with the DoL in improving and increasing the milk production capacity of the rural farmers (Zimdra Project Proposal, 2010).

The Department of Livestock through the support of the GoI Livestock Project operates a yoghurt manufacturing plant in Thimphu with a production capacity of 250 liters/day. The products are marketed in 100ml, 150ml and 400ml plastic containers and
sold through retailers. The DoL will soon establish a 2000 liter per day milk pasteurization plant also in Thimphu that will also have the capacity for the production of 300 liters of yoghurt. The plant is being established to cater to the demand of consumers for fresh whole milk and to increase the shelf-life of milk supplied by the TPUDFG. Milk collection will further be expanded to include the regions of Paro and Haa thereby providing a ready market for the dairy groups in these regions.

Two small scale cheese units in Gogona, Wangduephodrang and Bumthang are engaged in the production of Gouda type cheese. These units however produce only a small quantity of cheese that is marketed to the urban centers.

11. **Value Added Dairy Products in Formal and Traditional Dairy Sectors**

Milk produced in the country is either consumed or marketed as fresh milk with the surplus being converted into local butter and cheese. In the higher altitude regions, some of the milk is kept for home consumption while the majority is converted into butter, cheese and fermented cheese for increased shelf life. Value addition in the formal dairy sector also follows a similar pattern, with some dairy groups marketing fresh unpasteurized milk while others produce butter and local cheese (datshi).

Local butter is traditionally produced from natural soured milk and is unsalted. This practice still continues in farm houses and also in the various dairy farmer processing groups. The churning of butter is traditionally carried out in piston wooden butter churners and is a time consuming activity. The dairy farmer groups that process and market butter are equipped with modern small scale stainless steel electric or hand operated butter churners (figure 7) and cream separators (figure 8). The formation of groups has eased the burden for individual farmers having to churn their surplus milk into butter that is now carried out collectively by either group members or by hired personnel. The products are also packaged in butter packaging paper and marketed.

Datshi or local cheese (figure 9) is manufactured from butter milk and is an important component of the Bhutanese diet. The datshi is produced in both traditional and established MPUs. The product is shaped into a ball with an average weight approximately of 250gms, packaged and marketed.

The other traditional dairy products are Chugo, Phelu and Zoethey. Chugo is a variety of cheese that is
manufactured from yak milk while Phelu and Zoethey are fermented cheese produced in the alpine region.

In the formal dairy sector yoghurt is one of the value added products produced in Thimphu. The product is marketed in 100ml, 150ml and 400ml plastic cups with the market solely in the capital city of Thimphu.

The BDAL and Zimdra dairy plants produces UHT toned milk in tetra brik packages that are marketed to major urban centers in the country. The products are marketed under the brand name Duyul for BDAL and Zimdra for Zimdra Foods Pvt Ltd. Zimdra dairy however does not have a production unit located in the country and packages their products from India. The company will initiate production at a local site upon completion of the construction of their dairy plant. In addition to UHT milk, both companies are also engaged in the production of fruit juices.

12. Quality Control

The traditional dairy sector involves many small holder farmers scattered throughout the country and majority of their produce is home consumed or given as gifts to family members. A very small portion of these products are sold in the market.

The various Dzongkhag Livestock Sectors in the different regions of the country continually imparts training and provides technical support on various aspects of hygienic milk production and processing of milk. The sector also provides veterinary services to the farmers and discourages the farmers on the supply of milk from animals undergoing antibiotic treatment. The various extension agents along with the Dzongkhag livestock office and the DoL are continually involved in the screening of animal health and disease outbreaks.

There are several dairy farmers groups that are operational in the country. The individual member farmers supply the milk to the collection and processing unit that is either marketed as fresh liquid milk or processed into butter and datshi. The milk received at these collection points are subject to basic quality tests. These tests include the organoleptic tests, lactometer test, clot on boil test and the alcohol test. Some random samples are also subject to the geber butterfat test to check for the fat content of the milk. For increased quality assurance the supply of milk analysers that checks for fat, proteins, SNF, total solids and added water has been initiated and by the end of 2010 all MPUs and collection centers will be equipped with the milk analysers. Additionally, some of the MPUs are also equipped with testing kits for adulterants in milk.

The Bhutan Agriculture and Food Regulatory Authority (BAFRA) carry out regular inspections for monitoring the quality and standards for local and imported products. BAFRA has established a laboratory where tests on the standards and quality of food products are carried out.
13. MILK MARKETING IN THE FORMAL AND TRADITIONAL DAIRY SECTORS

Dairy farmers that are not part of the dairy groups generally have 1 – 2 cows reared on farm. The milk and dairy products from these cattle are mainly used for home consumption and as such marketing of dairy products remains very basic and limited to the management of local surpluses and shortages. No organized marketing system exists in the traditional dairy sector expect for the occasional unplanned surpluses being bartered or sold for cash (Phanchung et al, 2002).

However, with the formation and expansion of dairy groups a structured marketing system has come into existence with the support of establishing MCCs and MPUs.

13.1. Milk Collection, Preservation and Transportation

Farmers involved in the dairy farmer groups supply their morning milk to the MCC or directly to the MPU. The collected milk then converted into butter and cheese and packaged for marketing. As the collection centres and MPUs are built in close proximity of the village, the farmers deliver the milk in 5 – 10 liter milk cans or plastic jerry cans. The MCCs and marketing outlets dealing in fresh milk are equipped with milk chillers.

Each group have their own group savings and expenditure incurred in the transportation of products to the market outlets are met from the group savings.

13.2. Milk Supply Chains

The production and distribution of locally produced milk and milk products follow the schematic presented in figure 10.

As described under the section on Milk Production Systems, there are three types of dairy groups engaged in the production and sale of dairy products. In relation to the flow of products from the farm to consumers Phanchung et al. (2002) identified three systems:

- Producer – consumer
- Producer – middlemen or traders – consumers
- Producer – MCCs/MPUs – retailers – Consumers

The first system is applicable to the traditional sector where farmers have a limited milk production and are not members of dairy groups. The individual farmers takes the surplus production directly to the market for sale that may be within the village or another village or depending on accessibility to urban centers and sold to shopkeepers or consumers. Individual farmers also sell their products along the road side where their products are purchased by passerby’s.

The other two systems are applicable to organized farmer groups. Majority of the collection and marketing groups engage the use of middlemen or traders for marketing their products. Their produce are delivered by the individual members to a MCC from
where the middlemen or traders collects it for marketing in nearby towns or urban centres.

14. CONCLUSIONS

Fresh milk marketing and production groups generally carry out the marketing of their products with either sale to retailers or directly to consumers from the MPUs or group sales outlets as in the case of fresh milk. The expenditure incurred for the sales and production personnel are met from the group savings. Some of the processing groups however engage the use of a middleman for marketing of products.

The dairy production in Bhutan is still in subsistence level due to predominance of cattle population by the local cattle whose performance at farmers’ level are relatively low. The production of this breed can be improved, close to production level of 50%
crosses of improved breeds, through instituting rigorous selection programme among Nublang herds. The local cattle form the basic stock for cross breeding with the improved breeds. The approach adopted to enhance dairy production in the country is via intensification of cross breeding programme viz. supply of breeding bulls in remote areas and strengthening AI programme in motorable areas by providing mobile AI services and estrus synchronization programme.

Irrespective of the location and accessibility of the villages, free animal health care and breeding services are provided to the farmers including improved husbandry practices. The formation of farmers’ group are encouraged in all dairy potential areas and are supported with the construction of MCCs and establishment of MPUs, packaging facilities and marketing.

With the MPUs in place among the farmers group, the uniformity in size and shape of the products are maintained as well as quality of milk and milk products are assured with regular monitoring by the technical staff.

The establishment of private dairy plants in the country is in pipeline and once established with network of milk collection and transportation facilities it is expected that more volume of milk will be produced and marketed, resulting in import substitution.

However, owing to the religious sentiments, the culling of unproductive animals is always a hindrance to the development of dairy sector in Bhutan.

15. RECOMMENDATIONS

The enhancement of dairy production in Bhutan requires

- the intensification of the cross breeding program, as the jersey cross bred population is the main milk producer accounting for 42% of the milk production,
- the training of educated farmers/ school drop-outs interested take up the business in the community to provide uninterrupted AI services in the extension
- the initiation of crossbred heifer production scheme for distribution to farmers in dairy potential areas
- the strengthening of contract bull production programme and forming Breeders’ Association with the contract breeders at different level who shall share with the govt. the responsibilities of breed improvement programme
- instituting rigorous selection programme among nublang, yak and buffalo herds to supplement milk production as well as provide draught power to sustain agriculture
• identification of dairy production potential belts in every Dzongkhags, in which cross breeding will gear towards production of improved breeds only
• encourage buffalo production in southern belt
• improving fodder availability through development of feed resources that require less land and exploration of possibilities for integrating growing of fodder within the existing farming systems, rather than emphasizing pasture development. For serious dairy farmers willing to allocate land for growing fodder, the development of a feed garden incorporating grass, legumes, and fodder trees presents great potential for increasing fodder production.
• need to conduct nationwide market survey on the size, preference, seasonality of consumption etc to help identifying the most potential products to be produced. Furthermore, a comprehensive planned marketing strategy needs to be developed addressing issues such as production of products based on market demand and maintaining a consistent supply of products.

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RGoB (2007) Trade Statistics, Ministry of Finance, Department of Revenue and Customs
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A*

Annexure 1: Major Agro-ecological Zones of Bhutan

<table>
<thead>
<tr>
<th>Agro-ecological Zone</th>
<th>Altitude (meter)</th>
<th>Temperature (degree Celsius)</th>
<th>Rainfall (mm per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Monthly (Maximum)</td>
<td>Monthly (mean)</td>
</tr>
<tr>
<td>Alpine</td>
<td>3,600 - 4,600</td>
<td>12</td>
<td>-0.9</td>
</tr>
<tr>
<td>Cool Temperate</td>
<td>2,600 - 3,600</td>
<td>22.3</td>
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</tr>
<tr>
<td>Warm Temperate</td>
<td>1,800 - 2,600</td>
<td>26.3</td>
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<tr>
<td>Dry Subtropical</td>
<td>1,200 - 1,800</td>
<td>28.7</td>
<td>3</td>
</tr>
<tr>
<td>Humid Subtropical</td>
<td>600 - 1,200</td>
<td>33</td>
<td>4.6</td>
</tr>
<tr>
<td>Wet Subtropical</td>
<td>150 – 600</td>
<td>34.6</td>
<td>11.6</td>
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</table>


Annexure 2: Distribution of Cattle

<table>
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<tr>
<th>Dzongkhag</th>
<th>Nublang</th>
<th>Mithun Pure</th>
<th>Mithun Cross</th>
<th>Jersey Pure</th>
<th>Jersey Cross</th>
<th>BS Pure</th>
<th>BS Cross</th>
<th>Yak</th>
<th>Buffalo</th>
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<td>0</td>
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<td>71</td>
<td>1,781</td>
<td>43</td>
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<td>3,928</td>
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<td>Dagana</td>
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<td>763</td>
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<td>2,965</td>
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<td>3</td>
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<td>Gasa</td>
<td>472</td>
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<td>246</td>
<td>0</td>
<td>108</td>
<td>0</td>
<td>120</td>
<td>9,511</td>
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<td>Haa</td>
<td>5,211</td>
<td>279</td>
<td>851</td>
<td>8</td>
<td>1,933</td>
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<td>5</td>
<td>3,583</td>
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<td>Lhuentse</td>
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<td>25</td>
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<td>Paro</td>
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<td>121</td>
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<td>77</td>
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<td>Punakha</td>
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<td>Samdrupjongkhar</td>
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<td>805</td>
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<td>Samtse</td>
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<td>1,876</td>
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<td>Trongsa</td>
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<td>20</td>
<td>1,542</td>
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<td>1,980</td>
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<td>700</td>
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<td>Tsirang</td>
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<td>Wangduephodrang</td>
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<tr>
<td>Total</td>
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<td>48,203</td>
<td>996</td>
<td>57,717</td>
<td>80</td>
<td>5,200</td>
<td>48,400</td>
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Source: Livestock Statistics, 2008
### Annexure 3: Organised Dairy Farmers Groups supported with MCCs and MPUs

<table>
<thead>
<tr>
<th>Dzongkhag</th>
<th>Name of Group/ (Geo)</th>
<th>No.</th>
<th>Avg. Monthly Milk Collection (liters)</th>
<th>Cash Flowback (in Nu.)</th>
<th>Group savings (in Nu.)</th>
<th>Type of Group</th>
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<tr>
<td>Bumthang</td>
<td>Chumey Gonor Lothuen Tshogpa</td>
<td>30</td>
<td>1,460.00</td>
<td>38,400</td>
<td>75,740</td>
<td>Processing and Marketing</td>
</tr>
<tr>
<td></td>
<td>(Chumey)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Chokor Gonor Lothuen Tshogpa</td>
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<td>10,985.00</td>
<td>359,680</td>
<td>241,943</td>
<td>Processing and Marketing</td>
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<tr>
<td></td>
<td>(Tamshing)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>Tang Community Welfare Association</td>
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<td>856.00</td>
<td>33,750</td>
<td>115,000</td>
<td>Fresh Milk Marketing</td>
</tr>
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<td></td>
<td>(Tang)</td>
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<td></td>
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<td>Chukha</td>
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<td>(Chukha)</td>
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<td>Haa</td>
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ABBREVIATIONS AND ACRONYMS

BAFRA  Bhutan Agriculture and Food Regulatory Authority
BDAL  Bhutan Dairy and Agro Products Limited
CBPP  Contract Bull Production Programme
DoL  Department of Livestock
Dzongkhags  Districts
FYP  Five Year Plan’Geogs
MCC  Milk Collection Unit
MoAF  Ministry of Agriculture and Forests
MPP  Milk Processing Centre
NCAH  National Centre for Animal Health
NFFDP  National Feed and Fodder Development Programme
NLBP  National Livestock Breeding Programme
NSB  National Statistical Bureau
PCS/GNHC  Planning Commission Secretariat/Gross National Happiness Commission
PPP  Public – Private Partnership
RGoB  Royal Government of Bhutan
RMA  Royal Monetary Authority
RNR  Renewable Natural Resource
TPUDFG  Thimphu Peri Urban Dairy Farmers Group
Dairy Production, Quality Control and Marketing System in India

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1. **INTRODUCTION**

1.1 **Background**

In an ancient country like India, the tradition of Dairying is indeed very strongly ingrained. There has been a long tradition of consuming dairy products in the dietary regimen. An appreciation of the historical perspective is crucial to the proper understanding of the ethos of dairying in the current context of SAARC countries. India has taken rapid strides for restructuring the unorganized sector of dairy industry during the past four decades. An impressive infrastructure has been created through the Operation Flood Project as well as Technology Mission on Dairy Development, and India has developed expertise on ‘Tropical Dairying’, unparalleled by any other nation in the world. Dairying under the Tropical climatic conditions prevailing in India are more akin to the SAARC countries compared to the cold-temperate climatic condition prevailing in most of the advanced countries of the world. Technologies developed in the advanced countries of the west cannot be adopted under the tropics without extensive modification. India is in a very unique position to share this expertise, which could be the harbinger for the modernization of the dairy industry in the SAARC countries.

**Industrial Perspective: The White Revolution’s new wave:**

India’s white revolution has generated a new wave, and its ripples have traveled to the farthest corners of the world. Liquid market milk and western-type dairy products have been reaching the urban consumer in keeping with the market demand. Export oriented market for ghee and dairy ingredients for food processing industry (e.g., whey powder, whey proteins, lactose, milk minerals, caseinates, coprecipitates etc.) are fast developing. The modernization for the industrial-scale production of mithais represents the next milestone in the development of the Indian dairy industry, specifically its organized sector. Yet another important dimension is India’s high-value, high-volume market for mithais, which is set to explode under the impact of technology of mass production. This market is already sizable in value, estimated at Rs. 250 billion. Already this output is more than twice that of the organized sector.

The number of dairy plants taking to the production of traditional products is on the increase. This trend will help to strengthen the economic viability of the organized sector. So far, its share of milk handled has been stagnating at 14-16 per cent over the past 10-15 years. Its new thrust in the traditional sector would expand this share. This development would also have a cascading effect on the dairy industry’s equipment and other input sector by boosting the demand for its products and services.

The increasing disposable income among the middle-income groups in the urban and rural areas is bringing to the surface the hitherto suppressed demand for milk products due to the poor purchasing power. These groups need the nutritive goodness of milk. Consequently, the current annual milk production, estimated at 109 million tonnes
in 2009, is expected to cross the 125 million tonnes mark by 2010. As the new wave gathers momentum, the production of mithais on modern lines is reinforcing the Indian food wave overseas, riding on the back of the Indian curry – a byword in the international cuisine today.

Dairying has been one of the livelihood options for many rural poor, especially for landless, marginal and small farmers in countries of South Asian Association for Regional Cooperation (SAARC). In India, presently over 120 million rural families are engaged in dairying. Dairying is an effective tool for rural development, employment and sustained income and it acts as an insurance against several odds. Dairy development in SAARC countries, especially in India is phenomenal mainly owing to the dedicated efforts of National Dairy Development Board (NDDB), Indian Council of Agricultural Research (ICAR) and milk federations. India is the largest milk producer in the world and is growing at 4% per annum. Among the agricultural produce, milk is the major contributor to national GDP. Despite of the best efforts to improve dairy production in countries like India, the per capita availability of milk is lower than 246 gram per day against the world’s average of 285 grams per day. The average production of Indian milch animals is only about 987 kg per lactation as against the world’s average of 2308 kg. This low productivity is mainly due to low genetic potential, shortage of quality feed and fodder and lower health status of animals. The per capita milk production and consumption in India are 82.4 and 81.2 kg / annum respectively.

The production system in India is almost similar in SAARC region, with crop residues forming the major feed resource base. Buffalo has been the mainstay in contributing significantly towards total milk production, particularly in India and Pakistan and in recent years the total share of milk production has significantly increased.

The demand of milk in India is steadily increasing, particularly among the urban population, low and middle income households. It is essential to make dairying remunerative occupation by reducing the cost of production and making selling price attractive. The major input that adds to the cost of milk production (65-70%) is the feed and in the recent times the feed costs have risen 2-3 times, and hence it becomes necessary to address this issue with greater emphasis.

**Strategies for Orchestrating Future Growth of Dairy Industry in India:**

National policies need to be evolved keeping in view the social fabric and needs of the masses for nutritional security. Requirements for ensuring availability of Market fluid milk for drinking purposes and meeting domestic requirements of the urban population can be met through the well established channels of pasteurized milk and /or UHT milk.

Milk processing for balancing regional / seasonal fluctuations of milk can be met through, once again, the well established technologies of producing dried milk products. Likewise, technologies for production of dairy products like butter, cheese, and other western dairy products are also well established.
However, considerable scope exists for the inter-regional cooperation and transfer of the commercial production of the local and traditional dairy products of SAARC countries. Some 20 million persons of the Indian subcontinent abroad, over half of them living in the west are a part of the upper income group. They constitute a major market for Indian milk-based sweets. In North America alone, this market is estimated around US $1 billion. It represents a unique opportunity for globalization of mithais and other related milk products. Entrepreneurs in Europe and North America are looking at the possibilities of manufacturing these products as is evident from the number of enquiries received in India for equipment to manufacture khoa, shrikhand, gulabjamun, paneer, etc. A Canadian initiative for a project to produce Indian milk products in North America is on the anvil and is an eloquent testimony to this growing trend.

A global market economy should provide free flow of technology to produce dairy products typical of the Indian subcontinent and provide access to them in the affluent western economies. India does not have to re-invent the wheel for the industrial production of its traditional dairy products. Synergies between unit operations performed to make the western-type have been successfully adapted for performing similar unit operations for the large-scale production of indigenous dairy products utilizing the energy efficient equipments being used by the food industry in the west. Thus Quarg separators have been used to concentrate dahi for the production of shrikhand. Cheese kettles have been used to pasteurize and process shrikhand. Meatball-forming machines and doughnut fryers have been used in the manufacture of gulabjamun. Japanese pastry-making machines have been used to make products similar to burfi. Tofu-making machines have been tried successfully to make paneer.

Over the years, consumers have got used to and, in fact, like some of the new versions of traditional foods. Some of the changes in the traditional foods were brought in to adapt to the available technology, including quality, hygiene and extended shelf-life considerations. The future of dairy industry in SAARC countries will have to be built on quality alone. The dairy industry must have the latest modern technology for milk production, processing and marketing. Planning process need to be initiated and adequate resources mobilized to achieve and maintain world-class quality.

1.2 Objectives

The objective of this write up is to bring into focus issues concerning promotion of dairy industry in India with regard to:

- Policy Planning for orchestrating growth of dairy industry in India
- Identify areas for inter-regional cooperation in R&D and technology transfer/dissemination.
2. **Milk Production Systems**

2.1 Small Holder Dairying

The small holder and landless farmers together constitute over 75 per cent of India’s livestock resources. Small holders obtain nearly half of their income from livestock (Birthal et al., 2003). Hence a rapid growth in livestock production in India has the potential to contribute to poverty reduction. Three major milk production systems are rural subsistence, rural market oriented and peri urban plus commercial dairying. Dairy development based on small holder production system has made an excellent contribution to rural development in both developing and developed countries (Joe Phelan, 2007). In addition to providing employment and income, it has improved the living standards in rural areas. Rapid structural changes occurring globally in the livestock sector could pose a threat to poor livestock producers in rural areas. Simulation of increased productivity, better farm financing and improved milk marketing through pro-poor dairy development policies have shown that landless rural dairy farmers have the potential to reduce the cost of milk production to the level of large farms and hence theoretically have the potential to maintain a profitable dairy enterprise, especially women. The main risks of dairying by rural landless farmers are not having an animal in milk in any one year, the death of a lactating animal and having to meet the high cost of feed, fodder and poor accessibility to health coverage. Occurrence of any of these events can lead to a reduction of the already low household income by 50% and would probably force the family to abandon the dairy enterprise. Reduction of production risks faced by rural landless dairy farmers requires the availability of improved breeding services, targeted preventive animal health care, better feeding strategies and easy access to formal credit facilities (Torsten et al., 2003).

![Figure 1. Features of an organised dairy sector (Joe Phelan, 2007)](image-url)
2.2 Periurban Milk Productions

Periurban dairying is essentially a market oriented enterprise. Easy access to market prompts small holders to produce more milk for sale and earn cash income. The number of periurban dairy farms in Asian and African countries has increased substantially in the recent years due to rapid urbanisation and increase in demand for milk. Periurban dairying provides employment and income to the unemployed and low income urban families. This type of farming is expected to reduce the gap between food demand in the city and supply from the rural areas, where production is declining and marketing and distribution are inefficient due to inadequate infrastructure. Periurban dairying, in general has the technical constraint of limited milk production potential of local breeds, seasonal quantitative and qualitative feed / fodder shortage, poor management and health care. A weak infrastructure base and poor support services have been shown to adversely affect the economic returns of periurban dairy units. Poor roads, unreliable power supply, inefficient cooling and processing capacity can discourage production. Services in terms of credit facility, health coverage, input supply and distribution, technical advisory services are of crucial importance to the successful management of periurban dairy units. In periurban dairying feed accounts for more than 2/3rd of the operational cost as the animals are stall fed with purchased feed and fodder. There is a need to suitably address these issues. In view of the growing contribution of this sector to meet the specialised food needs of growing urban population, periurban livestock production needs to be recognised as an important component of the National livestock industry. Adequate government investment in infrastructure and incentive to private investment will be the pre requisite to promote this sector. Close proximity of peri urban units to urban areas
could pose the health and environment related problems like zoonosis and improper animal waste disposal. This needs special attention through sensitization, education, quarantining and strict sanitary and safety measures.

**2.3. Dairying through Cooperatives**

The merit of the cooperative ideology is the coordination and balancing of the fundamental principles of equality, democratic control and equality in institutions, and practices to maximize social welfare. Milk production system in India is entirely the domain of farmer. In India, milk production is largely a subsidiary activity to agriculture in rural areas in contrast with organized dairying in western countries. Farmers and landless labourers mostly maintain one to three milch animals. As a result, small quantities of milk are produced widely spread over the country. This situation makes the task of milk collection complex.

In organizing efficient milk procurement system, good microbiological quality of raw milk should be the prime focus. Milk produced should be checked for safety and quality assurance at the collection centres. The farmer should be made aware of the perishable nature of milk and ways to safeguard it against post-secretion contamination under various farming systems and environments. For continuous monitoring of milk quality at the farm, facilities like mobile testing kits and rapid microbiological testing must be made available at farmers’ doorstep. Notable strides have been taken in the country in this direction by the cooperative dairy sector under the National Dairy Development Board (NDDB) as well as the large organized dairy plants in the private sector. With the growth of the organized dairy industry in India, a trend towards establishing organized farms for milk production has already set in. In the current scenario, such farms with a herd of 100-300 cows/buffaloes on the pattern of advanced countries have been set up in the major pockets of milk production. These farms have machine milking and bulk cooling systems.

For a systematic approach to rural milk collection, the first phase is to undertake extensive surveys in the milkshed area where a dairy plant is to be established. Availability of milk at various collection points is ascertained, based on the number of animals, future potential of milk availability, and the presence of competitors. The second phase involves “route planning” taking into account availability of milk, access to roads for plying vehicles and distance from the site of dairy plant. The third phase calls for planning the location of primary collection centres as well as chilling centres.

Organized marketing with the application of advanced dairy technology commenced only in 1955 with the establishment of the Amul Dairy in Gujarat, the forerunner of the White Revolution. It is the first dairy in the World to manufacture milk powder, condensed milk and cheese from buffalo milk. The Amul Dairy now handles over one million litres of milk per day. Presently, some 14-16 per cent of the milk produced in India is processed by the organized sector in over 660 dairy plants in the
cooperative, public and private sectors, with a combined throughput of 66 million litres per day. In 1998, the value of milk and its products exceeded Rs. 80 billion, ranking it above rice and wheat. The value of output of dairy industry has grown almost 100 times in the last 50 years, while its volume has gone up more than four times.

The Operation Flood program (1970-1996) spread the Anand model of cooperative dairying in India by establishing vertically integrated projects, linking them to urban markets, and expanding them. As a result, milk production increased from 17 million tones in 1950-51 to 80 million tones in 2000. It is projected to increase to 220 million tones in 2020 AD. The establishment of rural dairies, largely in the cooperative sector, has also resulted in the upgrading of animals, better feeding practices and well organized veterinary services, including artificial insemination. As of 2005, the cooperative network covered some 12 million farmer-members in over 115,000 village dairy cooperative societies in 170 milk sheds spread over 270 districts. These are part of a national milk grid which links producers with consumers in over 700 towns and cities bridging seasonal and regional variations in milk availability. Institutional infrastructure set-up at the village, district and state levels has progressively eliminated middlemen, enabling direct interface of the producers and processors. Operational Flood has been possibly India’s largest rural development project that paved way for restructuring the unorganized sector of dairying in the country.

Nearly 60% of the world’s agricultural population lives in the villages of Asia, but its share of the world’s agricultural land is only about 28%. The small holders have access only to about 20% of the arable land and hence economic activities that are not necessarily land- based such as dairying have become crucial for small holding and landless farmers. In this context, farmer’s cooperatives play useful role in promoting dairy and rural development. Most dairy cooperatives adopt either a two or three tier system. The concept of milk co-operatives has been well structured with one village or a cluster of villages forming the primary cooperative. A group of many primary cooperatives forms a union, which can be a district, region or milk shed area. The third level is the unions joining up to form a Federation at State or National level. The Federation has the power to decide on policies of pricing, human resource, exports/imports, subsidies and credit facility. In Asian countries the dairy cooperatives are the major means of promoting dairy husbandry and proved to be a strong viable economic institution and a way for improving the living condition of the impoverished rural population. They provide farmers with an organisational support at grass root level in planning, decision-making and scheme implementation. Besides this, the cooperatives also provide services related to animal health, insemination, feed, fodder seeds, fertilisers, credit, training and education. With their vast network and deeper penetration and assured market for the producer they have become a popular sustainable model.
3. **DAIRY ANIMAL HEALTH CARE AND BREEDING ASPECTS**

A dairy animal’s health is utmost important to produce high quality milk. Nutritious diets, hygienic living conditions and good veterinary care are all essential for a healthy herd. Typical managerial practices in a modern dairy farm must include:

**Nutrition and shelter:** Dairy animals should have access to quality feed, fodder and clean water all the time. Scientifically formulated, balanced and nutritious diet involving hay/green fodder, grains, oil meals, minerals and vitamins must be adopted. A good housing with adequate ventilation, lighting and proper waste disposal system should be in place. Adequate protection against cold, heat and wind must be ensured.

**Health and veterinary care:** dairy animals must receive regular Veterinary care, prophylactic vaccinations against endemic viral / bacterial diseases and prompt treatment of illness. Animals that are under antibiotic treatment should be separated from the main herd and put back only after the completion of treatment. All milk produced needs to be strictly tested for antibiotic residues. Separating the calf from mother at early age helps prevent diseases and feeding of colostrums soon after birth and feeding of calf starter after 20 days of birth helps in better health and early maturity.

**Tail docking and dehorning:** Some dairy farmers crop the tail of their animals to promote cleanliness. Switch trimming (removal of hair at the end of tail) is the preferred alternative to docking for hygiene. Dehorning to avoid injury to cows and animals handlers should be practiced at an early age (disbudding).

**Milk quality:** Clean and quality milk can be produced through strict feed safety regulations, sanitation and rapid cooling soon after milk collection. Routine monitoring for somatic cell count in milk and preventive measures against mastitis will help in producing quality milk.

**Herd health and productivity management (HHPM):** This programme has the primary objective to optimise dairy operations through improving general health, reproduction, udder health, hoof health and calf health. The various components of HHPM programme in a herd include animal identification system, health data recording, farm activity schedule, farm policies, reproduction, milk production, milk composition, scheduled Veterinarian’s visits, vaccination, deworming schedules and breeding details. Various indices of good breeding are presented in Table 1.
### Table 1. Important breeding indices in a dairy herd

<table>
<thead>
<tr>
<th>Index</th>
<th>Target value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age of first estrus (Months)</td>
<td>Cow: 10-12</td>
<td>Good calf/heifer management is required.</td>
</tr>
<tr>
<td>Mean age at first breeding (Months)</td>
<td>Buffalo: 14-18</td>
<td></td>
</tr>
<tr>
<td>Mean days of estrus detection after calving</td>
<td>Cow: 60-65</td>
<td>Indicator of pre and post parturient nutritional status.</td>
</tr>
<tr>
<td>Mean interval of estrus after calving (days)</td>
<td>Buffalo: 80-90</td>
<td>Indicator of good post parturient nutrition.</td>
</tr>
<tr>
<td>Mean services per conception</td>
<td>Cow: 2-2.5</td>
<td>Higher value indicates male or female fertility problems.</td>
</tr>
<tr>
<td>Mean days required for conception (days open)</td>
<td>Buffalo: 2.5-3</td>
<td>Higher value suggests reproductive problems.</td>
</tr>
<tr>
<td>Abortion rate (%)</td>
<td>Cow: 3-5</td>
<td>Higher value indicates uterine infections, hormonal insufficiency.</td>
</tr>
<tr>
<td>Pregnancy rate (%)</td>
<td>Buffalo: 65</td>
<td>If lower, animals should be tested for uterine infections, nutritional status and semen quality.</td>
</tr>
<tr>
<td>Incidence of retention of placenta (%)</td>
<td>Cow: &lt;8</td>
<td>If higher, indicates calcium deficiency, low nutritional status during dry period.</td>
</tr>
<tr>
<td>Endometritis (%)</td>
<td>Buffalo: &lt;10</td>
<td>If higher, indicates poor sanitary practices during calving, incidence of retention of placenta, faulty insemination technique.</td>
</tr>
<tr>
<td>Cystic ovaries (%)</td>
<td>Cow: &lt;5</td>
<td>If higher, indicates genetic predisposition.</td>
</tr>
<tr>
<td>Repeat breeders (%)</td>
<td>Buffalo: &lt;15</td>
<td>If higher, indicates low reproductive efficiency and needs detailed investigation.</td>
</tr>
</tbody>
</table>

#### 4. Feed Scenario

##### 4.1 Feed Industry

With dairy farming gaining a commercial importance, the demand for feed has increased greatly. The setting up of compounded feed manufacturing units has become a viable enterprise. The production of compounded cattle feed by member of CLFMA has
increased by several times. In addition, the cooperative sector and few private sectors also manufacture the feed. A growth rate of 10% is estimated in this sector and the demand for cattle feed is about 10 million tonnes in the year 2010. As per the norms of feeding each cattle with 1.5 kg of concentrate for maintenance and 1kg concentrate for every 3 kg of milk production and this implies that the potential market for cattle feed would be about 45 million tonnes annually. But majority of cattle and buffalo in SAARC countries are fed home made feed mixture, concentrates and grazing and the existing market for cattle feed is only about 5.5 million tonnes. The private sector produces about 1.2 million tonnes and dairy cooperatives produce about 2.5 million tonnes of feed and the rest is produced by home mixes in the unorganised sector. The cooperatives produce low – cost feed that is sold to the farmer-members, numbering around 10 million of a total of about 80 million farmers in the country. The private manufacturers also produce feed for dairy animals and they focus on private farmers and buffalo meat industry.

About 50% of India’s milk production comes from genetically poor, low yielding indigenous animals and they are mainly provided with home-made mixes.

Table 2. Fodder requirement in India (in million tonnes)

<table>
<thead>
<tr>
<th>Year</th>
<th>Supply Green</th>
<th>Supply Dry</th>
<th>Demand Green</th>
<th>Demand Dry</th>
<th>Deficit (% of demand) Green</th>
<th>Deficit (% of demand) Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>379.3</td>
<td>421</td>
<td>947</td>
<td>526</td>
<td>59.95</td>
<td>19.95</td>
</tr>
<tr>
<td>2000</td>
<td>384.5</td>
<td>428</td>
<td>988</td>
<td>549</td>
<td>61.10</td>
<td>21.93</td>
</tr>
<tr>
<td>2005</td>
<td>389.9</td>
<td>443</td>
<td>1025</td>
<td>569</td>
<td>61.96</td>
<td>22.08</td>
</tr>
<tr>
<td>2010</td>
<td>395.2</td>
<td>451</td>
<td>1061</td>
<td>589</td>
<td>62.76</td>
<td>23.46</td>
</tr>
<tr>
<td>2015</td>
<td>400.6</td>
<td>466</td>
<td>1097</td>
<td>609</td>
<td>63.50</td>
<td>23.56</td>
</tr>
<tr>
<td>2010</td>
<td>405.9</td>
<td>473</td>
<td>1134</td>
<td>630</td>
<td>64.21</td>
<td>24.18</td>
</tr>
<tr>
<td>2025</td>
<td>411.3</td>
<td>488</td>
<td>1170</td>
<td>650</td>
<td>64.87</td>
<td>24.92</td>
</tr>
</tbody>
</table>

Source: Draft report of the working group on animal husbandry and dairying for five year plan, 2002-2007, Govt. of India, Planning Commission

Table 3. Concentrate requirement in India (in million tonnes)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentrate available</td>
<td>41.96</td>
<td>43.14</td>
<td>44.35</td>
<td>45.63</td>
<td>48.27</td>
</tr>
<tr>
<td>Concentrate required</td>
<td>117.44</td>
<td>120.52</td>
<td>123.59</td>
<td>127.09</td>
<td>130.55</td>
</tr>
<tr>
<td>Concentrate deficit (%)</td>
<td>64.27</td>
<td>64.21</td>
<td>64.12</td>
<td>64.10</td>
<td>63.03</td>
</tr>
</tbody>
</table>

Source: Draft report of the working group on animal husbandry and dairying for five year plan, 2002-2007, Govt. of India, Planning Commission
4.2 Dairy Animal Nutrition and Production

Scarcity of feed and fodder resources

Shortage of quality feed ingredients and lack of adequate green fodder cultivation has limited the potential of milk production. The available feed and fodders are diverted for productive animals and growing calves/heifers are underfed. Lack of vitamin A and mineral intake through green fodder results in stunted growth rate, delayed puberty and low resistance to diseases. The crop residues are not pre treated to improve their nutritive value. Legume fodders (cow pea, lucerne, berseem) and fodder trees (kaliyandra, subabul, glyricidia) cultivation is limited.

Imbalanced feeding

The productive animals are not fed as per requirement and in some places, there is a mismatch between protein, energy and fibre. A minimum of 25-30% fibre is required in total diet for optimum rumen fermentation. In some places, farmers feed dairy animals with home made feed mixtures comprising bran, oil cake and gram husk without any cereal grain as energy source. This imbalance in protein and energy will lead to inefficient utilisation of protein in rumen and low microbial protein synthesis. Some farmers feed excess concentrates, particularly oil cakes with a belief that there will be more milk yield. This practice will lead to more urea formation and burden the metabolic system. Also more urea in blood will have a negative effect on conception rate and fertility. The dairy animals should never be fed excess protein. Excess feeding of protein (oil cakes) supply high phosphorus and thus create calcium and phosphorus imbalance. High phosphorus excretion in dung is an environmental problem.

Negative energy balance during post partum period

Many farmers do not practice the method of drying the pregnant animals at about seventh month of pregnancy and also not practice challenge feeding to allow reserve nutrient deposition. Due to this, soon after parturition because of high milk yield, low voluntary feed intake coupled with parturition stress, there will be negative energy balance. This predisposes the animal for ketosis, milk fever and delays the ovarian activity, leading to post-partum anoestrus, low conception rate and longer inter calving period. This can be prevented by adequate pre-partum and post-partum nutrition. High yielding animals would require feeding of by-pass fat, which will help in maintaining peak milk yield and also the reproductive events.

Mineral deficiency and imbalance

Deficiency of both macro and trace minerals is common in dairy animals under field condition manifested in the form of reproductive disorders, general weakness, low immunity and rough hair coat. Though the compounded feeds are added with mineral supplements, often the absolute requirement of minerals is not met due to the fact that only few farmers purchase commercially available compounded feeds and feed in required quantity. This necessitates the supplemental feeding of mineral mixture,
particularly during growing, pregnancy and lactation. Most commonly deficient minerals in field conditions are calcium, phosphorus, copper and zinc. Supplementation of these most limiting minerals in the form of area specific mineral mixture has shown improvement in reproductive performance of dairy animals. Pica is a problem under field conditions and it will respond positively to feeding of phosphorus with common salt.

**Toxic elements**

In certain endemic areas, fluoride and arsenic level in water is high leading to toxicity both in humans and animals. The ensuing abnormalities will limit the productivity. Fluoride is also known to disturb the glucose and iodine metabolism in the body. Though, defluorination of water is an option, its successful implementation at large scale has become difficult. Rain water harvesting and providing surface water (river) and supplementing the water with additional calcium and boron are the other strategies to minimise the fluorosis problem. In industrial areas, improper disposal of chemical wastes has led to contamination of soil and water resources with nitrates and heavy metals. This is recycled into green fodders grown in that area and affecting the health of animals.

**Contaminants of feed and fodders**

Improper storage of feed ingredients like grain, oil cakes at high moisture (>12%) content during hot-humid conditions favours the growth of fungi and mycotoxin production like aflatoxin and ochratoxin. These are toxigenic / carcinogenic and reduces immunity in animals. Use of pesticides and insecticides for crop protection also contaminates the by-products like grains, oil cakes and crop residues. Animals may suffer from cumulative toxicity on prolonged ingestion of residual agro-chemicals. Use of biodegradable agro-chemicals and organic methods of crop cultivation will help in preventing this problem.

**4.3 Feed Quality Management**

With the establishment of WTO, Quality, food safety and bio security have become vital issues in the international scenario. The SAARC countries are adhere to the stipulated norms of safety standards for market access, domestic support and export. Though presently India is the largest milk producer, its global trade share is less than 1% due to lower product quality and price competitiveness. Consumers all over the world have become quality and safety conscious and prefer products of high quality with best taste, colour, texture, odour along better keeping quality with a high degree of assurance for human safety and wholesomeness. These can be achieved through adopting strict sanitary measures, legislations, policies and programmes from production at farm level to consumption stage. In a dairy farm, most commonly grains, processed ingredients, animal feeds, visitors, and delivery vehicles serve as potential vectors for contamination. Generally, feed and feed ingredients may become contaminated by the following means.

1. Physical: plastic, glass, metal
2. Chemical: Pesticides, industrial pollutants
3. Biological - Bacteria, virus, fungi, mycotoxins, parasites
4. Radiological: Radioactive agents

Some of the common deleterious substances that could be present in feeds/fodders and potentially present in milk are:

**Pesticides**

Synthetic pesticides have been used since past several years to increase agricultural production, and crop residues and by-products will in turn contain these chemicals. Due to their higher lipid solubility, milk and milk products are more vulnerable to pesticide residue due to their high fat content. It is reported that Indian milk and milk products contain detectable levels of pesticide residues like organochlorins, organophosphates, carbamates, herbicides and fungicides. Organic farming is one of the strategies for overcoming the hazards of pesticide residues in milk. Use of certain binders like charcoal in feed is also known to partially limit the transfer of pesticide residues in products.

**Heavy metals**

Contamination of feed materials by heavy metals is due to industrial pollution and agricultural activities. Heavy metal contamination of milk occurs when dairy animals are fed on contaminated fodder grown in industrially polluted areas and additives and medicines are included in feed. Commonly heavy metals like lead, cadmium, arsenic and mercury are found in milk of animals fed contaminated diets.

**Mycotoxins**

The residue of mycotoxins in milk appears due to consumption of fungal contaminated feeds by dairy animals. Among mycotoxins, aflatoxins are more toxic, carcinogenic and the metabolite aflatoxin M1 is secreted in milk. In many countries milk and milk products are closely monitored for very low level of aflatoxin M1. The upper limit of aflatoxin M1 in milk is 0.5 ppb and the carry – over percentage of aflatoxin from feed to milk ranges between 1-2% and higher values of 6% also have been reported. The carry-over of other mycotoxins like ochratoxin, deoxynivalenol, zearalenone and fumonisin to milk is very low.

**Pollutants**

The common pollutants in milk are mainly nitrates and polychlorinated compounds. The nitrate contamination in milk occurs through feed additives pasture and forages fertilized with nitrate compounds. Consumption of nitrate contaminated milk leads to gonotoxicity and carcinogenicity. Amongst the chlorine pollutants in milk, polychlorinated biphenyls, poly chlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans are important. The source of chlorinated compounds is plastic packaging materials.
Natural plant toxins

Consumption of feed/plants containing endogenous toxicants may contaminate the milk. Drinking of phyto toxicated milk may induce poisoning in human or in infants. Generally alkaloids have been frequently detected in milk, other plant toxins include glucosinolates, cyanogens, pyrrolizidine, indiolizidine and piperidine derivatives can be excreted in milk on consumption of such plants. Genetically modified crops aimed to produce varieties of a desirable trait like pest resistant, amino acid enriched or free from anti nutritional factors have been frequently debated for their safety as animal feed. Most reports on use of genetically modified crops as animal feed/fodder like Bt cotton have not shown any safety concerns, however long term trials are required to ascertain the complete safety of products like milk.

Microbial contaminants

Certain bacteria (E.coli, Salmonella, Campylobacter) virus (Bovine viral diarrhoea) and protozoa (Coccidia, Giardia) can be transmitted through feed, pasture and forage. Feed processing like pelleting, roasting and steam flaking can reduce microbial load (Table 4).

Table 4. Potential microbial contaminants in a dairy farm

<table>
<thead>
<tr>
<th>Disease / pathogen</th>
<th>Manure</th>
<th>Water</th>
<th>Pasture</th>
<th>Forage</th>
<th>Feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovine viral diarrhoea</td>
<td>+++</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coccidiosis</td>
<td>+++</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Cryptosporidiosis</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Giardiasis</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>E. Coli</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Campylobacter</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Listeria</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Jhone’s disease</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

+++: Most common, +: Sometimes, - Nil

Biosecurity/ Biosafety

Series of management steps needs to be taken to prevent the introduction of infectious agents into animal herd through feed stuffs, water or any other means. It involves screening and testing of feed materials/ animals, quarantining or isolation, monitoring and making a action plan. Biosecurity programme is an essential aspect of farm animal safety to maintain a healthy environment and produce products of safe quality. This helps to ensure consumer demand for quality product and ultimately the profitability of dairy enterprise. The potential hazards in feed and dairy farming can be categorized as high or low, major or minor. These hazards, which are high and major
becomes the part of Hazards analysis and critical control point (HACCP) plan. Hazard analysis are based on known feed contaminants and error-prone areas that could compromise biosecurity. The majority of these are directly related to possible effects on feed safety, such as Salmonella, *E. coli*, mycotoxin contamination, rancidity of fats etc. The HACCP programme initially developed by human food companies, now have been successfully applied to feed safety in livestock sector in many countries. This system identifies potential problems with feed/food safety in advance and sets up methods to control each of the possible hazards identified. It is a proactive preventive programme with a focus on quality of finished product. Seven basic steps of HACCP system are

- Identification of potential hazards.
- Observation of feed production process to identify critical control points.
- Establishment of appropriate control protocol.
- Establishment of monitoring procedures.
- Development of a corrective/alternate action plan, if there is a deviation from an established critical limit.
- Record keeping.
- Establishment of verification procedures that the system is working.

### Table 5. Model of HACCP programme

<table>
<thead>
<tr>
<th>Steps</th>
<th>Hazard</th>
<th>Critical control points</th>
<th>Control protocol</th>
<th>Monitoring procedure</th>
<th>Corrective plan</th>
<th>Record keeping</th>
<th>Verification procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aflatoxin</td>
<td>Preharvest conditions, feed storage practices, moisture level</td>
<td>Use of anti-fungal agents, drying of feed</td>
<td>Fungal counts, aflatoxin estimation, moisture analysis, signs of aflatoxicosis in animals</td>
<td>Dilution of contaminated feed, use of toxin binders, use of antioxidants.</td>
<td>Records on feed procurement, analysis reports, operating procedures, measures taken</td>
<td>Feed acceptability, performance of livestock, consumer response</td>
</tr>
<tr>
<td></td>
<td>Salmonella</td>
<td>Contamination of feed with manure, use of animal proteins</td>
<td>Hygienicity, cleanliness, manure disposal away from feed rooms</td>
<td>Bacterial counts, signs of Salmonellosis</td>
<td>Heat treatment like pelleting, roasting</td>
<td>Records on feed procurement, analysis reports, operating procedures, measures taken</td>
<td>Feed acceptability, performance of livestock, consumer response</td>
</tr>
</tbody>
</table>
Table 6. Issues and actions for dairy sector in India

<table>
<thead>
<tr>
<th>Issue</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low productivity, poor cattle hygiene practices</td>
<td>Cross breeding, establishment of semen banks at regional level, develop feed quality standards, develop high yielding fodder crops, improve veterinary services, create awareness</td>
</tr>
<tr>
<td>Poor quality of milk processing</td>
<td>Train farmers on hygienic milk production, ensure fund availability for bulk coolers and develop technologies for longer life of raw milk.</td>
</tr>
<tr>
<td>Lack of availability of uninterrupted power in milk production regions</td>
<td>Improve power availability, promote use of unconventional energy</td>
</tr>
<tr>
<td>Dairy effluents and environmental hazards</td>
<td>Adopt technology for processing effluents into by-products for small scale industries.</td>
</tr>
</tbody>
</table>

5. DAIRY BREED AND THEIR PERFORMANCE

Livestock improvement is an integral part of productivity enhancement. India has a rich agro-ecological diversity, and concurrently one finds a range of unique livestock production systems that have evolved in each region in tune with the naturally available resources and needs of the people. This diversity begins with the choice of species reared, breeds that have evolved, management and feeding practise, health care systems that are closely linked to the natural flora and fauna, and local marketing systems. The country has 90,000 animal species, representing 7.28% of the total global faunal species. Mixed crop-livestock farming and pastoralism are the two common production systems found across different agro-eco regions. In the former, farmers derive their livelihood somewhat equally from agriculture and livestock; in the latter, people’s livelihood depend primarily upon livestock, which are exclusively maintained on grazing.

Livestock and land distribution in India has shown that in 2002-03 marginal land holders (<1.0 ha) who comprised 47 per cent of the rural households controlled 51 per cent bovines and 62 per cent small ruminants. Together, marginal and small landholders possessed three fourths of the large and small ruminants, more than 80 percent of the pigs and poultry. However, the landless that comprised 32 per cent of the rural households are deprived of land as well as livestock.

Indian ranks first in world’s cattle, buffalo and goat population with 16.10, 56.50 and 16.50 percent respectively occupying first position in milk, 3rd in egg and 5th in broiler production in spite of the production system being predominantly based on agro-by-products and crop residues. Medium to large herds of cattle and buffalo, however, exist in the periphery of large towns and cities mainly for supply of milk (peri-urban system). Small ruminants and pigs are reared under extensive and semi-intensive system of production. Resource-poor small and marginal farmers and landless labourers are the
main custodian of the livestock owning 71% of cattle, 63% of buffaloes, 66% of small ruminants, 70% of pigs and 74% of poultry. Intensification of production system has occurred only in poultry and on a limited scale in dairy industry. Intensive pig farming has been initiated at a low scale.

5.1 Species-Wise Status

Bovines (cattle and buffalo)

Any Animal Husbandry improvement programme is greatly dependent on availability of superior germplasm for natural service, fresh service or as frozen semen. The three methods have applicability in different regions, states and areas depending upon the bulls available and the infrastructure of AI, particularly bull production, semen production, frozen semen facility and field AI network organization.

Small Ruminants, Pigs and Camel

Among sheep, goat, camel and pigs, breeding involves the selection of males which are to be used for mating with females. In the absence of quality males among each of these species limited National animal improvement programme is in progress and that too only in organized farms which do not cater to needs of even 1% of total small ruminant, camel and pig population.

Some states have male distribution programmes but they are sporadic and do not substantially address the genetic improvement. Any such genetic improvement programme should address 2% replacement of males annually among these species. Demographic distribution of these animals in small holder system puts an added demand situation for males. However, taking a conservative view for improvement, a phased programme will involved the requirement of 20,000 superior rams annually among sheep and about 40,000 bucks among goats. A germplasm improvement plan should project to have at least 400 superior males among sheep and 800 superior bucks among goats to be produced annually. Among pigs, effective piglet distribution programme of superior exotic breeds and crossbreed from indigenous species is the only effective way for 12 million pig population. Due to high prolificacy and high slaughter rate, replacement through piglet distribution is much superior improvement program. To keep pace with 6-8% growth in pig sector, about 20,000 piglets annually are needed for distribution as superior germplasm. There is no selection for breeding or germplasm distribution for camel improvement. Though the animal is of great importance in certain agro-ecologies, a selection process for producing superior males need to be put in place in the first instance.

Availability of Quality Germplasm

Massive development support for contributed availability of quality semen, chicks, piglets etc. and production of improved breeds and an effective supply system for different regions befitting varying production system are imperative to capitalize on the potential of breeds for substantially enhancing productivity and production.
Policy-setting and effective plan of action for potential indigenous breed improvement in livestock viz. cattle, buffalo, goat etc. are essential for which quality for which quality semen production, storage, transportation, cold-chain facility and effective insemination system are required for reaching and end-user. In this endeavour, sampling of existing genetic variability and utilizing the potential livestock using both conventional and molecular approaches are essential.

For exploitation of crossbreds, not only the policy but also its effective implementation is critical with proper breeding policies for different agro-climatic regions based on the resource availability.

Table 7. Indigenous breeds of buffalo/ cattle in India and production performance

<table>
<thead>
<tr>
<th>Breed</th>
<th>Native tract</th>
<th>Trait</th>
<th>Lactation yield (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Buffaloes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bhadawari</td>
<td>Agra (UP), Bhind (MP)</td>
<td>Dairy</td>
<td>2200</td>
</tr>
<tr>
<td>Jaffarabadi</td>
<td>Junagarh, Bhavnagar (Gujarat)</td>
<td>Dairy</td>
<td>2000</td>
</tr>
<tr>
<td>Marathawada</td>
<td>Latur (MH)</td>
<td>Dairy</td>
<td>900</td>
</tr>
<tr>
<td>Mehsana</td>
<td>Mehsana, Gandhinagar, Ahmedabad(Gujarat)</td>
<td>Dairy</td>
<td>1800</td>
</tr>
<tr>
<td>Murrah</td>
<td>Haryana</td>
<td>Dairy</td>
<td>2200</td>
</tr>
<tr>
<td>Nagpuri</td>
<td>Nagpur, Akola (MH)</td>
<td>Dairy</td>
<td>1200</td>
</tr>
<tr>
<td>Nilliravi</td>
<td>Punjab</td>
<td>Dairy</td>
<td>1800</td>
</tr>
<tr>
<td>Pandarapuri</td>
<td>Solapur, Satara (M H)</td>
<td>Dairy</td>
<td>1500</td>
</tr>
<tr>
<td>Serti</td>
<td>Vadodara, Surat (Gujarat)</td>
<td>Dairy</td>
<td>1400</td>
</tr>
<tr>
<td>Toda</td>
<td>Nilgiris (TN)</td>
<td>Dairy</td>
<td>500</td>
</tr>
<tr>
<td><strong>Cattle</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deoni</td>
<td>Maharashtra, Bidar (Karnataka)</td>
<td>Dual</td>
<td>900</td>
</tr>
<tr>
<td>Gaolao</td>
<td>M P and Maharashtra</td>
<td>Dual</td>
<td>700</td>
</tr>
<tr>
<td>Gir</td>
<td>Junagadh, Bhavnagar (Gujarat)</td>
<td>Dairy</td>
<td>2000</td>
</tr>
<tr>
<td>Hariana</td>
<td>Haryana, U P and Rajasthan</td>
<td>Dual</td>
<td>800</td>
</tr>
<tr>
<td>Kangayam</td>
<td>Erode, Karur (T N)</td>
<td>Dual</td>
<td>700</td>
</tr>
<tr>
<td>Kankrej</td>
<td>Gujarat and Rajasthan</td>
<td>Dual</td>
<td>1600</td>
</tr>
<tr>
<td>Kenkatha</td>
<td>Lalitpur, Hamirpur (UP), Chhatarpur (MP)</td>
<td>Dual</td>
<td>550</td>
</tr>
<tr>
<td>Malvi</td>
<td>Indore, Ujjain (M P)</td>
<td>Dual</td>
<td>1100</td>
</tr>
<tr>
<td>Mewati</td>
<td>Mathura (UP), Alwar (Rajasthan)</td>
<td>Dual</td>
<td>800</td>
</tr>
<tr>
<td>Ongole</td>
<td>Nellore, Guntur (A P)</td>
<td>Dual</td>
<td>700</td>
</tr>
<tr>
<td>Rathi</td>
<td>Bikaner, Jaisalmer (Rajasthan)</td>
<td>Dairy</td>
<td>1600</td>
</tr>
<tr>
<td>Red Sindhi</td>
<td>Orissa, U P, Sindh province</td>
<td>Dairy</td>
<td>1800</td>
</tr>
<tr>
<td>Sahiwal</td>
<td>Punjab</td>
<td>Dairy</td>
<td>2200</td>
</tr>
<tr>
<td>Tharparkar</td>
<td>Jodhpur, Jaisalmer(Rajasthan)</td>
<td>Dairy</td>
<td>1600</td>
</tr>
</tbody>
</table>
6. QUALITY CONTROL IN DAIRY SECTOR

As stated earlier, the future of dairy industry in SAARC countries will have to be built on quality and quality alone. The dairy industry must have the latest modern technology for milk production, processing and marketing. Planning process need to be initiated adequate resources mobilized to achieve and maintain world-class quality. Good Manufacturing Practices (GMP), Hazard Analysis Critical Control Point (HACCP), and Total Quality Management (TQM) are widely accepted among large and progressive dairy industry establishments around the world as the basis of quality assurance and food safety. In the international trade in dairy commodities, the World Trade Organization (WTO) insists that manufacturers demonstrate that they are applying them. These concepts need to be extended among the small and medium dairy processors also. Various unit operations involved in basic processing as well as quality management are highlighted in this sub-section. Quality issues envisage management of hygienic aspects of milk production, raw milk handling, procurement of milk from rural areas, processing, manufacture, packaging, storage and distribution.

6.1 Input Supply and Service Delivery

Both pre- and post-secretion management of milk at the farm level should focus on controlling milk quality, since management of quality begins at this level. Certain factors considered crucial for good milk production are: type of farming system, feeding of dairy animals, shelter management, type of milking practices, impact on environment, farm waste disposal facilities, prompt cooling of milk on the farm, procurement systems, quality-related price policy and farmers education/training programmes. Various recommended management practices for quality assurance are discussed in the following text.

6.2 Milk Purchase from Producers by Processors

Four systems of milk procurement popular in India are:

Directly from individual producers: Producer brings milk directly to the dairy plant. This practice is more suited for those large producers, located near the processing plants.

Through contractors: The traditional middleman is involved for interface between the dairy plant and small milk producers. Contractors ply cans and milk tankers for transportation of milk from rural areas to dairy plants. In such situations, milk processor has very little control on the quality of milk procured/purchased by the contractor from milk producers.

Through cooperatives: They have successfully organized milk procurement in rural areas. At the village level, farmers organize themselves in a cooperative society which establishes milk collection centres. The society members deliver milk twice a day. Here, milk is weighed, tested, and price is paid to farmers according to the quantity and
quality of milk supplied. Its payment is based on percentage of fat, SNF, or total solids in milk. The village society supplies/sells milk to their own district cooperative dairy plant. It organizes transport of milk in cans by truck or by insulated road milk tanker, if there is a chilling centre. In addition to collection of milk, the society also provides technical input services such as artificial insemination, veterinary aid, supply of concentrated cattle feed, fodder seeds and counseling to society members to enhance milk production.

**Through chilling centres:** If the distance from milk plant is more, rurally-collected milk is first brought to a centralized chilling centre. Here, milk is cooled to 4°C and stored in insulated milk storage tanks of 5,000-20,000 litre capacity. Subsequently, the chilled milk is transported in the insulated road milk tanker to the milk processing plant. The collection of milk, from the chilling centre to the central dairy usually takes place once a day.

### 6.3 Quality Control in Traditional Dairy Sectors

In India, cows and buffaloes are normally milked twice a day, once early in the morning and then late in the afternoon. Milk is brought in producers’ own utensils at the village level collection centres twice. As soon as the milk supply reaches collection centres, it is weighed and a representative sample is drawn for quality grading. The common tests carried out at the point of milk collection are taste and smell, sediment, fat and SNF content and acidity test. These quick tests generally form the basis for acceptance or rejection of milk supplied. It is common to pay the producer on the basis of the quantity of fat, while the minimum standard for SNF is set for accepting milk (Cow milk – fat: 4.5 percent, SNF: 8.5 per cent; Buffalo milk – fat: 6.0 per cent, SNF: 9.0 per cent; Mixed milk – fat: 5 per cent, SNF: 8.5 per cent). Fat is usually tested by the Gerber method or an electronic milk tester, especially when the number of samples to be tested is large. The SNF is mostly checked by a lactometer. All the milk so collected is generally filled in cans for transportation to the chilling centre or directly to the milk plant. Care should be exercised to bring the milk for chilling/processing plant within three hours of milking. Otherwise, a serious deterioration of milk can take place that affects the quality of products.

The tropical temperatures prevailing in India make this problem all the more acute, since the ambient temperature acts favourably for microbial growth to result in rapid deterioration in quality. The potential harm to dairy products due to disease-producing organisms or their toxins cannot be easily and readily detected in time. Similarly, financial losses due to spoilage of milk and milk products in the plant can be prevented by adequate precautions to obtain raw milk of good quality. Titratable acidity, Clot-on-boiling (COB) test, alcohol test, and Alcohol Alizarine test may be done on suspected samples of milk for confirmation.

Improper handling at the producer’s level can be detected by several bacteriological tests. This may be done conveniently by employing the Methylene Blue Reduction (MBR) Test or the Resazurin Reduction Test. Milk with reductase time of 4 hours may have a keeping quality for about 24 hours.
Quality parameters of raw milk

- Microbial content
- Somatic cell count
- Integrity of fat globule as effected by mechanical handling
- Organoleptic attributes
- Chemical residues (antibiotics, pesticides, radio nuclides)
- Adulterants

In addition, the following aspects should be kept in view:

- The supervision of a veterinarian to ensure disease- (brucellosis, tuberculosis) free herd;
- Individual buffaloes/cows in the herd should be identifiable;
- Flies, rodents and other vermins must be controlled;
- Pigs and poultry must not be housed in the shed or premises where buffaloes/cows are milked;
- The milking equipment should be clean and sanitised; and,
- Adequate supply of water for cleaning should be available.

Grading of milk at chilling centre

At the chilling centre, the total bacterial count is taken by the direct microscopic method or by the plate count method. The standard plate count test is devised to estimate the number of viable bacteria present in milk. Bacterial content of milk is judged by the total bacterial count and the presence or absence of coliforms and pathogenic bacteria. Raw milk is considered satisfactory if coliforms are absent in 1:100 dilution. Examination for pathogenic bacteria involves elaborate work and is, therefore, generally not carried out as a routine test in dairy plants.

Grading of Raw Milk at Dairy Plant

The term “Platform Tests” includes all those tests, performed to check the quality of incoming milk on the receiving platform for a quick decision regarding its acceptance/rejection. Milk from each tanker is subjected to the prescribed tests for checking the organoleptic, chemical and microbiological quality of milk.

<table>
<thead>
<tr>
<th>Methylene Blue Reduction (MBR) Time</th>
<th>Plate count (million per ml)</th>
<th>Direct count (million per ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 5 hours and 30 minutes</td>
<td>Less than 0.5</td>
<td>Less than 1.5</td>
</tr>
<tr>
<td>2 to 5 hours and 30 minutes</td>
<td>4 to 1.5</td>
<td>12 to 1.5</td>
</tr>
<tr>
<td>20 minutes to 2 hours</td>
<td>20 to 4</td>
<td>69 to 12</td>
</tr>
<tr>
<td>Less than 20 minutes</td>
<td>Over 20</td>
<td>Over 60</td>
</tr>
</tbody>
</table>

The Bureau of Indian Standards has prescribed standards for bacteriological quality of milk (IS: 1479 (pt III)-1977, first revision).
Table 9. Bacteriological standards for raw milk

<table>
<thead>
<tr>
<th>Grade</th>
<th>Methylene blue reduction test</th>
<th>One-hour Resazurin Test</th>
<th>Total Plate Count of milk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time (hours)</td>
<td>Resazurin disc No.</td>
<td>(SPC per ml)</td>
</tr>
<tr>
<td>Very Good</td>
<td>5 and above</td>
<td>-</td>
<td>Not exceeding 0.2 million</td>
</tr>
<tr>
<td>Good</td>
<td>3 to 4</td>
<td>4 or higher</td>
<td>Between 0.2 and 1 million</td>
</tr>
<tr>
<td>Fair</td>
<td>1 to 2</td>
<td>3.5 to 1</td>
<td>1 to 5 million</td>
</tr>
<tr>
<td>Poor</td>
<td>0.5</td>
<td>0.5 to 0</td>
<td>Over 5 million</td>
</tr>
</tbody>
</table>

About 30% of milk produced in India is processed. The organised sector processes about 13 million tonnes annually, while the unorganised sector (Halwaïs and vendors) processes about 22 million tonnes per year. In the organised sector, there are over 700 dairy plants in the cooperative, public and private sectors. There is a huge potential for processing and value addition, particularly in ethnic Indian products. The difference with organised and unorganised sector is with respect to investments in preserving the quality of milk, processing technology and compliance of food standards. The viable option is promoting investments in quality control and adopting efficient technologies for the unorganised sector. Key issues in processing include lack of availability of milk in lean seasons, limited diversity in product mix, regional demand-supply imbalances, lack of scaling-up and commercialisation of Indian ethnic milk products.

Tradition milk products in India and other SAARC countries offer a considerable opportunity for value addition in organised sector. The value added to milk through processing is nearly twice the price of milk. Dahi, lassi, yoghurt, shrikhand are used as desserts. Paneer (cottage cheese) is used for pizza and pakora making. Other value added products are rasogolla, gulabjamune, raita, buttermilk, kheer, ghee and ice creams. The dairy sector needs to realise the importance of traditional products. Further value addition is required through fusing the traditional technology with modern processing methods to prepare a new product. Such foods can be developed into functional foods for therapeutic purposes.

6.4 Poor Quality Control Limits the Development of Dairy Industry

Milk produced in large-scale organized farms constitutes only a negligible fraction of the market milk. These include farms, which cater to the requirements of military personnel or are attached to the cattle breeding stations or form a part of educational/research institutions. The size of milk herds in these farms varies from less than 100 animals to about 1000 head of cattle and buffalo, while the volume of milk handled ranges from 200 to 2,000 kg per day. Most farms are provided with modern cattle sheds, milking byres, milking machines, milk collecting and recording rooms and other facilities required for hygienic milk production. Some of these farms also have pasteurizing plants and cold storage facilities. The organized dairies are gearing themselves up to handle the issue of pesticide residues and aflatoxins. The product...
quality will certainly improve considerably with the organized sector coming into the scene. A lot of concentrated effort and investment in the product and process development would help the organized sector to expand the share of the market for traditional milk products. The traditional method of the by-gone era is followed to this day. Federal, state and local authorities regulate all milk processing and marketing as well as manufacture of dairy products. The regulatory composition for the manufacture of dairy products in the USA is discussed below.

**Food and Drug Administration (FDA):** Production of Grade A dairy products is regulated by the Milk Safety Branch of the FDA. Product safety, labeling, packaging and other product issues are included. In addition, other departments of the FDA are involved in product standards, labeling in general under the Fair Packaging and Labeling Act, and matters related to overall compliance. Milk specialists represent Milk Safety Branch’s regional offices and work with the state regulatory agencies by providing scientific, technical and inspection assistance. In this manner, compliance with regulatory policies and procedures is assured. Besides liaison with the FDA, the State Department of Agriculture (Dairy Division or Health Department) is also involved in regulating milk production and manufacturing operating in a particular state. Furthermore, the state enforces regulations related to Grade A Pasteurized Milk Ordinance (PMO).

PMO describes the requirements for product safety, milk hauling, sanitation, equipment, and labeling. PMO is very extensive and covers milk production at the farm to the manufacturing facility. The requirements for product and package include the following:

- Must contain the word Grade A
- Must contain the identity of the plant
- Product Standards of identity must be met
- Temperature - cooled to 45°F (7°C) or less and maintained there at.
- Bacterial limits specified in the PMO
- Coliforms - not to exceed 10/ml
- Phosphatase test <1 mg/ml
- Antibiotics - no zone greater than or equal to 16 mm with the *Bacillus sterothemophilus* disc assay method.

National Conference of Interstate Milk Shippers (NCIMS) plays a key role in setting standards and regulations related to PMO, methods of making sanitation ratings of milk supplies, sanitation requirements for Grade A condensed and dry milk products as well as condensed and dry whey. Furthermore, NCIMS is involved in regulations pertaining to fabrication of single service containers, and closures for milk and milk products, and in the evaluation of milk laboratories. The purpose of NCIMS is to promote the best possible milk supply for all the people and to provide for unrestricted availability
of milk and milk products in interstate shipment. The NCIMS operates to establish uniformity of product standards from state to state. Both producers and processors of milk are represented in NCIMS. They address issues related to laws and regulations governing Grade a milk sanitation (storage, handling), reciprocity between regulatory jurisdictions and violations of reciprocity.

Suggested routine tests for quality control in dairy plants

- Sensory evaluation to assure fresh flavour and odour in milk
- Fat, total solids and weight of milk for accounting purposes
- Methylene Blue Reduction Test (MBRT)
- Alcohol Alizarin test
- Titratable acidity/pH to detect sour milk
- Sediment test to detect dirt and extraneous matter in milk
- Freezing point determination to detect watering of milk (Cryoscopy).
- Detect adulterants like starch, neutralizers, preservatives, etc.
- Direct microscopic somatic cell count for detection of abnormal milk
- Standard Plate Count (SPC) and Direct Microscopic Counts on all incoming milk
- Coli form count (Violet red bile agar) test to check sanitary quality
- Antibiotic screening test to check for drug residues

Quality Issues for Indigenous Products

Most of the Indigenous products are produced on small scale in the unorganized sector. Because of the small scale of operations, laboratory support for controlling the quality is not a feasible proposition. There are day-to-day variations in the quality attributable to the quality of raw materials as well as manufacturing procedures. In the unorganized sector, ghee is made by collecting makkhan from villages and refining it in bulk for marketing in the mandis. Only large traders brand ghee. Ghee mandis exist in Hathras and Khurja in Uttar Pradesh, Porbandar in Gujarat, Guntur in Andhra Pradesh and Erode in Tamil Nadu. Jodhpur in Rajasthan is the largest ghee-trading center in India. Ghee branded by organized dairies is in demand because of the guaranteed quality. However, ghee from Saurashtra is known for its graininess and long-keeping quality, while that from Hathras and Khurja is known for its characteristic smoky flavor.

Additional problems may occur in many manufactured products which contain non-dairy ingredients for example, cereals, sugar, flavorings, nuts, herbs. These may not only contribute additional type of microorganisms but may also alter foodstuffs to permit growth of microorganisms previously unable to proliferate. Therefore, the number and type of organisms present in dairy products at a given point depend upon the microbial
quality of raw materials, the conditions under which the products are produced and also on the temperature and duration of storage. Due consideration must also be given to the source of contamination into milk and milk products. For example, the presence of Salmonellae in finished dairy product would be a matter of great concern. Environmental sampling for some microorganisms is, therefore, certainly recommended. Salmonellae may originate from the feathers and droppings of birds in the vicinity in milk processing plants. Some birds tend to perch up on the roof, skylights, openings, ventilators and windows, etc. of milk plant building and their feathers/droppings may become airborne and get into the processing environment. Detection of Salmonellae in an environmental sample may necessitate extensive "Clean up" procedures. Design elements must be incorporated duly while planning for building and landscaping around the dairy plant so as to discourage nesting of birds and their frequenting in the vicinity of processing area.

Testing for pathogenic microorganisms on the milk plant site is sometimes not recommended and such test should be preferably done in an off site laboratory or subcontracted to competent microbiology laboratories. Their presence demonstrates deviation from "Good Manufacturing Practices" and in case of their presence in finished the product, description is needed with the choice of indicator microorganisms and the interpretation given to their detection.

In India, Ministry of Commerce is the nodal ministry for all consumers relating to export. The ministry has set up number of commodity related boards including “Agricultural and Processed Food Export Development Authority “(APEDA) and “Export Inspection Council”, which are also under the charge of this ministry. Ministry of health is regulating the food quality both for domestic consumption and import through the boards vested under the prevention of food adulteration act 1955. The Bureau of Indian Standards and Directorate of Marketing are also implementing voluntary standards and Extension under the boards vested through respective Acts passed by the Parliament. Through ISO 9000 a family of standards is being implemented the world over since the preceding decade. In some countries ISO 9000 with HACCP in the form of HACCP-9000 for food sector is being implemented.

Policy perspectives

In India, the livestock has been a livelihood issue and therefore the policies should aim at both at social and economic aspects. Successful dairy development programmes have been based exclusively on the integrated approach, which links primary producer with the consumer. Market oriented approach is the key for many successes, as trade and consumer issues such as quality, safety and choice are gaining importance due to increase in awareness.
Policies

- Upgrade good indigenous milch breeds of cattle to suit local conditions.
- Adopt intensive and well-defined action plan to achieve growth in productivity.
- Adopt pure breeds / cross breeds in areas commensurate with agricultural production and fodder availability.
- Initiate programme on promoting silvipasture system in revenue and waste lands, which will give equal access to poor and also improve the environment.
- Promote green fodder cultivation through better agronomic practices and use of improved seeds. Proper extension work is required and the fodder production programme needs to be taken up by milk cooperatives because of their wide network at farm level. Focus has to be given for fodder production in dry land or partially irrigated land.
- Extension work to promote pre-treatment of straws, chaffing, balance feeding, fodder conservation and use of mineral mixtures.
- Government must take active part in development and dissemination of technology through training and extension programmes.

Globalisation and trade liberalisation

Globalisation provides a single world market access for trade. Those who produce cheapest would market it globally. Developed countries provide huge subsidies to their milk producers. But the developing countries can not afford to do so even to realise the cost of milk production. Apart from subsidies, the developed countries raise non-tariff barriers to imports from developing countries through sanitary measures. Also most developed nations provide export subsidies, thus creating an unhealthy competition in the domestic market of the importing countries. The farm-gate price of milk in Asia is one of the lowest in world and Asian dairy farmers do not receive much subsidy and hence are not able to compete with developed nations.

Regional cooperation

India, as the highest milk production in the world can help other SAARC countries by market-oriented dairy developments and milk producer group organisation, dairy institutional setup, low-cost milk collection, processing, marketing and by capacity building for sustainable milk processing. A unified dairy sector of the SAARC nations has the potential to improve regional economy, food security and nutritional status of their population. The SAARC technical committee on Agriculture and rural development had earlier proposed to set up a SAARC milk grid to allow easy import / export, exchange of knowledge, manpower, training and research. In a situation like the European Economic Union, where the trade barriers are brought down, benefits have
been shown. SAARC has been a slow mover on this regard. India has signed free trade agreement with Pakistan, Sri Lanka and Nepal to promote bilateral trade for regional economic development. SAARC should stand together at the WTO negotiations to protect regional interests. There is a need for vigilance to stop unfair application of sanitary measures and discriminatory technical barriers to trade that may hurt the regional growth of dairy sector.

**The Way Forward**

The R&D base of the traditional dairy product sector needs to be strengthened through greater financial inputs involving stakeholders for restructuring the hitherto otherwise a very large segment of the unorganized dairy industry. There has been a gross lack of scientific and financial inputs for upgrading the existing methods for large-scale production of traditional milk products. For undertaking requisite R&D efforts, intensive basic studies are required to be carried out to fill up knowledge gaps to pave way for equipment and process design. There is a need to characterize at the molecular level various physico-chemical changes, that are responsible for imparting desired flavor and texture attributes in the finished product. For instance, there is need to elucidate the mechanism and quantify the requirement of thermal energy to bring about desired level of protein denaturation/protein-protein/shear force interactions to develop desirable body, texture and flavor when milk is converted into khoa. Further, how much free fat is required to give the light frying effect during final stages of khoa making. Likewise fine differences in the body, texture, and flavor differences between end products, when khoa is converted into burfi, peda, Kalakand etc. need to be characterized at the molecular level as well as in terms of the energy requirements. Such studies would help to standardize the technological parameters to produce desired organoleptic attributes in the finished product. In-depth knowledge regarding these aspects is an essential pre-requisite for engineer designing of process equipments as well as standardizing of technological process variables for performing large-scale operations.

For the industrialization of the manufacturing processes, a cohesive interdisciplinary teamwork is crucial for the success. Efforts of the R&D scientists in concert with the equipment manufacturers, designing experts for packaging material/equipments, end-users need to be coordinated in a result oriented approach. In this context of modernization, excellent scope is indicated for undertaking a systematic approach towards process upgradation for he commercial production of traditional dairy products under industrial conditions:

- Scientific documentation of the traditional practices for the preparation of the vast range of traditional milk products for preparing data bank of the traditional wisdom to obtain requisite product quality in terms of the physico-chemical and nutritional attributes so as to provide scientific basis for process development.
• Establishment of the regional preferences for the sensory, theological and physico-chemical profile of the commercially important indigenous milk products through systematic surveys so as to provide scientific basis for standardization of product attributes for commercial trade practices.

• Incorporating the principles of energy conservation efficient by integrating newly emerging technologies / equipments for performing various unit operations involved in the large-scale manufacture. This approach would permit greater mechanization and amenability for automation of processes for industrial production. While manufacturing in traditional ways, a considerable amount of heat energy goes waste that can possibly be conserved / recovered in a modern plant. (Evaporation of milk in a karahi consumes five times more energy than vacuum evaporators.) Unit operations / Technologies such as UHT-particulate processing, MF/UF/RO Membrane processing, microwave heating, aseptic packaging developed in the western food processing industry have the potential being utilized where ever appropriate and technologically feasible.

• Utilizing alternative sources for milk solids such as skim milk powder, whole milk powder, concentrated milks, cream, butter oil / ghee etc. to cope with the regional and seasonal fluctuations of the availability of fluid milk for maintaining steady supply to the market and for greater economy.

• Evaluation of the newly developed processes / equipments in relation to the product quality, shelf life and consumer acceptability. This feedback would permit sustained efforts for process refinement for greater commercial success.

• The newly evolved processes / equipments also need to be constantly evaluated for operational difficulties, process control, safety, electrical and mechanical failures, maintenance problems, cleaning and sanitation problems and operational costs for constant refinement and improvement.

• Demonstration of the performance of newly evolved processes and equipments to pave way for industrialization. These demonstration centers could also be utilized for training of personnel from industry as well as further R&D work.

The many advances that dairy technology has made will provide the tools to further explore and improve upon the quality and shelf life of these time-tested products. Manufacture of khoa powder and chhana powder is another way of using western technology to make indigenous products. Ultra Filtration/Reverse Osmosis (UF/RO) technologies can be used for chhana making and concentration of milk for many indigenous dairy products. Whey produced in the manufacture of chhana is today wasted. Its organized manufacture will help in utilizing this valuable by-product.
The production of traditional products through modern technology can ensure utilizing larger quantities of milk during the flush season, thus helping in stabilizing farmer prices. The technology of recombining milk constituents can also help in providing these products in the lean season in far off places. Some of these products will have to undergo modifications to suit the processing, manufacturing and packaging requirements.

Large-scale manufacture of these products will also open the way for trying out newer ingredients. The processed food industry in the United States has emerged as the largest user of corn syrup solids and high fructose corn syrup. These sweeteners add to the moisture retention properties of many foods, apart from adjusting the sweetness to a desired level. These are exciting possibilities that can be explored to the advantage of processors and consumers.

Another challenging task for modernization of this sector is to develop appropriate packaging systems consistent with the international standards for labelling and quality assurance to pave way for establishing marketing networks. In this regard, there is also a need to have in depth studies on the biochemical and microbiological changes that take place during the storage period that seem to limit the shelf life. Furthermore, cost effective packaging materials and machines need to be identified/developed/adapted for the commercially important range of indigenous milk products.

Packaging of these products can also follow a similar approach. In Italy, Mozzarella cheese balls are being packed in whey in consumer packs. This can be tried to market rasogolla and gulabjamun. Chocolate and candy packaging lines can be used to pack burfi and peda. Tetrapaks can be used to pack lassi, basundi, kheer and sevian.

An R&D Centre for development of traditional milk products can provide an interactive link between ongoing research and all the stakeholders in the industry on all aspects of manufacturing, packaging, quality assurance and distribution of indigenous dairy products on a continuous basis. Apart from qualified dairy technologists, the center can attract the progressive halwais to use its research facilities in upgrading the process know-how for making indigenous dairy products. Such a R&D centre may also develop its own product formulations as part of its program for continuous product improvement. It could take out process and equipment patents, and charge royalties on the use of such patents as was done by the NDDB at the Sugam Dairy, Baroda.

Yet another major function of such a center would be to organize training of halwais to raise their skill level, particularly the hygienic handling of milk and milk products. This will help raise the overall image of the sector. It could also participate in standardizing, processing parameters, and equipment both for small and large-scale manufactures as well as develops product standards. It could find ways and means for increasing the shelf life of the traditional products. It could also explore avenues to promote export.
An important feature of the traditional milk products in India is the absence of the use of stabilizers, emulsifiers, processing aids, or preservatives in them. While this feature needs to be cherished, it may become necessary to incorporate some of those food additives that are “Generally Recognized as Safe (GRAS)” to help in the industrial production. It would also allow the use of available packaging and storage technologies. This is a path that needs to be treaded carefully.

Many options are available to the organized dairy sector in India to make use of the traditional milk sweets to productively use the growing milk surplus. One option is to get into the manufacture of these products on an industrial scale as has been done for shrikhand, dahi, mishti doi, paneer, etc. The other option is to take on board some halwais who are willing to be trained and can follow standardized procedures for manufacture of these products, as franchisees for their brand named sweets.

Amul and the Delhi Mother Dairy are already planning fast food chains, and traditional products could fit into such chains. Franchising, having done wonders for several food-based products all over the world, is an option open for wider marketing of mithais. Some other food products can easily be made along with the Indian milk-based sweets at such outlets. This is currently done by halwais such as Haldiram, Bikanerwala and Aggrawals in Delhi who seem to be the Indian version of fast food chains.

Consumer consciousness for health and cholesterol-free diets is making demand for newer range of nutritional products. The industry must see the writing on the wall and gear itself to respond adequately to the demand. It must move on to sustain the tremendous growth it has shown in the past 30 years that has made India the largest producer of milk in the world. Now, mithais and related products provide a platform not only to sustain such growth, but also take a quantum leap as their globalization takes roots overseas.

6.5 Factors That Discourage Producing Quality Milk

Some 70 million small and marginal farmers and landless laborers in 500,000 villages spread throughout the country produce milk in small quantities of two-four litres. This widely distributed production makes the task of milk collection difficult. Further, many villages are not connected by good roads, and many are inaccessible during the monsoon season. There are no facilities for cooling/refrigeration of milk on receipt at village collection centers and for its rapid transport to processing centers. Under these conditions, the procurement of suitable quality of milk is difficult. Many people are involved in the collection, transport and distribution of milk. Village producers directly supply milk to village cooperatives; others collect milk from producers for supply to halwais, milk vendors and dairies in urban areas.

Numerous agencies in urban areas supply raw or pasteurized milk. Firstly, there are the urban milk producers who deliver milk at the consumer's doorstep. These producers generally maintain a large number of animals. The consumer at times collects milk
directly from these urban dairy farms. Secondly, bicycle peddlers bring milk from nearby villages in 2 or 3 small cans and supply it from house to house. Halwai shops receive milk generally from bicycle peddlers and sell boiled milk kept in open pans directly on a low fire. They also convert milk into traditional milk-based sweets for direct sale. In many cities, retail and wholesale markets collect milk from villages for sale. Increasingly, the public sector/cooperative dairies, which supply packaged, pasteurized milk, apart from loose milk, and usually toned, from bulk-vending outlets, are now meeting with a large share of the urban milk market.

Various reasons that impede producing quality milk are enumerated below:

- Lack of awareness and concern for hygiene of surroundings and animals among the farmers.
- Lack of availability of water.
- Lack of requisite infrastructure.
- Lack of financial resources.
- Lack of incentives.

In organizing efficient milk procurement system, good microbiological quality of raw milk should be the prime focus. Milk produced should be checked for safety and quality assurance at the collection centres. The farmer should be made aware of the perishable nature of milk and ways to safeguard it against post-secretion contamination under various farming systems and environments. For continuous monitoring of milk quality at the farm, facilities like mobile testing kits and rapid microbiological testing must be made available at farmers’ doorstep. Notable strides have been taken in the country in this direction by the cooperative dairy sector under the National Dairy Development Board (NDDB) and the large organized dairy plants in the private sector.

With the growth of the organized dairy industry in India, a trend towards establishing organized farms for milk production has already set in. In the current scenario, such farms with a herd of 100-300 cows/buffaloes on the pattern of advanced countries have been set up in the major pockets of milk production. These farms have machine milking and bulk cooling systems.

For a systematic approach to rural milk collection, the first phase is to undertake extensive surveys in the milkshed area where a dairy plant is to be established. Availability of milk at various collection points is ascertained, based on the number of animals, future potential of milk availability, and the presence of competitors. The second phase involves “route planning” taking into account availability of milk, access to roads for plying vehicles and distance from the site of dairy plant. The third phase calls for planning the location of primary collection centres as well as chilling centres.

In view of the significance of clean milk for producing good quality products, new initiatives are needed to induce the farmers to pay more attention to the task. For providing incentive to the farmer to produce clean milk, it is crucial to develop an
effective payment system based on quality. For examples, the Punjab State Cooperative Milk Producers’ Federation Ltd (Milkfed) has taken steps to motivate their 360,000 dairy farmer-members of their 6,500 village cooperative societies (VCS) to take to clean milk production. The programme launched in 2000 has the following components:

- A price incentive has been announced for the milk having low bacterial count, in addition to the basic payments for the fat/SNF contents of milk.
- The incentive payment to milk producers for better quality milk is an additional Rs 3 to Rs 8 per kg fat, depending on MBR time ranging from 25-40 minutes and over in summer and between 45-65 minutes and over in winter.
- In all the Unions, the MBR time test is being used to determine the bacterial load in raw milk at various levels i.e. from the animal’s udder to producer (utensils), society, transport and, finally, the dairy dock.
- For achieving the international standards of testing, Punjab Milkfed has installed the Bactoscan and Somatic Cell Counter at their Ludhiana Milk Plant. It will help the milk plants to increase efficiency of testing, commercialize the testing for somatic cells and help detecting mastitis at an early stage. The Bactoscan can test 50 samples/hour with digital display of the results along with a detailed printout.
- Almost 30 of the targeted 150 bulk milk coolers have been installed at the village-level societies for chilling raw milk immediately after its collection for transportation to milk plants under insulated conditions. This number is expected to increase rapidly in the coming years.

7. MILK COLLECTION, PRESERVATION AND TRANSPORTATION

Preservation of Raw Milk

Milk leaves the udder at body temperature of about 38oC. If not immediately cooled to 4oC, the bacterial load may grow rapidly and bring about undesirable changes when milk is held at the ambient atmospheric temperature. The common milk microorganisms grow best between 20 and 40oC. Bacterial growth is invariably accompanied by deterioration in milk quality due to the development of off-flavours, acidity, etc. Freshly drawn raw milk should be promptly cooled and held at 4oC till processing to preserve it against bacterial deterioration.

In-can cooling: Portable refrigeration units may be employed for in-can cooling of milk by direct immersion of cooling coil. The cooling coil is kept immersed in the can till desired cooling temperature is attained. Such a unit is fitted on a trolley and is suitable for cooling 5-7 cans (200-280 litres of milk) at the farm.

Bulk milk cooler: This method is more suitable for bulk cooling as well as for storage of milk for handling 500-2,500 litres of milk/day. It is increasingly being used by
the dairy industry in India for village-level milk collection centres. From the bulk milk coolers, milk is pumped to insulated road milk tankers for transportation to the central dairy. Bulk milk coolers are usually horizontal, semi-circular or a vertical cylindrical tank with an inner jacket and outer insulated body. The inner shell of the tank provides either chilled water around its external periphery or a direct expansion cooling coils from a mechanical refrigeration system for cooling. The milk is either directly poured into the tank or pumped through a balance tank. The milk coming in contact with the inner shell of the tank is cooled to around 4°C. The agitator inside the tank helps to maintain uniform cooling of milk.

Plate chillers: It is widely used for large-scale (5,000-50,000 litres/day) cooling of milk in the chilling centres. They are highly efficient, compact and easily cleanable. It is made up of a frame, a number of gasketed plates tightly held in between the frames. These plates are arranged in such a manner that there is a flow passage for milk on one side of the plate and cooling medium (usually chilled water) on the other side of the plate. There is a counter-current flow between the milk and the chilled water through alternate plates. It helps in efficient transfer of heat from milk to the cooling medium — chilled water, which results in quick chilling of milk. The chilled milk flows from the plate cooler to the insulated or chilled water-jacketed milk storage tank for storing milk at 4°C. A mechanical refrigeration system with ice bank tank ensures supply of chilled water to the plate cooler.

**Transportation of Raw and Chilled Milk**

Ideally, milk should be transported under chilled conditions (4°C) to ensure that undesirable microbiological changes do not take place during transportation period. In the Indian context, most of the raw milk collected from rural collection centres is transported to the dairy plant employing different modes of transport depending upon the volumes of milk handled, and the distance between the central dairy and collection/chilling centres.

- Cans for transporting up to 3,000 litres of milk per truck.
- Tankers for transporting chilled milk, between 2,000 to 10,000 litres per tanker.

**Milk Reception at Dairy Plant**

Milk may be delivered to the dairy plants in cans or tankers. The handling of milk inside the plant is the key element in assuring good quality milk. On arrival, the milk is graded for acceptance/rejection, weighed, sampled for testing, cooled and stored under refrigeration until next unit operation for preliminary processing in the dairy plant. In the case of road milk tanker, gross weight of the tanker on weighbridge is recorded, once when it is full and again after it has been emptied. This may be counter-checked by the volumetric measurement using flow meters at the time of unloading the tanker. Cleaning of tankers: The cleaning and sanitization of the tanker should follow immediately after it is emptied. This is done either by manual cleaning or connecting to CIP systems for the tankers.
Shelf Life Extension and Food Safety

In general, life of food products can be extended as a result of a variety of processing treatments like pasteurization, sterilization, canning, dehydration, concentration, refrigeration, freezing, irradiation, vacuum treatment, high pressure processing, use of permissible preservatives, followed by appropriate packaging. Because of chemical interactions induced by processing treatments possibly resulting in deterioration of flavor, color or texture, various foods can be processed only in a discrete manner. Indian milk products are no exception in this regard.

Determination of shelf life of a product depends on the type of product, chemical composition and microbiological status. From the public health hazard standpoint, they may be classified into two basic groups: (a) Fermented dairy products (pH below 4.6) and (b) Confectionery products (pH above 4.6). Refrigeration and in appropriate cases freezing may extend the shelf life considerably. It is imperative to make sure that product characteristics are not adversely affected as a result of refrigerated or frozen storage. Generally, microbial hazards in products with a pH of 4.6 or below are related to spoilage organisms primarily yeasts and molds. The other products when stored under favorable conditions would pose substantial health hazard due to the presence and multiplication of pathogenic organisms as well as spoilage by bacteria yeasts and moulds.

Shelf life may be defined as the number of days a product can be stored at a certain temperature and can be consumed safely without deterioration of sensory characteristics of taste, color and texture. The shelf life is therefore determined by microbiological and organoleptic acceptability. Either of the two criteria whichever manifests first determines the shelf life (Lewis and Dale, 1998). Factors affecting shelf life may be summarized as:

Quality of Milk and other raw materials

Milk is the basic ingredient used in the preparation of Indian milk products. Besides milk other raw materials like sugar, spices, and flour can introduce microorganisms, toxins and chemicals which may alter the safe status, wholesomeness and shelf life of the product. Certain products require the use of buffalo milk exclusively and others are better made from cow milk. All the milk used must have low bacterial counts, lacking in off-flavors and enzymatic breakdown of fat or protein. Consistency in the quality of milk is assured by entering into agreements with milk suppliers based on specifications covering fat, solids not fat, temperature at delivery time, titratable acidity, handling practices and processing parameters prior to delivery, aroma, flavor, and microbial standards. The microorganisms gain entry into milk from the cow or buffalo, utensils used, sanitation in the animal shelter, and hygienic practices of milkers. Furthermore, the storage conditions, transportation time and temperature compound the sanitary quality of milk by exposing it to conditions conducive to the growth of bacteria leading to uncontrollable degradation of milk constituents. In order to check the growth of microbial flora in milk, it should be cooled down to 4°C as soon as possible after milking and held at this temperature until processed. Public health and quality issues pertaining to milk have been discussed elsewhere.
Cream, butter, ghee, and other milk concentrates may be used in the preparation of IMP. These products should conform to similar sanitary standards as milk. In addition, concentrated fat products are more vulnerable to rancidity problems unless stored under refrigeration. Quality tests include organoleptic examination, microbial tests like coli forms, spore counts, total counts and chemical tests including levels of fat, solids-not-fat and titratable acidity or pH.

All ingredients other than milk and milk-derived products must conform to stringent quality standards to limit their chances of contamination in the Indian milk product manufacture. In several cases they may require blanching treatment in water, steam, or sugar solution to reduce their microbial load. In certain instances as in spices and nutmeats, they may have to be autoclaved or dry roasted with the objective of reducing microbial load or to generate roasted flavors.

**Product formulation**

Shelf life of milk is a function of its perishable nature. However, by appropriate heat treatment (even boiling), followed by refrigerated distribution extends its life to permit its marketing as fluid milk. Production of khoa, in rural areas of abundant milk supply, by heat dehydration extends the life further and permits its use as an ingredient in metropolitan areas of high demand by urban consumer. Concomitantly, removal of water concentrates milk solids to effect economy of transport costs and provides a functional raw material for production of gulabjamun, burfi, kalakand and other sweets. Practically all the water can be removed from milk by further dehydration to yield milk powder with an enormous extension of shelf life. Similarly, it is conceivable that technology would be developed to produce a khoa powder and Chhana powder with desirable functional attributes to extend the use of khoa and chhana even further.

The concept of water activity (Aw) entails manipulation of available water for arresting microbial growth as well as retarding chemical deterioration of foods. Water activity may be defined as a measure of water available for microbial growth (Fox and Sweeney, 1998; Surak, 1994). It varies from 1.00, which represents the Aw of pure water at 00C to 0.00, which represents the Aw of perfectly dry food. It may be defined as:

\[
\text{Aw} = \frac{\text{pequ}}{\text{p0}} = \frac{\% \text{ERH}}{100}
\]

where, pequ equals the partial pressure of water in equilibrium with the food, p0 is the vapor pressure of pure water at the same temperature and pressure, and % ERH represents the equilibrium relative humidity of the air enclosed above the food.

Foods can be classified into three groups, depending on their moisture content and Aw.

- High moisture foods, containing moisture above 50% and Aw of >0.85;
- Intermediate moisture foods, containing 15–50% moisture and Aw ranging from 0.60 to 0.85;
- Low moisture foods, containing < 25% moisture and Aw of <0.60.
In general, most bacteria, yeasts and molds are inhibited at Aw of 0.85. The growth of all bacteria can be stopped at Aw of 0.75, while the growth of all yeasts and moulds requires Aw of 0.65. Accordingly, water activity plays a crucial role in predicting and engineering extension of shelf life in foods. Since all microbiological activity requires water for growth in addition to nutrients and presence or lack of oxygen or air, food preservation techniques include not only manipulation of available moisture but also involve control of atmosphere by replacing air with nitrogen and other inert gas in the package. This is the basis of Modified Atmospheric Packaging, which is widely used for cheese and possibly could be applied to paneer packaging. Most preservation methodologies involve management of available water to control microbial growth. Addition of salt in pickle making, and sugar in fruit jam is really designed to impart enough osmotic pressure in the food system to retard microbial activity. Addition of fruit acid or vinegar reduces the pH to effect selectivity of microbial growth. Under these conditions, pathogens are excluded from growing and the spoilage organisms are controlled by the action of reduced water activity. Sweetened condensed milk is a good example of a dairy product in which water activity has been reduced by partial dehydration and addition of sugar. The added sugar exerts osmotic pressure on the contaminant organisms to prevent their proliferation. By manipulating the solute type and its concentration, the availability of water to microbes has been manipulated so that spoilage of the product has been significantly delayed. Packaging further insures its integrity until it reaches the consumer. Accordingly, canned sweetened milk can be stored at ambient temperatures for several months to years.

8. MILK MARKETING

Livestock sector plays an important role in generating income and employment, ameliorating income of marginal farmers and landless labourers and in meeting nutritional requirement. Farmers in general in India follow mixed crop and livestock farming system because of strong linkage between these two activities. Besides land owning households, livestock are also reared by a large number of other households, most of which belong to poorer sections of the society. Because of this, livestock wealth in India is more egalitarian, compared to land, and hence it is found to promote equity and livelihood security. Livestock formed a major component of poverty alleviation strategy of government of India. Another attractive feature of livestock sector in the country is that significant employment and income generated by this activity accrues to women which has its own social gains.

Demand for livestock products is rising at a fast rate in the country and export demand is also increasing. Demand for livestock products during 11th Five year plan is envisaged to grow at annual rate varying from 3.2 to 4.7 per cent for various products (Planning Commission, 2007). On supply side, India has a very large population of livestock but productivity is very low. The main reasons for this are poor feeding, low
quality of animals and inadequate veterinary facilities. Other factors which affect livestock productivity and output growth are related to infrastructure, output marketing, institutions and price incentives.

India is rich in agro-ecological diversity, and concurrently one finds a range of unique livestock production systems that have evolved in each region in tune with the naturally available resources and needs of the people. This diversity begins with the choice of species reared, breeds that have evolved, management and feeding practices, health care systems that are closely linked to the natural flora and fauna, and local marketing systems. Mixed crop-livestock farming and pastoralism are the two common production systems found across different agro regions. In the former, farmers derive their livelihood somewhat equally from agriculture and livestock; in the latter, people’s livelihoods depend primarily upon their livestock, which are exclusively maintained on grazing.

The development of animal husbandry has been envisaged as an integral part of sound system of diversified agriculture. With its large livestock population, India has vast potential for meeting the growing needs of teeming millions, particularly in respect of livestock products such as milk. However, the livestock producers are constrained by lack of quality inputs, improved technology and support systems (Birthal and Taneja, 2006).

The livestock sector contributes over 5 per cent to the total Gross Domestic Product (GDP) and about a quarter of the GDP from agriculture and allied activities. The 11th five Year Plan envisages 6 per cent per annum growth rate in livestock sector output in order to achieve 4 per cent growth rate in agriculture (Planning Commission, 2007). India ranks first in the world in milk production, which increased from 17 million tones (MT) in 1950-51 to about 108.5 MT by 2008-09. The per capita availability of milk has also increased from 112 grams per day in 1968-69 to 258 grams during 2008-09. But it is still low compared to the world average of 265 grams / day. About 80 per cent of milk produced in the country is handled in the unorganized sector and the remaining 20 per cent is equally shared by cooperatives and private dairies. Over 1.33 lakh village –level dairy cooperative societies spread over 265 districts in the country, collect about 25.1 million litres of milk per day and market about 20 million litres. The efforts of the Government in the dairy sector are concentrated in promotion of dairy activities in non-Operation Flood areas with emphasis on building cooperative infrastructure, revitalization of sick dairy cooperatives and federations and creations of infrastructure in the States.

Livestock production systems are based on low cost agro by products and crop residues as nutritional inputs, using traditional technologies. The spectacular growth of livestock products especially milk, however, attributed to the initiatives taken by Government through its schemes, the organized private sector and the increasing demand for those products in response to rising incomes in urban and rural areas. This has
resulted in the rapid growth of peri-urban livestock systems. Higher growth in urban population is an indicator of this. Unlike rural livestock systems, peri-urban systems are commercially oriented and intensive in nature, depending mainly on purchased inputs. Technical coefficients of crossbred animals are better under peri-urban systems and adoption of technology is therefore also expected to be higher. Adoption of technologies related to health, nutrition, and management is also expected to be higher in peri-urban areas. Thus there might be increasing technological dualism between rural and urban areas with the rising demand for livestock products.

Composition of Livestock Population

India has huge livestock population with 185 million cattle, 98 million buffaloes, 124 million goats, 61 million sheep (Table 10). Out of the total livestock in the country, around 38.2 per cent are cattle, 20.2 per cent are buffaloes, 12.7 per cent are sheep and 25.6 per cent are goats. All other animals are 3.3 per cent of the total livestock population. The composition of livestock population in broad groups like bovine (cattle and buffaloes), ovine (sheep and goats), however, has changed over the last five decades. Cattle population that had increasing until 1992 has started declining and between 1992 and 2003, it declined by 9 per cent. The decline in the cattle population is confined to indigenous stock that comprised 87 per cent of the total cattle population in 2003. The number of indigenous cattle declined by 15 per cent, while that of the crossbred increased by 62 per cent. Within the indigenous stock, decline was drastic for males (22%). The main reasons for decline in indigenous-cattle population are: increasing substitution of draught animals with mechanical power and low milk yield (Birthal and Taneja, 2006). The buffalo population has increased from 43 million in 1951 to 98 million in 2003. There has been a small decrease in total bovines in the country by 1.9 per cent between 1992 and 2003. Total ovine population has increased from 86 million in 1951 to 185 million in 2003. The number of goats increased from 47 million in 1951 to 124 million in 2003. The population of sheep increased from 39 million in 1951 to 61 million in 2003.

Table 10. Livestock Population in India (million numbers)

<table>
<thead>
<tr>
<th>Census Year</th>
<th>Total Livestock</th>
<th>Cattle</th>
<th>Buffalo</th>
<th>Sheep</th>
<th>Goat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>293</td>
<td>155</td>
<td>43</td>
<td>39</td>
<td>47</td>
</tr>
<tr>
<td>1961</td>
<td>335</td>
<td>176</td>
<td>51</td>
<td>40</td>
<td>61</td>
</tr>
<tr>
<td>1972</td>
<td>354</td>
<td>178</td>
<td>57</td>
<td>40</td>
<td>68</td>
</tr>
<tr>
<td>1982</td>
<td>420</td>
<td>192</td>
<td>70</td>
<td>49</td>
<td>95</td>
</tr>
<tr>
<td>1992</td>
<td>471</td>
<td>205</td>
<td>84</td>
<td>51</td>
<td>115</td>
</tr>
<tr>
<td>2003</td>
<td>485</td>
<td>185</td>
<td>98</td>
<td>61</td>
<td>124</td>
</tr>
</tbody>
</table>
Table 11. Annual Growth percent

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Livestock</th>
<th>Cattle</th>
<th>Buffalo</th>
<th>Sheep</th>
<th>Goat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951-1961</td>
<td>1.37</td>
<td>1.24</td>
<td>1.67</td>
<td>0.28</td>
<td>2.09</td>
</tr>
<tr>
<td>1961-1972</td>
<td>0.53</td>
<td>0.16</td>
<td>1.15</td>
<td>-0.05</td>
<td>1.04</td>
</tr>
<tr>
<td>1972-1982</td>
<td>1.73</td>
<td>0.77</td>
<td>1.97</td>
<td>2.01</td>
<td>3.51</td>
</tr>
<tr>
<td>1982-1992</td>
<td>1.16</td>
<td>0.62</td>
<td>1.90</td>
<td>0.42</td>
<td>1.93</td>
</tr>
<tr>
<td>1992-2003</td>
<td>0.30</td>
<td>-0.87</td>
<td>1.38</td>
<td>1.82</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Source: Basic Animal Husbandry Statistics, 2006

Livestock and land distribution in India

Table 12 presents ownership distribution of land and livestock suggesting that the poor have a higher stake in livestock income. In 2002-03 marginal land holders (<1.0 ha) who comprised 47 per cent of the rural households controlled 51 per cent bovines and 62 per cent small ruminants. Their share in monogastrics was even higher. Share of marginal land holders in land was only 19 per cent. Share of small land holders (1-2 ha) in land as well as livestock almost corresponded to their share in rural households. Together, marginal and small landholders possessed three fourths of the large and small ruminants, more than 80 per cent of the pigs and poultry. However, the landless that comprised 32 per cent of the rural households are deprived of land as well as livestock. Further, a comparison of livestock ownership pattern in 1991-92 with that in 2002-03 shows an improvement in distribution of land and livestock holdings. Share of marginal landholders improved both in land and livestock, although their number too increased simultaneously. Share of landless in livestock holdings, however, declined during this period.

Table 12. Distribution of land and livestock holdings in India, 1991-92 and 2002-03 (%)

<table>
<thead>
<tr>
<th>Item</th>
<th>Year</th>
<th>Landless (0 ha)</th>
<th>Marginal (&lt;1ha)</th>
<th>Small (1-2 ha)</th>
<th>Medium (2-4 ha)</th>
<th>Large (&gt;4ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households</td>
<td>1991-92</td>
<td>21.8</td>
<td>48.3</td>
<td>14.2</td>
<td>9.7</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>2002-03</td>
<td>31.9</td>
<td>47.1</td>
<td>11.2</td>
<td>6.2</td>
<td>3.4</td>
</tr>
<tr>
<td>Land</td>
<td>1991-92</td>
<td>0</td>
<td>15.5</td>
<td>18.6</td>
<td>24.2</td>
<td>41.7</td>
</tr>
<tr>
<td></td>
<td>2002-03</td>
<td>0</td>
<td>18.8</td>
<td>20.2</td>
<td>24.0</td>
<td>37.0</td>
</tr>
<tr>
<td>Bovines</td>
<td>1991-92</td>
<td>2.5</td>
<td>43.8</td>
<td>23.3</td>
<td>17.7</td>
<td>12.7</td>
</tr>
<tr>
<td></td>
<td>2002-03</td>
<td>0.6</td>
<td>51.3</td>
<td>21.2</td>
<td>15.0</td>
<td>11.9</td>
</tr>
<tr>
<td>Small ruminants</td>
<td>1991-92</td>
<td>5.1</td>
<td>46.2</td>
<td>19.3</td>
<td>15.0</td>
<td>14.4</td>
</tr>
<tr>
<td></td>
<td>2002-03</td>
<td>2.1</td>
<td>61.5</td>
<td>15.7</td>
<td>9.6</td>
<td>11.0</td>
</tr>
</tbody>
</table>

Source: NSSO (2005), Land and livestock holding survey
Livestock producers in India operate on a small scale. On an average, there were 156 bovines, 64 small ruminants per 100 households in 2002-03 (Table 13). Scale of production, however, is positively associated with land holding. The difference in the scale is huge between marginal and large landholders. This is expected, as the latter are better economically, have higher investment capacity and sufficient supply of feed and fodder.

Table 13. Average size of livestock holdings by farm size in 1991-92 and 2002-03 (No / 100 households)

<table>
<thead>
<tr>
<th>Year</th>
<th>Landless</th>
<th>Marginal</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bovines</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1991-92</td>
<td>23</td>
<td>180</td>
<td>324</td>
<td>361</td>
<td>418</td>
<td>198</td>
</tr>
<tr>
<td>2002-03</td>
<td>3</td>
<td>169</td>
<td>293</td>
<td>374</td>
<td>535</td>
<td>156</td>
</tr>
<tr>
<td><strong>Small Ruminants</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1991-92</td>
<td>20</td>
<td>81</td>
<td>115</td>
<td>131</td>
<td>203</td>
<td>85</td>
</tr>
<tr>
<td>2002-03</td>
<td>4</td>
<td>84</td>
<td>90</td>
<td>99</td>
<td>203</td>
<td>64</td>
</tr>
</tbody>
</table>

Source: NSSO (2005), Land and livestock holding survey

Scale of livestock production of smallholders has been declining. Between 1991-92 and 2002-03 average number of dairy animals owned by marginal and small landholders decreased by 8 per cent. Increase in scale was much more for large land holders. In fact, scale of production on all farms declined over this period. Scale of small ruminant production witnessed a general decline except marginal farms. This was mainly due to quantitative and qualitative deterioration in common grazing lands, which are important sources of fodder for small ruminants. Relatively faster increase in the scale of large holders implies that large holders respond better to demand signals than do the small land holders.

**Growth in Livestock output and its composition**

Livestock are becoming an important source of income in India. Their share in agricultural income increased from about 17 per cent in 1950’s to 23 per cent in 1980’s and further to 27 per cent during 2008-09. It is interesting to note that growth in livestock income has always been higher than the growth in crop sector but lower than non-agricultural sector. The most important livestock products in India are milk, meat, poultry, dung, wool and hair. The estimated per cent annual growth of livestock output at 1999-2000 prices is presented in Table 14. The dairy and poultry are high–growth sectors and is reflected in the growing importance of the contribution of these sub sectors in the livestock economy. The value of output from milk sector grew at an annual compound growth rate of 3.33 per cent between 2000-01 to 2005-06, ranging from 0.84 per cent in the sixties to 5.47 per cent in the 1990’s. The growth in dairy sector is mainly attributed to the successful implementation of the Operation Flood and other dairy development programmes implemented by the central and the state governments.
Table 14. Annual growth of livestock output at 1999-2000 prices (%)

<table>
<thead>
<tr>
<th>Period</th>
<th>Milk group</th>
<th>Meat group except poultry</th>
<th>Poultry meat +eggs</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-51 to 1959-60</td>
<td>1.04</td>
<td>0.76</td>
<td>3.65</td>
<td>1.42</td>
</tr>
<tr>
<td>1960-61 to 1969-70</td>
<td>0.84</td>
<td>1.23</td>
<td>-1.46</td>
<td>0.41</td>
</tr>
<tr>
<td>1970-71 to 1979-80</td>
<td>4.64</td>
<td>1.66</td>
<td>6.88</td>
<td>3.92</td>
</tr>
<tr>
<td>1980-81 to 1989-90</td>
<td>5.47</td>
<td>3.86</td>
<td>8.26</td>
<td>4.91</td>
</tr>
<tr>
<td>1990-91 to 1999-00</td>
<td>4.28</td>
<td>2.61</td>
<td>4.14</td>
<td>3.78</td>
</tr>
<tr>
<td>2000-01 to 2005-06</td>
<td>3.33</td>
<td>3.00</td>
<td>4.47</td>
<td>3.55</td>
</tr>
</tbody>
</table>


Milk: Milk is the single contributor to the livestock output in the country and contributes significantly for human nutrition as a single largest source of animal protein. The share of milk group in total value of output from livestock sector has increased from 65 per cent in 1950-51 to 1959-60 to 69 per cent in 2000-01 to 2005-06 (Table 15). The growth in output of milk has been that 1.04 per cent in 1950-51 to 1959-60 to 3.33 per cent in 2000-01 to 2005-06. This has increased by nearly 2.29 percentage points in milk output from bovines and goat. It is significant to note that buffaloes are the largest contributors to milk production although the years outstripping the cattle whose numerical strength more is as compared to buffaloes.

Table 15. Composition of Value of Livestock output at current prices (%)

<table>
<thead>
<tr>
<th>Period</th>
<th>Milk group</th>
<th>Meat group except poultry</th>
<th>Poultry meat and eggs</th>
<th>Wool &amp; hair</th>
<th>Dung</th>
<th>Increment in stock</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-51 to 1959-60</td>
<td>64.81</td>
<td>10.82</td>
<td>5.23</td>
<td>1.03</td>
<td>14.99</td>
<td>3.13</td>
</tr>
<tr>
<td>1960-61 to 1969-70</td>
<td>66.97</td>
<td>12.04</td>
<td>7.43</td>
<td>0.82</td>
<td>10.96</td>
<td>1.76</td>
</tr>
<tr>
<td>1970-71 to 1979-80</td>
<td>68.39</td>
<td>9.97</td>
<td>7.99</td>
<td>0.59</td>
<td>11.51</td>
<td>1.56</td>
</tr>
<tr>
<td>1980-81 to 1989-90</td>
<td>67.96</td>
<td>9.35</td>
<td>9.55</td>
<td>0.39</td>
<td>10.45</td>
<td>2.31</td>
</tr>
<tr>
<td>1990-91 to 1999-00</td>
<td>68.12</td>
<td>10.48</td>
<td>10.57</td>
<td>0.25</td>
<td>8.53</td>
<td>2.04</td>
</tr>
<tr>
<td>2000-01 to 2005-06</td>
<td>68.69</td>
<td>10.47</td>
<td>9.83</td>
<td>0.22</td>
<td>7.95</td>
<td>2.85</td>
</tr>
</tbody>
</table>

Source: Various issues of National Accounts Statistics, Central Statistical Organization, Government of India, New Delhi

Milk-Marketing System

India has the largest cattle and buffalo population in the world. More than 67 percent of dairy animals are owned by marginal and small farmers, which constitute the core milk-production sector in the country. Many of these farmers own dairy animals primarily to supply milk for their own consumption. Slightly more than 30 per cent of the milk produced in the country is retained in producer households. Eighty per cent of milk...
is marketed through the highly fragmented unorganized sector, which includes local milk vendors, wholesalers, retailers, and producers themselves. On the other hand, the organized dairy industry, which accounts for about 20 per cent of total milk production, comprises two sectors: government and co-operatives. Though co-operatives provide a remunerative price to the producer, the unorganized sector plays a major role in milk marketing because of three factors.

1) The pricing policy of the co-operatives - their purchase price is based on the fat content of the milk, whereas the private sector pays a flat rate per liter of milk.

2) The type of milk animals reared by the producer - Crossbred cows yields more milk with a lower fat than do buffalo.

3) Payment policy - The private sector can pay their producers everyday, whereas the co-operatives pay weekly or fortnightly.

Figure 3. Milk marketing channel in India

**Constraints and issues to be addressed in Indian Milk Marketing**

Major constraints are: unorganized milk-animal holders; low productivity; inadequate and inappropriate animal feeding and health care; lack of an assured year-round remunerative producer price for milk; an inadequate basic infrastructure for provision of production inputs and services; an inadequate basic infrastructure for procurement, transportation, processing and marketing of milk; and lack of professional management. Low productivity of milk animals is a serious constraint to dairy development. The productivity of dairy animals could be increased by crossbreeding low-yielding nondescript cows with high-yielding selected indigenous purebreds. While fixing procurement prices, producers’ interests should receive the utmost attention. The producer price should at least cover the long-run average cost of milk production and
provide a reasonable mark-up. Liberalization of world trade in dairy products under the new trade regime of the WTO poses new challenges and has opened up new export opportunities for the dairy industry. Another major impediment to an efficient marketing system is the presence of numerous intermediaries, which take advantage of producers’ weakness.

The Indian dairy industry needs to focus simultaneously on the four-fold challenge of quality, product development, infrastructure-support development, and global marketing. Urgent is the need for strategic alliances with some of the leading dairy companies in the world for technical collaboration and marketing tie-ups. Restructuring the governments’ legal and regulatory framework, thus liberating the cooperative movement, will enable milk producers to extensively adopt the proven Anand Pattern producers’ cooperative model to manage their assets and business interests.

Integrated food supply chains serving urban areas are the fastest growing and most visible market phenomenon, yet small scale milk market agents and chains supplying fresh milk and traditionally processed dairy products still play a very major role in India. However, the growing middle class with increasing income coupled with rapid urbanization is likely to boost the demand for more formally processed products, which the traditional market generally cannot provide. This will further fuel the growth of a formal, modern organized milk market. In India, the modern milk supply chain is quite important in an agriculturally developed states while the traditional milk marketing supply chain continues to play a dominant role in less developed states. When we look at who is selling to different chains, there are no distinguishable differences in terms of land or herd size. In other words, landless and small farmers face few if any barriers in India’s milk markets.

Livestock output in India has been growing at a faster rate as compared to crop sector. This could happen mainly due to rapid growth of milk output and poultry meat and eggs. This has helped India not only to meet demand of rising population but also improved per capita availability, besides reducing import dependence and increase in export. Major factors that have contributed to growth of livestock sector are improvement in bovine composition in favour of productive animals, artificial insemination, spread of cross-breeding of cattle, expansion of veterinary facilities, development of road network, setting up of dairy cooperatives and favorable effect of rising income transmitted through demand. After 1992-93, growth rate in output of most of the livestock products has slowed down which does not augur well with growing domestic and export demand for livestock products. In order to harness the potential of livestock sector and to maintain high growth of this sector there is a need to improve veterinary facilities in rural areas, improve composition and quality of bovine, and ensure better return to livestock farmers through improved market outlets, effective spread of dairy cooperatives, expansion of processing capacity and better availability of feed and fodder. If the factors affecting livestock sector increase at the same rate as experienced
during 1992-93 to 2004-05 then output of livestock sector is not likely to achieve more than 4 per cent annual growth rate. In order to achieve targeted growth rate of 6 per cent in livestock output, progress in livestock infrastructure, institutional efforts and availability of livestock feed is required to be accelerated by about 50 per cent.

Livestock is an important and a vital sector of India’s economy. It makes sizeable contribution to the nation’s income and has a substantial and a rapidly rising share in the contribution made by agriculture. Animals are a major source of energy for crop production. Livestock contributes in three ways. Besides providing bullocks, the major source of energy, animals provide dung manure and supply of dairy products and other products like meat, hides, wool, etc. Over a period of time, the livestock economy has undergone a major transition. A gradual but persistent trend is observed away from cow and in favour of buffaloes for milk.

The data shows that there is a long-term trend in favour of buffaloes. This compositional change has been rapid during the planning period and especially after marketing of milk was put on organized basis on the AMUL pattern. Planning raised incomes and consequently the demand for milk and milk products increased. Concentrated demand in the urban areas facilitated organization of marketing of fresh milk through the setting up of chilling centers and processing units. Efforts are made for increased production of milk by breed improvement through artificial insemination, breeding programmes and control of diseases. However, the problem of improving the production of dairy products through improved milking quality of animals is complex and huge in magnitude. With the impetus provided by organized marketing, a persistent upward trend is observed.

### 8.1 Milk Supply Chain

**Urbanization and income growth**

It is well established that the urban per capita demand for dairy products is higher than in rural areas. Increased urbanization and income growth in the developing countries will fuel a strong increase in demand. Urbanization is generally associated with increased disposable income and access to a greater variety of food products. One facet of this situation is the increased consumption of high-value foods, such as milk and milk products. Here, the fact that urbanization is also characterized by the general provision of electricity, and hence the potential for developing an extended cool chain, is of particular importance for a highly perishable product such as milk. In such a situation, household expenditure shifts from tinned and dried milk products, which do not require refrigeration, to the wide range of dairy products which can be found in any of today’s supermarkets.
8.2 Formal Sectors

Growing power of supermarkets

As urbanisation leads to a concentration of population, so the way in which food is marketed is becoming more concentrated in all countries. One manifestation of this is the increased importance of supermarkets. In a number of countries, the concentration of food distribution in the hands of a relatively small number of companies gives such firms a great deal of power in negotiating prices and deciding what products will be presented to the consumer. The movement towards food distribution through supermarkets is a world-wide phenomenon and is not limited only to the developed countries. For example, in Argentina, 60 percent of food is purchased through supermarkets. For dairy products, the spread of supermarkets is particularly important as they offer both refrigeration capacity and space to display a wide range of fresh dairy products, thereby acting as a stimulus to increased consumption. A parallel trend in many countries is the rapid expansion of sales of UHT milk. For example, in Brazil, sales of this type of milk have risen from virtually nothing five years ago to 50 percent of the liquid milk market at present.

Increased Market Concentration

The growth of supermarkets is in itself one instance of the way in which economic activities are becoming more concentrated; however, this applies to many sectors - dairying included. Thus, for example, in Denmark, a single co-operative - MD Foods - accounts for two-thirds of the milk processed and 85 percent of the country’s exports of dairy products. Similarly, in Uruguay a single co-operative, Conaprole, processes 80 percent of the country’s milk production and is responsible for 85 percent of exports. Again, in Israel, a single co-operative, Tnuva, processes 70 percent of national milk production. In 1998 the world’s 25 largest milk processing companies had a joint turnover of around $86 billion and 16.0% of this was generated by Nestlé. The top 5 companies together accounted for $37 billion and the top 10 accounted for $60 bn. ten of the top 25 companies were cooperatives and had a joint turnover of $33 bn. Although Europe produces only 25.0% of the world’s milk, 16 of the top 25 milk processing companies are in Europe.

In the instances cited above, a predominant position has been achieved through a consolidation of the company’s position in the national market. In other cases, and especially in the expanding dairy markets of Asia and Latin America, a common phenomenon is for international dairy companies to acquire, and then expand, national processing capacity. For example, in Venezuela, two companies account for 85 percent of powdered milk produced. The first of these, Indulac, is owned by Parmalat and the second, Ilapec, is partly owned by the New Zealand Dairy Board. Chile is another country where multi-national companies account for a substantial proportion of milk processed.
The importance of brands

In some cases, the involvement of an international company in a country’s dairy sector is immediately apparent; for example, Nestlé may offer the same products in a number of countries, generally displaying the company’s name prominently on the packaging. In other instances, the connection between the product and the producing company may be less clear. For example, an existing brand name may be acquired and the original packaging maintained, frequently without the new owner’s name being prominently displayed. Staying with the example of Nestlé, the company’s ownership of the Carnation brand of evaporated milk would be a case in point.

The “globalization” of products through brands is an increasingly important facet on the international market place. Consumers are attracted to such brands because they are (a) a known quantity and (b) represent a known quality. In terms of dairy products, some brands which spring to mind are: Kraft’s Philadelphia Cream Cheese; Kerry Gold, Anchor and Lurpak butter; Danone and Yoplait yogurts; and Anchor, Fernleaf and Nido dried milk. In India of course we have the AMUL brand making a significant impact. It should also be remembered that at the level of international trade, dairy products, with the partial exception of cheese, are generally traded as bulk products for reprocessing. However this aspect of world trade is changing. For example, 25 percent of the value of New Zealand’s exports now comes from branded consumer packs. This development has also facilitated the evolution of niche market products geared to a specific market or group of consumers. Examples of this would be the development of calcium enriched milk for the South-East Asian market, where osteoporosis is a health concern and low-lactose milk powders for the large lactose intolerant population in South-East Asia.

Emphasis on quality/health

Today’s consumer is increasingly interested in the quality and health benefits of what he or she eats. Milk and milk products generally enjoy a positive image both in terms of quality and health benefits. Butter and dairy fat in general, have fared less well, although it would appear that in most countries, butter is once again being seen as a “natural” product. In the Indian context, butterfat in the firm of ghee always retained a quality image.

Increased segmentation of the market

A glance at the dairy counter of any large supermarket is sufficient to show us the vast array of forms in which milk is presented. We now have milk and dairy products in a multitude of fat levels, enriched or flavoured in varying ways, and aimed at various sections of the market - pregnant women, breast feeding mothers, toddlers, children, adolescents, slimmer, active adults, pensioners.

Changes in eating habits

The place where food is eaten and the company in which it is eaten are all changing. These changes have important implications for the market for dairy products.
In many countries, the main growth in food expenditure is in the area of food eaten outside the home, while for meals eaten in the home there is more emphasis on pre-prepared dishes and snack foods. The growth in consumption of food outside the home has brought several challenges to the dairy industry, especially as its products are so closely associated with the household kitchen, and in particular, the refrigerator. Here dairy products have been slower than many other food groups to move easily into the “meals away from home” sector. Perhaps, perishability of fresh milk and the general need for refrigeration have been the two principal constraints.

Dairy products are, however, adapting to these changes. For example, standard packaging of milk in litre and half-litre containers, is well adapted to home consumption, but not well adapted to competing with soft drinks sold from vending machines. For this market, the size of the packaging needs to change (often to between 200 and 350 ml) to encourage sales of milk products, such as flavoured milk and chilled coffee, which can compete with soft drinks. Originally, the marketing of this type of product was mainly in Asia, for example Japan, Malaysia, Thailand and Indonesia, where milk does not traditionally form an important part of the national diet. Here, dairy products are not generally consumed at the principal meals of the day and milk, often flavoured, is drunk in similar situations to soft drinks. In other continents, the recent popularity of small containers of drinking yogurt, also usually consumed between meals, has mirrored this trend. Growth in the market for sports drinks, many of which are based on milk protein, is another instance of consumption of dairy products moving out of the home.

One highly visible manifestation of the growth in eating outside the home is the fast food industry. In considering this phenomenon, it is useful to reconsider the characteristics associated with premier brands discussed above. The most important companies in this sector are all distinguishable by the following characteristics:- high level of international coverage and recognition; premier position in the market; known quality. As many items on the menus of these companies contain milk products, the growth of this sector has also influenced the dairy sector.

8.3 Traditional Sectors
Indigenous Milk Products
Impelled by their mass appeal, pre-eminence in the dietary regimen, and sheer volumes of usage of milk, traditional milk products occupy the most prominent place from marketing point of view. Attempts for modernizing the unorganized sector of dairy industry needs a pragmatic approach especially for consolidation of newly emerging marketing opportunities both at the domestic and global levels. Liberalization of world economies would provide hitherto unknown opportunities for export to countries where ethnic Indian / South Asian populations are settled. Most formidable challenge lies in developing production systems consistent with the quality systems envisaged under sanitary and phytosanitary regulations under the WTO regime. Development of appropriate packaging materials and packaging machines are essential pre-requisites for marketing of indigenous milk products in the domestic and global marketing networks.
There is also an increased awareness regarding the health aspects of food. Milk and milk products have enjoyed a very favorable health image over the centuries and could be promoted as special health foods. Scope also exists for developing specially formulated indigenous milk products to suit the specific needs of specialized group of peoples afflicted with health problems relating to obesity, heart disease and somewhat ill perceived motions of lactose intolerance in the newly emerging context.

Any assessment of marketing prospects in the national and international context must be seen in terms of anticipated socio-economic and demographic changes at global level. Studies carried by FAO envisage that the world population will reach 7.2 billion by year 2010. The absolute increment in world population would continue to be high, being about 80 million people per annum. The Sub-Saharan African region will experience the highest growth rate and will account for 90% of the total increase in the population. There is also expected to be greater urbanization of population in the developing countries, which are expected to double by 2025 when an estimated 50% of world’s population will be living in cities of more than 1 million people. Asia is also urbanizing rapidly, with even such traditional rural countries as China and India would have hundreds of million of people living in towns and cities. According to United Nation projections, out of 26 agglomerations of more than 10 million people, in 2015, 22 will be in developing countries. These demographic changes have significant implications for Dairying, particularly in India where growth is most rapid. Rapidly growing urban demand will be a major factor in determining the type of milk and milk products produced and marketing arrangements to link production sites with the market. India also represents the largest segment of urban middle class in the world, which is in the range of 160-200 million. Besides this the rural households with a disposable income of Rs.2500 plus per month would be 2 to 4 million. The literacy levels are expected to rise rapidly. These combined influences will create a market niche for the ‘convenience’, ‘ready-to-serve’ and ‘long-shelf-life’ packaged food products.

The GATT agreement concerning Dairying came in to effect from July, 1995. From 2000 AD, EEC subsidized exports were reduced up to an extent of 2 million tones (MT) of milk equivalent. At the same time, access to high price market would increase the world market by 5 MT equivalent. Also anticipated is growth in demand for whole milk powder and cheese. It is worth noting that withdrawal of subsidies has forced EEC to reduce milk production by 9 MT. In the post-GATT period, significant changes are also anticipated in global trends of export of dairy products. World trade is expected to increase modestly from 28 MT to 38 tones MT. There is also expected a reduction in the availability of skim milk for products of skim milk powder and casein. Production of cheese is expected to increase by 500 MT and that of whole milk powder by 250 MT. In the recent years, India has been exporting milk powders worth Rs.385 million, butter and ghee 65.9 million and the value of the total exports of dairy commodities was 384.5 million. However, because of strong of growth of internal demand, India would have to cope with both domestic demand vis-à-vis export potential to more lucrative international
market. Only those countries, which are able to produce milk on competitive prices on global basis such as USA, New Zealand, Australia have been able to project increase their milk production. In the International trade, development of efficient export system based on national quotas, tenders etc. without destroying present production/marketing systems, therefore, assume crucial importance.

As urbanization leads to concentration of population, so the way in which perishable foods in general, and milk and milk products in particular are marketed is becoming more concentrated in all countries. One manifestations of this is the increased power of the super markets, which has necessary infrastructure for procurement refrigerated storage and power of deciding what form of product will be presented to the consumer. For example in Argentina, which represents a typical trend of food distribution in developing countries, 60 percent of food is purchased through super markets. In India, similar trends are expected to emerge in the coming decades.

The globalization of products through brand is also becoming increasingly important factor in the international market place. Consumers are attracted to established brands because they are of known quality and they represent a system of quality assurance. In India, Amul brand has been making significant impact, and domestic industry has been strongly vying with the multinationals for carving out their share of the consumer confidence.

However, certain critical gaps exist in the global context. Firstly milk procurement efficiency has to be improved for superior physico-chemical and microbiological quality of our products. Secondly, it will become imperative to adopt ‘Good Manufacturing Practices’ (GMP) for plant design, process control and hygienic practices in processing of milk. Thirdly, lot of developmental work needs to be for production dairy products and effective packaging systems having superior shelf life consistent with the international standards. And fourthly, the labeling and quality assurance programs would have to conform to the international standards suggested by the World Trade Organization.

**Export of Indigenous Milk Products**

For the entrepreneurs based in India, intending to export indigenous milk products, an agency, the Agricultural Products and Processed Food Export Development Authority (APEDA), has been set up by the Ministry of Commerce, Govt. of India for evolving modules of testing schedules for different products to assist exporters for establishing in house quality control laboratories. These modules cover the requirement of relevant tests, standard operating procedures for identified parameters, list of required equipments and chemicals etc. It also maintains documents on the import specifications and standards of major importing countries for the guidance of the exporters. The ultimate aim is to provide the product quality commensurable with the global specifications and sanitary ecological norms, which are of significant consumer concern.
Table 16. Effect of GATT on World Trade with the EU

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Demand (1992)</th>
<th>Imports</th>
<th>Increased demand</th>
<th>Total Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butter</td>
<td>800</td>
<td>50</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>Skim Milk powder</td>
<td>900</td>
<td>100</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Whole milk powder</td>
<td>990</td>
<td>20</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>Cheese</td>
<td>905</td>
<td>150</td>
<td>100</td>
<td>250</td>
</tr>
<tr>
<td>Milk equivalent</td>
<td>28.5</td>
<td>2.8</td>
<td>2</td>
<td>4.8</td>
</tr>
</tbody>
</table>

With the enhanced consumer awareness regarding role of food and health, recent trends in marketing of milk and milk products favor lower fat content and high protein in dairy products. There would be greater emphasis on health foods targeted to meet the specific requirements of special nutritional groups. Products could have also to be designed for the Government sponsored mid-day meal for school children. Future demand is also expected to focus on long shelf life fluid milk products; UHT processed flavored milks, mild flavored cheeses, yogurts, dairy desserts and specialty ice-creams.

An entrepreneur with a desire to manufacture Indian Milk Products in The United States may wish to contract manufacture at an established dairy plant with an extra capacity available for lease. For example, paneer manufacture and packaging could be contracted out in Wisconsin, Minnesota, New York, Pennsylvania or California where there is a lot of ongoing activity in cheese manufacture. Paneer may be manufactured conforming to the given specifications of ingredients, processing and packaging and delivered to the designated warehouse in refrigerated distribution channels. Products marketed abroad must meet the local regulatory obligation with respect to package design and labelling. Alternatively, a may want to control the manufacturing operation by owning and operating it in accordance with certain management objectives. In both cases it is imperative that the prospective entrepreneur must be familiar with the regulatory laws governing the manufacture and packaging of dairy products of the Country where manufacturing or marketing or done.

**Standard of Identity for Exports**

Most Indian Milk Products would not be included in the Standard of Identity list of products at this time. However, with time as their recognition and popularity gets established they might be defined by Food and Drug Administration with a standard of identity of their own. All dairy products with standard of identity definition must conform to the FDA standard and the regulations published in Code of Federal Regulations (CFR) . A few dairy products (e.g. butter and nonfat dry milk) are regulated by USDA grading and inspection programs (Table 17). FDA has the authority to establish standards of identity for foods whenever doing so will promote honesty and fair dealing in the interest of consumers. Standards generally specify the types of ingredients the food must contain (mandatory ingredients), as well as those it may contain (optional ingredients). Standards
also may set minimum and maximum content requirements for valuable constituents as well as for fillers. FDA has established more than 280 standards for staple food items, including milk, peanut butter, jams and jellies, and milk chocolate. The USDA’s Food Safety and Inspection Service (USDA/FSIS) have approximately 74 standards for foods regulated by that agency.

**Food Labelling for Exports**

Under the Nutrition Labelling and Education Act of 1990, the FDA promulgated new labelling regulations that became effective on May 8, 1994.

All nutrients contained in dairy foods are declared on the label in relation to a standard reference amount (serving size) of the food. The label must declare the amounts per serving for calories, calories from fat, total fat, saturated fat, cholesterol, sodium, total carbohydrates, sugars, dietary fiber, and protein. Also, percentage Daily Value must be shown to a 2,000-calorie and 2,500 cal/day diet for the above nutrients as well as for vitamins A and C, and calcium and iron to make the label consumer-friendly and useful.

Daily (Reference) Values (DRV) relative to various dairy foods are based on an evaluation of scientific data. For example, scientific data indicate that carbohydrates should compose 60% of the daily calorie allowance. Therefore, the DRV for carbohydrates is 300 g, providing 1,200 cal. This amount of carbohydrate would furnish approximately 60% of reference caloric intake for 2,000 cal intake per day. Accordingly, if a serving of food contains 30 g of carbohydrates, the percentage DV will be 10%. Nutritional labelling is based on actual analytical data obtained with the food.

The general standard also provides that, under certain circumstances, safe and suitable ingredients that perform a technical effect (for example, thickeners and stabilizers) may be added to modified foods to maintain performance characteristics similar to the traditional food. Thus, revoking the standards will increase flexibility for manufacturers, decrease confusion about claims with conflicting meanings, and increase consumers’ product choices.

**Analytical tests for Export Products**

To conform to the regulatory SOI and company standards of quality, safety and cost, various analytical tests are performed in the industry. In general, quality tests for milk and dairy products include analysis for chemical composition, physical attributes, microbiological quality and sensory characteristics. Dairy testing in the industry is typically directed towards the incoming milk, cream, condensed and dry dairy ingredients to determine their suitability for use in the plant operations. Incoming tanker loads of milk are subjected to organoleptic assessment (odor, flavor, mouth-feel, texture, body), fat content, moisture and total solids content, freezing point determination to detect adulteration with water and antibiotic tests (in cheese and fermented milk products plants). Freshly pasteurized milk and product mixes are tested for coliform count (violet red bile agar) as an overall index of sanitary quality. Pathogenic organisms receiving
attention include Salmonella spp., Staphylococcus aureus, Yersenia enterocolytica, E.coli O157: H7 and Aeromonas hydrophillia due to profound impact associated with their recent outbreaks.

**Table 17: Parameters identified for evaluation of the quality of Ghee meant for export purposes**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Name of the importing countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Density, refractive index, moisture, total acidity, peroxide value, Iodine value, saponifiable matter, unsaponifiable matter, melting point, color</td>
<td>All the major countries identified</td>
</tr>
<tr>
<td>2. Fat content</td>
<td>All the major countries identified</td>
</tr>
<tr>
<td>3. Vegetable fat</td>
<td>Gulf countries, Thailand</td>
</tr>
<tr>
<td>4. Additives (antioxidants)</td>
<td>Gulf countries (UAE, Bahrain, Saudi-Arabia, Qatar, Oman), and Japan</td>
</tr>
<tr>
<td>Butylated hydroxytoluene (BHT)</td>
<td></td>
</tr>
<tr>
<td>Butylated hydroxyanisole (BHA)</td>
<td></td>
</tr>
<tr>
<td>Nordihydroguaiaretic acid, Gallates propyl, octyl, dodecyl, ascorbyl palmitate, isopropyl citrate, sodium dihydro acetate</td>
<td></td>
</tr>
<tr>
<td>5. Metallic contaminants</td>
<td>European Union, UK, Sweden, Thailand</td>
</tr>
<tr>
<td>-Pb, As, Cd, Sn, Hg, Fe, Cu, Zn-</td>
<td></td>
</tr>
<tr>
<td>6. Pesticide residue</td>
<td>European Union, U.K., Sweden, Thailand, USA</td>
</tr>
<tr>
<td>7. Microbiological specifications</td>
<td>Australia, Canada, Gulf states (UAE, Bahrain, Saudi-arbia, Qatar, Oman), Japan, Jordan, Netherlands, Thailand, United States and United Kingdom</td>
</tr>
<tr>
<td>-Standard plate count, E.coli, Coliforms, Yeasts &amp; Molds, Enterococci, Salmonella, Campylobacter, Yersinia, Listeria monocytogenes, Lipolytic bacteria, Staphylococcus aureus</td>
<td></td>
</tr>
</tbody>
</table>

With a view to expediting the results of microbiological analyses and to implement corrective actions in a timely manner, various rapid methods are being developed. Accuracy, speed, simplicity, cost, and validity are the key factors in their development.

**8.4 Value Added Products**

Understanding consumer needs and preferences are critical to successful value addition and marketing. Present day consumers recognize that there is a relationship between the food consumed, health effects and role of medicine to maintain normalcy. So they prefer foods that promote good health and prevent disease. Furthermore, these foods must fit into current lifestyles providing convenience of use, good taste and acceptable price-value ratio. Such foods constitute current and future wave in the evolution of food development cycle.

The health-driven foods are commonly referred to as functional foods, designer foods, pharma foods or neutraceuticals. The dairy foods industry in the West has responded to consumer preferences by marketing low-fat and fat-free dairy products.
Nutritionally improved foods with at least one nutritional improvement over the conventional counterpart have been successful in the marketplace. Product modification strategies include removal or reduction of fat, cholesterol, sodium and calories, and fortification with vitamins, calcium, fibre and active cultures to align with health perception of the consumer.

Milk and milk products are perceived as healthy foods. However, Indian sweets are generally considered as indulgent foods by certain section of the population. Consumers committed to weight loss, or those with diabetic condition are likely to limit their intake of milk sweets. It appears that by accentuating the positive attributes of inherent milk constituents and by reduction of fat and sugar content, the dairy industry can develop Indian milk products, which would appeal to such consumers. Providing dietetic type milk sweets to the consumers would give them informed choices in the marketplace. Consumption of Indian milk products should increase as a result of reduction in fat and sugar content and permit all the consumers to enjoy nutrients inherent in natural milk constituents without the liability of those constituents the consumer wants to avoid. In addition, the sweets may be augmented with health-promoting ingredients like fibre, vitamins, minerals, and other functional ingredients. Recent advances in high intensity sweeteners and fat replaces show much promise in developing analogues of Indian sweets with reduced sugar, fat, and caloric content.

Application of Biotechnology for Value Addition

The discipline of Dairy Processing in the twenty-first century will require newer ways of capturing the application of genetically engineering, whether it is through in vivo or in vitro approach, and will revolutionize our notions of food, from production to processing. These brand new developments are the products of intellectual earthquakes that change things so completely that it is difficult, after the event, to remember that once the landscape was different. Spurred by the growth of global market of US $134 billion during recent decade, intensively researched area of functional foods and probiotical foods shows considerable potential to diversify GM Dairy Foods industry into new arenas in near future. Besides the biotechnological approaches to improve the yield of milk, amelioration of technological properties of milk through genetical engineering assume a special significance for obtaining end products having improved functional attributes. Recent research clearly demonstrates that the genetic variants of milk proteins can have a marked influence on the processing quality of milk, such as the pH / total solids related heat stability, rennet coagulation time, rate of curd syneresis, firmness of curd and age related storage defects in processed milk products. This has led to a newer concept of 'Designer Milks' - achieved through the genetic manipulation of milk proteins. Recent advancements in molecular biology permit genes from one species to be introduced into the genome of the same or another species and subsequently transmitted to its progeny in a stable fashion. The discovery that linking foreign genes to milk protein genes, particularly their 5' promoter sequences, resulted in expression of the transgenic products
almost exclusively in the milk of transgenic animal indicates enormous possibilities. The range of these foods includes natural functional foods such as foods and ingredients for specified health use, special dietary food formulas, medical foods, nutraceuticals, and drug foods. Within this continuum between food and drug, there are seemingly unlimited niches for the development of food systems that promote optimal nutriture, health and general well being. The newly acquired capability to manipulate genome permits cross species barrier by inserting genetic material. Three classes of food products emanate through the application of genetically engineering:

- Foods where the newly introduced DNA does not cause a substance novel to be expressed in the part of the organism that is consumed, e.g., transgenic micro organisms, plants or animals developed for different amino acid content, vitamin content or higher level of probiotical attribute;
- Foods where the newly introduced DNA does cause a substance novel to food to be expressed in the part of the organism that is eaten, e.g., crops developed for herbicides tolerance;
- Food ingredients derived from genetically modified organism or in vitro bioprocess, e.g., flavours, fragrances, dyes etc. These ingredients should be treated like any other chemical being considered as a food ingredient.

For the future Technologists, there will be more exciting issues of food safety, preservation, bioprocessing, and most certainly, probiotics. In this context, processing of genetically modified foods of the future would involve consideration of: Maximum retention of the nutritionally significant and probiotical attributes; Increased processing efficiencies with a reduction of environmental impact; Utilisation of component interactions in formulated food systems; Superior strategies to control food borne illnesses; Development of foods that promote human health; and Expanded value addition to increase competitiveness.

Bio protective Foods: Milk proteins are widely known and used as ingredients for their functional and nutritional properties. Milk also contains minor protein fractions that have gained interest because of their bioprotective / antimicrobial functions. Among these proteins are lactoferrin, immunoglobulins, lysozyme and lactoperoxydase. These protein fractions in the milk that contribute to these properties can now derived employing genetical engineering, either in vivo from transgenic animals or in vitro from bioprocesses. Lactoferrin has been ascribed several biological functions, such as iron carrier, anti-inflammatory, protection of intestinal flora and cell growth promoter. Lactoperoxydase is another prominent enzyme in bovine milk, which has been ascribed significant functional role of preservative, anti-inflammatory and promotion of useful intestinal flora. In concert with the immunoglobulins and lysozyme, these proteins serve as protective proteins for the host. Diet, stress and modern medical practices have been implicated as factors capable of exerting an influence on human health and nutrition.
**Fermented Milks:** Plasmid biology of lactic acid bacteria have opened new vistas for exploring possibilities for using recombinant DNA technology and genetic engineering to improve the nutritional / therapeutic value of these products. Molecular biologist is now in a position to deliberately manipulate the proteolytic system of LAB and to determine the consequential effect on flavour and body development during ripening. The generation of starter cultures expressing proteinases and peptidases with relative activities significantly different from those expressed by the wild type of strains will soon be an achievable goal. Genetic manipulation of these cultures with respect to commercially important traits has helped the dairy industry in efficient production of high quality fermented products with higher consumer acceptability. GM Starter Cultures are being increasingly employed for the manufacture of a wide range of dairy products including cheese, yogurt, sour cream and cultured butter. There has been a phenomenal growth of the probiotical foods judging from the wide and diverse range of processed foods that have been introduced in different parts of the world. The most prominent amongst these products are acidophilus bifidus yoghurt (Germany), AB milk products (Denmark), bifidus milk (Germany), bifidus milk with yoghurt flavour (UK), Bifilact (USSR), Biokys (Czechoslovakia), Mil-Mil (Japan), Progurt (Chile) etc. With a view to overcome the unfavourable flavour aspects of traditional fermented products, R&D work has been carried out to develop non-fermented range of dairy products such as sweet acidophilus bifidus milk (USA, Japan), sweet bifidus milk (Japan, Germany) and ice cream also, incorporating probiotical organisms. Studies at NDRI show that ingestion of ice cream prepared by the direct addition of a culture concentrate of Lactobacillus acidophilus (without involving the fermentation process), led to an increase in faecal counts of *L. acidophilus* and decrease in *E. coli*. Their studies demonstrated the hypocholesterolaemic effect of SAI in the group of individuals having more than 250 mg % of blood cholesterol.

**Probiotic Cheeses:** Taking advantage of the consumer interest in the improved therapeutic and nutritional attributes of such cultures, European manufacturer have introduced different varieties of cheese with added Lactobacilus paracasei NFBC 338. This cheese displayed probiotic count of more than 10^8 cfu/g. Dinakar and Mistry (1994) made Cheddar cheese supplemented with B. bifidum (ATCC 15696). The organisms remained viable till the end of 24 weeks and had no effect on flavour, flavour intensity, texture or appearance. A starter entirely composed of Bifidobacterium sp. strain Bo and *L. acidophilus* strain Ki was used by for the manufacture of a Gouda-type cheese. At the National Dairy Research Institute, Edam cheese carrying viable cells of Bifidobacterium bifidum has been developed, which displays ability to implant these organism in the GI tract when ingested.

Research addressing the impact of probiotics on the native microflora has recently entered a new and exciting dimension, following the development of molecular techniques that can amplify, separate, and then identify major rRNA species present in
mixed populations. The technique employs highly conserved primers for the 16S rRNA gene and uses PCR to amplify this region from bacteria. The amplicons of different organisms vary in their internal 16S rRNA nucleotide sequence and base composition and, thus, can be separated by thermal or denaturing gel electrophoresis (TGGE or DGGE, respectively). Further, these rRNA-based technologies allow a quantitative assessment that (i) follows the introduction of a probiotical culture into the GI tract communities, (ii) determines its relative level within the population, and (iii) identifies its potential to alter the presence and/or level of residing microbes. Exacting methods for the identification, tracking, and analysis of probiotical cultures within complex microbial ecosystems are now available and promise to revolutionize our understanding of their functional roles, and in vivo effects.

**Exopolymer Production:** Texture of fermented dairy products is also important in flavour perception. Amelioration in the body and texture of fermented foods has been attributed amongst other factors to polysaccharide production by the selected strains of LAB. The use of EPS predicting lactic starter cultures is of interest in the dairy industry for improvement of body and texture. There are variants of LAB, which produce exopolymers. These will change the mouth-feel of the product and encourage flavour volatiles to remain in the mouth for a longer period. It has been shown that the ropy phenotype is linked to plasmid DNA. Since the number of naturally ropy strains is limited, conjugal transfer of the mucoid plasmid to other strains could be used to construct additional ropy cultures useful in producing a ropy texture in a variety of fermented milk products.

**Nutraceuticals:** Genetic polymorphisms of milk proteins (from transgenic milch animals) influence the occurrence of bioactive peptides, which display physiologically significant 'extra-nutritional' attributes. They are released by enzymatic digestion of the food proteins, either in vivo or in vitro. Since during the microbial fermentations involved in the manufacture and cheese and fermented milk products, milk proteins undergo controlled proteolysis under the combined influence of native microflora, starter bacteria and rennet, cheese is a natural source of dietary peptides. Additionally, proteinases produced by the starter organisms could complement the complex enzyme system of the starter micro-organisms, leading to the accumulation of beneficial peptides. Cheese and fermented milk products, therefore, potentially serve as the natural source of prophylactic peptides.

**Opioid Biopeptides:** Two types of opioid peptides have been isolated from milk proteins, the agonists which exhibit opiate-like traits and the antagonists which have anti-opiate-like properties. The first category is characterized as a family of peptides containing 4 to 7 amino acids with a common N-terminal sequence and 0 to 3 additional residues. These peptides represent β-CN fraction 60-63/6 (β-CN f 60-63/6) and are called β-casomorphins (β-CM) 4 to 7 respectively. The most effective opioid agonist peptide isolated so far is the amide of β-CM 4, morphiceptin. β-CMs are very resistant to
enzymes of the GIT and appear in the contents of the small intestine, following the ingestion of milk.

**Antihypertensive Biopeptides:** The physiologically inactive form of angiotensin, a blood polypeptide, causing constriction of the arterioles is converted into the active one, by the Angiotensin I-converting enzyme (ACE). Some peptides derived from αs-1-casein and β-casein employing *Lactobacillus helveticus* CP 790 exhibit inhibitory activities against ACEs. Milk fermented with a strain of *L. helveticus* CP 790 and containing about 0.3% peptides showed antihypertensive activity in rats. The C-terminal sequence of αs-1-casein was also identified as such a peptide. It has been suggested that these exogenous ACE inhibitors may affect different regulatory systems involved in modulating blood pressure, the immune system and neuroendocrine information transfer.

**Antithrombotic Biopeptides:** A portion of the glycomacropeptide of β-casein remaining after chymosin action on milk, the β-casein 106-116 has been reported to inhibit blood platelet aggregation. It also combines with the receptor sites, thus preventing the binding of fibrinogen with platelets, hence expressing its antithrombotic activity. Two other fractions of β-casein, (106-112, 113-116) have similar activity, but to a smaller extent.

**Immunomodulating Biopeptides:** Some phagocytosis-stimulating peptides have been isolated from β-casein. They stimulate in-vitro phagocytic activity of human microphages and exert in-vivo, a protective effect against Klebsiella pneumoniae in mice. From the view of point of application in food industry, it has been suggested that the molecular weight range with regard to the immunogenicity of αs-1-casein needs to be restricted between 1400 to 5000, since excessive hydrolysis leads to unpalatability.

**Replacement of Sugar:** Preference and craving for sweet taste is acquired early in life. Honey and cane sugar has been used as sweeteners for thousand of years. Most of the consumers do not regard sugar as an ingredient to avoid, but a sizeable section of the population is urged by medical community to restrict or eliminate sugar consumption to treat or control diabetes and obesity. Traditional sweetening with sugar is now giving way to sweetening with starch derivatives, monosaccharides and sugar alcohols as well as new high intensity sweeteners to impart pleasing sweet flavor in foods. Cane sugar is the standard for qualitative and quantitative comparison with the other sweeteners.

In recent years, styvia has also emerged as zero calorie sweetener for the replacement of cane sugar. Many countries have paved way for its use in the food industry, as it is one of the natural sweeteners obtained from plant source and is relatively more stable during processing.

Reduction of sugars leads to alcohols, commonly referred to as polyols. Reduction of dextrose yields sorbitol and mannose gives mannitol. After consumption, these ingredients do not raise the blood sugar level to the same extent as sugar, making them good sugar substitutes for insulin-deficient individuals. Therefore, polyols are commonly
used for sweetening of confections and ice cream for diabetics. The sugar alcohols are not metabolized by oral bacteria and are therefore anti-cariogenic (prevent tooth decay). Calorie reduction by the use of sugar alcohols is not significant except in the case of erythritol. Most of the polyols have a laxative effect if consumption is at high levels. Depending on the regulatory laws, it is desirable to label the product to warn the consumer to limit their daily intake to certain specified servings.

**Table 18. Relative sweetness potency and caloric value of some sweeteners and polyols**

<table>
<thead>
<tr>
<th>Sweetener</th>
<th>Sweetness factor</th>
<th>Calorie/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar (Sucrose)</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>Fructose</td>
<td>140</td>
<td>4</td>
</tr>
<tr>
<td>Dextrose (Glucose)</td>
<td>70</td>
<td>4</td>
</tr>
<tr>
<td>Sorbitol</td>
<td>60</td>
<td>4</td>
</tr>
<tr>
<td>Mannitol</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>Xylitol</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>Maltitol</td>
<td>90</td>
<td>2</td>
</tr>
<tr>
<td>Isomalt</td>
<td>55</td>
<td>2</td>
</tr>
<tr>
<td>Erythritol</td>
<td>60</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Substitution of part or all the sugar content requires careful screening of sweet flavour. Products containing the sugar substitutes must match the intensity of sugar flavour. It is widely known that the substitutes do not possess the exact flavour profile of sugar. They do have different flavour sensation in the mouth. The sweet sensation may begin earlier or later, may display a flat or spike type flavour intensity and may have a lingering sweet flavour. Accordingly, the sweet flavour profile curve immediately after eating the sugar-substituted food has to be adjusted to reflect the flavour profile observed with sugar containing food. A judicious selection of the sugar substitutes has to be undertaken to balance the factors of degree of sugar replacement, caloric reduction, flavour profile and maintenance of textural and mouth-feel attributes. Compliance with regulatory status and labelling laws relative to the use of sugar substitutes must be ascertained prior to initiation of such approach to market modified Indian milk sweets.

Several solid sweeteners derived from the hydrolysis of starch can possibly be used in dairy foods. For example, corn sweeteners are widely used in ice cream where they perform multiple functions. They act as a sweetener, provide heat shock resistance and build stiff body during extrusion process for ice cream manufacture. Starch is a polymer of D-glucose. Hydrolysis of starch leads to corn syrup products of varying degree of hydrolysis commonly designated as Dextrose Equivalent (DE). When approximately 42% of the bonds in starch are hydrolyzed, it is called 42 DE. In general, liquefaction of starch is initially achieved by acid hydrolysis, followed by specific enzyme treatment to affect
further hydrolysis. Thus, corn syrups of 65 DE or even 95-98 DE are produced. The lower DE syrups (4 to 15 DE), also known as maltodextrins are not used for their sweetening power, but for their body, texture bulking and viscosity effects in foods. They are effective in fat reduction programs. In ice cream, 34 or 42 DE corn syrups are commonly used in the ratio of 5 parts syrup solids to 12-15 parts of sugar (Table 19).

Conversion of D-glucose in 95-97 DE corn syrup to D-fructose is carried out by treatment with the enzyme xylose isomerase to yield a product containing 56% dextrose and 44% fructose. Since fructose is 1.4 times sweeter than sucrose and dextrose is 0.7 times as sweet as sucrose, their mixture approaches the sweetness of sucrose. This product is called High Fructose Corn Syrup (HFCS). In fact, fructose level in the finished syrup can be increased from 42 to 90% by non-enzymatic processes, depending on its application in various segments of food industry. Bakeries generally use 46% fructose product, while soft drink industry uses 55% fructose syrup, which equals the sweetening power of cane sugar. Fructose syrup containing 90% fructose is very sweet and furnishes more sweetness per gram of sugar or more sweetness with fewer calories. This product is also used to prepare crystalline fructose, the sweetest sugar available.

Invert sugar syrup is obtained by hydrolyzing a saturated solution (67%) of cane sugar and contains equal proportions of glucose and fructose. These monosachcharides inhibit sugar crystal growth and are useful in fondant, a semi-solid confection containing extremely small crystal size. Honey, another natural sweetener contains 75% invert sugars and 2% sucrose. It varies in flavor and color depending on the flower source of bees. It can have a strong flavor and a characteristic aroma. To achieve desired sweetness (equivalent to 13-16% sucrose) of a food, various sweeteners can be selected from the list given in the table below. The combination should lead to desired sweetness level and introduce functional attribute (for example, body, chewy character, and pliability) without flavor loss. The perceived sweetness is dependent on the moisture level in the product. Accordingly, sweetener concentration in the water phase determines sweetness perception. For the same concentration of sweetener in the confection, lower moisture confection would taste sweeter than the confection containing higher moisture. Table below summarizes comparative sweetness ratings of corn syrups.
Table 19. Sweeteners and bulking agents for possible use in sweetened Indian milk products

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Relative sweeteners</th>
<th>% total solids</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maltodextrins</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 DE</td>
<td>6</td>
<td>95</td>
</tr>
<tr>
<td>10 DE</td>
<td>11</td>
<td>95</td>
</tr>
<tr>
<td>15 DE</td>
<td>17</td>
<td>95</td>
</tr>
<tr>
<td>18 DE</td>
<td>21</td>
<td>95</td>
</tr>
<tr>
<td><strong>Corn Syrup</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 DE</td>
<td>23</td>
<td>80</td>
</tr>
<tr>
<td>25 DE</td>
<td>28</td>
<td>80</td>
</tr>
<tr>
<td>36 DE</td>
<td>42</td>
<td>80</td>
</tr>
<tr>
<td>42 DE</td>
<td>48</td>
<td>80</td>
</tr>
<tr>
<td><strong>High maltose corn syrup</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55 DE</td>
<td>55</td>
<td>81</td>
</tr>
<tr>
<td><strong>High fructose corn syrup</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42%</td>
<td>86</td>
<td>71</td>
</tr>
<tr>
<td>55%</td>
<td>98</td>
<td>77</td>
</tr>
<tr>
<td>90%</td>
<td>125</td>
<td>77</td>
</tr>
<tr>
<td><strong>Sugars</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dextrose (glucose)</td>
<td>74</td>
<td>92</td>
</tr>
<tr>
<td>Fructose</td>
<td>173</td>
<td>100</td>
</tr>
<tr>
<td>Lactose (milk sugar)</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>Maltose</td>
<td>32</td>
<td>100</td>
</tr>
<tr>
<td>Invert sugar</td>
<td>95</td>
<td>77</td>
</tr>
<tr>
<td>Honey</td>
<td>75</td>
<td>74</td>
</tr>
</tbody>
</table>

(*DE = Dextrose Equivalent)

**High-intensity sweeteners**

These sweeteners are named high intensity sweeteners because of their potency of sweetness. On weight basis, they are 30 to 8,000 times sweeter than cane sugar (Table 20). Thus, they are effective tools in reducing calories in dietetic foods as well as in formulating foods for the diabetic individuals. Saccharin was discovered in 1879, cyclamates in 1937, followed by the development of a number of high intensity sweeteners in the last 30 years. Table below lists the more common sweeteners of this type approved in certain countries. Alitame and Neotame are still awaiting approval. Their use may be restricted to certain foods and checking their approval status is advised prior to their incorporation.
Table 20. High-intensity sweeteners and their potency

<table>
<thead>
<tr>
<th>Sweetener</th>
<th>Sweetness potency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cane sugar</td>
<td>1</td>
</tr>
<tr>
<td>Saccharin</td>
<td>300</td>
</tr>
<tr>
<td>Cyclamate</td>
<td>30</td>
</tr>
<tr>
<td>Aspartame</td>
<td>200</td>
</tr>
<tr>
<td>Acesulfame-K</td>
<td>200</td>
</tr>
<tr>
<td>Sucralose</td>
<td>600</td>
</tr>
<tr>
<td>Alitame</td>
<td>2000</td>
</tr>
<tr>
<td>Neotame</td>
<td>8000</td>
</tr>
<tr>
<td>Cane sugar</td>
<td>1</td>
</tr>
</tbody>
</table>

Possible use of these sweeteners is in the preparation of Indian sweets and in the preparation of syrups for Rasogollas and Gulabjamuns. Reformulation with high intensity sweeteners to substitute sugar would require the use of maltodextrins and corn syrup solids and other bulking agents. Sugar contributes not only sweetness, but also bulk and viscosity in foods. A judicious application of bulking agents would be needed to offset the functional effects of sugar in syrup or in Indian khoa-based sweets. Often polydextrose, starches, cellulose derivatives and dietary fibres are employed as bulking agents. Polydextrose and dietary fibers like cellulose have another advantage in that they contribute 1 and 0 cal/ per g, respectively. Accordingly, it is possible to conceive Indian sweets with significantly lower calories and sugar content to meet the needs of health conscious consumers. Product development work is highly recommended in this area. Traditional recipes for Indian sweets are expected to satisfy the demand of bulk of the consumers. Specialty products made with alternative sweeteners, and bulking agents could fulfill the needs of consumers looking for dietetic and diabetic foods.

**Fat Replacers/ mimetics**

Reducing fat in the starting milk best does reduction of fat in dairy products. Using milk with 2% milk fat can reduce milk fat in the finished product by as much as 50% or more. In order to maintain acceptable flavor and texture profile of the fat reduced traditional milk products, it would be prudent to add a bulking agent for effecting moisture management in the product. Milk fat contributes body, flavor, mouth-feel and lipid based emulsifiers may provide some of these attributes in fat-reduced traditional milk products.

Emulsifiers such as sucrose fatty esters, mono and diglycerides, sodium stearoyl-2 lactate, lecithin, and polyglycerol esters, exhibit both hydrophilic and hydrophobic (lipophilic) properties. This characteristic enables the emulsifier to stabilize the interface between water and fat droplets through hydrogen bonding. Their surface activity helps in replacing up to one half of the fat in formulation of many foods. They may stabilize aeration in Rasagolla formation, provide lubricity in khoa based sweets and complex starch in gulabjamuns, control syneresis in fermented products like dahi and shrikhand, carry flavors and control rheological properties in other traditional milk products.

Protein-based fat replacers may stabilize by emulsification of dairy constituents and
carbohydrate based replacers may be helpful in increasing viscosity, stabilization of texture by thickening and gel formation effects. Protein-based fat mimetics for use in dairy systems are derived from whey protein concentrates or from casein. Whey protein can be sheared under heat (microparticulation process) to form microscopic coagulated particles of specific size, which mimic the mouth-feel and texture of fat. Some mimetics are processed to yield traditional milk products improved water-binding and emulsification characteristics. Use of mimetics may require modification in flavor system as well.

Carbohydrate-based fat mimetics include digestible starches such as modified starch, maltodextrins (caloric value 4/g.), and nondigestible starches (caloric value 1-3/g.), gums, pectins and cellulosates. Guar gum, locust bean gum, gum acacia, xanthan gum, oat fiber, pectins and carrageenan are often used for thickening and for traditional milk products imparting fat-like mouth-feel. Various kinds of starches are available to replace fat and for traditional milk products imparting slippery mouth-feel to mimic functionality of an oil. Starches are prepared from normal corn, high amylose and waxy maize, potato, tapioca and rice, each of which exhibits distinct application and functional behavior. They may be pre-gelatinized or instant forms. They work well in high moisture systems. Starches modified by acid or enzymatic hydrolysis, oxidation, dextranization, cross-linking or mono-substitution are more functional and used as fat mimetics more often.

Cellulose and its derivatives in combination with pectin and gums are commonly used in fat replacement formulations. Chemically modified cellulose includes: chemically derived methyl cellulose, sodium carboxymethyl cellulose or cellulose gum, methyl cellulose or modified vegetable gum, hydroxyl propyl methyl cellulose or carbohydrate gum, powdered cellulose obtained by mechanical grinding, micro-crystalline cellulose or cellulose gel produced by chemical depolymerization and mechanical disintegration. Microcrystalline cellulose has zero calories. It is a good fat replacer in dairy products (in aqueous systems) by furnishing body, consistency and mouth-feel. Methyl cellulose and hydroxypropyl methylcellulose are surface-active ingredients that hydrate in water, and form a gel on heating. They contribute creaminess, stable foam formation and lubricity. They are generally used in fat-reduced ice cream and frozen desserts.

Maltodextrins deliver functionality attributes like viscosity, body and smooth mouth-feel. They may be ingredients of choice in syrups for rasogolla and gulabjamun, and help in building solids in fat-reduced khoa based sweets.

Polydextrose is a randomly- bonded polymer of glucose, sorbitol, and citric/phosphoric acid. It is a good low-calorie bulking agent, humectant and texturizer. It is widely used in foods. It is effective in syrups, ice cream, confections, and soft candy and is worth exploring in reduced fat traditional milk products. Excessive consumption may cause diarrhea in sensitive individuals. Accordingly, the product label should reflect that.
Oatrim is made from starchy portion of oats hull/bran of oat or corn by selective hydrolysis. It contains 5% beta-glycan, which has cholesterol-lowering properties. The mouth-feel of oatrim mimics that of fat. It is suitable for fat reduction in confections, dairy products and frozen products. Z-trim, a zero calorie ingredient is obtained from the high-cellulose portion of the indigestible fiber found in the hull of oats, soybeans, peas, rice and from the bran of wheat and corn. The hulls are processed, purified, dried and milled into a fine powder. Possible applications include cheese products to traditional milk products to impart moistness, and smoothness.

A fat-reduction strategy should involve the use of several fat mimetics and bulking agents. An acceptable analogue of traditional milk products should be possible by partial replacement of fat and sugar.

9. ROLE OF PUBLIC-PRIVATE-PARTNERSHIP IN DAIRY DEVELOPMENT

The dairy industry in most SAARC nations has its base in the small holders and marginal farmers. This leads to a complex supply chain that is compounded by a lack of proper cold chain facilities and logistics. Many Governmental schemes patronage the cooperative societies and small holding farmers, thus fostering growth in this sector. But still there has been a dearth of incentives for the private agencies to venture into this enterprise. Low productivity of crossbred animals necessitates the need for an intervention to boost the overall yield and quality parameters. Hence, it is important that the private sector investments are promoted in dairy sector. Public-Private-Partnership (PPP) in today’s context has become an important alternate service delivery mechanism for the Government and public sector institutions to achieve growth and both forward and backward linkages. PPP is collaboration between the public and private sector entities, wherein the partners jointly plan and execute various activities for accommodating common objectives while sharing the costs, risks and benefits incurred in the joint venture.

There are various models of PPP depending on nature, location and end users of the project. Broad categories of PPP are service contracts, operation and management contracts, leasing type contracts, build-operate transfer, design-build-finance-operate. Productivity enhancement in dairying depends on degree of mechanization. Many dairy farmers are not able to afford the expensive equipments to boost the productivity. In Pakistan, Rural Service Provider (RSP) business model has been launched to achieve growth in rural sector including agriculture and dairy. In this scheme, farmers can engage the services of a rural contractor who owns and operates expensive and specialized equipments. Grameen Danone Food Limited is a model of social business operational in Bangladesh aimed at reducing the poverty by creating job opportunities. In India, the potential thrust areas in dairy industry where PPP can intervene are: procurement and processing, infrastructure and logistics development, operations management, capacity building through training and extension, research and knowledge transfer.
The banks and other financial institutions need to play a proactive role in providing easy and user friendly credit to the entrepreneurs. Contract farming has been considered as a viable business model by the cooperative milk unions and the private sector for providing assured and reliable inputs to the farmers to produce quality milk. The unions and private sector agencies provide the technical services for improving the productivity of animals, distribution of fodder seeds and cattle feed and veterinary services. Banking linkages could be provided to the dairy farmers through the cooperative network. Most of the cooperative milk unions have tied up with financial institutions under contract farming model.

In India, there are quite a few successful private players like Nestles, Nilgiris and a highly successful co-operative organization viz., AMUL. Today with global liberalization there are better chances for having P-P-P mode of functioning in Dairy and Livestock sector. The need is to identify right partners and provide technology support and ensure steady market and other infrastructure.

10. CONCLUSIONS AND RECOMMENDATIONS

Scientific developments in the field of genetically engineering are the harbinger of value addition to the dairy products and bring about radical industrial changes of the future. This technology is in its infancy but holds promise of improving the quality and quantity of food production that will reap rich benefits as knowledge accumulates and new discoveries support practical applications. Biotechnological developments have led to the production of innovative range of dairy foods, where cultured cells could be incorporated through suitably prepared microbial cell concentrates, thus bypassing the fermentation process entirely. Cheese as a potential carrier for probiotical cultures and as a natural source of biological peptides, is a fascinating area for technological development. Current R&D is directed to develop advanced GM foods with antimicrobial and protective factors of milk such as lysozyme, lactoperoxydase, lactoferrin and vitamin binding proteins. Biotechnological developments in the bio preservation of these valuable foods are proving to be a boon in their bio-safety. Scope is also indicated for the application of biotechnology for the development of the range of dairy foods, which would meet the special health and nutritional requirements of athletes and during geriatric period.

A comprehensive approach in addressing the issues concerning dairy production and processing in terms of livestock improvement, feed management veterinary health care, quality of produce, marketing infrastructure, forward and backward linkages, involving Public-Private-Partnership is essential to take the dairy sector to higher pedestal amongst the SAARC countries.

For promoting further development, a pragmatic policy is essential which would facilitate interaction between R&D Institutions as well as development of requisite human resource to deal with the challenges of future.
### Annexure I. Animal Population and Milk Production in India

<table>
<thead>
<tr>
<th>Species</th>
<th>Animal Population ('000 heads)</th>
<th>Milk Production ('000 tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffaloes</td>
<td>97922</td>
<td>98175</td>
</tr>
<tr>
<td>Cattle</td>
<td>185180</td>
<td>182996</td>
</tr>
<tr>
<td>Goat</td>
<td>124358</td>
<td>124632</td>
</tr>
<tr>
<td>Sheep</td>
<td>61469</td>
<td>62157</td>
</tr>
<tr>
<td>Total</td>
<td>468929</td>
<td>467960</td>
</tr>
</tbody>
</table>

### Annexure II. Contribution of Livestock in India

<table>
<thead>
<tr>
<th>Particulars</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Population (mill.)</td>
<td>1060.37</td>
<td>1078.11</td>
<td>1095.76</td>
<td>1113.28</td>
<td>1130.61</td>
<td>1147.74</td>
<td>1164.67</td>
<td>1181.41</td>
</tr>
<tr>
<td>Per capita Income (USD)</td>
<td>463</td>
<td>484</td>
<td>563</td>
<td>649</td>
<td>740</td>
<td>824</td>
<td>1046</td>
<td>1017</td>
</tr>
<tr>
<td>Share of Agri. In GDP(%)*</td>
<td>23.2</td>
<td>20.87</td>
<td>20.97</td>
<td>19.2</td>
<td>19.06</td>
<td>18.15</td>
<td>18.11</td>
<td>17.47</td>
</tr>
<tr>
<td>Share of livestock in Agriculture GDP(%)</td>
<td>24.37</td>
<td>25.95</td>
<td>24.25</td>
<td>25.88</td>
<td>24.62</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cal. Avail./capita/day(Kcal)</td>
<td>2330.46</td>
<td>2380.57</td>
<td>2389.21</td>
<td>2336.68</td>
<td>2348.47</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Protein avail./capita/day(g)</td>
<td>55.39</td>
<td>55.39</td>
<td>57.38</td>
<td>55.64</td>
<td>54.57</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Protein from animal sources(g)</td>
<td>10.1</td>
<td>9.91</td>
<td>9.96</td>
<td>10.2</td>
<td>10.34</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Milk/capita/day(g)</td>
<td>225</td>
<td>230</td>
<td>231</td>
<td>233</td>
<td>241</td>
<td>243</td>
<td>252</td>
<td>258</td>
</tr>
</tbody>
</table>
11. REFERENCES


Dairy Production, Quality Control and Marketing System in Nepal

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1. INTRODUCTION

Nepal is predominantly an agricultural country. More than 65% of active populations are involved in agriculture sector, which provides about 38% to the Gross Domestic Products (GDP) of the country. Livestock is an integral and important component of mixed farming system in Nepal. The sector shares about one third of the Agricultural Gross Domestic Products (AGDP) of the country. The dairy sub sector is the most important component of livestock sector and contributes almost two third (63%) of the livestock GDP shares. The sector not only contributes in national GDP, but also ensures flow of money from urban to rural sectors. Above 100,000 dairy farmers deliver milk, with a large number engaged in the milk processing industry in both rural and urban areas. Similarly, thousands of people are engaged in production and marketing of indigenous dairy products like Ghee, Hard Cheese and Khoa. Cattle and buffaloes are the major dairy species in the country and yak (nak) to some extent in the high mountain region of Nepal. Almost three fourth and one half of the households in Nepal keep cattle and buffaloes respectively. Despite larger cattle population, the buffalo contributes around 71% of the annual milk production and only rest 29% by cattle. This is mainly due to extremely low productivity of non-descript indigenous cattle as compared to the productivity of buffaloes. Buffaloes are also being kept for meat whereas the contribution of yak and their crossbred in the high Himalayan region as pack animals is also substantial. The yak cheese is a unique product, which has great potential for export. The dairy sector is gradually emerging as commercial/ semi commercial enterprise particularly in the peri urban areas of the country.

Table 1. Dairy animal population distribution in different ecological regions (2008/09)

<table>
<thead>
<tr>
<th>Ecological regions</th>
<th>Population ('000 heads)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cattle</td>
</tr>
<tr>
<td>Mountains</td>
<td>907</td>
</tr>
<tr>
<td>Hills</td>
<td>3356</td>
</tr>
<tr>
<td>Terai</td>
<td>2911</td>
</tr>
<tr>
<td>Total</td>
<td>7174</td>
</tr>
<tr>
<td>Proportion of milking animal</td>
<td>13%</td>
</tr>
</tbody>
</table>

Source : Ministry of Agriculture and Cooperatives

Of the total population of cattle and buffaloes, it has been estimated that around 8-10% and 25% are improved/ crossbred respectively (DLS, 2007/08). The crossbred/improved populations are mostly concentrated in the peri urban areas of hill and Terai regions with comparatively better infrastructures and marketing facilities. Holstein Friesian and Jersey are the predominant exotic breeds of dairy cattle introduced in Nepal for genetic improvement of indigenous cattle, whereas Murrah is the only exotic buffalo breed introduced for the same purpose. Of the total cattle and buffalo population in the country, it has been estimated that about 13% and 26% are in milking stage. Both solo and mixed species are being raised by the farmers particularly for milk production and
sale. Majority are smallholder farmers with some medium sized and extremely few large scale producers (Shrestha et al., 2010).

The concentration of cattle and buffalo population is higher in Terai and mid hills physiographic regions of the country, while in the high hills and mountains, they are distributed sparsely.

The cattle population has remained static or increased slightly (0.06%/annum) whereas annual increase of 2.7% in buffalo population during the last 10 years has been observed. However, critical observation in the villages makes one to speculate that the population of indigenous cattle and buffaloes are decreasing at dramatic rate which needs to be verified.
The number of milking animals (cattle and buffalo) and the volume of milk production are steadily increasing in the country. Annual fluid milk production is around 1.4 million metric ton from nearly 2.2 million milking animals (Figure 4).

Per capita milk availability in Nepal is around 51 kg which is far below the 256g/day (93 kg/annum) recommendation of WHO. The per capita availability of milk in developed world is 222kg. Among the South Asian countries, Pakistan has highest per capita availability (134kg), followed by India (79kg). Per capita availability of milk in Bangladesh (18kg) and Sri Lanka (33kg) is below compared to the figure in Nepal.

Agriculture Perspective Plan (APP) has considered livestock sector as demand driven product and aims at attaining annual growth of 5.5% in the dairy sector during the next 10 years of APP. Due emphasis has been given to milk and associated milk production. Consequently, buffalo has received high priority under dairy sector. The National Agriculture Policy – 2061 emphasized on commercial agriculture production. The National Dairy Development Policy 2064 has also been formulated and has guided for the competitive dairy production and marketing.

1.1 Background

The historical developmental initiation of livestock in Nepal can be traced back to 1917 Bikram Era in which the then Rana regimes brought some European cattle breed in the country. The first official organization "Livestock Improvement Section" was established in 1952 for development of livestock in the country with main objectives of improving genetic potentialities of indigenous cattle through introduction of exotic cattle.
breeds. Thereafter Red Sindhi, Jersey and Brown Swiss cattle and Murrah buffaloes were introduced in Nepal. These animals were initially kept at Singh Durbar Livestock Farm, which later on moved to Khumaltar from Singh durbar in 1969. To speed up genetic improvement programme, artificial inseminations using warm semen at initial stage and with frozen semen later were initiated in Nepal. The other exotic cattle breeds used for improvement are Brown Swiss and Ayreshire.

The first five-year plan of Nepal had indicated the need for development of modern dairy industry. The dairy development initiative in the country was taken by the government with experimental production of Yak cheese in 1952. The first Yak Cheese production factory was established in Langtang, Rasuwa with assistance of FAO. Later in 1954, a small-scale experimental milk processing plant was established in Tushal of Kavrepalanchowk district and by 1956; a Central Dairy Plant with processing capacity of 500 lph was established at Lainchaur in Kathmandu. In the mean time two additional cheese factories were established in high hill regions under Department of Agriculture.

The Dairy Development Section was established within Department of Agriculture in 1954. A Dairy Development Commission was formed in 1955, which later on 1962 converted into Dairy Development Board. Again, the Dairy Development Board was converted into Dairy Development Corporation in 1969 under the Corporation Act of 1964. With this institutional set up, four major Milk Supply Schemes namely BMSS in the east, HMSS and KMSS in central and PMSS in the west were established during 1973 to 1980, which are involved both in collection and processing of milk. The involvement of private sector on dairy development started in the late 1970s. Milk producers' Associations and later on milk producers' cooperatives were formed to channelize milk marketing in the formal sector in the country. There are more than 1580 such cooperatives at present. As milk is of perishable nature and the range of skills involved in its production and marketing, dairying requires a number of services that can best be provided by cooperative action. It is not surprising therefore that the cooperative movement has featured prominently in the development of the dairy industry worldwide.

In 1992, the government established National Dairy Development Board with the major functions and responsibility of formulating and recommending policies and plans for dairy development in Nepal and strengthen the dairy sector by bringing coordination between private and public sector.

**Chronology of Dairy Sector Development in Nepal**

- **1917-** Importation of European cattle in Rana regime
- **1952-** Establishment of Livestock Improvement Section
- **1952-** Yak cheese production in Rasuwa with FAO support
- **1953-** Small scale milk processing plant in Tushal
- **1954-** Dairy Development Section within DOA
- **1955-** Dairy Development Commission
- **1956-** Central Dairy Processing Plant (500 lph capacity) in Lainchaur
- **1962-** DD commission changed into Dairy Development Board
- **1969-** Dairy Development Corporation (DDC)
- **1973-1980** BMSS, HMSS, KMSS, PMSS established
- **Late 1970s-** Involvement of private sector
Dairy Production, Quality Control and Marketing System in Nepal

1980- Milk producers’ cooperative and Association
1990- Ten year Dairy Development Plan with Danish support
1992- National Dairy Development Board (NDDB)
1995 - Establishment of SMPP in Biratnagar
2008-09 SMPP in Kaski and Chitwan (private sector)

1.2 Objectives

The main objective of this paper is to highlight and share information on i) dairy production scenario, ii) best practices of milk production, processing and marketing and iii) quality control measures adopted throughout the milk supply chain in Nepal among the SAARC countries. It is envisaged that through this exchange of information.

2. MILK PRODUCTION SYSTEM

Milk production in Nepal broadly can be classified into two systems 1) traditional subsistence milk production system and 2) market linked commercial/semi commercial milk production system. Under traditional subsistence production system, majority of the dairy animals are of indigenous origin, are kept in low input and mostly under grazing management with rare uses of external inputs. Under this system animals are kept for milk and milk products mainly for household consumption. Surplus milk if any is sold to village tea shop if the opportunity for this exists in the village. The products particularly Ghee (clarified butter) are traded in the nearby town. The system is under pressure and gradually shifting towards commercial/semi commercial production, once the villages are connected by road network and national milk grids. In the areas lacking these opportunities, farmers are gradually abandoning raising of animals in search of other employment opportunities in cities or abroad. The second type of milk production system which is emerging in the country is described under following sub headings:

2.1 Smallholder dairying

Smallholder dairy systems are common throughout the developing countries. Market-oriented dairy farming by smallholders practicing a mixed crop-livestock form of farming can be a key to economic development in many areas of the HKH including Nepal. Over the past 10 to 15 years, considerable changes have taken place in the structure and management systems of smallholder dairy farming within the mixed crop-livestock farming systems. In particular, there have been notable changes in the species and breeds of the dairy population, infrastructure, and market developments. Increasing urban markets and improved marketing systems have led to a slow but steady move towards dairy farming as a means of supplementary income generation and even as a commercial venture rather than as part of a subsistence system.

Devendra (2001) categorized smallholder dairy production system into three systems:

- Traditional, usually with ad hoc marketing arrangements such as many peri urban farms
Cooperative, formed from natural aggregation and concentration of farms

Intensive, where herd sizes become larger

Smallholders manage their herds in order to maintain a steady supply of milk. The number of milch animals that can be reared in a smallholder system has a certain ceiling. The obvious determining factors to this are the size of landholding, the availability of feed, and human labour. In the major dairy pocket areas of Nepal, majority of the dairy farmers are smallholders. Out of 880 farms under recording scheme for genetic improvement programme across 14 hill and Terai districts of Nepal, the median herd size was found to be 5 with majority of households (56%) having cattle herd size of 1-5. Very few households were having more than 10 cattle and extremely low had herd size of more than 20 cattle. Some of the smallholder dairy farmers keep the mixed herd of cattle and buffalo, some only buffaloes and rest only cattle with their unique explanation for such practices. Although government programmes have promoted crossbred cows for use as dairy animals, the use of buffalo is becoming popular among small farmers because of their adaptability to local feed resources, high milk fat content, and salvage value in the hills. The milk produced from these smallholder farmers come into formal milk market through organized private and public dairy sector in the country. Some farmers are still opt to supply milk directly to the consumers or to the intermediate processor (hotel and restaurants producing sweets) as they get better price for milk compared to the price when they sell it to the formal milk market.

![Figure 5. Herd size of dairy cattle in major dairy pocket areas of Nepal](image-url)
In Nepal's hills and Terai, areas that are accessible via the road network have experienced significant growth in smallholder dairy farming. The marketing of milk has been facilitated by the establishment of milk collection canters that transport milk to the main chilling canters established by DDC (government), as well as by private dairies, in the main towns or cities. The government has established chilling canters that are the ultimate market for the milk sold by the smallholder.

Private sector involvement in processing milk from smallholdings is increasing. However, the private sector's efforts are also uncoordinated, and quality enforcement is lacking. The private sector also suffers from unfair competition with the subsidized public sector.

In the high hills and mountain areas, Chauries (crossbred between yak and hill cattle) are being raised mainly for milk production. The milk is being utilized for Yak cheese production by DDC owned and private cheese factories. Milk production from Chauries are seasonal (not milked during winter feed scarce period) and thus the operation of these cheese factories located in the remote high hills of the country are also seasonal.

2.2 Periurban milk production

Most of the smallholder dairy production development has been evolved around peri urban areas as there is good road link and good market potential for the milk and products in adjoining city centre. The state owned Dairy Development Corporation (DDC) initiated 5 different milk supply scheme namely Kathmandu Milk Supply Scheme (KMSS), Biratnagar Milk Supply Scheme (BMSS), Hetaunda Milk Supply Scheme (HMSS), Pokhara Milk Supply Scheme (PMSS) and Lumbini Milk Supply Scheme (LMSS) in Kathmandu, Biratnagar, Hetauda, Pokhara and Butwal respectively. Consequently, the smallholder as well as medium to large scale dairy farms emerged in the vicinity of these city centres. The collection and chilling centres were established around these dairy farm settlements. The private dairy sectors also focused their activities on these established centres thus smallholder dairy grew faster in these peri urban areas.

However, in the present context of short supply of around 400000 lit of milk daily to the established capacity of small to large dairy industries, the private sectors are expanding their coverage in new peri urban areas as well as in the villages where there is good road linkage. The lower oppertunity costs of land and labor in peri urban areas compared to that within the cities have greatly encouraged dairy development in peri urban areas. However, smallholder dairy farming is not uncommon in the city centre itself. Small to medium sized dairy farms are found in major cities like Kathmandu, Pokhara and Biratnagar. The feeding of these dairy animals kept in the city itself however differs from that kept in the peri urban areas. In the city centres, the animals greatly depends on straw and concentrates, whereas there is a practice of cultivating forage grass depending on availability of land in peri urban areas. Green grasses from fallow land and roadside and from fodder tree is also available in the peri urban areas.
2.3 Dairying through co-operatives

The fundamentals of the cooperatives is working together to build self reliant communities. Cooperatives are often cited as one of the most effective way of grouping small dairy farmers to deal with the challenges of producing and marketing milk. As a result of the perishable nature of milk and the range of skills involved in its production and marketing, dairying requires a number of services that can best be provided by cooperative action. It is not surprising therefore that the cooperative movement has featured prominently in the development of the dairy industry worldwide.

A dairy cooperative business is owned, operated, and controlled by the dairy farmers who benefit from its services. Members finance the cooperative and share in profits it earns in proportion to the volume of milk they market through the cooperative. Milk producers' cooperatives and association were formed for the first time in 1980 in Nepal to cope with the challenges being faced by smallholder farmers in milk production pockets. At present, there are 1657 Milk Producer's Cooperative Societies (MPCs) functioning in 62 districts in the country. These primary cooperatives used to have at least 25 member farmers. Nearly 100 thousands households/ members are involved in these primary cooperatives in which one third of the members are women. In the district level, District Milk Producers’ Cooperative Unions (DMPCUs) are in function in 38 districts which coordinates and facilitates its member primary cooperatives within the district for dairy operation. Central Dairy Cooperative Association of Nepal (CDCAN) is the national level umbrella for primary cooperatives and union in the country.

The farmers’ are paid for milk on basis of fat and SNF content of the milk. However, the primary cooperatives are additionally paid for total solid content of the bulk milk from DDC and dairy industries. This amount helps to run cooperative for its day to day operation. The salary to the personnel involved in the cooperative, transportation cost from collection to chilling centres or dairy industries, and purchase of chemicals and glassware required are also paid from these earnings of the cooperatives.

Support from non governmental sector to cooperative union

District Milk Producers' Cooperative Union, Dadeldhura (DMPCUD) was established in 2002 with the financial support of Canadian Cooperative Association (CCA) and technical supports from the Canadian Center for International Studies and Cooperation (CECI) and Central Milk Producers' Cooperative Union (CMPCU). From the very beginning of its establishment, the DMPCUD has been carrying out buying and selling business of milk and milk products in Dadeldhura district. Until recently, DMPCU in its fold had nine Milk Producers' Cooperative Societies (MPCS) but now the number is gradually growing and has reached to 13. There are currently 565 MCPS members, of which 234 are women.

Outcome: Number of households benefiting increased from 75 to 250; average HH income increases from Rs 29000 to Rs. 36000; number of liters sold through DMPCUD increases from 105 liters to 500 liters per day; total DMPCUD sales revenues increases from Rs 766,000 to Rs 1,650,000; number of products marketed by DMPCUD increases from two (milk and ghee) to five (milk, ghee, curd, Cottage cheese, chharpi (hard cheese).

Example of the activities being undertaken from non government sector (CECI) to strengthen the dairy cooperatives societies and union
Dairy Production, Quality Control and Marketing System in Nepal

- Training on Village Animal Health Worker, livestock rearing practices, milk quality control and cooperative and account management.
- Mobilization and training on Milk Producers’ Cooperative formation & development
- Facilitation for market linkage of dairy products (both for Forward and backward market linkages)
- Forage and fodder planting materials distributed and available in the coops members
- Cooperative expansion and strengthening
- Enhancing of processing capacity
- Product diversification
- Market expansion
- Business plan development

Farmer-owned dairy cooperatives engage in a variety of activities to provide members an assured market for their milk. Dairy cooperatives range widely in size and function—some solely arrange for the sale of members’ milk and provide few services, while others manufacture range of products and may market their products directly to consumers. Most MPCs are engaged in milk collection, quality testing and distribution of milk payments. Some MPCs operate input supply, veterinary services, and consumer goods outlets for members. Feed manufacturing by the cooperatives and selling to the cooperative member is gaining popularity as there is greater quality assurance and payment ease in the process.

3. Dairy Animal Health Care and Breeding Services

Dairy Animal Health Services

Various diseases and parasites have been identified as major constraints in dairy animal farming in Nepal. Though sporadic information are available, comprehensive analysis of the economic loss due to these diseases and parasites in the country is still lacking. As rinderpest disease has been eradicated from the country, Hemorrhagic septicaemia (HS), FMD, mastitis, infertility, metabolic diseases and internal parasites are some of the economically important diseases prevalent in dairy animals. FMD is important disease, which causes significant economic losses mainly due to loss in milk and meat production, mortality of neonates, loss of draft animals due to lameness, and restrictions on trade (James and Rushton 2002). As in many developing countries, FMD is endemic in Nepal, where the disease has been reported in all 75 districts of the country and confirmed by laboratory testing in 61 districts (Gongal and Karki 2000). They have estimated economic losses due to FMD infection in Nepal which comes around USD 5.36 million per year. In another study on the economic impact of livestock diseases in rural areas of Nepal, Lohani and Rasali (1992) estimated that FMD could account for 26% of the overall economic losses in livestock production. Epidemics of FMD outbreak in 2009/10 throughout the country greatly affected smallholder dairy farmers. Mastitis is
another important disease having greater economic significance, the loss being due to reduced milk production, discarding of spoiled milk and high cost of treatment. Internal parasites are also the cause of significant production loss in dairy animals. Apart from these diseases of economic significance, diseases like tuberculosis and brucellosis have public health concern. The overall herd health, farm sanitation and dairy production environment is regarded as poor in the country. It can be speculated that substantial loss has been occurring to the smallholder dairy farmers due to these diseases.

Listing of some of the diseases and parasites of dairy animals having economic and zoonotic significance:

- Ectoparasites and Vector borne haemoproteozoon diseases
- Endoparasites (Fasciola/Paramphistomum/Toxocara)
- Mastitis
- Reproductive disorders (Infertility/Abortion/Prolapse/Repeat breeder)
- Mycotoxicosis
- Specific infections (H.S., Anthrax, B.Q., Brucellosis, Calf scours)
- Tuberculosis and Paratuberculosis
- Foot and Mouth Disease (FMD)
- Nutritional and metabolic diseases (Milk fever)

Development of veterinary and animal production services in the country

- First veterinary dispensary to provide allopathic treatment to animals was established in Kathmandu in 1996 B S.
- 33 Hospitals, 21 dispensaries and 18 check-posts were established by 2021 B S with the assistance of India, FAO/OXFAM
- Department of Livestock Development and Animal Health was established in 2023 BS
- Animal Health and Livestock Services Act 2055, Regulation 2056 were formulated.

Service Delivery Network of the Government

- 999 Service/sub-service centers at village level
- 75 District Livestock Services Offices at district head quarters
- 5 Regional Labs
- 24 Animal Quarantine Check Post, 8 Animal Quarantine Office
- 5 Regional Directorates
- 5 Regional Training Centers
- 10 Central Offices

The service provided from this government networks are:

- Treatment, prevention and control
- Disease investigation & diagnosis
- Hygienic production
- Research
- Training
- Package services
The Village Animal Health Workers (VAHW) is the approach taken by the government through DLS to provide animal health services particularly in the remote areas.

Nepal Agricultural Research Council (NARC), an apex body for agricultural research in the country is responsible for carrying out researches to solve problems of the dairy animals and farmers through its Animal Health Research Division and other research stations located at different agro-ecological regions of the country.

Institute of Agriculture and Animal Science under Tribhuvan University and Himalayan College of Agriculture Sciences under Purbanchal University are responsible for producing veterinary and livestock production graduates to deliver the respective services in the country. Mid level technicians are being produced from different public and private institutions affiliated with Centre for Technical and Education and Vocational Training (CTEVT).

**Breeding Service**

The gradual development of dairy sector in the country can be greatly attributable to the breed improvement programme undertaken by the government of Nepal through support of different countries around the world. The native breed of cattle and buffaloes are greatly been upgraded to exotic dairy breed of cattle and buffaloes through use of artificial insemination and natural services from breeding bull distribution. National Livestock Breeding Centre (NLBC) formally known as Animal Breeding and Artificial Insemination Section under Department of Livestock Services is fully responsible for producing frozen semen in the country for cross breeding and upgrading of dairy animals. Animal Breeding Division under NARC is responsible to undertake research activities to improve productivity of dairy animals. The District Livestock Service Offices (DLSOs) have responsibility to provide suitable breeding bulls (cattle and buffalo) and carry out AI services through its networks and technicians. Each year DLSO has programme of distribution of breeding bulls in the districts. NARC and DLS is jointly undertaking Dairy Cattle Genetic Improvement Programme formally with the support of FAO and recently on their own in the major dairy pocket areas of the country.

**Brief history of dairy animal genetic improvement programme in Nepal:**
- AI with fresh semen started in 2017/18 BS
- AI with frozen semen started in 2025/26.
- AI Coverage- 207 AI centres including 34 private in 44 districts
- AI Coverage- 8.06% in cattle and 1.55% in buffaloes
- Frozen semen import – 300000 doses (Brown Swiss, Jersey, Holstein, Ayreshire, Tirentase breeds of cattle and Murrah buffalo),
- Average conception rate- 49%
Currently AI services are available in 44 districts through the technicians/veterinarians through District Livestock Service Office and its Service Centres/sub centres. Private (technician not involved in government services) AI services are also available in the major dairy pockets of the country.

Table 2. Organizations and Technicians Engaged in Insemination: 2062/63

<table>
<thead>
<tr>
<th>Region</th>
<th>DLSOs / AI Centers</th>
<th>Private Centers</th>
<th>Total centers</th>
<th>Inseminators</th>
<th>Total AI</th>
<th>AI/ Center</th>
<th>AI/ Inseminator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>8/51</td>
<td>6</td>
<td>57</td>
<td>115</td>
<td>25594</td>
<td>385</td>
<td>190</td>
</tr>
<tr>
<td>Central</td>
<td>16/73</td>
<td>12</td>
<td>85</td>
<td>161</td>
<td>36225</td>
<td>341</td>
<td>221</td>
</tr>
<tr>
<td>Western</td>
<td>10/35</td>
<td>14</td>
<td>46</td>
<td>104</td>
<td>21669</td>
<td>373</td>
<td>210</td>
</tr>
<tr>
<td>Mid-western</td>
<td>8/10</td>
<td>1</td>
<td>11</td>
<td>22</td>
<td>1982</td>
<td>169</td>
<td>90</td>
</tr>
<tr>
<td>Far-western</td>
<td>2/4</td>
<td>1</td>
<td>5</td>
<td>13</td>
<td>1971</td>
<td>389</td>
<td>81</td>
</tr>
<tr>
<td>Total</td>
<td>44/173</td>
<td>34</td>
<td>207</td>
<td>415</td>
<td>87441</td>
<td>354</td>
<td>200</td>
</tr>
</tbody>
</table>

Source: National Livestock Breeding Centre (2062/63)

The number of AI in cattle and buffaloes has been steadily increasing over the years. AI is more in cattle compared to buffalos in Nepal. Currently Annual AI has reached well above 150 thousands (per. Communication BK Nirmal, 2010) and upsurge in the demand of AI has been noticed.
National Livestock Breeding Centre, Pokhara produces semen of Jersey bull and Murrah buffalo bulls for AI in the country. It has recently restarted producing HF semen after the amendment in the breeding policy in the country. Informal import of semen from border area of India is not also uncommon in Nepal. Formally 10000 doses of semen of Jersey and HF bulls were imported during 2009 for the genetic improvement of dairy cattle in the country.
4. Feed Industry, Dairy Animal Nutrition and Production

In developing countries and particularly in resource poor areas, feeding systems are, unlike developed countries, complex and considerable variability exists. The systems are also indicative of variability of nutritional status of the dairy animals and that in turn influences performance. One of the main reasons of this variability is use of a wide variety of local feed resources and that in turn is the reflection of diversified cropping systems and non-commercialization of dairy production.

The dairy animal feeding system in the country is determined mostly by the availability of feeding resources in the livestock farming areas and their production potentials. Thus great variation in the feeding system prevailing in the different locations of the country can be observed. Indigenous cattle, which are basically not meant for commercial milk production purposes completely depends on grazing on communal land, barren crop field and nearby forest with little or no supplementation except during early stage of lactation. In contrary, buffaloes, even indigenous are better cared particularly during lactation period as buffaloes are better producers of milk. In the villages not covered by the country’s milk grid, where 1-2 buffaloes are being kept by the farmers, used to feed KUNDO (cooked mixed grains, byproducts with little salt) to their lactating animals.

Fodder based dairy animal feeding with limited supplementation of concentrates is common in the Ilam district in eastern part of Nepal, whereas, in Kathmandu valley, complete straw and concentrate (either purchased from feed mills or home made by mixing wheat bran, rice polish and cakes) feeding with grazing in the roadside and open land can be observed. In some part of the country, cultivation of fodder grasses in the cropping land for feeding productive (crossbred and exotic) dairy animals is also common, but depends on the availability of the land. The Community Livestock Development Project (CLDP) implemented by the Department of Livestock Service under loan support of ADB emphasized on utilization of community forestry for forage cultivation. Most of the dairy farms in the country are emerging on the main road corridor and within urban and peri urban areas, where the opportunity cost of land and labor is very high. The limited land and high opportunity cost has forced the dairy farmers to depend mostly on straw and concentrate based farming. During winter, straw is the major bulk of ration for the dairy animals. Price of straw has increased tremendously in the last few years.
Though straw constitutes the major feed constituents for dairy animal feeding and its intact nutritive value is very poor, the urea or ammonia treatment of straw is virtually non-existent despite it has been emphasized by the government extension services. The non-adoption of the practices could be attributed to less availability or affordability of urea as well as the risk associated with the improper use. However, chopping of straw mixed with green forage whenever available is the commonly adopted practices by the dairy farmers.

Both in peri urban areas and in the villages, uses of terrace risers and bunds for fodder production is common. Napier and Amliso are common forage species used in terrace risers, bunds and roadsides open land.
Tree fodder plantation for feeding animals during dry period is a common practice across hills of Nepal. They are important source of green feed for dairy animals during that period. In subsistence dairy animal production system, foliage collection form nearby forest (government or community forest) is also very common. Recently open land under community forestry has been extensively utilized for fodder production in the milk grid areas of the country.

Silage production to feed dairy animals during winter scarce period is only practiced in government farm or large scale dairy farms. However, the small scale plastic bag silage technology is gaining popularity among small holder dairy farmers in the country. Uses of Urea Mineral Molasses Blocks (UMMB) is also getting popularity among the dairy farmers again particularly during the feed scarcity period.

In general the dairy cattle feeding system in Nepal can be categorized into 3 categories on the basis of share of dry matter of straws, greens and concentrate in the dry matter of the ration offered to the dairy animals.

1. **Straw based systems** – where greens are not available for 9 months in a year and concentrates are used to supplement the ration. The share of each of the components, in the total dry matter (of ration) offered to dairy animals, range between:
   - 50 to 60% through cereal straws,
   - 25 to 40% through concentrates and
   - 00 to 15% through Greens.
2. **Straw and limited Greens Systems** – These are systems where greens are available for 9 or more months of the year, but in limited quantities and concentrates are used to supplement rations. The share of each of the components, in the total dry matter (of ration) offered to dairy animals range between:

- 25 to 40% through cereal straws,
- 20 to 30% through concentrates and
- 25 to 40% through Greens.

3. **Green fodder based systems** - where green fodder is available in ample quantity for most parts of the year, it is supplemented by concentrates and straw is offered only to meet dry matter requirement (if needed). The share of each of the components, in the total dry matter (of ration) offered to dairy animals range between:

- 10 to 20% through cereal straws,
- 15 to 30% through concentrates and
- 60 to 75% through Greens.

**Common feeding practices observed in dairy farms in Nepal:**

- Most of the animal owners use home made feed mixtures for dairy animals.
- Commonly used ingredients are – maize floor, wheat bran, rice bran, pulse chuni and small quantity of oil cake (varies between areas). The ingredients are mixed in certain proportions – measures are used for adding ingredients.
- Compounded feed is purchased by many but is used as one of the ingredients.
- Most feed mixtures appear to be low in protein (considering limited use of oilcakes) and this could be a limiting factor for high producing animals and particularly in some parts of the year (except during winters when leguminous fodder is available). Animal owners need to be advised to adjust feed formulae.
- Majority of animal owners add mineral mixture and salt to feed mix (although not regularly) and some use vitamin mixtures and galactoluges.
- The feed mixes are either cooked or soaked for feeding animals – very few feed the mixture dry. Some owners add wheat straw also to the mix while cooking or feeding (probably to increase the bulk).
- The feed mix is offered individually to milking animals - either in feeding manger or in a large vessel – usually with large quantity of water.
- Higher producing animals are given some extra quantity of feed mix.
- Practices of feeding Non-producing animals (growing or dry cows) vary between owners- small quantity of concentrate is of offered by most owners.

**Fodder production and utilization**

- While most owners are aware of importance of green fodder for dairy production limitation of land is a major constraint and to some extent information about high producing crop varieties and their seeds.
- It is observed that much of the greens are cereals, except on a few farms and in winters. There is need to create awareness to have a mix of cereal and leguminous fodder,
- Most producers chop the fodder and some even mix greens with dry fodder for chopping. Introduction of more durable and efficient (low power consuming) choppers would be useful.
• In some cases quantity of dry fodder offered appeared insufficient (based on limited observation). Extension staff should pay attention to this aspect and advice animal owners suitably.

Maize Cobs and Sugarcane Bagasse as cheaper source of roughage
Considering high cost of cereal straws and likely availability of maize cobs in large quantities in view of extensive cultivation of maize it is worth exploring feasibility of urea treatment of cobs to convert it into roughage for cattle feeding. In the manner there is possibility of converting sugarcane bagasse into roughage through urea treatment (Bagasse and Cobs are used as fuel or just thrown away).

Feeding system of yak and Chauries
In the yak rearing regions, Yak and Chauries are normally grazed throughout the year. In winter (January/February) they do not receive supplementary feed and subsist on dead grasses and roots under the snow. Herders only provide grain supplements to the milking, working animals, young calves and weak animals. However, common salt is provided one or twice a week and cheese whey is fed to milking animals. In heavy snow fall day, some stall feeding of hay and concentrate feeds such as maize flour, soybean, potato, radish, gur and a mixture of mustard oil and poultry eggs, and local brewery by-products such as rice, maize, barley and millet is done.

Forages on natural grassland are in surplus in summer but deficient in winter under the traditional grazing system. The nutritional status of Yak can be improved by ensuring adequate protein intake in summer - but Yak suffer deficiency of crude-protein and of energy from grass in winter. The use of feed supplements seems vital if the productive and reproductive potentials of grazing Yak cows are to be developed. Concentrate and urea block supplements are effective in improving the productivity of grazing Yak and maintaining the body weight of animals in winter.

Feed Industry
Feed industries are of major importance for blooming poultry industry in the country. However, with the emergence of commercial/semi commercial dairy farming in the country, its importance has been increasing. There is one government owned feed industry (Hetunda Cattle Feed – though it also produces feed for other livestock and poultry species, it is named as “Cattle Feed”) in the country, while small to large capacity feed industries have been established in different parts of the country. Milk producers’ cooperatives are also preparing compound feed and being utilised by the member farmers in major dairy pocket areas.

Table 3. Feed Industries in the country

<table>
<thead>
<tr>
<th>SN</th>
<th>Development Region</th>
<th>No of feed mill</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Eastern</td>
<td>6</td>
<td>2.3</td>
</tr>
<tr>
<td>2</td>
<td>Central</td>
<td>218</td>
<td>82.0</td>
</tr>
<tr>
<td>3</td>
<td>Western</td>
<td>29</td>
<td>10.9</td>
</tr>
<tr>
<td>4</td>
<td>Mid Western</td>
<td>8</td>
<td>3.0</td>
</tr>
<tr>
<td>5</td>
<td>Far Western</td>
<td>5</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>266</td>
<td>100</td>
</tr>
</tbody>
</table>
A total of 266 feed mills of varying capacities are in operation in the country. Among them, 165 feed mills are small (0.5-1 ton/day) and medium (10-15 ton/day) and the rest are large scale feed mills. Among the feed produced from these feed mills, more than 93% are utilized in the poultry sector and only remaining 7% by dairy animals, goats and pigs. The annual utilization and import of feed ingredients for these feed mills is presented in Table 5.

The quality standard fixed for cattle feed is given in Table 6. However it is the major concern of farmers that the quality of compound feed is not as per the standard set. There are Animal Nutrition Laboratories under DLS and NARC to check the quality. Department of Food Technology and Quality Control (DFTQC) the regulatory body for maintaining quality standard of feed and food items in the country.

| Table 5. Utilization and importation of the feed ingredients 2007/08 |
|---|---|---|
| SN | Ingredients | Amount used (mt) | Proportion of import (%) |
| A. | Energy Source | | |
| 1 | Maize | 194742.0 | 45.0 |
| 2 | Rice polish | 47295.0 | 0 |
| 3 | Rice Polish Deoiled | 18546.0 | 0 |
| 4 | Wheat | 12983.0 | 0 |
| 5 | Wheat Bran | 25502.0 | 0 |
| 6 | Molasses | 11592.0 | 0 |
| B. | Protein Source | | |
| 1 | Soybean | 51003.0 | 98 |
| 2 | Sesame cake | 27820.0 | 95 |
| 3 | Sunflower cake | 23183.0 | 95 |
| 4 | Mustard cake | 13910.0 | 0 |
| 5 | Fish meal | 13910.0 | 99 |
| C. | Minerals and Vitamins | | |
| 1 | Oyster Shell | 4136.0 | 95 |
| 2 | Bone meal | 4336.0 | 50 |
| 3 | Limestone | 9273.0 | 0 |
| 4 | Feed supplements and additives | 5231.0 | 80 |

Source: Bhattarai TC (2008) Calendar of Nepal Feed Industries Association

| Table 6. Minimum quality standard for dairy animal feed |
|---|---|---|
| SN | Parameters | Amount (%) |
| 1 | Moisture | Max 11.0% |
| 2 | Crude protein | Min 18.0% |
| 3 | Crude fat | 2.5-5.0% |
| 4 | Crude fiber | Max 7.0% |
| 5 | Acid insoluble ass | Max 4.0% |
| 6 | Calcium | Min 0.5% |
| 7 | Sodium chloride | Max 2.0% |
| 8 | Phosphorus | Min 0.5% |
| 9 | Vitamin A | Min 5000 IU/kg |
| 10 | Oflatoxin | Max 50 ppb |

Source: Upreti (2008)
5. Dairy Breed and Their Production Performance

In Nepal, seven indigenous breeds of cattle including yak and 3 indigenous buffalo breeds have been characterized and performance evaluated. Indigenous cattle are generally poor in milk production performance; rather they are being kept for manure, power for agricultural operation and for religious purpose. The value of indigenous cattle as dairy animals particularly in reference to commercialization is very poor. However, their utility for production of crossbred dairy cattle through imported frozen semen or bulls is tremendous. They have their unique nature and are considered to be resistant against diseases and parasites e.g. indigenous cattle are not affected by ticks. Achhami cattle, the smallest cattle breed in the world (Epstein, 1984) found in western hill districts of Nepal are capable of producing milk compared to their body size in adverse environmental condition. Similarly Lulu cattle, the only humpless indigenous cattle breed found in mountainous region are also considered to have potentiality to produce in poor management condition.

Table 7. Productive and reproductive performances of native cattle (Values are means ± standard errors)

<table>
<thead>
<tr>
<th>Breeds</th>
<th>Age at 1st service (months)</th>
<th>Age at 1st calving (months)</th>
<th>Gestation length (days)</th>
<th>Calving intervals (months)</th>
<th>Average daily milk yield (litres)</th>
<th>Lactation length (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lulu</td>
<td>42 (36-56)</td>
<td>52 (46-58)</td>
<td>280±1.7</td>
<td>18 (12-24)</td>
<td>1.6±0.31 (0.5-3.57)</td>
<td>195 (180-210)</td>
</tr>
<tr>
<td>Achhami</td>
<td>48 (36-60)</td>
<td>60 (48-72)</td>
<td>285±1.8</td>
<td>17 (12-24)</td>
<td>1.5±0.22 (1-4)</td>
<td>225 (180-270)</td>
</tr>
<tr>
<td>Siri</td>
<td>40 (36-48)</td>
<td>50 (42-70)</td>
<td>295.2±2.2</td>
<td>19.6±0.9</td>
<td>4.5±0.22 (2-6)</td>
<td>268.6±2.0</td>
</tr>
<tr>
<td>Khaila</td>
<td>45 (40-60)</td>
<td>55 (50-65)</td>
<td>288±1.8</td>
<td>18.0</td>
<td>2.5 (2-3)</td>
<td>305.0</td>
</tr>
<tr>
<td>Yak</td>
<td>45.3±0.65</td>
<td>56.6±0.75</td>
<td>252.2±1.5</td>
<td>21.3±0.76</td>
<td>0.8 (0.5-2.0)</td>
<td>160 (180-210)</td>
</tr>
<tr>
<td>Terai</td>
<td>39.4±0.50</td>
<td>49.9±0.46</td>
<td>296.1±0.25</td>
<td>16.3±0.23</td>
<td>2.1 (2-3)</td>
<td>246.0</td>
</tr>
<tr>
<td>Pahadi</td>
<td>48 (40-55)</td>
<td>50.1±1.1</td>
<td>275±1.65</td>
<td>17.6±1.98</td>
<td>1.1 (1-1.5)</td>
<td>240±2.1</td>
</tr>
</tbody>
</table>

Source: Neopane and Pokharel (2005)

Three indigenous breeds of buffaloes namely Lime, Parkote and Gaddi have been characterized so far. Of the three breeds, Gaddi are found only in the far western hills of the country, whereas other two breeds are scattered throughout the country. Buffaloes are rare in the northern Himalayan districts.

Among the three indigenous buffalo breeds identified, Gaddi buffaloes found in far western hill districts are comparatively better in terms of lactation performance. The average daily milk yield for the first three months was 4.69 lit from two teats and 4.62 lit in next three months with one teat for calf. The lactation length varied from 14 to 22 months (Pokharel, 2007). Average lactation yield of Lime and Parkote buffaloes have been observed to be 963 and 1022 kg respectively (Shrestha, 2003). A great deal of variation within indigenous buffaloes (figure 14) has been observed among indigenous buffaloes and selective breeding strategy in supplement to cross breeding with Indian Murrah buffalo has been lately suggested.
Jersey and Holstein Friesian are the two primary breeds of dairy cattle introduced in Nepal either through importation of live animals (limited numbers) or through upgrading Yak (female are known as Nak) and their crosses with hill cattle (known as Dimjo and Urang Chauries) are important livestock species in the high hills and mountains of Nepal. Though milk production potential of Nak is poor (less than 200 lit in 6 months lactation period) crossbred Chauries are better in lactation performance (around 400 lit). Crossing Nak with Brown Swiss frozen semen was attempted in Nepal. The crossbred Chauries produced more than 1000 lit of milk in a whole lactation (number of crossbred Chauries was only 2) by importation of frozen semen. After some years of promoting both Jersey and HF cattle in the country, the government later considered that HF is not suitable under Nepalese farming system and management condition. Many reproductive problems were reported in these crossbred animals. Therefore, DLS stopped producing frozen semen from HF bulls in its centre. Artificial insemination with Jersey semen to the crossbred HF cattle were practiced and three breeds cross cattle were produced. Some farmers were not happy with the government decision and illegal import of HF semen from India was continued in the boarder areas. However, recently the government revisited its policy of not promoting HF cattle due to farmers’ demand and restarted production of frozen semen from HF bulls also. Apart from Jersey and HF, Brown Swiss, Ayeshire, Tarentase semen were also introduced in Nepal, but their uses were limited. Likewise Red Sindhi and Sahiwal cattle have also been introduced, some blood of these breeds can also be found in the farmers’ cattle herds. Significant improvements in the production potential of these crossbreds and upgraded cattle have been achieved. Milk production of these crossbred are many fold higher than that of the indigenous cattle breed, and also the age at first calving and calving intervals are considerably lower in these crossbred cattle. However, some reproductive problems (repeat breeding, post portem anestrous, delayed puberty) have also been encountered mainly due to the management fault. The estimated (based on monthly recordings) milk yield of crossbred cattle in the major dairy pocket areas of the country is presented in Table 8.

![Figure 13: Lactation yield of indigenous buffaloes](image1)

![Figure 14: Variation in the lactation Performance of indigenous buffaloes](image2)
Table 8. Performances of cattle breed in major dairy pocket areas of Nepal

<table>
<thead>
<tr>
<th>Breeds</th>
<th>300 day Milk yield (kg)</th>
<th>Fat %</th>
<th>Protein %</th>
<th>Valuable solid (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>St Dev</td>
<td>Mean</td>
<td>St Dev</td>
</tr>
<tr>
<td>Predominant Jersey</td>
<td>2469.0</td>
<td>853.6</td>
<td>4.5</td>
<td>0.7</td>
</tr>
<tr>
<td>JXHFXNepali</td>
<td>3056.0</td>
<td>991.9</td>
<td>4.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Predominant HF</td>
<td>3239.1</td>
<td>1107.1</td>
<td>4.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Jersey Cross</td>
<td>2838.8</td>
<td>839.2</td>
<td>4.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Holstein cross</td>
<td>3200.0</td>
<td>1008.0</td>
<td>4.3</td>
<td>0.7</td>
</tr>
<tr>
<td>Unknown/mixed</td>
<td>2640.4</td>
<td>921.1</td>
<td>4.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Overall mean</td>
<td>2801.8</td>
<td>975.1</td>
<td>4.4</td>
<td>0.69</td>
</tr>
</tbody>
</table>

The overall 300 days lactation yield of crossbred cattle has been found to be 2800 lit, with HF performing better (3239 lit) than that of the Jersey (2469 lt). The three way cross also performed better compared to Jersey. The overall fat content (averaged over whole lactation) of crossbred cattle has been found to be 4.4% with slightly better in Jersey (4.5%) compared to HF (4.2%). However, the protein content across breed didn’t vary. The valuable solid (Fat + Protein) produced during 300 days lactation was slightly better in HF (241.8 kg) compared to Jersey (192.7kg). The variation in lactation performance, fat and protein content and valuable solid yield have been depicted in the following figures.
Figure 15: Histogram of 300 days lactation in crossbred cattle in Nepal

Figure 16: Histogram of 300 days valuable solid yield (kg) in crossbred cattle in Nepal
Figure 17. Histogram of fat content

Figure 18. Histogram of Protein content
The principal buffalo breeds imported in Nepal for upgrading indigenous buffaloes is Murrah. Nili Ravi buffaloes have also been imported (sperm), but the number is insignificant. Some Surti buffaloes are also observed to be unofficially introduced in Nepal. About 10% buffaloes in the hills and slightly greater than 10% in Terai are considered to be exotic Murrah and their crossbred with indigenous buffaloes. However, the CBS (2001/02) report gives this figures to be slightly less than 2% of the national buffalo population and highly contradicting with this report, DLS estimates that about 24.6% of the buffalo population are improved (exotic and crossbred). Kavre, Rupandehi, Sarlahi, Saptari, Dhanusha, Nawalparasi, Dhading, Chitwan, Nuwakot and Kaski are some of the districts having higher number of exotic buffaloes. The occasional importation of Murrah she buffaloes and continuous upgrading of indigenous buffaloes with frozen semen and Murrah bull distributed are basic buffalo development strategies adopted in the country. Recently, government has made a policy to unrestricted upgrading to Murrah in Terai and maintenance of up to 62.5% Murrah blood in the hills. However, the regulation and monitoring mechanism is very poor to implement the policy.

**Performance of Murrah buffaloes at Lampatan Livestock Farm**

The herd average of Murrah buffaloes at Livestock Development Farm, Lampatan in 1990s was 1265 lit per lactation which has improved significantly to 1543 lit in a standard lactation of 305 days in recent years through continuous selection and culling practice. The average milk yield per buffalo per year in the farm has reached to 1847 lit excluding milk offered to calves, which is generally for a period of 5 months. The herd
Performance in different lactation is: 1st lactation – 1279±288 lit, 2nd lactation – 1556±318 lit, 3rd lactation – 1520±305 lit, 4th lactation – 1562±283 lit and 5th lactation – 1578±192 lit. in 305 days (LDF, 2064/65).

**Performance of Murrah buffaloes at IAAS Farm**

The lactation performance of Murrah buffaloes at IAAS farm seems to be very poor. In early period (1968-78), the average age at 1st calving, average 1st lactation yield, average all lactation production, average calving interval and average dry days were found to be 50.5 months, 1013 kg, 1095 kg 445 days and 164 days respectively. In mid period (1979-91) - The average lactation yield was 785 lit. Milk production varied from 140 to 2080 lit. The average lactation length and dry period were 292 and 232 days respectively. The higher lactation yield observed in the 1st (836 lit) and 2nd (827 lit) lactation compared to other lactations. Similarly the average lactation yield were 1176, 944, 784 and 747 lit and average lactation length were 305, 288, 306 and 283 days for spring, winter, summer and autumn calving respectively (Dhakal and Pandey, 1992).

**Performance of Murrah/ crossbred buffaloes at farmer’ field**

In western hills, Rasali et al., (1998) revealed that, the average lactation performance of crossbred Murrah buffaloes were as follow:
- 50% Murrah cross = 1222.7 lit
- 75% Murrah cross = 1560.3 lit

In Chitwan, Kolachhapati et al., (1993) found the average lactation milk yields of crossbred buffaloes to be 1927.95±76.618 lit in 10.42 months. Crossbred buffalo had nearly 50% higher milk yield and the age at 1st calving was shorter (4.69±0.07 years) when compared to local buffaloes (4.91±0.08 years).

Better performances of Murrah/ crossbred buffaloes have been reported from eastern Terai region of Nepal (Table 9).

**Table 9. Lactation Milk Yield of Murrah Buffaloes in Dhanusha District**

<table>
<thead>
<tr>
<th>Sites</th>
<th>Number and percent of buffaloes with lactation yield of</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&gt;2400 litres</td>
<td>&gt;2100 &lt;2400 lit</td>
<td>&gt;1800 &lt;2100 litres</td>
<td>&lt;1800 litres</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Sapahi</td>
<td></td>
<td>18</td>
<td>57</td>
<td>9</td>
<td>28</td>
</tr>
<tr>
<td>Kurtha</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Laxmipur</td>
<td></td>
<td>8</td>
<td>47</td>
<td>6</td>
<td>27</td>
</tr>
<tr>
<td>Sinurjora</td>
<td></td>
<td>8</td>
<td>22</td>
<td>13</td>
<td>36</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td>34</td>
<td>32</td>
<td>34</td>
<td>32</td>
</tr>
</tbody>
</table>

**Source:** Annual Report of ABD (2065/66)
6. Quality Control in Dairy Industries

Quality is an important aspect in the dairy sector both from the nutritional and health aspects. As is the milk perfect food for human nutrition so is also the perfect medium for microbes to grow and transmit diseases to the human beings. Quality philosophy, these days are considered to be the password to the market. Quality aspects encompasses right from the farm production and general health of dairy animals till the end products are consumed. Special attention need to be paid right at farm production, during transportation and post processing handling. Quality standard are set for nutrient content of milk and milk products and microbiological loads in it. Obvious contamination with dirt and dung are also the matter of concern.

Dairy farmers are in the business of producing food. They aim to ensure that the safety and quality of their raw milk will satisfy the highest expectations of the food industry and consumers. On-farm practices should also ensure that milk is produced by healthy animals under acceptable conditions and in balance with the local environment. The overarching principles applying to the production, processing and handling of all milk and milk products are:

- From raw material production to the point of consumption, all dairy products should be subject to a combination of control measures. Together, these measures (good agricultural practice – GAP and good manufacturing practice – GMP) should meet the appropriate level of public health protection.
- Good hygienic practices should be applied throughout the production and processing chain so that milk and milk products are safe and suitable for their intended use.
- Wherever appropriate, hygienic practices for milk and milk products should be implemented following the Annex to the Codex Recommended International Code of Practice – General Principles of Food Hygiene.
- GAP/GMP together should be effective.

All dairy farmers, suppliers to dairy farmers, milk carriers and hauliers, dairy product and food manufacturers, distributors and retailers should be part of an integrated food safety and quality assurance management system. Good farming practices underpin the marketing of safe, quality-assured milk-based products.

The role of dairy farmers is to ensure that good agricultural, hygienic and animal husbandry practices are employed at the farm level. The focus should be on preventing a problem (including animal diseases) rather than solving it after it has occurred.

Good dairy farming practices should contribute to ensuring milk and milk products are safe and suitable for their intended use.

Quality Standard for milk and milk products have been set in the country and are given in table 10 and 11.
Table 10. Specification of referred standards for raw milk in Nepal

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Name of the standards</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>PFA</td>
<td>Minimum 4.5% (for mixed milk)</td>
</tr>
<tr>
<td>SNF</td>
<td>PFA</td>
<td>Minimum 8.5% (for mixed milk)</td>
</tr>
<tr>
<td>Acidity</td>
<td>DDC</td>
<td>Maximum 0.2%</td>
</tr>
<tr>
<td>TPC</td>
<td>DDC</td>
<td>Not exceeding 200,000 Very good</td>
</tr>
<tr>
<td></td>
<td></td>
<td>From 200,001 to 1,000,000 Good</td>
</tr>
<tr>
<td></td>
<td></td>
<td>From 1,000,001 to 5,000,000 Fair</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 5,000,000 Poor</td>
</tr>
<tr>
<td>MBRT</td>
<td>DDC</td>
<td>5 hours and above Very good</td>
</tr>
<tr>
<td></td>
<td></td>
<td>From 3 to 4.5 hours Good</td>
</tr>
<tr>
<td></td>
<td></td>
<td>From 1 to 2.5 hours Fair</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5 hours and less Poor</td>
</tr>
</tbody>
</table>

Table 11. Specification for referred standards for milk products

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Butter</th>
<th>Cheese</th>
<th>Cream</th>
<th>Curd</th>
<th>Ghee</th>
<th>Ice cream</th>
<th>Paneer</th>
<th>Past. milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat (%)</td>
<td>Min 50 (NFAR)</td>
<td>Min 42 (NFAR)</td>
<td>Min 35 (DDC)</td>
<td>Min 3 (DDC)</td>
<td>Min 99.5 (NFAR)</td>
<td>Min 10 (NS)</td>
<td>Min 50 (PFA)</td>
<td>Min 3 (NFAR)</td>
</tr>
<tr>
<td>SNF (%)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Acidity (%)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>0.7-0.9 (DDC)</td>
<td>Max 3 (CFRL)</td>
<td>X</td>
<td>x</td>
<td>X</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>Max 18 (CFRL)</td>
<td>Max 43 (DDC)</td>
<td>NA</td>
<td>x</td>
<td>Max 0.5 (NFAR)</td>
<td>X</td>
<td>Max 70 (PFA)</td>
<td>X</td>
</tr>
<tr>
<td>Salt (%)</td>
<td>1-2 (DDC)</td>
<td>Max2.5 (DDC)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Peroxide</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>8 milli. Equi./kg (NS)</td>
<td>X</td>
<td>x</td>
<td>X</td>
</tr>
<tr>
<td>Total solid (%)</td>
<td>X</td>
<td>x</td>
<td>X</td>
<td>NA</td>
<td>X</td>
<td>Min 36 (NS)</td>
<td>x</td>
<td>X</td>
</tr>
<tr>
<td>TPC</td>
<td>X</td>
<td>x</td>
<td>Max 50000/ml (DDC)</td>
<td>NA</td>
<td>X</td>
<td>Max 25000/ml (DDC)</td>
<td>NA</td>
<td>Max 50000/ml (NFAR)</td>
</tr>
<tr>
<td>Coliform</td>
<td>&lt;10/ml (NFAR)</td>
<td>&lt;10/ml (NFAR)</td>
<td>&lt;10/ml (DDC)</td>
<td>&lt;10/ml (DDC)</td>
<td>X</td>
<td>&lt;10/ml (NS)</td>
<td>&lt;10/ml (DDC)</td>
<td>&lt;10/ml (NFAR)</td>
</tr>
<tr>
<td>Yeast and Mould</td>
<td>&lt;10/ml (DDC)</td>
<td>x</td>
<td>&lt;10/ml (DDC)</td>
<td>&lt;10/ml (DDC)</td>
<td>X</td>
<td>&lt;10/ml (DDC)</td>
<td>x</td>
<td>X</td>
</tr>
</tbody>
</table>

CFRL Central Food Research Laboratory
DDC Dairy Development Corporation, Nepal
NFAR Nepal Food Act and Regulation
PFA Prevention of Food Adulteration
NS Nepal Standard

Source: NDDB, 2001

Department of Food Technology and Quality Control (DFTQC) is the regulatory body for quality control of food products and ingredients in the country. The department has full responsibility and authority for maintaining quality of dairy products.
6.1 Input supply and service delivery

The major input supply in the dairy industry (dairy farms and processing industries) are dairy animal feed, feed ingredients, veterinary drugs and vaccine, breeding bulls and semen, forage and legume seeds and dairy equipments. Quality of feed and feed ingredients is the major concern of farmers. Farmers are always complaining that the quality of commercial feed is not as per standard to maintain the production level of dairy animal. Feed samples analyzed in the laboratory often reveal that the protein content of feed is far below to the nutritional requirement of dairy animals. Consequently most of the farmers prefer to prepare the feed mix themselves or use commercial feed as one of the ingredient in their feed mix. Some primary dairy cooperatives have started to prepare dairy animal feed and sell to the member farmers for better assurance of the quality.

Vaccine to control major diseases of economic importance often comes into question. Either poor efficacy or failure to maintain the cold chain in vaccine storage before use has created havoc among the dairy farmers. Last year also, outbreak of FMD in dairy animals created significant economic loss to the farmers, even farmers who have vaccinated their animals against FMD. The tracing of causes for outbreak revealed that there was breakdown of cold chain in some places. It is also possible that some new strain of virus might have caused FMD outbreak, however it has not been verified so far. The ineffective functioning of the regulatory body is causing huge economic loss to the dairy farmers. Though veterinary drug regulation act is in place, monitoring of the quality of veterinary drugs sold from private agro-vets to the dairy farmers is quite rare.

Frozen semen and breeding bull distributed to farmers for upgrading their dairy stock is another important area where quality matters. National Livestock Breeding Centre is trying hard to improve quality of semen distributed both from genetic make up and processing point of view for better fertility. Recently dairy cattle improvement programme is in place in the country with joint effort of NARC and DLS.

The quality of forage seed supplied to the farmers is of also equal importance. Nutritious fodder species with good germination and higher green matter yield are farmers’ major concern.

The quality of veterinary and AI services provided to the farmers depends on the technical capabilities of the technicians. The technicians with good skills are always in high demand. The services provided from the government institutions is at nominal price or free of charge (e.g. Rs. 25.0 as revenue for a dose of frozen semen, Rs 5.0 for HS and BQ vaccine etc).

6.2 Milk purchase from producers and processors

Farmers are paid for milk based on fat and SNF content. Protein till date has not been considered in Nepal as the specification for quality standard, however, the Dairy Cattle Improvement Project jointly implemented by NARC and DLS with the financial support of FAO has taken initiative to measure it which in future would have its significance.
The farm sanitation and milking hygiene is the prime factors for maintaining quality of milk produced in the farm. External contaminations are strained at the farm level. Milk is collected at collection centre of MPCs from individual producer farmers. If the collection center is far, the producers keep the evening milk and mix with next day morning milk and bring to collection centre in the morning. Farmers’ brought milk is tested for fat and SNF content. Occasionally, if the person at collection centre doubt about the spoilage of milk, the COB and alcohol test is performed. The collected milk from the producers is brought to the chilling centres and transported to state owned DDC or private dairies as per the contract. The individuals brought milk are never subjected to antibiotic residues test, but sometimes examined for microbiological quality (e.g. Total plate count). NDDB, CLDP (DLS) and other NGOs have supported milk producers cooperative and some commercial dairy farmers by providing chilling vats of various capacities. State owned DDC and some large scale private dairies have also provided chilling vats in their collection centres.

The dairy processing plants are occasionally inspected by authority for ensuring adoption of code of practices (COP) made for dairy processors, violation in which is prosecutable. Frequent violation of COP by dairy processing industries may lose goodwill and thus the market for their products.

NDDB (2001) conducted a market survey study on quality of milk and milk products at various point of it value chain, and have found discrepancy in quality standards.

Training on hygienic milk production practices to the farmers and good practices for dairy entrepreneurs have been provided by NDDB, CLDP/DLS and NARC. This is the regular and continuous programme of government institutions related with livestock development in the country. Some NGOs working in these fields have also initiated to work in hygienic milk production aspects.

6.3 Quality control in traditional dairy sectors

There are practically no organized marketing centres for traditional milk products in Nepal. The marketing channel is unorganized and without any rules and regulations. There may be some rules and regulations, but they are not applied. The assurance of the quality of traditional dairy products thus totally depends on the personal and business ethics of the producers. There is a general lack of literature, data on production and marketing and standard specifications for production and quality control. That limits the opportunities that are available to explore, modernise and expand the production and marketing of these products. Some of these products are very fragile and delicate to process and handle, their preparation requires a great deal of manual skills. The overall standards of hygiene and manual handling need to be improved.

The method of preparation of dairy products by the traditional methods needs to be studied and well documented on a scientific basis. The technological parameters, the biochemical changes and the keeping quality of these products should be further researched, with a view to developing the unit processes required for the large scale manufacture of these products.

The marketing channel for ghee is more or less organized. The role of different categories of personnel involved in ghee marketing is well defined already. There is
however no control of quality of ghee. Similarly, with other traditional milk products. Khoa, chhana, paneer, shekurm and butter have no quality control. The lack of any guarantee from the government of the quality of traditional products is the reason for a lower price of the products. In the traditional way, curd (dahi) is sold in an open earthenware pot. If this method of package is used to transport dahi over long distances then all kinds of atmospheric contamination may occur. Khoa and soft cheese are often left in a shop in open containers thereby attracting a lot of flies. Traditional milk products are prepared under unhygienic conditions. Cleaning and washing of equipment and milking animals are seldom done. Hygienic conditions are poor in most of the stages involved, from milk production to the sale of final products.

In order to improve the quality of traditional milk products the following suggestions may be considered:-

• Training for hygienic milk production should be given to farmers at farm gate level.
• Training on milk quality control aspects should be provided to the milk handler at collection centre.
• Dairy Technical Support Services should be provided.
• Marketing of traditional milk products should be channelised through identified institutions and premium price for quality products need to be imposed.
• A locally-relevant research and development plan with special attention to appropriate technology is needed.
• Ghee grading, and specifications, should be fixed by establishing ghee refinery factories and laboratories to raise quality to export standards to third countries.

6.4 Poor quality control limits the development of the dairy industry

Dairy development is essentially a process of collecting raw material and after adding value by processing, selling it to consumers at reasonable rates. The demand for milk and milk products in the country is increasing partly due to increase in population and partly due to change in feeding habits associated with improvement in income status. The country has experienced transition into commercial dairy production from the subsistence system and dairy animal farming and processing industries are emerging particularly in the peri urban areas. The few years back ‘Milk Holiday’ situation has been totally reverted and the country is in short supply of around 400000 lit of milk daily.

Compromise in quality in both inputs (breeds, feeds, veterinary medicines and vaccine, services) and outputs (milk and milk products) can seriously hamper the dairy sector development in the country. Poor quality inputs including services leads to poor performance of the animals and thus economic loss to farmers that leaves no option to the farmers except leaving the dairy animal farming and milk production profession. This might cascade series of implication in the booming dairy processing industries. On the other hand, the processing industries can only survive if they get quality raw milk which is very essential for further processing. Thus it is very essential that the producers be
trained for hygienic milk production (from healthy animals in healthy environment), milk handlers at collection point and transportation for proper handling and processors at processing industries. Quality control at each point is of equal importance that can sustain long term development of dairy sector in the country. So far, dairy entrepreneurs also have not been fully trained on quality and product diversification aspects. They should be also made aware regarding good manufacturing practices.

6.5 Factors that discourage producing quality milk

Lack of incentive and motivation might be one of the single most important factors that discourage farmers from producing quality milk. Though it is the matter of ethics also in part of producers, sometimes farmers might be compelled to produce milk in unhygienic way due to simply lack of water. Ignorance, lack of proper training and skill might also lead to compromise in the quality milk production. It is possible that farmers are unaware about the implication of antibiotic residues in the milk and they are selling milk from the animals during the antibiotic treatment period. Some farmers are concerned only about the visible external contamination. Most of the dairy farmers in the country perceive that the milk price is not conducive enough to produce hygienic milk.

In one study by Animal Health Training Centre (AHTC) located in Kaksi, they found that farmers are not practicing the method of clean milk production at farm because majority of the farmers are not aware about it and some of them are not following it because they are not getting any extra bonus for it and hygienic quality is not incorporated in the present milk payment system of the country. Other farmers are not applying it because of not using even simple milk testing procedures (COB test, alcohol test and acidity test) to control the quality of milk at collection level. Although the farmers’ practices are the most important entry points of bacterial contamination in the milk chain of the country, lack of chilling facilities in every collection centres, only one time (mostly morning) collection of milk, long way transportation of milk in ordinary vehicles, unhygienic handling during processing and distribution of processed products in ordinary vehicles were found important to flourish the bacterial contamination in the milk and milk products.

It was also found from their study that training and awareness programme to farmers for clean milk production is the most important encouraging factor for clean milk production. Bonus and penalty in milk payment on the basis of hygienic quality of the milk collected in the collection centres is found to be the second and third encouraging factors for the production of clean milk respectively. Moreover, it was identified from the study that technical advices, easy availability of veterinary services, credit facilities for the farmers and favorable government policy in the sector are some other encouraging factors for clean milk production at farm level.

Training and awareness programme for farmers, introduction of hygienic quality in milk payment system including bonus first and later on penalty, regular testing of milk by using simple tests to control the quality of milk at the collection level, provision to provide some facilities to the farmers for clean milk production and preparation of favorable government policy in dairy sector by increasing farmers’ participation is recommended to produce clean milk at farm level.
7. **Milk Collection, Preservation and Transportation**

Except to the milk directly sold by producer to the consumers or to the hotel and restaurants, milk produced by the individual farmers are collected in the collection centres developed by DDC or private dairies collection Network through milk producers cooperatives. Two times a day collection is most prevalent system in most of the collection centres in Terai but only morning collection is prevalent in the hilly region. Fat and SNF are tested for the payment to the producer farmers. Fortnightly payment for the milk is common. Milk collected in these collection centres are transported to the nearest chilling centres either in the backpack or by animals or by using any transportation means. Care is taken not to delay the transportation of milk to avoid spoilage. Preservatives are generally not added at this point but in the hot season in Terai region, sodium bicarbonate is added as milk preservative. In some collection centres operated by producers’ cooperatives, some milk products such as curd, ghee, lassi and paneer are prepared and sold to the local markets. Remaining milk is transported to chilling centre and delivered to DDC or private dairies operating in the country. Large scale dairy industries and DDC have their milk transport tankers equipped with cooling facilities and scheduled to pick up milk from different chilling centres to their factories.

8. **Milk Marketing**

Number of actors are being involved in the dairy sector right from producing, collecting, processing and vending to the consumers in milk market chain.

The milk collection, processing and distribution system has been depicted in Figure 20.

![Figure 20. Milk collection, processing and marketing system in Nepal](image-url)
The country is net importer of dairy products importing more than 6000 MT of skinned milk powder, 3000 MT whole milk baby food and 2000 MT of condensed milk annually (NDDB, 2001). Sizeable amount of cheese and ice cream are also imported in the country, whereas Ghee is only the product exported from the country in substantial amount beside yak cheese in small quantity.

Two axial pricing systems based on fat and SNF content in milk prevails in the country, whereas in some regions, price is fixed based only on fat content. The consumer price is partly controlled by the government.

**Demand and supply situation for fluid milk**

The demand for milk in the formal markets exceeds to the supply situation mainly due to recent establishment of SMP plants from private sector. Some years back, the dairy farmers had faced an acute problem of milk holidays (days in the week in which milk were not purchased from the farmers by the formal sector for processing) during flush season. Now the dairy industries are facing short supply of fluid milk and their industries are running far below their actual capacity. The finance sector is now investing on dairy animal farming with the collateral support of private dairy industries.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Flush Season</th>
<th>Lean Season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Demand</td>
<td>Supply</td>
</tr>
<tr>
<td>Public</td>
<td>225000</td>
<td>235000</td>
</tr>
<tr>
<td>Private</td>
<td>650000</td>
<td>425000</td>
</tr>
</tbody>
</table>

It has been estimated that there is annual growth of around 11% in milk and products demand mainly in the urban city centres due to population growth and migration (9%) and increase consumption (2%) (NDDB, 2001). As livestock products are income elastic, it can be speculated that the demand for dairy products in the country further accelerates once the economic development starts and stabilise. The current per capita availability of 51 litre milk is below the consumption level suggested by World Health Organization.

**8.1 Milk supply chain**

The collected milk transported to processing plant is subjected to pasteurization, filling in suitable containers (poly packs) and stored at 4-5oC for whole night till delivered to retailers/booth man in the next morning. The processed milk thus is made available to the consumers from these retailers/boothman located in various points of the city. There is a provision of fixed amount (depending on volume of sell) of commission for the retailers/boothman. The system is prevalent both in DDC and other private or cooperative dairies.

In some places, middlemen are involved in collection of milk from the producers and directly sell to the consumer (door to door delivery) and hotel/restaurants in the city centers without any further processing. There is chance of water adulteration in this system, however, the consumer price is also determined by the amount of adulterated water in the milk.
8.2 Formal sectors

About 15% of the total volume of milk produced in the country comes into formal market for processing. With increasing road network, the volume entering in to the formal market could be expected to increase in the days to come. Kathmandu is the major market for processed milk (70%) and rest being sold in other urban city centres. Small volumes of milk are traded across the border on either side. It has been estimated that 35% of the milk produced are sold in informal markets (e.g. door to door supply, supply in hotel, restaurants etc.). Remaining 50% are assumed to be consumed at household level or used for producing ghee and other products either for home consumption or sale.

The government owned Dairy Development Corporation (DDC) is the major player in milk market. It shares about 40% of the total market of fluid milk and rest by the private sector. The share of private sector is gradually increasing. The major activities of DDC includes 1) Collection of milk from various parts of the country 2) Processing of collected milk 3) Production of various milk products and 4) marketing of milk and milk products. The milk processing capacity of DDC is 225000 and that of private dairies is around 650000 litres per day. The DDC is basically operating at its' full capacity and actually is stagnant since last few years providing opportunities for the private sector to expand. However at present, the private sector is operating at about half of its capacity.

Almost 95% of the milk collected in the formal market for processing is sold as fluid pasteurised milk in major city centres. The rest 5% is utilised for making butter, cheese, ice cream and sweets. As such product diversification, which seems to be vital for sustained development of dairy sector in the country, is very poor. The indigenous dairy products like curd (Dahi), churned butter (Ghee), Chhurpee, Khoa and Chhena are being produced at household level or in small cooperative in the milk production areas, whereas cheese, butter and ice cream are being popular in city centres. The DDC has Skimmed Powder Milk Plant at Biratnagar with annual capacity of 600 ton, which produces skimmed milk powder required for DDC but at a higher price than the price at which it could be imported. Recently, two skimmed powder milk plants have been established in the country from private sector with total operating capacity of 250000 lpd.

Dairy industries

The dairy industrial set up in the country is generally considered to be small scale. The government owned Dairy Development Cooperation has the milk handling capacity of 225000 litre per day, whereas there are only 4 dairy industries in the country having capacity of handling more than 50000 litre milk per day. There are quite a few (less than 10) dairy industries having milk handling capacity of 10000-50000 litre/day, around 30 such industries having capacity of 1000-10000 lpd and around 700 small dairies handling less than 1000 litre milk per day throughout the country. It has been estimated that around 9 billion Nepalese rupees is invested in dairy industry in the country benefiting around 300000 households.
Table 13. Status of annual production of cheese and other dairy products (2008/09)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Dairy products (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yak Cheese</td>
</tr>
<tr>
<td>Public sector (DDC)</td>
<td>48317</td>
</tr>
<tr>
<td>Private sector</td>
<td>65500</td>
</tr>
<tr>
<td>Total</td>
<td>113817</td>
</tr>
</tbody>
</table>

8.3 Traditional sectors

Traditional sector involved in milk and milk products marketing are greatly unorganized and operate on individual farmer basis. Production of ghee in the villages with little opportunity of selling milk to the formal milk market is common practices. The remaining ghee after home consumption is sold in the nearby town. Khoa (evaporated milk) is the other important products of milk, which are produced in the villages, linked to city and are sold for consumers or sweet producing restaurants. In high hills, Chhurpi from Yak milk is also produced and traded in the small amounts. Home made curd is also traded in town generally during hot season.

8.4 Value added products

Yak cheese, paneer, ghee, mozzarella cheese, yogurt, different kinds of sweets, ice creams, butter, cheese spread are some of the important value added milk products traded in the country. These value added products are generally produced by formal dairy sector, whereas traditional dairy sectors are also involved in production and trade of these value added products in small amount.

9. Conclusion and Recommendations

The dairy is the gradual emerging sector having great potential in employment and income generation with significant contribution in the national economy. The demand for fluid milk is increasing tremendously due to establishment of private dairy industries in the country, increasing urban population and increasing consumption. Further expansion of sector in the days to come can be expected due to current gap in supply and demand situation. The established dairy industries are presently running at less than half of their capacity. The per capita availability and consumption of milk is less (51 lt) than the required amount. In such scenario, the market force has attracted the population towards dairy animal farming and milk processing industries establishment. The young generations seeking employment abroad are also gradually attracted towards dairy sector. To meet increasing demand for fluid milk and milk products and to substitute import of milk products, the sector has been prioritised from the government also. There also exist the potential for export, if become competitive in production cost and address the quality issues in future.

However, there exists some challenges which need to be overcome by consolidated and concrete efforts from all concerned stakeholders for flourishing of the sector in future.
Some of the major challenges and issues for dairy development in the country are:

- Poor genetic potential of indigenous dairy animals
- High cost of production
- Scattered production- higher collection cost
- Lack of appropriate insurance policies
- Diseases and parasites
- Feed quality and cost
- Hygienic milk production related with trade and human health (SPS measures)
- Infertility of crossbred animals
- Policy regarding animals with diseases (TB, Brucellosis etc.) and infertility problem
- Price control system
- Low investment from public sector
- Environmental issues – methane gas emission from dairy animals

In the present context of global climate change, livestock production being blamed for green house gas emission and country having already high number of cattle and buffaloes, it is imperative that increasing the productivity rather than the number of animals is absolute necessary. The policy makers in the country have to rethink regarding the current development of import of Haryana cattle from India.

The Dairy Policy has been recently endorsed by the government with the vision of:

- Increasing employment and minimize poverty
- Developing qualitative and competitive dairy business among public, private and co-operative dairy sector
- Availing sufficient amount of high quality milk and milk products for consumers
- Developing National economy in multiple way

**Recommendation**

A coordinated approach from all concerned stakeholders for sustainable dairy development in the country need to be initiated with the following roles and responsibilities

**National Dairy Development Board**

- Formulate and recommends policies on import & export of good necessary for production & promotion of milk and milk Products & accelerates the implementation of approved policies.
- Formulate & recommends pricing policy of milk to Government of Nepal
- Encourage development of dairies through the medium of Co-operatives.
- Monitoring, evaluating & reviews dairy development
- Registration of dairy industries

**Dairy Development Cooperation**

- Facilitate marketing network
- Product diversification.
• Act as buffer institution for pricing
• Technology transfer at field level.

**Department of Livestock Services**
• Dissemination of generated dairy technologies
• Training of human resources
• Campaigning for hygienic milk production
• Developing and implementing policies for animal insurance

**Nepal Agricultural Research Council**
• Research to reduce cost of milk production
• Development of prevention and control strategies for disease of economic and zoonotic importance
• Research to mitigate effect of climate change on livestock (adaptation strategies) and to reduce impact of livestock on climate change
• Researches for sustainable genetic improvement of dairy animals
• Researches on feeding management
• Research on product diversification

**Milk Producers Cooperatives**
There are more than 1657 Milk Producers’ Cooperatives working in the different parts of country (62 districts) with more than 38 Districts Milk Producers’ Cooperative Unions.

• Develop/Strengthen collection network
• Take part in running Milk Chilling Centers
• Run Milk Processing Units
• Develop Coop as Enterprises
• Be partner for taking Dairy Extension
  Launch Programs for:
  • Reducing cost of milk production
  • Improving quality of raw milk
  • Trainings for HRD
  • Introduce commercial milk production

**Nepal Dairy Association**
• Undertake activities for linkage with Farmers/Coops
• Suggest MOAC/DLS for promoting dairy sector
• Identify private sectors for investments
• Take steps to improve plant efficiency
• Coordinate dairies for investment

**Commercial bank**
• Invest in dairy farming and industries
10. REFERENCES


### ABBREVIATION

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ADB</td>
<td>Agriculture Development Bank</td>
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<tr>
<td>AGDP</td>
<td>Agriculture Gross Domestic Product</td>
</tr>
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<td>AHTC</td>
<td>Animal Health Training Centre</td>
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<tr>
<td>APP</td>
<td>Agriculture Prospective Plan</td>
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<tr>
<td>BMSS</td>
<td>Biratnagar Milk supply Scheme</td>
</tr>
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<td>BQ</td>
<td>Black Quarter</td>
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<td>CDCAN</td>
<td>Central Dairy Cooperative Association of Nepal</td>
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<td>CECI</td>
<td>Canadian Center for International Studies and Cooperation</td>
</tr>
<tr>
<td>CFRL</td>
<td>Central Food Research Laboratory</td>
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<td>CLDP</td>
<td>Community Livestock Development Project</td>
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<td>COB</td>
<td>Clot on Boiling</td>
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<td>COP</td>
<td>Code of Practice</td>
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<td>DDC</td>
<td>Dairy Development Corporation</td>
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<td>DFTQC</td>
<td>Department of Food Technology and Quality Control</td>
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<tr>
<td>DLS</td>
<td>Department of Livestock Services</td>
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<tr>
<td>DLSO s</td>
<td>District Livestock Service Offices</td>
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<td>DOA</td>
<td>Department of Agriculture</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
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<tr>
<td>FMD</td>
<td>Foot and Mouth Disease</td>
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<td>GAP</td>
<td>Good Agriculture Practice</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>Good Manufacturing Practice</td>
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<td>HMSS</td>
<td>Hetaunda Milk Supply Scheme</td>
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<td>HS</td>
<td>Hemorrhagic Septicaemia</td>
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<td>KMSS</td>
<td>Kathmandu Milk Supply Scheme</td>
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<td>MOAC</td>
<td>Ministry of Agriculture and Cooperatives</td>
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<td>MPCs</td>
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<td>NFAR</td>
<td>Nepal Food Act and Regulation</td>
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<tr>
<td>NLBC</td>
<td>National Livestock Breeding Centre</td>
</tr>
<tr>
<td>NS</td>
<td>Nepal Standard</td>
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<td>PFA:</td>
<td>Prevention of Food Adulteration</td>
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<td>PMSS</td>
<td>Pokhara Milk Supply Scheme</td>
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<td>SAARC</td>
<td>South Asian Association for Regional Cooperation</td>
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<td>Sanitary and Phytosanitary</td>
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<td>Tuberculosis</td>
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<td>UMMMB</td>
<td>Urea Mineral Molasses Blocks</td>
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<td>WHO</td>
<td>World Health Organization</td>
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Dairy Production, Quality Control and Marketing System in Pakistan

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EXECUTIVE SUMMARY

This is the Country Report from Pakistan commissioned by the SAARC Agriculture Centre, Dhaka, Bangladesh from all its member countries on Dairy Production, Processing, Quality Control and Marketing Systems. The Report is spread over 16 chapters that cover all the topics identified by the SAARC Agriculture Centre.

The Report starts with the geographic location of Pakistan, its natural resources and an overview of the background and salient features of livestock in general and dairy in particular. This includes livestock population, milch animals, milk production, role in national economy, pattern of production, milk quality, consumer preference, gender dynamics, etc. Points discussed under each chapter following the introduction are summarized as under:

This is included in the National Livestock Policy that was approved in 2007. Out of the 9 items in this policy document relate directly or indirectly to dairy. Important among these are Level Playing Field for Local Dairy Industry, Deregulation of Milk and Meat Prices, Rationalization of Taxes/Tariff and Review of Legal Framework.

There are 8 species of farm animals. Cattle and buffaloes are the two milch species but buffaloes are the major producer of milk. According to the latest estimates there were 33.0 million cattle and 29.6 million buffaloes. Sahiwal and Red Sindhi are the two internationally recognized Zebu dairy breeds. Other cattle breeds are classified as dual purpose (draught and milk) and draught breeds. However, majority of the cattle population comprises of Non-Descript Cattle. In addition there are about one million crossbred cattle mainly produced as a result of crossing the non-descript cattle with the imported dairy breeds mainly Holstein-Friesians. There are three breeds of buffaloes (Nili-Ravi, Kundi and Achai) but the Nili-Ravi is the principal breed that produces most of the milk.

There are several breeds of sheep, goats and camels that are regularly milked. But their milk is consumed by the family and seldom, if ever, sold. There is a very small population of Yaks in the north but these are an important source of milk for the local communities.

Milk production of all the dairy animals is generally low. Buffaloes in spite of being the principal dairy animals produce only around 1,800-2,400 liters of milk with 6-8% fat in lactations of about 295 days. The dairy cattle produce about 1,500-2,200 liters of milk with +4% fat in about 260 days. The non-descript cattle produce only about 1,000-1,800 liters of milk with +4% fat in about 270 days.

On the whole, the milk production systems in Pakistan are Low Input-Low Output system. Five production systems are generally recognized. Rural smallholders’ subsistence milk production system is the dominant system. It involves the largest number of farmers and produces the bulk of the total milk produced mainly from buffaloes. This is followed by smallholders market oriented production system. These
have more milch animals per household and have better overall management. Rural commercial milk production system is a fairly new production system that started in the 1980s. This has larger herds of 40 or more mainly buffaloes and has the best management system with highest milk yield per animal. Peri urban milk production system started first around the city of Karachi to meet the increasing demand for fresh milk. Over the years, this system has spread to all the cities and large towns of the country. In Karachi alone there is an estimated 1.4 million dairy animals mainly buffaloes. There is no real cooperative milk production system in Pakistan. These are based on associations or groups. The system is growing but very slowly.

The entire livestock production including dairy production is in the private sector but all the services like training, research and extension services are the responsibility of the government. All the provinces provide animal health and production services through their Livestock and Dairy Development Departments. However, in spite of the name the focus of these departments are still on animal health activities. Even for animal health, the approach to the service is clinic based where the sick animals are expected to be brought to receive the service.

The animal health and production services are provided through 1,601 veterinary hospitals, 4,107 veterinary dispensaries, 51 mobile dispensaries, 252 AI centers, 812 AI sub centers and 24 diagnostic laboratories. These facilities are looked after by 2,437 professional and 7,906 sub professional staff.

In addition, the dairy associations/groups provide extension services to their members. One large dairy company also provides such services to the farmers that sell their milk to the company.

Feeds and feed resources of the different seasons and the provinces and their availability are described and discussed. There is an overall deficiency of 26.4 % TDN and 42.2 % DP that are one of the factors responsible for poor productivity of the dairy animals. Cultivated seasonal fodders are the mainstay of dairy animals’ nutrition. However, the smallholders’ subsistence farmers depend more on grazing their animals. Concentrates are seldom if ever used by these farmers. Oilseed cakes are the only concentrate used and that too for the lactating animals.

Majority of farmers practice mixed grazing and stall feeding system. Stall feeding is more popular with the large and commercial milk producers. These are the farmers who are using commercially available compound feed. Some of these farmers mix their own ration.

Commercially produced feed is still not very popular. Although introduced some 50 years ago, at present only about 5 % of the total feed required is manufactured. Rest of the feed is still traditional. At present there are only 29 feed mills almost all of these are in Punjab and Sindh.
Livestock production that includes milk production is still a family operation in which men, women and even children participate. But women have crucially important role in the agro-livestock production system. However, their contribution to the rural economy has neither been fully recognized nor documented until recently. The dominant role of women in livestock/dairy production is now being increasingly recognized. In two recent studies women were found to be involved in all the 10 livestock related activities with dominant role in 3 activities on a national basis. Women spent 3.5 hours/day in livestock activities compared with 2.0 hours/day by men. Another study revealed that women performed exclusively 12 livestock activities compared to only 5 activities performed by men.

At present there are two types of education/training in livestock/dairy. These are university education leading to a degree and training of varying duration leading to a diploma or certificate. The education leading to a degree is awarded by 11 universities. All these have a 5 year uniform degree program called DVM. This degree includes courses in dairy and related subjects. One can further specialize in dairy and related topics leading to master and doctorate degrees. Some universities now also offer bachelors degree in dairy science, as well.

Non-degree training programs in livestock related subjects including aspects of dairy are offered by the agricultural/veterinary science universities, provincial livestock departments, some NGOs, some large livestock development projects as well as large dairy companies. These trainings are of varying durations, types and on different topics. Some agencies offer structured courses on a regular basis while most have facilities for custom made training programs for their different clients.

Four types of R&D organizations are present. These are universities, research institutes, livestock experiment stations and AI and embryo transfer units. The University of Veterinary and Animal Sciences, Lahore and 10 Faculties of veterinary and animal sciences in 10 agricultural and other universities in addition to their regular courses also undertake research and development work on various aspects of dairy like milk yield, quality control, marketing, etc. as part of theses research as well as other R&D programs. There are several research institutes at both federal and provincial levels dealing with various aspects of livestock including dairy. In addition, there are experiment stations devoted to R&D of some buffalo and cattle breeds like Kundi and Nili-Ravi buffaloes and Sahiwal and Red Sindhi cattle breeds. Similarly, there are several semen production units as well embryo transfer units which also undertake R&D work in addition to their regular semen and embryo transfer work.

Over the years 38 dairy processing plants were established. Most of these closed down due to various reasons. However, at present 19 processing plants are operational. Of these, 17 are in the private sector and two in the public sector (Army). These mainly produce UHT and pasteurized toned and flavored milk. Other products are yogurt, butter,
cheese, powder milk, condensed milk, cream, dairy whitener, baby food, ice creams and ghee. Except yogurt and ghee, these plants do not produce any indigenous dairy product.

A total of 13 value added dairy products are manufactured by the formal sector but only 9 by the traditional sector.

This is presented as the standards, rules and regulation and the implementation of quality under the formal and traditional sectors. The Standards for the milk quality have been formulated by the Pakistan Standards Institute of the Government of Pakistan. The last edition of Dairy Safety Standards for Milk and Milk Products issued in 2005-2006 is a comprehensive document that includes all aspects of the milk and milk products quality. The quality of milk and milk products is regulated under the Pure Food Rules of 1965 which have been formulated under the Pure Food Ordinance of 1960.

Strangely, there is no federal agency for checking the milk quality as required under the rules. The municipal authorities do undertake random checks of the milk quality entering their cities. This check is however limited to the fat content of the milk only. The formal sector claims to follow their own quality standards for their different products. The traditional sector has no quality check what so ever for milk or any other dairy product except the fat content check that is randomly carried out by the municipal authorities.

By and large, the milk collection, preservation and transportation system is the same for both the traditional and the formal sectors. Primarily, milk is collected by a group of middle men called Katcha Dodhies from thousands of smallholders from the farm gate in small quantities (50-150 liters) who sells it to Pucca Dodhies located on main roads. The latter collects milk from several Katcha Dodhies and sells it to whole salers who in turn supply it to retailers/vendors in the cities. The Pucca Dodhies may also supply it directly to the dairy companies or others who may convert it to some indigenous dairy products mainly khoa. This is the overall system. But in some areas there may be more than two middle men. The most common preservation system is to add ice particularly during hot summer months.

Over the years, the formal sector has added sophistication into the foregoing system by establishing large milk collection centers and quality control system and more recently insulated/refrigerated milk tankers that collect milk from remote areas. One large dairy company has also introduced a system of providing extension service for the farmers in return for sale of their milk.

At present only about 3 % of the total milk marketed is processed. The remaining 97 % is sold unprocessed under unhygienic condition through thousands of small vendors/retail shops. The processed milk is sold through commission agents in the urban areas at the general/grocery stores, bakeries and drug stores.
The price of milk and milk products follows supply and demand. The price is higher in large cities than in small towns. Local municipal authorities however, generally fix the price of milk and some milk products like yogurt at the retail end without considering the cost of production. This is not a rational system. Strangely, the price of processed milk is not fixed by the municipal authorities.

It is part of the overall policy of the government to promote public-private partnership. This concept is being implemented in building infrastructure like roads and highways. But nothing has so far happened in the dairy sector.
1. INTRODUCTION

Pakistan is located between the latitude 23° N and 37° N and longitude 60° E and 76° E. Geographically speaking, it is a highly diverse country with very high mountain ranges in the north that remain frozen most part of the year and vast deserts in the south and the warm waters of the Arabian Sea. In spite of being arid in general, it has one of the world’s largest irrigation systems. It has 10 agro-ecological zones comprising of Indus delta, southern irrigated plain, sandy desert, northern irrigated plains, rainfed areas, wet mountains, northern dry mountains, western dry mountains, dry western plateau and the Suleiman piedmont. Pakistan has a total area of 79.61 million hectares. Of this, only 27% are cultivated and 5% under forests. There are 8.9 million hectares of uncultivated land and 24.4 million hectares not available for cultivation. Most of the 17.2 million hectares of cultivated land are irrigated, with 70% of the water coming from canals and the rest from wells.

It has an estimated population of 180.3 million people. Agriculture is the largest sector of the economy. It accounts for half of the employed labor force and is the largest source of foreign exchange earnings. Its growth rate over the last five decades has remained at around 4% per annum. Available annual animal protein per capita is 18 kg of meat, 155 liters of milk and 44 eggs, which, although one of the highest in South-East Asia, is still far below the proper health requirements.

Pakistan is bound by two SAARC countries namely India and Afghanistan respectively in the east and west. To its north is China and in the south lies the Arabian Sea. It also borders Iran in the west-south.

1.1 Background

Domestication of animals is one of the early achievements of human beings. It made his life more productive, healthy, easy and secure. Since those early days, livestock has served the human beings well. It still does so in Pakistan. Majority of people in this country still live in the rural areas where their very survival depends on livestock for quality foods like milk and meat, power for farm operations, farm yard manure as organic fertilizer for crop production and for cooking fuel, etc. Milk production is the only farming activity that generates daily income throughout the year. Livestock is deeply integrated with crop production and one cannot be sustained without the other. Because of a wide ownership and asset base livestock provide the much needed stability to the otherwise fragile rural economy. Women are deeply involved in almost all aspects of livestock production. The value of livestock is 6.1% more than the combined value of the major and minor crops.
Over view

Before describing the livestock sector in some detail and to enable the reader quickly get the picture, here is the salient features of the sector.

- There are some 8 millions farmers that raise livestock, one million of which are landless.
- The total animal population (in millions) according to the latest estimates (2008-9) was 33.0 cattle, 29.9 buffaloes, 27.4 sheep, 58.3 goats and 1.0 camel.
- Majority of these farmers are smallholders - each owning just about 5 cattle and buffaloes, 10 sheep and goats and a dozen or less Desi (indigenous) chickens.
- Nearly 2/3rd of the total milk (43.56 million tons/year) is produced by smallholders having only 5 milch animals per household.
- Milk yield per animal is very low – less than 6 liters/day.
- Livestock production is deeply integrated with crop production and has a wide asset base.
- Bulk of the milk comes from buffaloes (62.0 % from buffalo and 34.3 % from cows). All other species (sheep, goats, camels and yaks) contribute less than 4 % to the total milk produced.
- The buffalo milk has 6-8 % fat while the cows’ milk has only about 4 %.
- There is a distinct consumer preference for the high fat content buffalo milk.
- Only the morning milk is sold and the evening milk is generally consumed by the family itself. Thus about 1/3rd of the total milk produced does not enter the market.
- Of the total milk that enters the market, only about 3 % is processed mostly as toned UHT milk containing only 3 % fat. Rest of the milk is sold unprocessed.
- The quality of the unprocessed milk is very poor – produced under unhygienic conditions, adulterated and transported and sold under conditions that promote high bacterial load.
- Management of livestock including milch animals is traditional and more or less a family effort but women have the major role in the daily care of the animals followed by men and children. However, traditionally, the women do not directly receive any share in the income from milk or related products.
- The government extension department now called livestock and dairy
development department in all the provinces has the responsibility to provide health and production services to the livestock. However, in reality these departments are still essentially animal health department with very little production activity like feeds, fodder and breeding. Moreover, their approach to providing service is clinic based where the sick animals are expected to be brought to the clinics for service. The weakest aspect of the service is their failure to reach the villages where the animals are located.

- The nutritional status of animals is very poor, indeed. The feeds and feeding system is based mainly on crop residues and byproducts and grazing on crop aftermaths, road sides and along irrigation canals. Fodders are generally cultivated by each farmer on his small land holding. Their idea of concentrate begins and ends with oilseed cakes mainly cotton seed cakes. There is no concept of balanced feeds and feeding including the important role of water. However, the encouraging news is the establishment of several feed mills in the last few years. But its use is still not popular.

- Breeding is haphazard. To make things worse, there is a serious shortage of bulls. Quality bulls are rare. Artificial insemination (AI) introduced some 50 years ago still covers only about 10 % of the stock. Like health service, AI service also hardly reaches the villages.

- Marketing of milk is dominated by up to four middle men called Dodhies. However, most of them do collect milk at the farm gate. Generally, they make advance payments for the milk but tend to be exploitative by paying lower price and purchase only the morning milking.

- Adulteration is the order of the day, the least harmful being water. One large collection center belonging to a multinational dairy company has recorded 23 adulterants that include detergents and white cement.

- Among the traditional dairy products manufactured, khoa (a partly dried milk product) is the most popular dairy product and is the principal ingredient of local sweets. This is followed by yogurt and ice cream. Cheese is not common except in cold northern areas.

**Role in Economy**

Livestock is an integral part of the national economy. At macro level, its contribution to the agricultural GDP now stands at over 52 % and to the national GDP it contributes 12 %. At the micro level, it provides about 40 % of the family income for about 35 millions rural populations. It is now well accepted that the livestock is the most effective vehicle for poverty alleviation. Livestock is not susceptible to the vagaries of nature like the crops. Thus it provides the much needed stability to the otherwise fragile rural economy. In other words, livestock do not create crises like those by wheat and
cotton. May be this is the reason livestock has not received the attention and support it deserves, at least until recently.

**Population**

Pakistan has a large livestock population. According to the latest estimates (2008-9), there were 33.0 million cattle, 29.9 million buffaloes, 27.4 million sheep, 58.9 million goats and 1.0 million camels.

**Basic Considerations**

**Principal Milk Producer:** As stated earlier, buffaloes are raised mainly for milk but cows are generally dual purpose i.e. for both milk and work. This is in spite of the fact that Pakistan has two of the world’s best zebu dairy breeds in Sahiwal and Red Sindhi. But their numbers are very small. Now there are also a million crossbred cows that yield much higher milk than the local non-descript cows but these have problems of breeding and adaptation to the local environment mainly at the smallholder level.

**Seasonality of Milk Production:** Buffaloes are somewhat seasonal breeders as more of them calve during autumn. Thus more buffalo milk is available during the winter months.

**Demand and Supply of Milk:** The consumption pattern of milk varies between summer and winter. The demand is higher during hot summer months mainly due to the increased demand for milk and milk based drinks and ice cream. Given below is a graphic presentation of the demand and supply situation of milk. This chart has been adapted from Hasnain and Khan (2008).
Quality of Milk: A major difference between buffalo and cow milk is the high fat content of 6-8% in buffalo milk compared to only 4% in cow milk. The fat content of milk is generally the first casualty in the nefarious and unethical practice of adulteration of milk. Several studies have revealed poor physical and chemical quality of milk sold. But the more dangerous aspect is the very high microbial load of the unprocessed milk in the country.

Price of Milk: Buffalo milk always fetches about Rs 10/liter more than the cow milk.

Consumer Preference: There is a distinct consumer preference by a vast majority of people in this country for high fat content buffalo milk. In addition to the high cost of UHT milk, the other reason for the poor sale of UHT milk is stated to be their low fat content.

Milk Production

According to the latest estimates of 2008-9, the total milk produced in the country was 43.56 million tons. Of this buffaloes produced 27.02 million tons (62.0%) and cows produced 14.98 million tons (34.3%). All the other species (sheep, goats and camels) contributed less than 4% to the total milk produced.

Of the total milk produced in the country 15% was estimated to have been lost during transportation and 5% was fed to the calves.
1.2 Objectives of the Study

1. Dairy production scenario
2. Factors constraining adoption of modern practices
3. Recommended best practices of milk production, processing, marketing and quality control measures throughout the milk supply chain

2. National Policy for Dairy Development

National dairy policy is included in the overall national livestock policy. Livestock Development Policy is contained in a document produced by the Livestock and Dairy Development Board, Ministry of Food, Agriculture and Livestock, Government of Pakistan in 2007. As can be seen from its contents, it is a comprehensive document.

The Federal Minister of Livestock and Dairy Development on October 4, 2009 during the World Animal Day function at Islamabad announced that a task force has been constituted by the government to prepare a national livestock policy. Obviously, this is going to take sometimes. Notwithstanding this announcement by the minister and the time it may take for a new policy, technically speaking most if not all the policy items contained in the well prepared policy document of 2007 still remains valid. These are as follows:

i) Review and update existing legal framework
ii) Deregulation of milk and meat prices
iii) Rationalization of taxes/tariff at government level
iv) Sale of meat animals on live weight basis
v) Easy access and affordability of credit
vi) Strengthening of policy and regulatory capacity at Ministry of Food, Agriculture and Livestock (MINFAL)
vii) Level playing field for local dairy industry
viii) Establishment of Livestock and Dairy Development Board (LDDB) and Pakistan Dairy Development Company (PDDC)
ix) Reorienting public sector institutions

A. Government farms to be used for superior male production
B. Phased privatization of slaughterhouses
C. Self-sustaining/private-public partnership for vaccine production
D. Improvement in research and development infrastructure as well as funding levels

Of the foregoing items, two major events relevant to dairy sector have already taken place. The Livestock and Dairy Development Board and Pakistan Dairy Development Company have been established and are operational. Moreover, a separate Ministry of Livestock and Dairy Development has also been formed at the federal level.
3. DAIRY ANIMALS, BREEDS AND THEIR PERFORMANCE

Species

The following eight species of livestock are found in Pakistan:

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<th>Scientific Name</th>
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<td>Cattle</td>
<td>Bos indicus</td>
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<td>Buffaloes</td>
<td>Bubalis bubalis</td>
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<tr>
<td>Yak</td>
<td>Bos grunniens</td>
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<tr>
<td>Goats</td>
<td>Capra hircus</td>
</tr>
<tr>
<td>Sheep</td>
<td>Ovis vignei</td>
</tr>
<tr>
<td>Camel</td>
<td>Camelus dromedaries</td>
</tr>
<tr>
<td>Horse</td>
<td>Equus cabalus</td>
</tr>
<tr>
<td>Donkey</td>
<td>Equus asinus</td>
</tr>
</tbody>
</table>

Of the 8 species listed above, only the first two i.e. cattle and buffaloes are the real dairy species. Some goats, sheep and camels are also milked but their milk is generally not traded. Yaks are also milked but their number is too small to be of any significance.

Population

Livestock population census is carried out every ten years. The last census was conducted in 2006. But the Ministry of Livestock and Dairy Development, Government of Pakistan updates the population every year on the basis of the growth trends between the last two censuses. According to the latest estimates (2008-2009), there were 33.0 million cattle, 29.9 millions buffaloes, 27.4 millions sheep, 58.8 millions goats, one million camels, 4.5 millions asses and 0.4 million horses.

Dairy Breeds

Cattle: Three types of cattle according to their performance are present. These are dairy type, dual purpose (dairy and draught) and draught type. The two dairy breeds are Sahiwal and Red Sindhi and are internationally recognized as the best heat tolerant zebu dairy breeds. These have been used for cross breeding with temperate breeds of dairy cattle by several countries. Tharparker, Cholistani and Achai breeds are less recognized as dairy breeds and are still considered as dual purpose breeds.

In addition, there are about one million crossbred cattle mostly as a result of crossing the nondescript local cattle mainly with Holstein-Friesian. Some Jersey crosses are also present.

Buffaloes: Three breeds are recognized namely Nili-Ravi, Kundi and Azakheli. Of these, Nili-Ravi is the dominant breed in the country. Originally from the riverine tracts of the province of Punjab, it is now found in all parts of Pakistan. This is the principal milch animal of the peri urban herds of the country.
Dairy Production, Quality Control and Marketing System in Pakistan

The original habitat of the Kundi buffalo breed is the irrigated tract of the province of Sindh and is second to the Nili-Ravi breed in milk production. Azakheli buffalo breed is much smaller animal and found only in the north western parts of the province of Khyber Pakhtunkhawa.

**Goats:** As stated earlier, some goats in the country can be classified as dairy breeds and are regularly milked but their milk is generally not sold. In this category 4 breeds are prominent namely Beetal, Dera Din Panah in Punjab, Kamori from Sindh and Damani from Balochistan. There are several other breeds that are classified as dual purpose meaning for mutton and milk.

**Sheep:** There are several breeds of sheep that are used for mutton, wool and milk. But their milk like that of goats are not traded and mostly consumed by the family.

**Camels:** All Pakistani camels are dromedaries i.e. one humped although few two humped Bactrian camels are also found in the extreme northern areas of the country. Of the 20 breeds of the camels described, most are classified as dual purpose i.e. both for transportation of goods as well as for riding. Most of these are also milked but the milk is consumed by the family and not sold.

**Yaks:** These are to be found in the northern parts (Gilgit-Baltistan) of the country and their population is less than 100,000. These are triple purpose animals i.e. for meat, milk and transportation and are also the only animals that can survive in the extremely cold climate of the area.

**Performance**

Milk production has been taken as the only performance parameter for discussion. This is presented as follows for only two cattle and two buffalo breeds only because of their major contribution to total milk production in the country. The numbers of Tharparker and Cholistani cattle breeds are few. Therefore, most of the cattle in the country are described as non-descript. Strictly speaking, buffaloes are the principal producers of milk contributing around two-third of the total milk produced in Pakistan. The remaining one-third milk comes mainly from the large numbers of the non-descript cattle.

**Table 3.1 Milk Production Performance of Dairy Cattle and Buffalo Breeds of Pakistan**

<table>
<thead>
<tr>
<th>Breeds</th>
<th>Milk Yield per Lactation (kg)</th>
<th>Lactation Period (days)</th>
<th>Fat Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sahiwal cattle</td>
<td>1,500-2,200</td>
<td>270-300</td>
<td>+4</td>
</tr>
<tr>
<td>Red Sindhi cattle</td>
<td>1,500-2,000</td>
<td>270-290</td>
<td>+4</td>
</tr>
<tr>
<td>Non-descript cattle</td>
<td>1,000-1,800</td>
<td>260-290</td>
<td>+4</td>
</tr>
<tr>
<td>Nili-Ravi buffaloes</td>
<td>1,800-2,400</td>
<td>270-325</td>
<td>6-8</td>
</tr>
<tr>
<td>Kundi buffaloes</td>
<td>1,800-2,300</td>
<td>280-320</td>
<td>6-8</td>
</tr>
</tbody>
</table>
4. MILK PRODUCTION SYSTEMS

Milk production system depends on the production environment which varies with the agro-ecological regions and from farm to farm within the region. The level of livestock management and the management interventions also influence the production systems. The markets forces also greatly influence albeit determine the production system. But on the whole, milk production system in Pakistan is a Low Input – Low Output Production System. The following five types of milk production systems are recognized:

1. Rural Smallholder Subsistence Milk Production System
2. Cooperative Milk Production System
3. Rural Smallholder Market Oriented Milk production System
4. Rural Commercial Milk Production System
5. Peri Urban Milk Production System

Each of these is described as follows:

4.1 Rural Smallholders Subsistence Milk production System

As the name suggests, it is basically a subsistence production system. This is the major milk production system in the country and is dominated by buffaloes in this category. An average smallholder unit comprises of around six or less buffaloes with only about half of them adults. All the labor required for their management is provided by the family mostly women. These survive principally on grazing along the roads, irrigation canals and crop aftermath. Some fodder and concentrates are also offered but only to milking animals. Male calves are generally not reared and sold early to save milk. Hardly any veterinary cover or breeding facilities are available to these animals. Generally speaking, only the morning milk is sold while the evening milk is consumed by the family. Average lactation yield remains around 1,200 liters and the farmers generally try to ensure that at least one buffalo remains in milk. A fair number of these farmers are landless.

4.2 Cooperative Milk Production System

Legally speaking, there are no milk cooperatives in the country. All such bodies are called associations or groups and registered under the Societies Act and not under the Cooperative Act. However, all these systems are conceptually based on the AMUL milk cooperative model of Gujarat, India. Historically speaking this system is relatively new. It all started some two decades ago by the GTZ assisted agency called Idara Kissan. Several years later this concept was launched by the rural support programs in some provinces and more recently by the Livestock and Dairy Development Board as Milk Production Groups in all the 4 provinces. The province of Sindh is about to launch a slightly different program as Dairy Development Associations. But in all these different programs the basic concept remains very similar. In the totality of the milk production in the country, the role of such programs is still very marginal.
4.3 Rural Smallholder Market Oriented Milk Production System

These are also smallholders with a few more animals (5-7 mainly buffaloes) that have better access to milk markets. Even though these are nearer to markets, they still depend almost entirely on middle men for the sale of their milk. Although most of their animals are still buffaloes they may have one or two cows to ensure that at least 2-3 of their animals are in milk. Their milking animals are generally stall fed on green fodders and concentrate while the dry animals and growing stock are grazed on waste land and crop stubbles. Under this system, the lactation yield is higher (1,800-2,000 liters). This group also does not have any breeding bull. Male calves are sold as soon as possible but the females are raised for replacement.

Evening milking is still mostly consumed by the family. Together with the subsistence farmers, this group produces the bulk of the milk in the country.

4.4 Rural Commercial Milk Production System

This is a fairly new phenomenon that started in 1980s. These have 40 or more animals still comprising mainly of buffaloes with only about 10 % cows. These are mixed crop-livestock farms that generally have their own breeding bulls even when government AI facilities are available nearby. They mostly grow their own fodder including crop residues like wheat straw. The animals in milk are generally stall fed in properly constructed sheds. Most of the milk produced is sold in bulk to traders or milk processing plants in their areas. The overall management of the farm is better than that under any other milk production system but still not optimal. The milk yield per lactation is about 2,000 - 2,4000 liters. However, the number of such farms is still few and their contribution to the total milk production in the country is still small.

4.5 Peri Urban Milk Production System

Initially, households on the fringes of cities and towns used to keep a buffalo or cow generally for the production of milk for their families. Some milk was also sold to the neighbors. With growing urban demands for milk, this system developed into what is now called the peri urban milk production system. It became very visible and got recognized as a new milk production system in Karachi in 1958 where some 15,000 buffaloes with a few cows were located in the city suburb of Landhi. Since then, this system has developed into a population of over 1.2 million animals in 4 locations around Karachi- most of which (over 90 %) are elite buffaloes of Nili-Ravi and Kundi breeds. This is said to be largest group of buffaloes in the world.

All these animals are stall fed mostly on concentrates, some green fodders and wheat straw prepared by the owners themselves. Over the years, several feed mills have also been established and some owners feed their animals on these. The per lactation milk yield of these animals is over 3,000 liters. The herd size varies from some 20-40 animals to over 500 animals. Freshly calved or about to calve animals are brought to these areas. The calves are mostly sold to butchers within about a week of their birth to save on milk.
The animals are generally sold when their milk production comes down to about 4 liters/day because it becomes uneconomical. Most of these animals are purchased by butchers for slaughter. Only about 10% of such animals are purchased for rebreeding when they are taken to Larkana, Badin and Tando Allah Yar and other districts.

Similar herds have also been established in almost all the large cities and towns of Pakistan. Lahore is estimated to have some 500,000, Rawalpindi over 100,000, Peshawar about 100,000, Hyderabad about 80,000 and Quetta over 100,000. The overall management and other aspects are more or less similar to that in Karachi. This system is estimated to contribute only about 1% to the total milk production in the country.

5. **Dairy Animals Health and Production Services**

The entire livestock and dairy production in Pakistan is in the private sector mostly carried out by some 8 million households, one million of whom are landless. The only exception is the Remount, Veterinary and Farms Corps of the Pakistan Army which maintains a few thousands buffaloes and cows for the supply of milk and milk products to the armed forces of the country. However, almost the entire livestock services including that for dairy production comprising the extension, research, development and education services are in the public sector. The role of private sector in providing livestock services is marginal. The federal and provincial governments provide these services through different departments but the role of the federal government is mainly regulatory, coordinating and some research in special areas. Major livestock services in the provinces are the provision of extension services through their respective departments. These extension departments have recently been renamed as departments of livestock and dairy development. However, these are still essentially animal health departments with only marginal animal production services.

The provision of services is clinic based which means that sick animals have to be brought to the clinic. This approach is colonial and archaic and does not reach most of the animals that are in the villages.

**Extension Services Infrastructure**

As stated earlier, the approach to provision of extension services is clinic based and comprise of animal health/veterinary services. This is of 3 types according to the quality of services available. On the top is a veterinary hospital always headed by at least one qualified veterinary graduate. If it is a large hospital catering to a large animal population, there may be more than one veterinarian. Each veterinary hospital may have under its supervision several veterinary dispensaries and veterinary centers. These are manned by sub-professionals called stock assistants who are diploma holders. The hospitals have facilities for some surgeries, as well as arrangements to keep sick animals. But the major function of the hospitals and dispensaries are to undertake preventive vaccinations against important epidemics of the area. However, services are also
provided for other ailments. There are a few mobile veterinary dispensaries also in some areas.

Animal production services are more or less limited to artificial insemination (AI). These are provided through AI centers and sub-centers where frozen semen of buffaloes and major cattle breeds are available. There was a time when breeding bulls were also made available for natural services to the farmers’ animals. There is no other animal production service. Thus animal nutrition is totally missing.

The extension services are provided through the following:

1. Professional staff: 2,437
2. Sub-professional: 7,906
3. Veterinary hospitals: 1,601
4. Veterinary dispensaries/centers: 4,107
5. Mobile dispensaries: 51
6. AI centers: 252
7. AI sub centers: 812
8. Semen production centers: 8
9. Diagnostic laboratories: 24

For the last few years, a new category of extension workers called Paravet is being developed to provide primary animal health and production services at village levels. Several NGOs have also taken up this program with varying degrees of success. There is a lot of promise in this concept and is likely to progress and expand in future.

All the foregoing services, good, bad or indifferent are provided by the public sector. The role of private sector in providing extension services is limited to manufacture of feeds, supply of drugs and medicines and more recently in provision of AI services including semen production. Moreover, a few private clinics for large animals have also come up in addition to the already existing private clinics for pets and small animals in the cities and towns. Some NGOs like NRSP and Idara e Kissan also provide extension service to the members of their organizations called dairy associations/groups.

Cost of extension services

Officially speaking, all the services provided by the livestock extension departments are free except some nominal charges for vaccination and AI services. But in reality the services are not free. Actually, there is a de facto privatization of the services. The farmer has to pay for the examination of his sick animals; he has to buy the medicines prescribed by the veterinarian from the market and also has to pay for administration of the medicine.

The NGOs generally provide such services free, subsidize it or at cost. The private sector charges for all the services it provides. This is very true for the AI and some veterinary services like dystokia.
6. DAIRY ANIMALS NUTRITION AND FEED INDUSTRY

6.1 Dairy Animal Nutrition

This is presented under Feed Resources, Availability of Nutrients and Feeding Systems

6.1.1 Feed Resources

In Pakistan several feed resources are available for livestock/dairy animal feeding. These feed resources are generally classified in two ways. According to the more commonly used approach based on their bulk and nutritive value, the feed resources are broadly divided into Roughages and Concentrates. Roughages are feedstuffs with high fiber content and low values for TDN and DP. The roughages can be further classified into green forages and dry roughages. Green forages of Pakistan mainly comprise of summer and winter fodders (locally called Kharif and Rabi fodders respectively) and rangelands. Dry roughages include hay, straws, stovers, hulls and silages. Concentrates are those feedstuffs that are low in fiber content and high in TDN and DP. Three types of concentrate feeds are commonly used in Pakistan for animal feeding. Cereal product-based concentrates are high in TDN as compared to their DP value. Both vegetable-based and animal-based concentrates are rich in DP as well as TDN but the quality of dietary proteins available in animal-based concentrates is superior to vegetable-based concentrates.

There is another way of classifying the feed resources. This is based on their traditional usage for livestock feeding. According to this approach, feed resources are grouped into Conventional and Non-conventional. The non-conventional feed resources are those that are not traditionally used for animal feeding but have the potential to be used for animal feeding. These include resources like several agro-industrial by-products and wastes from sugar industry, food and fruit processing industries, and residues of soybean, pea nut, and mustard and sun flowers.

In Pakistan cultivated forages are called fodders and are mainly grown in areas where irrigation water is available. In times of scarcity of fodders, leaves of certain trees are also lopped for animal feeding. Popular fodders cultivated in Pakistan are Berseem (Trifolium alexandrinum), Lucerne (Medicago sativum) and oats are the popular fodder crops in winter. Other winter fodders are mustard, rape seed and turnips. Popular summer fodder crops are sorghum, maize, millet and cow pea. A few hybrid multicut fodders are also becoming popular.
Table 6.1. Sources of Nutrient Supply for Livestock Feeding

<table>
<thead>
<tr>
<th>Source</th>
<th>Contribution (%)</th>
<th>TDN</th>
<th>DP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fodder Crops</td>
<td>17.8</td>
<td>23.8</td>
<td></td>
</tr>
<tr>
<td>Brans &amp; Oilseeds</td>
<td>3.6</td>
<td>9.3</td>
<td></td>
</tr>
<tr>
<td>Grains</td>
<td>4.0</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Weeds &amp; Other Plants</td>
<td>5.7</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>Crop Residues &amp; Agro-industrial By-products</td>
<td>31.7</td>
<td>8.1</td>
<td></td>
</tr>
<tr>
<td>Rangelands</td>
<td>9.7</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>Other Grazing</td>
<td>24.7</td>
<td>27.8</td>
<td></td>
</tr>
<tr>
<td>Animal Related Products</td>
<td>2.8</td>
<td>8.6</td>
<td></td>
</tr>
</tbody>
</table>

6.1.2 Availability of Nutrients

The availability of nutrients for livestock feeding is presented in the following table:

Table 6.2. The Availability of Nutrient for Livestock Feeding

<table>
<thead>
<tr>
<th>Province/Area</th>
<th>Total Digestible Nutrients (TDN) Available (million tons) (%)</th>
<th>Digestible Proteins (DP) Available (million tons) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punjab</td>
<td>33.56 3.8</td>
<td>3.73 16.0</td>
</tr>
<tr>
<td>Sindh</td>
<td>10.45 23.0</td>
<td>0.71 40.8</td>
</tr>
<tr>
<td>KP</td>
<td>4.97 27.0</td>
<td>0.58 30.0</td>
</tr>
<tr>
<td>Baluchistan</td>
<td>2.58 38.0</td>
<td>0.23 54.0</td>
</tr>
<tr>
<td>AJK</td>
<td>0.69 35.5</td>
<td>0.03 62.5</td>
</tr>
<tr>
<td>Northern Areas</td>
<td>0.49 31.0</td>
<td>0.04 50.0</td>
</tr>
<tr>
<td>Pakistan</td>
<td>52.74 26.4</td>
<td>5.32 42.2</td>
</tr>
</tbody>
</table>

The Table 6.2 clearly shows that the nutrients available in the country do not meet the requirements of the livestock. This nutrient deficiency is mainly due to the poor quality of the available feed resources in terms of TDN and DP. Crop residues and grazing that constitute the major component of feed available in the country have very low values for TDN and DP. This deficiency is the primary cause of poor performance of Pakistani livestock in terms of growth, production and reproduction as they are unable to fully express their genetic potential. The problem of nutrient deficiency is more severe in case of DP than TDN. As presented in the Table 6.2, the overall deficiency of DP for livestock feeding is 42.2 % whereas that for TDN it is only 26.4 %. An earlier study also found that the deficiency of DP was 48.5 % and that of TDN only 25.1 %. On a provincial basis, this situation was less severe in Punjab than in other provinces.
6.1.3 Feeding Systems

Feeding system in Pakistan varies with the species, purpose of rearing livestock, resource availability, agro-ecological conditions and market orientation of the farmers. Thus three types of systems namely grazing only, stall feeding only and a combination of both grazing and stall feeding are practiced. As expected, the system varies between the provinces. Therefore, the feeding systems for buffaloes and cattle in the provinces and in the country as a whole are presented as follows.

**Buffalo Feeding System:** As stated earlier, buffaloes are the principal milk producers and they contribute about two third of the total milk produced in Pakistan. These are generally stall fed with only some grazing. The feeding practices of buffaloes are presented in the Table 6.3.

<table>
<thead>
<tr>
<th>Location</th>
<th>Grazing Only (% of Population)</th>
<th>Stall Feeding Only (% of Population)</th>
<th>Both Grazing and Stall Feeding (% of Population)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punjab</td>
<td>6.5</td>
<td>64.5</td>
<td>29.0</td>
</tr>
<tr>
<td>Sindh</td>
<td>6.1</td>
<td>12.2</td>
<td>81.7</td>
</tr>
<tr>
<td>KP</td>
<td>4.5</td>
<td>44.5</td>
<td>51.0</td>
</tr>
<tr>
<td>Baluchistan</td>
<td>10.2</td>
<td>16.2</td>
<td>73.6</td>
</tr>
<tr>
<td>Pakistan</td>
<td>7</td>
<td>34</td>
<td>59</td>
</tr>
</tbody>
</table>

The Table 6.3 clearly indicates that in Punjab and KP, the dominant feeding practice is stall feeding but in Sindh and Balochistan the combined stall feeding with grazing is the prevailing practice. So, on a national basis the most common feeding practice is the combined stall feeding and grazing.

**Cattle Feeding System**

The cattle feeding system for cows is presented in Table 6.4

<table>
<thead>
<tr>
<th>Location</th>
<th>Grazing Only (% of Population)</th>
<th>Stall Feeding Only (% of Population)</th>
<th>Both Grazing and Stall Feeding (% of Population)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punjab</td>
<td>8.0</td>
<td>51.4</td>
<td>40.6</td>
</tr>
<tr>
<td>Sindh</td>
<td>8.7</td>
<td>11.6</td>
<td>79.7</td>
</tr>
<tr>
<td>KP</td>
<td>6.5</td>
<td>21.2</td>
<td>72.3</td>
</tr>
<tr>
<td>Baluchistan</td>
<td>20.2</td>
<td>13.4</td>
<td>66.4</td>
</tr>
<tr>
<td>Pakistan</td>
<td>11</td>
<td>24</td>
<td>65</td>
</tr>
</tbody>
</table>
It can be seen from the Table 6.4 that Punjab is the only province where stall feeding is dominant feeding system. But in all the remaining three provinces as well as on a national basis the principal feeding system is the combined stall and grazing feeding system.

6.2 Feed Industry

Balanced feed manufacturing was introduced in Pakistan in late 1970s by the institutions involved in livestock and poultry research and development. The manufacture of poultry feed was almost immediately picked up by the newly introduced modern poultry farming by the private sector. The new poultry industry was something very different from the traditional poultry keeping in the rural areas. Thus the new system of keeping poultry needed an entirely new technology and system of poultry feeding. But at that point in time, there was no change in the traditional livestock production system including livestock feeds and feeding. So, the idea of manufactured feed did not really register with the farmers who continued to raise their livestock the way they always did. However, the increasing demand for milk did help develop more commercially oriented milk production in the peri urban areas as well as in villages close to large cities and towns. The few animal feed companies also did not produce quality feeds and the prices were high. The rising costs of main feed ingredients and introduction of some new feed ingredients like molasses and oilseed meals helped in establishing the feed industry.

After all these years, now there is a feed industry but it still amounts to only about 5% of the total feed required for livestock feeding. Now there are about 29 modern livestock feed mills in the country-most of which are in the province of Punjab followed by Sindh. Compared to this there are over 72 poultry feed mills in Pakistan. Some of the large poultry feed mills also produce cattle feeds.

7. Gender Dynamics in Milk Production

In Pakistan, agriculture production is still a family operation in which men, women and even children are involved and crop and livestock production are deeply integrated. Their degree of involvement however, varies. There are situations in some areas like in Baluchistan where livestock raising is the main source of livelihood but even in intensively cropped regions of the country, livestock are still important component of the farming system. Nevertheless, whatever the situation, rural women have crucially important role in the agro-livestock production system. The role may be dominant in one area and somewhat lesser in other areas but it is always present and is vital.

The relevant stakeholders have always known about the crucial role of women in livestock production but their contribution to the rural economy has neither been fully recognized nor documented. Even the social scientists have ignored the topic until recently. The information that follows is taken from some recent reports and surveys. But it must be realized that the following apply mainly to the smallholder livestock
production system because as the herd/flock size and intensification of the production system increases, there is a tendency to work more with hired labor, which is generally male. Women participation in larger livestock enterprises with larger herds is greatly reduced because these are generally in peri-urban areas and far from villages.

However, the dominant role of women in livestock production is now being increasingly recognized. Several studies have recently been undertaken to determine more precise information on the subject. The results of two recent studies provide quantitative information on the subject. Under one study 12,600 respondents in 30 districts in the four provinces, AJK, GB and FATA were asked about their roles in 10 livestock related activities and the time spent by the family members. Women were reported to be involved in all the 10 activities with greater involvement in 3 on a national basis. However, women had greater roles in 7 activities in GB and FATA. This was also reflected in the time spent because women in GB and FATA spent 2.5 hours/day on livestock against only 0.7 hours/day by men. Moreover, in the urban and peri-urban areas, women spent 3.7 hours/day while men spent only 2.0 hours/day. The following information is very revealing.

**Tasks Performed Exclusively by Women**
- Stall feeding of animals
- Milking
- Processing of byproducts
- Fodder Management
- Detection of sickness
- Care of sick animals
- Hand suckling of young animals
- Processing local herbal medicines
- Dung management
- Cleaning animal shelters
- Detection of heat
- Watering animals

**Tasks Shared with Men**
- Fodder harvesting and transportation
- Grazing animals
- Sale/purchase of animals and animal products
- Assistance in births
- Decision making
The above tasks, exclusively carried out by women or shared with man also vary due to farming system, socio-ethnic background, ecology and climate. Therefore, a task performed exclusively by women in one region may be shared with men in another region and vice versa.

Agriculture employs the greatest proportion of the working population but accounts for less than 25 percent of GDP. In Pakistan's economy women play a key role through agriculture production, livestock/poultry raising and cottage industries. But their contribution has been grossly underreported in various censuses and surveys. As a result, official labor force statistics show a very minimal participation of women. For example, the 1991-92 Labor Force Survey revealed that only about 16% of women aged 10 years and over were in the labor force and in comparison, the men's participation rate was 84%. On the contrary, the 1980 agricultural census showed that woman's participation rate in agriculture was 73% and that women accounted for 25% of all full-time and 75% of all part-time workers in agricultural households. Also, the 1990-1991 Pakistan Integrated Household Survey indicated that the female labor force participation rate was 45% in rural areas and 17% the urban areas.

According to the 1991-92 Labor Force Survey, agricultural and allied industries absorb the largest proportion of employed persons, both women and men, particularly in the rural areas. However, the proportion of the persons engaged in the agricultural sector is higher among rural women (79.4%) as compared to rural men (60.8%). A rural woman in Pakistan works approximately 15 hours a day, spending on an average 6 hours in caring for livestock. In Pakistan, women are responsible for 60% to 80% of the feeding and milking of cattle. It is important to remember that the extend of the involvement in different tasks and the time spent on livestock by the households vary from region to region and more time is spent in rural households as compared to urban households in the respective regions.

a) **Fodder/forage harvesting**

Women make a considerable contribution to livestock/milk production and this contribution is more visible than their work in fodder/crop production.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Female</th>
<th>Male</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land preparation</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applying manure</td>
<td>x</td>
<td>xx</td>
<td></td>
</tr>
<tr>
<td>Applying fertilizer</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weeding/hoeing</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Harvesting</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Husking/threshing</td>
<td>xx</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Drying</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Storing</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Preparing storage</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>
b) Fodder/forage and handling (transportation/storage/chaffing)

In rural setting this is jointly done by women and men of the household. If the herd comprises of more than 6 or 7 adult large ruminants they require large quantity of fodder on daily bases. In that case, both men and women work concurrently.

In case of only one or two large ruminants men and women in a household might take turns to accomplish the task. Most of the households with one or two animals are the ones with no land. They either lease land for folder or work as labor to remove weeds and grass from other people’s fields. In return they are allowed to keep the grass, which they use to feed their animals.

In urban/peri-urban areas men of the family mostly purchase fodder from the market. In situations where men have gone away from home for work, household women or older of the male offspring might assume the role.

c) Feeding/watering

In case of landless farmers the animals are kept in the courtyard of the house where they are fed and looked after mainly by women. In case of land holders, the animals are kept at the Dera in the midst of their fields. In that case the men mainly take care of the animals. Usually the animals are only given water once in the morning and once in the evening. Most of the time mangers (wooden, earthen or cemented) are constructed for fodder but no permanent arrangement is made for water.

d) Grazing

In case of nomads the whole family is involved. In case settled population this is not too common. However, in some areas of Punjab and Sindh seasonal grazing is common in spring (such as in Bahawalpur, Cholistan, Sukkar, Tharparker, etc.). Usually the settled populations send their animals with Gujjars (men, women and children).

e) Milking and Marketing

In case the animals are kept at home females do milking. Men milk the animal kept at the Deras. The milk is brought home where the milk is separated for domestic use. The rest is sold. As most of the villages lack local market usually the men sell the milk. During the grazing season the Gujjars collect and sell the milk. He gives the cowl owner their share at the end of the season.

f) Washing and animal shed cleaning

Both men and women are involved in washing/bathing the animal. However more men are involved as compared to women. In case of urban/peri-urban setting or in case of larger herds men are the main caretakers while in case of small holders in rural setting women are the main caretakers.

Unlike all other activities women in the rural setup predominantly clean the animal sheds. Even if the animal is kept on the Dera women will do the job of cleaning. The cleaning of the shed is usually done twice a day. Women also make dung cakes for use as
cooking fuel and collect and store the manure which is later used as fertilizer in the fields. Farmers feel that the dropping from goats and sheep though less in volume but are much stronger as fertilizer.

g) Health Care

Women are the first to detect signs of sickness and providing first aid. They take the sick animals to the village quack or if available to provider of animal health services. If no health service is available then the women ask the men to take the sick animals to the nearest veterinary hospital/dispensary

h) Breeding

Men are predominantly involved in breeding. In case of absence of any male help in the household and/or community women have been traditionally participating in breeding of their female animals by arranging natural mating with bulls available in the village. Now, Artificial Insemination (AI) is becoming more popular with many private (profit and non-profit actors) extending the services. Regarding AI, women feel that if they can access a female contact/local person they can better avail the service avoiding missed estrous, increasing milk production and for improving the breed of their animals.

8. Education in Dairy at Professional and Technician Levels

There are currently two types of training in livestock/ dairy in Pakistan. These are:

Training leading to a professional degree awarded by a university or a degree awarding institution. These universities also have facilities for further specialized research based training leading to Master, M.Phil and even Doctorate degrees in several livestock and livestock related subjects including aspects of dairy science

Training leading to diploma/certificates of various durations on several subjects including dairy provided by universities, livestock departments and other private sector agencies like NGOs, autonomous/semiautonomous agencies and even livestock development projects. Each of these is described in further details below.

University Degree Program

There are 11 universities in the country that award the same professional 5 year composite degree called DVM (Doctor of Veterinary Medicine). However, some universities also award other livestock and poultry related degrees like B.S. (Honors) in Dairy Technology and B.S. (Honors) in Poultry Science. These are 5 year courses and have been recently started by the University of Veterinary and Animal Sciences (UVAS) in Lahore. The total intake of the students in all these faculties and colleges per year is around 900.

List of Universities offering 5 year composite DVM degrees in Pakistan

1. University of Veterinary and Animal Sciences, Lahore.
2. College of Veterinary Sciences, Jhang.
3. Faculty of Veterinary Science, University of Agriculture, Faisalabad.
4. Faculty of Veterinary Science, Sindh University of Agriculture Tando Jam.
5. Faculty of Veterinary and Animal Sciences, NWFP University of Agriculture, Peshawar.
6. Faculty of Veterinary Science, Gomal University, D.I. Khan.
7. Faculty of Veterinary Science, University of Arid Agriculture, Rawalpindi.
8. Faculty of Veterinary Science, Lasbela University of Agriculture, Water & Marine Sciences, Uthal, Balochistan.
9. Faculty of Veterinary Science, Bahau Din Zakariya University, Multan.
10. Faculty of Veterinary Science, Islamia University, Bahawalpur.
11. College of Veterinary Science, Baqai Medical University, Karachi,(It is a private sector university)

Training Programs

Universities

The University of Agriculture, Faisalabad, University of Veterinary and Animal Sciences, Lahore and Sind Agriculture University, Tando Jam have institutes of continuing education and extension. These have facilities for organizing non degree training programs generally on demand. At the NWFP University of Agriculture, Peshawar, this type of training is organized by its Faculty of Veterinary and Animal Sciences. The curricula, duration, etc. of such training courses are mostly provided by the clients themselves or jointly developed.

Provincial Livestock Departments

All four provincial livestock departments have established in-service training institutes generally for extended/refresher training of their staff. But in addition, these also organize training courses for stock assistants or special courses for clients on demand. These institutes have different titles as can be seen from the following:

- In Punjab, it is called Livestock Service Training Center and is located at Sheikhupura.
- In Sind, it is called Research and Training Institute for Livestock Development and is located at Tando Mohammad Khan. Here the NRSP and some other agencies get their extension workers (both male and females) trained according to their own modules. However, the regular 2 years course for the stock assistants for the department is
carried out by the Agriculture Training Institute at Sakrand which is under the Agriculture Department.

- In KP, it is called Animal Husbandry In-Service Training Institute (AHITI) and is located in Peshawar.
- In Baluchistan, it is called Institute of Animal Sciences and is located in Quetta.
- In AJK, there is an Extension Services Management Academy (ESMA) at Garhi Dopatta. This runs several extension courses for crops, livestock and others.

**Federal Government**

The PARC has an Institute of Technology Transfer at NARC in Shahzad Town, Islamabad. It organizes several courses for crops, livestock and related topics of varying duration from one to several days and weeks. It also organizes courses on demand.

**Private Sector/Projects/NGOs:** In addition to the foregoing public sector institutions, some of the large livestock and dairy development projects, mostly donor assisted, also run training courses. These vary from sort of raising awareness, general orientation, and farm visit programs for a day to structured courses of few days to several weeks’ durations. The major players are the following.

**CELDAC (UNDP/NESTLE and UNDP/Engro Foods):** This project originally got their 46 female master trainers trained at the veterinary university, Lahore, in 2 batches of 30 and 16 trainees. It is reported that currently only 25 are working and training their Lady Livestock Workers (LLWs) in their project areas. Of the 3,600 LLWs trained so far only 2,160 are working (60%). These LLWs are said to be earning about Rs 3,630 per month. However, CELDAC has no capacity to train others right now without vastly expanding their training facilities.

**Livestock and Dairy Development Board:** It has no training facility of its own. It has contracted out its training program to the agricultural and veterinary universities at Faisalabad, Lahore, Peshawar and Tando Jam. Of course, their course content, duration, etc. have been worked out with the institutions. The Board has so far in one and a half years got about 200 extension workers trained including 20 women. All the women were from the Northern Areas.

**SLSP (Strengthening of Livestock Services Project):** It is a joint EU/GOP project. This has developed modules of training for both men and women extension workers but the actual training is organized and conducted by the NRSP and the veterinary university, Lahore.

**ASLP/Dairy Improvement project:** It is an Australian assisted project. It also depends on NRSP/IRM and Idara e Kissan for its training needs.
PDDC: It is managed by New Zealanders and its training needs are provided by the Agricultural University, Faisalabad.

NRSP: It has the largest training facilities in the country through its IRM (Institute of Rural Management). The central office of IRM is located in Islamabad. The NRSP operates in all the 4 provinces and AJK with 9 regional offices. Last year it trained some 80,000 persons including women. IRM’s mandate is “to reduce poverty through skill enhancement and capacity building initiatives”. It offers 35 courses on crops, livestock, fisheries, etc. of varying durations and some 100 kinds of vocational and technical trades. IRM provides training for communities and select groups both at field and institute levels. It is the major provider of training facilities to several projects and agencies including the large livestock extension project called Prime Minister’s Initiative in Livestock (PMSIL). This have a large component of extension workers including women. This large project is being implemented by RSPN which is an umbrella organization for RSPs including NRSP. Under this project, so far 290 veterinary clinics have been established of which NRSP has 98. Their community livestock extension workers (CLEW) both men and women have been trained by IRM-men for 15 days and women for one month. So far, 853 men and only 5 women CLEWs have been trained. Of these, 87% of men are still working while just 3 out of 5 women trained are working. On the whole, IRM has so far trained 170,137 women in different subjects. This includes 42,248 women who have been trained in livestock related topics of 3-15 days durations.

9. RESEARCH AND DEVELOPMENT IN MILK PRODUCTION

The following four types of R&D institutions that deal with livestock including dairying are present in Pakistan:

1. Universities and Faculties
2. Research Institutes
3. Livestock Experiment Stations/Breeding and Dairy Farms
4. Semen Production Units/Embryo Transfer Units

Each of these is briefly described as follows:

9.1 Universities and Faculties

There is one University of Veterinary and Animal Sciences at Lahore and 10 faculties/college of veterinary and animal sciences with agricultural and other universities at Faisalabad, Rawalpindi, Multan, Jhang and Bahawalpur in Punjab province, one agricultural and another university at Tando Jam and Karachi in Sindh province, one with agricultural and another university Peshawar and Dera Ismail Khan in Khyber Pakhtunkhawa province and one with another university at Hub in Balochistan province. Several departments in these faculties and university undertake research on many aspects of milk, milk production, marketing, quality control, etc. in addition to their regular educational activities.
9.2 Research Institutes

The following are the research institutes that deal with research on different aspects of livestock including dairying:

1. Animal Science Institute, National Agricultural Research Centre, Islamabad. This is under the Pakistan Agricultural Research Council which is under the Government of Pakistan.
2. Livestock Production Research Institute, Bahadur Nagar, Okara, Punjab.
4. Research Centre for Conservation of Sahiwal Cattle, Jhang, Punjab.
5. Barani Livestock Production Research Institute, Kheri Murat, Punjab.
7. Livestock Development and Research Farm for Buffaloes, Rohri, Sindh.
8. Livestock Development Centre, Muzaffarabad, AJK.
9. National Veterinary Laboratory, Islamabad. As the name indicates it is under the Government of Pakistan.
10. Veterinary Research Institutes at Lahore, Peshawar, Quetta and Tando Jam under the provincial governments of Punjab, KP, Balochistan and Sindh respectively.

Of the foregoing research establishments, the first two are the largest and have a much wider mandate for research on almost all aspects of livestock including dairying. The others are much smaller with limited mandate. The veterinary research institutes are mainly involved in development and production of different vaccines against major epidemics affecting livestock including dairy animals.

9.3 Livestock Experiment Stations/Breeding and Dairy Farms

These are generally meant for conservation and development of important cattle breeds like Sahiwal, Red Sindhi, crossbred cattle and buffaloes. Following is a list of such stations in the country:

1-5. Livestock Experiment Stations at Jehangirabad, Khizerabad, Kallurkot, Fazilpur and Rakh Ghulaman. All in Punjab for Sahiwal cattle.
6. Livestock Experiment Station, Jogaitpur, Punjab for Cholistani cattle breed.
7. Livestock Experiment Station, Rakh Dera Chal, Punjab for Crossbred cattle and Nili-Ravi buffaloes.
8. Livestock Experiment Station, Chak Katora, Punjab for Nili-Ravi buffaloes.
10. Livestock Experiment Station, Haroonabad, Punjab for Nili-Ravi buffaloes
11. Livestock Experiment Station, 205/TDA, Bhakkar, Punjab for Tharparker cattle Breeding and Dairy Farm, Harichand, KP for Friesian and Jersey cattle
12. Red Sindhi Cattle Breeding Farm, Tando Mohammad Khan, Sindh for Red Sindhi cattle
13. Livestock Experiment Station, Karachi, Sindh for Red Sindhi cattle.
14. Livestock Experiment Station, Nabisar Road, Sindh for Tharparker cattle.
15. Red Sindhi Cattle Farm, Hub, Balochistan
16. Friesian Cattle Farms, in 12 different locations in Balochistan

9.4 Semen Production Units/Embryo Transfer Units
Following are the semen production and embryo transfer units in the country:

1. Semen Production Unit, Qadirabad, Sahiwal, Punjab, for semen of Sahiwal, Dhanni, Red Sindhi, Friesian and Friesian crossbred bred cattle bulls and Nili-Ravi buffalo bulls
2. Semen Production Unit, Kheri Murat, Attock, Punjab for semen of Friesian and Jersey bulls
3. Semen Production Unit, Kallurkot, Bhakkar, Punjab for semen of Sahiwal and Nili-Ravi bulls
4. Semen Production Unit, Karaniwala, Bahawalpur, Punjab for semen of Sahiwal and Nili-Ravi bulls.
5. Semen Production Unit, Harichand, KP for semen of Friesian, Jersey and buffalo bulls.
6. Semen Production Unit, Rohri, Sindh for semen of Kundi buffalo bulls.
7. Semen Production Unit, Karachi, Sindh for semen of Red Sindhi and Kundi buffalo bulls.
8. Semen Production Unit, Mirpur, AJK for semen of Jersey, Friesian, crossbred and Nili-Ravi bulls
9. Embryo Transfer Technology Centre and Semen Production Unit, Remount, Veterinary and Farms Corps, Okara, Punjab for embryo transfer and semen of Friesian and Jersey bulls.
10. Embryo Transfer Technology Unit at Buffalo Research Institute, Pattoki, Punjab for embryo transfer of Nili-Ravi buffaloes

10. Number Of Dairy Processing Plants
Over the years, 38 dairy processing plants were established both in the public and the private sectors. Most of these closed down due to a number of reasons like wrong location, non availability of raw milk, unsuitable technology, poor marketing, etc.
Currently, only 17 large and small plants are in operation in the private sector and two in the public sector. Following is a list of dairy plants in operation together with their location, products and capacity. Of these, only three are in Sindh, one in Islamabad and the rest are in Punjab. The products they manufacture are UHT and pasteurized milk, butter, ghee, yogurt, powder milk, condensed milk, flavored milk, tea/coffee whitener, cream, cheese, ice cream and baby food.

Table 10.1 Dairy Plants in Operation in Pakistan

<table>
<thead>
<tr>
<th>SL. No</th>
<th>Name and place</th>
<th>Products</th>
<th>Capacity per day</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nestle Milkpak. Sheikhupura</td>
<td>UHT milk, cream yogurt, Ghee, Nido (milk powder), Ceralac</td>
<td>150000 250000</td>
<td>Milk powder plant</td>
</tr>
<tr>
<td>2</td>
<td>CDL Foods Ltd, Bhai Pheru (Dist Kasur)</td>
<td>UHT milk, cream, ghee, butter, yoghurt, &amp; milk powder</td>
<td>8000 150000</td>
<td>Haleeb Foods Ltd Bhai Pheru</td>
</tr>
<tr>
<td>3</td>
<td>Noon PAKISTAN Ltd. Bhalwal</td>
<td>Milk powder, butter ghee, cheese, pasteurized milk, UHT milk</td>
<td>150000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Kabirwala Dairies Ltd. (Kabirwala)</td>
<td>UHT milk, milk powder</td>
<td>50000 150000</td>
<td>Taken over by Nestle Milkpak.</td>
</tr>
<tr>
<td>5</td>
<td>Ravi Dairies Ltd. Dairy Crest Foods Jarranwala.</td>
<td>UHT milk, cream</td>
<td>80000</td>
<td>Reactivated by Shakarganj Food Ltd</td>
</tr>
<tr>
<td>6</td>
<td>Pakistan Milk Food Manufacturing Ltd. Jhang</td>
<td>Milk powder condensed milk, ghee</td>
<td>30000</td>
<td>Reactivated by Millac Food Ltd-</td>
</tr>
<tr>
<td>7</td>
<td>Prime Dairy Ltd. Monga, Lahore</td>
<td>Milk powder</td>
<td>80000</td>
<td>Stopped processing yoghurt and pasteurized milk</td>
</tr>
<tr>
<td>8</td>
<td>Milkways Ltd. Tandlianwala. Nirala Dairy, Faisalabad</td>
<td>UHT milk, milk powder</td>
<td>80000</td>
<td>Reactivated by Nirala Dairy (Pvt.) Ltd</td>
</tr>
<tr>
<td>9</td>
<td>Lahore Milk Plant (Idara-e-Kissan) Lahore</td>
<td>UHT milk, pasteurized milk, yogurt, butter, milk powder</td>
<td>80000</td>
<td>Reactivated by Idara-e-Kissan</td>
</tr>
<tr>
<td>10</td>
<td>Islamabad milk plant (Idara-e-Kissan, Islamabad)</td>
<td>Pasteurized milk, butter, yoghurt</td>
<td>15000</td>
<td>Reactivated by Idara-e-Kissan</td>
</tr>
<tr>
<td>SL. No</td>
<td>Name and place</td>
<td>Products</td>
<td>Capacity per day</td>
<td>Remarks</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------------------------</td>
<td>--------------------------------</td>
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<td>-------------------</td>
</tr>
<tr>
<td>11</td>
<td>Halla Project (Idara-e-Kissan), Pottoki</td>
<td>Pasteurized milk yoghurt, butter</td>
<td>15000</td>
<td>Halla Project</td>
</tr>
<tr>
<td>12</td>
<td>Karachi Milk Plant (Idara-e-Kissan) Karachi</td>
<td>Pasteurized milk yoghurt, butter</td>
<td>20000</td>
<td>Sind Indus Project Not Known</td>
</tr>
<tr>
<td>13</td>
<td>Royal Dairy Products Karachi</td>
<td>UHT milk, flavored milk, and cream</td>
<td>50000</td>
<td>Pakola Beverages Ltd Karachi</td>
</tr>
<tr>
<td>14</td>
<td>Millac Food Ltd. Raiwind, Lahore</td>
<td>Milk powder</td>
<td>80000</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Premier Dairies Ltd Raiwind, Lahore</td>
<td>Milk powder, UHT milk</td>
<td>80000</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Butt Dairy, Tandlianwala Faisalabad</td>
<td>Milk powder, cheese</td>
<td>40000</td>
<td>New milk powder plant</td>
</tr>
<tr>
<td>17</td>
<td>Engro Foods Limited, Sukkar and Sahiwal</td>
<td>Milk Powder, UHT, ice cream</td>
<td>200000</td>
<td>2 plants at Sukkar</td>
</tr>
</tbody>
</table>

**Non Commercial**

<table>
<thead>
<tr>
<th></th>
<th>Milk powder, cheese</th>
<th>80000</th>
<th>Milk powder plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Military Dairy Farm, Okara</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Military Dairy Farm, Renala Khurd</td>
<td>Milk powder</td>
<td>100000</td>
<td>Milk powder plant</td>
</tr>
</tbody>
</table>

**11. VALUE ADDED DAIRY PRODUCTS IN FORMAL AND TRADITIONAL DAIRY SECTORS**

**Formal Dairy Sector**

1. UHT milk
2. Pasteurized milk
3. Flavored milk
4. Condensed milk
5. Powdered milk
6. Dairy whitener
7. Cream
8. Butter
9. Yogurt
10. Ghee
11. Cheese
12. Ice cream
13. Baby food
Traditional Dairy Sector
1. Khoa (dehydrated milk)
2. Rabri (dehydrated sweetened milk)
3. Yogurt
4. Lassi (yogurt drink sweet/salted)
5. Ghee (clarified butter)
6. Butter
7. Cheese
8. Sweets/confectionary (large variety generally based on khoa)
9. Kulfi (traditional ice cream)

12. QUALITY CONTROL OF MILK

There are three aspects of the quality control of milk as follows:
- Standards for milk and milk products
- Rules and Regulations
- Implementation of the standards

12.1 Standards for Milk and Milk Products
These are formulated by the Pakistan Standards Institute of the Government of Pakistan. The last edition issued in 2005-2006 is titled Dairy Safety Standards for Milk and Milk products. It is a comprehensive document of 23 topics including objectives, terms and definitions, roles of all the stakeholders, hygiene at all stages from milk production to consumers, labeling of dairy products, etc, etc.

12.2 Rules and Regulations
The quality of milk and milk products is regulated under the Pure Food Rules of 1965. These were formulated under the Pure Food Ordinance of 1960 that superseded all earlier food laws and regulations.

12.3 Implementation of the Standards
It is strange but true that there is no federal agency for the implementation of the quality standards as required under the existing rules. There is however, a rudimentary system of quality checks in cities and towns by the respective local municipal authorities. The focus is on the butter fat content of the milk that is brought into the cities for sale. This is a random exercise and not effective at all in checking the milk quality. In addition to this cursory check of liquid milk, no milk product is ever checked.

12.4 Quality Control in the Formal Dairy Sector
All the dairy companies in the formal sector claim that they follow all the required standards for the quality control of milk and milk products. But these claims have never been verified. Recently, a case has been filed against these companies in the Lahore High Court regarding the use of melamine in their processed milk.
12.5 Quality Control in the Traditional Dairy Sector

There is no quality control of milk or milk products at all in the traditional dairy sector. This is in spite of the presence of detailed standards about different types of milk and milk products as well as rules and regulation about them. Thus what is being sold as milk can be said to be a sort of white liquid. Several studies carried out in all parts of the country about the quality of milk over the years have revealed shocking state of the quality of milk. Adulteration is the rule rather than exception. One large milk collection centre of a dairy company identified 23 different adulterants that included ingredients like starch, urea, white cement, detergents, vegetable oils, etc. The poor quality of milk begins with the poor personal hygiene of the farmers to the unclean udder of the animal, dirty utensils, addition of ice made from poor quality water, poor transportation and all the way to the retailers’ dirty shops, utensils, and the vendors.

13. Milk Marketing in Formal and Traditional Sectors

Milk in Pakistan is produced by over 8 million farming families, one million of whom are landless. Most of these farmers are smallholders with less than 6 milch animals like cows and buffaloes. The smallest of these farmers who may own only a buffalo or a cow do not generally sell any milk at all because it is consumed by the family itself. But the majority of smallholders sell their morning milking only and the evening milk is consumed by the family. This is the main source of the family’s quality food. However, this system does not apply to large commercial farmers and the peri urban milk producers who sell all the milk produced by them.

Pakistan is now the fourth largest producer of milk in the world. The total production of milk in Pakistan has doubled over the past two decades or so. But this increase has come from the increased animal population and not due to their improved productivity. In Pakistan, generally fresh liquid milk is consumed normally boiled before consumption. Punjab and Sindh are the largest milk producing provinces of Pakistan and the milk marketing system is relatively better established in these provinces although a significant proportion of milk produced in deep rural areas still does not enter the milk marketing system.

13.1 Milk Collection, Preservation and Transportation

In case of milk, the usual concept of markets is not applicable because no milk market exists like that for food grain market, fruits market, vegetable, cloth market or livestock market. Moreover, there is no concept of market types like primary or secondary milk markets.

The small farmers, milkmen, milk processors, retail milk/dairy shops/vendors and halwai (confectioners) and tea stalls constitute the main infrastructure of milk marketing. The milkmen or Dodhies are the main intermediaries linking rural milk producers with the urban consumers and processors. The milkmen are classified as Katcha Dodhy and
Pucca Dodhy. Katcha Dodhy collects milk (about 50-150 liters) from farmers by personally visiting their farms/houses. Pucca Dodhy receives about 150-400 liters of milk from several Katcha Dodhies and takes them to the cities/collection centers directly or to the whole salers by using various transport means like motor cycles or even small or large pickups. Typically, Katcha Dodhies uses two G.I. cans of about 20-40 liters capacity straddled one on each sides of a bicycle. But now bicycles have been almost entirely replaced by motor cycles and the size of the cans has also increased. There was a time long gone when some Dodhies and even some farmers used animal drawn carts to transport milk to the Pucca Dodhies or even to the urban areas, but not anymore. Pucca Dodhies use motor cycles or now more commonly small and large pickups. The milk containers used are cans of 20-40 liters made from G.I. sheets and/or large empty plastic drums used for chemicals. However, a few such collectors/suppliers have started using seamless aluminum containers. There may be up to a total of four Dodhies involved from the primary milk collector from the farmer until the bulked milk reaches the processors/whole salers. But there is a minimum of two Dodhies, the Katcha Dodhy and the Pucca Dodhy. This is the traditional milk collection and transportation system. The preservation method used by the traditional system is ice and some chemicals like hydrogen peroxide and formaldehyde to prolong the shelf life of milk particularly during the hot summer days. Using ice also increases the quantity of milk but adversely affects its quality. However, the Katcha Dodhy generally does not use any preservatives because his collection and transportation operation is completed early in the morning in about two hours or so when preservation is not really needed. This action of extending the shelf life of milk is in fact passed on to the Pucca Dodhy.

The primary milk collection system used by the formal sector has been the same as that of the traditional system but with the addition of collection centers established in strategic locations where the collected milk is chilled before transportation to their processing plants. The Pucca Dodhies generally supplies large quantities of milk to these collection centers of the dairy plant owners in addition to the milk also supplied by the small farmers of the nearby villages. These centers have cooling/chilling as well as milk testing facilities. All the milk supplied is tested for quality and payments are made accordingly. The pooled milk is then transported in refrigerated/insulated tanks to the dairy plants for processing. Later, dairy companies added refrigerated/insulated vans to their collection centers for collecting milk from areas away from the collection centers. This system has extended their reach deeper into the rural areas. Some dairy companies have also organized small farmers into groups/associations and provide some extension services in return for the milk sold to the companies. By establishing this cool chain, the formal sector does not use any preservative.

13.2 Milk Supply Chains

Presently in Pakistan only about 3% of milk produced is processed and about 30% does not reach the marketing channel because the evening milking particularly from the
remote rural areas is not collected. Thus the bulk of the milk is supplied to the urban areas in raw form in most unhygienic conditions posing real health hazards. The milk not collected is consumed by the farmers’ families not by choice but because it is not collected.

Unlike developed countries where sale of raw milk is disallowed by law and processing is mandatory. Pakistan continues to allow about 97 per cent milk to be distributed through the traditional gawala system.

The unprocessed milk is marketed through the thousands of retail shops/vendors in the urban areas. The processed milk and milk products are generally sold through commission agents that cause relatively higher prices as compared to raw milk. Consequently, a large quantity of adulterated milk continues to be sold to consumers through the local vendors and urban milk producers. A survey showed that only 21% of the milk products in villages are available for sale. The rest of 79% is consumed in the urban areas in the form of fresh milk and milk products. About 51 percent of milk is sold in urban centers through retail market and milk vendors. Khoa makers are consuming about 23% of the available liquid milk.

A successful milk marketing system should ensure reasonable margin for both the producer and the consumers and ultimately should stimulate the growth and development of an organized milk marketing system. The present system of milk collection, transportation, processing and pricing is one of the major constraints in the development of dairy industry in Pakistan. The small sized farmers, milkmen (Dodhies), milk processors; milk/dairy shops and tea stalls constitute the main players in the milk marketing value chain. Because of the various systems of milk production in Pakistan and the task of supplying fresh milk regularly to consumers and manufacturers in both rural and urban areas, different marketing systems have been developed that often involve several intermediaries who form the marketing chain. The milk supply chain in Pakistan is presented in the following figure (Figure 13.1).

Almost all the milk is produced in the rural areas whereas most of it is consumed in the urban areas. To ensure regular supply of fresh milk to consumers and milk processing units, different marketing intermediaries are in involved in the milk supply chain depicted in the Figure 13.1. Some producer's manages to market their milk without the help of Dodhies. They produce quantities large enough to contract fixed regular supplies with urban wholesalers/retailers or they sell direct to the consumers.

The peri-urban milk producers sell all of their milk on a contract basis to urban distributors, milk shops and institutional consumers. Milk in excess of the contracted quantities is sold through commission agents in the free wholesale market. In Karachi, there are two associations of herd owners which function more as collective bargaining agents with the local authorities on topics like sale price, taxations, etc.
Milk producers who own transport facilities usually deliver milk to their urban contractors. Contractors are often sold the milk to the milk shops where some part of the milk is concentrated into confectionery products. In summer, the margins of the intermediaries are much higher as more ice is added to cool the milk. The highway milk collectors have assumed a more important role as suppliers after the emergence of modern dairy plants in the country. Most of the milk processing plants now procure major portion of their requirement from the highway milk collectors. The raw milk supplied by the private milk collectors nevertheless passes through stringent quality testing and is priced according to the fat/total solid contents.

### 13.2 Milk Supply Chains

In Pakistan, about 90 percent of the total milk entering the milk marketing channels is collected from the subsistence farmers while the remaining quantity is contributed by the commercial dairy farms and the peri urban herds. Of the total milk that enters the market only about 3% is processed. Thus the bulk of the milk reaches the consumers in the urban areas through thousands of retail outlets/shops and vendors in large cities and towns throughout the country. However, undetermined quantity of milk is converted into local sweets/confectionary. Though not supported by scientific studies, it is said that up to 50% of the total milk may be converted into intermediate products like khoa and other local sweets.

In Punjab and Sindh provinces, the milk supply channels are more or less similar. However, in KP, Balochistan and AJK, the milk marketing system is rather on a limited scale. In KP, the milk production is mainly at subsistence farms level and the milk is

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**Fig. 13.1 Milk Marketing Channels in Punjab**
directly sold to the consumers. But the rural commercial farmers sell 45% of their milk through urban retailers and the remaining through village retailers. In this way, the milk retail shops are the main intermediaries of supplying milk to the consumers of KP. In the northern hilly areas of KP, the milk distribution system is rudimentary as small ruminants are mainly raised here. In Balochistan, sheep and goats are the main animals raised. The milch animals (buffaloes and crossbred cattle) are mainly kept in the urban and peri-urban areas. Therefore, the milk is mainly (85%) produced in these areas which is marketed through retail milk shops. In this way, the retail milk shops are the main intermediary between producers and urban consumers. In AJK, about four-fifth of the total milk production takes place in the rural areas. About 7% of milk is brought from Punjab. The assemblers are the main collectors gathering milk from the producers of rural, peri-urban and Punjab.

Market Information and Pricing Mechanism

In rural areas, liquid milk demands are met mainly by local production whereas in urban areas, the supplies from peri-urban and rural areas fulfill a major proportion of total milk demand. There is no public intervention in setting the milk prices and it is mostly dependent on the interaction of market forces. However, the municipal authorities of the towns and cities do fix the retail price of milk without regard to the cost of production. This is very unfair. Moreover, to make things worse, the prices of processed milk are not fixed by the local authorities.

The milk pricing systems also vary by location and type of intermediary involved. In big cities, the milk prices are relatively high compared to small cities. The milk prices are relatively high in the villages well connected with the urban centers as compared with those situated in deep areas. In deep rural areas and deserts like Cholistan, the processing of milk for making butter, khoa and Desi ghee is relatively more common. There is some seasonality in the production of milk. In winter, milk supply increases because of calving pattern of buffaloes leading to decrease milk prices in rural areas. However, Ddhies” harvests this benefit and urban consumers rarely get the due benefit.

14. Public-Private Partnership in Dairy Development

It is part of the government’s over all policy to encourage and promote public-private partnership. However, it has only been seen to happen in the development of infrastructure like in construction of roads and highways. The Planning Commission of the Government of Pakistan in its policy paper for agriculture (including livestock/dairy) states:

“Public Private Partnership needs to be pursued aggressively with respect to agricultural marketing, storage, and supply chain infrastructure to enhance effectiveness of the public sector programs. It will be necessary to: (i) put in place an incentive structure for the private sector to enter into contractual arrangements with farmer
organizations and link delivery of public services to business development; and (ii) create public-private partnerships in agricultural research and extension to help public research systems become more responsive to farmers’ actual needs. (iii) Develop strategies for the achievement of the objectives”.

More specifically for livestock/dairy, this concept is elaborated in the statement “The private sector will play a crucial role in the development of livestock, dairy, poultry and fisheries sub-sectors with the public sector providing enabling environment and capacity building role”.

The one significant action in this direction is the establishment of the private sector led Livestock and Dairy Development Board in 2006. The livestock specialists feel that the areas that should actualize this concept are the establishment of vaccine production centers and establishment of farms for the development and propagation of superior germ plasm of important dairy cattle breeds.

15. CONCLUSIONS

Looking back at the various aspects of dairy production presented in the foregoing chapters, the message that emerges is that dairy production in Pakistan is still traditional and a way of life rather than an industry. This conclusion is supported by the fact that its dairy industry still processes only about 3 % of the total milk produced in the country. This conclusion is based on the following major factors:

1. Traditional production system
2. Low productivity of dairy animals
3. Weak livestock services
4. Poor design of development programs and projects

The above can be spelled out into the following constraints that confront the dairy sector:

i) Low overall productivity of dairy animals
ii) Inadequate animal health cover
iii) Poor and inadequate feed resources
iv) Non-availability of quality germ plasm
v) Serious shortage of trained manpower
vi) Primitive marketing infrastructure
vii) Absence of quality control of milk and milk products
viii) Very weak extension services
ix) Inadequate allocation of funds for development work
x) Limited credit availability with difficult processing procedures
xi) Outdated regulatory framework
xii) Very low investment
xiii) Weak research and development system
16. **RECOMMENDATIONS**

The following recommendations are proposed:

- Strategies for dairy development
- Action plan for dairy development

16.1 Strategies for Dairy Development

Following are the recommended strategies for the dairy development:

i. Increase public sector investment in education, research and development in the dairy sector

ii. Provide policy support for the dairy development including deregulation of milk prices

iii. Attract private sector investment particularly in hygienic production and collection of milk and cool chain for milk marketing.

iv. Restructure organizations that provide livestock/dairy services.

v. Organize small farmers into milk production and marketing groups/associations.

vi. Encourage value addition in the dairy industry

vii. Improve credit availability and terms of credit

16.2 Action Plan for Dairy Development

i) Enhance productivity of livestock resources through training of livestock farmers, development of better technologies, scientific farming methods and improved management practices

ii) Improve milk marketing system through establishing cool chain and quality control

iii) Organize a massive hands-on training program for technicians in all aspects of milk production and processing jointly with the relevant universities, public sector training institutes and the dairy industry

iv) Ensure easily accessible and affordable credit for livestock farmers especially landless livestock farmers

v) Promote import substitution of livestock and products

vi) Rationalize taxes/tariff on milk and dairy products

vii) Ensure availability of extension services at the door of the farmers

viii) Provide a level playing field for the local dairy industry to compete with the subsidized imported dairy products,

ix) Encourage value addition in dairy industry

x) Improve consumer safety
xi) Reorient public sector institutions on following lines:

- Government livestock farms to be used for production of superior germplasm.
- Phased privatization of livestock extension services
- Strengthen existing livestock R&D institutions and establishment of new livestock production research institutes in the provinces.
- Ensure allocation of funds for livestock commensurate with its contribution to Agriculture GDP

17. REFERENCES


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ABBREVIATIONS AND ACRONYMS

AI Artificial Insemination
AJK Azad Jammu and Kashmir
AMUL Anand Milk Union Limited
CELDAC Community Empowerment through Livestock Development and Credit
CSF Competitiveness Support Fund
DP Digestible Proteins
FATA Federally Administered Tribal Areas
GB Gilgit- Baltistan
GoPB Government of Punjab
GOS Government of Sindh
GTZ German technical assistance agency
IRM Institute of Rural Management
KP Khyber Pakhtunkhawa. New name of NWFP (North West Frontier Province)
LDDB Livestock and Dairy Development Board
MINFAL Ministry of Food, Agriculture and Livestock
MLDD Ministry of Livestock and Dairy Development
NA Northern Areas. Now Gilgit-Baltistan
NGO Non Governmental Organization
NRSP National Rural Support Program
PDDC Pakistan Dairy Development Company
PRSP Punjab Rural Support Program
RSPN Rural Support Program Network
SAARC South Asian Regional Cooperation
SOW Scope of Work
TDN Total Digestible Nutrients
UHT Ultra Heat Treated
UNDP United Nations Development Program
Dairy Production, Quality Control and Marketing System in Sri Lanka

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References
1. INTRODUCTION

Sri Lanka is still dependant as an agriculture based economy and the contribution of agriculture to the GDP is about 19% (Department of census and Statistics 2007). The agriculture sector traditionally divided into two sectors namely the plantation and the subsistence agriculture and provides employment for over 34% of the rural population. Dairy farming has been an integral part of agriculture throughout the history of the country and even today it provides a substantial income to the livestock farmers numbering around 300,000 mostly distributed in the rural areas. In addition, dairy farming provides indirect employment for a considerable number of people engaged in diverse activities of the industry. Furthermore, it makes positive contribution to the family nutrition and income levels. However, the dairy production in the country is far from requirement to fulfill the demand and at present the total milk supply of the country is around 18-20%. The balance is imported to the country spending large some of valuable foreign exchange. Furthermore, the promotion of milk production is one of the most rational options for developing rural areas and the overall economy of the country. Milk provides also the most critical nutrients for people and a daily source of income with a relatively low risk for producers. In many instances, the modest cash flow from milk sales has been the only source of daily income that helps the rural poor to purchase their day-to-day essentials. The feeds for milking animals can be supplied from crop residues and forages which have been mostly underutilized. Another advantage is that increasing milk production in the country will reduce the drain of foreign exchange on importation of milk products.

Therefore, improving Sri Lankan dairy industry would ensure diverse benefits such as meeting the domestic demand with locally produced milk, food security, reducing valuable foreign exchange drain out of the country and means of alleviate rural poverty. Therefore, the Dairy industry has given a top priority in development program of the present as well as the previous governments.

1.1. History of the dairy industry in Sri Lanka

Despite the fact that cattle (neat cattle and buffalos) have been used in ancient agriculture in Sri Lanka, dairying did not exist in the country. During the ancient times, fermented milk known as “Pasgorasa” have been consumed by the people but no animals have been reared for milk production based on pastoral farming systems. The dairying was introduced to the island by the British people who occupied the plantations in the hill country of Sri Lanka. They introduced dairy cattle of European origin (known as Cape cattle) during 1920’s to the tea plantations in the country to produce milk for their consumption. The excess animals of their dairies were distributed among the estate workers and milk production was initiated in the hill country, which later develops in to a milk shed area (Chandrasisri, 2010).
The government involvement in dairy farming was began with the establishment of cattle breeding farms in different part of the country during the latter part of the British rule and just after the independence (Bandaranayaka, 1970). However, milk industry was really taken off the ground as an industry following establishment of the National Milk Board (NMB) in 1954. Since then the dairy industry of the country has gone through many changes during the last few decades and its present situation is discussed in the proceeding chapters.

1.2 Importance of the dairy industry in Sri Lankan economy

The Sri Lankan society is predominantly agrarian and agriculture sector plays a prominent role and contributes substantially to the GDP of the country. The contribution of Agriculture to the GDP is around 19% (Central bank report 2007), while livestock contributes 1.3% to the GDP of the country. The livestock plays an important role in overall agricultural production and it’s around 6.5% (GDP of agriculture) showing a slight increase during the last few years as shown in the table 1.

<table>
<thead>
<tr>
<th>Year</th>
<th>Contribution of Agriculture(%) to the GDP</th>
<th>Contribution of Livestock % to the GDP</th>
<th>Contribution of Livestock to the Agriculture %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>28.0</td>
<td>1.2</td>
<td>5.6</td>
</tr>
<tr>
<td>1996</td>
<td>18.4</td>
<td>1.2</td>
<td>6.0</td>
</tr>
<tr>
<td>2006</td>
<td>16.8</td>
<td>1.6</td>
<td>6.5</td>
</tr>
</tbody>
</table>


Most of the farmers are involved in dairying are poor farmers and are distributed in the rural areas. As mentioned earlier a large some of valuable foreign exchange is draining out the country due to the importation of milk and milk products and it increasing every year. The trend will not be change in the future due to the increasing per capita income of the people and change of feeding habits accordingly. Since post independence, therefore, almost each & every government has considered livestock industry, particularly the dairy industry as an important sector in national development activities and allocated substantial amount of money and effort to improve it. Many foreign funded projects were implemented for the development of the dairying in the country. However, the development of the industry has never been up to the expectations. One major reason for the poor improvement is lack of national policy and a long term a plan to achieve self sufficiency in milk production. Compare to the dairy industry, poultry and swine industry has improved tremendously during last few decades which are totally control by the private sector today.

According to the definition given in the census of Agriculture, the small holder sector covers all the holdings below 20 acres in extent. More than 96% of cattle, 98% of buffalos and 92% of the goats are in the small holder sector. Over 90% of the total milk production of the country comes from the small holders. Therefore priority should be given to the small holders in any dairy development program in the country.
2. **Present Situation Of The Dairy Industry**

2.1. Milk demand and Supply

Since early 80s, the demand for milk and milk products in the country has been increasing at a rate of 5% annually (Daniels et al 2009). The recent developments in the dairy sector have failed to keep with the increasing demand for milk. Therefore the gap between local milk production and the imports is widening every year.

The per capita consumption of milk and milk products is below 100g per day compare to the 258g per day in developed countries. The fresh milk consumption among Sri Lankans was not popular. Majority of the people prefer powdered milk due to its easy handling and storage. Therefore, per capita consumption of powdered milk has increased from 1.59kg in 1980 to 3.63 kg in 2006 while fresh milk consumption has decline. The current production of powdered milk in the country is insufficient to meet the demand and at present the local production is only 18% of the national requirement. The country therefore has no option but to depend on importations.

The value of milk and milk products imported to Sri Lanka during 2009 was approximately 31 billion rupees. The past records indicate that the quantity of imported milk & milk products has decreased gradually while the price in the world market has increased tremendously during recent times (Figure1). The consumption of milk in 2006 was 90ml/person/day whereas the recommendation is 180ml. Therefore importation has had no significance impact on the per-capita availability of milk (Chandrasiri et al. 2003). However, since open economy policy adapted by the government in 1977, the imports have dominated the major share of the dairy market. During 1982 – 2006, the importation has increased from 34% to 80% of the total milk consumed by the people while the amount of locally produced milk decline from 66 to 20%. If this situation is not address the imports will continue to increase.

![Image](image.jpg)

*Figure 1. Import of milk and milk products to the country (1989-2007)*
According to the census and statistics (2007), the per-capita availability of milk has increased by 11% from 2000 - 2007. On an average, only 52.5% of the total milk production has been collected through the formal collection network. The informal milk market is estimated to be around 45% of the total milk produced in the country (Ranawana, 2007). The rest of the milk account to 2.5% is not collected by any organization. However, the contribution to the informal is only an estimated value based on various assumptions and not confirmed by any valid investigation. It is believed, that the milk sold to the informal market is mainly consumed as fresh milk by people in urban and rural areas. The recent drive towards popularization of fresh milk also contributes to a certain extent to the informal market. Estimated average milk production of neat cattle and buffalos is given in the table 2.

Table 2. Estimated average monthly milk production (liters)

<table>
<thead>
<tr>
<th>Category of Animal</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neat cattle</td>
<td>13,308,000</td>
<td>13,484,700</td>
<td>13,748,100</td>
<td>14,144,000</td>
<td>14,370,201</td>
<td>15,338,744</td>
</tr>
<tr>
<td>Buffalo</td>
<td>2,550,000</td>
<td>2,577,100</td>
<td>2,637,180</td>
<td>2,690,100</td>
<td>2,970,893</td>
<td>4,104,280</td>
</tr>
<tr>
<td>Total</td>
<td>15,858,000</td>
<td>16,061,800</td>
<td>16,385,280</td>
<td>16,834,100</td>
<td>17,341,094</td>
<td>19,443,024</td>
</tr>
</tbody>
</table>

Source: Statistics Department 2009

2.2 Potential for dairy development in Sri Lanka

In Sri Lanka, the potential for dairy development according to the available natural and animal resources are enormous, provide they are judiciously harnessed in the process of economic dairy production. The increasing demand for milk and milk products in the country and the high world market prices and due to the limitations of further increase of milk production in developed countries supports favorably the local milk production. In addition Sri Lanka has a well developed infrastructure and institutional net work and trained human resource base to provide required facilities to the industry. The details of the available resources are discussed below.

2.2.1. Geography and Climate

Geography and climate influence each other, plays an important role in any agricultural activity and in no exception for livestock. Sri Lanka is a tropical island situated in south tip of India covers a land area of 62562 km². According to the topography, base on the elevation of the island, three distinct regions can be identified. They are low country, mid country and the up country. These regions are further divided in to sub region based on the rainfall that received by the respective region. The table 3 demonstrates the salient feature of the each agro climatic regions and the areas for livestock development has been identified accordingly.

Due to the geographical location of the country and its position in the intra-tropical convergence zone most part of the country is hot and humid. The climate
of the country is mainly determined by the rain fall and the temperature. However, a considerable variation in climate could be seen due to its size and the sudden elevation in the center of the country.

**Temperature**

The average temperature in the island range from 25\(^\circ\)C - 28\(^\circ\)C throughout the country while mild climate prevails in the up country region where average temperature range from 2-16\(^\circ\)C. However, during the hottest months, the temperature in the dry zone goes up to 30\(^\circ\)-35\(^\circ\)C during the day, but nights are somewhat cooler.

The mean annual temperature is around 27.5\(^\circ\)C over lowlands in the coastal areas (below 150m in elevation) and it ranges from 15-28\(^\circ\)C. In the hill country it ranges from 15-19\(^\circ\)C due to decline of temperature due to the inclination of elevation.

Within the country there is only a small variation in the mean monthly temperature throughout the year. During the coolest months from November to February the mean temperature is about 25\(^\circ\)C and during warmest months from April to May it is 2.4 \(^\circ\)C higher than that of coolest months. In the dry zone of the country higher mean monthly temperature (33.3\(^\circ\)-34.7\(^\circ\)C) is experienced.

**Rainfall**

The annual average rainfall varies from 1000mm to over 5000mm. The country mainly receives its rainfall by monsoonal, conventional and inter-monsoonal rains experienced in binomial pattern. Therefore a distinct dry spell is common in between both main monsoonal periods in the wetter regions of the country. However, the main part of the country which comes under the dry zone receives rains normally during either north east or south west monsoon depend on its location. In between, the monsoon these areas received less rainfall compared to the wet zone of the island.

**Relative humidity**

The relative humidity varies generally from about 70% during the day to about 90-95% during night. In the dry zone these values are lower by about 5%.

**Table 3. Dairy development regions and their salient features**

<table>
<thead>
<tr>
<th></th>
<th>Hill Country Zone</th>
<th>Mid Country Zone</th>
<th>Low Country Zone</th>
<th>Dry Zone</th>
<th>Coconut Triangle</th>
<th>Jaffna Peninsula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation (M)</td>
<td>&gt;1200</td>
<td>450-1200</td>
<td>0-450</td>
<td>0-450</td>
<td>0-450</td>
<td>0-450</td>
</tr>
<tr>
<td>Ambient Temperature ((^\circ)C)</td>
<td>10-24</td>
<td>21-32</td>
<td>24-35</td>
<td>21-38</td>
<td>24-39</td>
<td>27-35</td>
</tr>
<tr>
<td>Rainfall (mm)</td>
<td>&gt;5000</td>
<td>1,675-5,000</td>
<td>1,875-2,500</td>
<td>1,000-1,750</td>
<td>1,200-4,000</td>
<td>1,000-1,500</td>
</tr>
<tr>
<td>Relative Humidity (%)</td>
<td>58-75</td>
<td>55-75</td>
<td>75-90</td>
<td>70-85</td>
<td>60-80</td>
<td>71-74</td>
</tr>
</tbody>
</table>
2.2.2. Dairy production systems in Sri Lanka

Over 90% of the dairy farms are small holdings having less than 1 acre of land or many do not have any land at all and depend on the communal lands for feeding their animals. The dairy production and the management systems varied according to the resources available and the general farming activities in different agro-climatic regions of the country. The management systems can be either intensive, semi-intensive or extensive while semi-intensive and extensive systems are widespread and intensive system of management is being promoted at present by the DAP&H. However, dairy production is mainly integrated with agriculture in every part of the country. The salient features of the different agro-climatic regions identified for livestock development is given in the table 3.

2.2.2.1. Hill Country Zone

The up country or the hill country zone is situated 1,200 m above sea level and has a mild climate. The average ambient temperature range is 10° C – 24° C. This region receives high rainfall throughout the year except in the month of February. The animals are managed under intensive or semi-intensive system. The dairy operators are mainly plantation workers, especially in tea estates and land less labourers in vegetable cultivation areas. Animals are fed with grasses including weeds and non-conventional feeds such as wild sunflower from the estate lands and from road sides. The crop stock integration which is common in other parts of the country is hardly practiced in this region due to tea and intensive vegetable cultivation.

Generally in the hill country, the temperate breeds such as Friesian, Ayrshire, Jersey and their crosses are popular and no buffalos are reared. The average daily milk yield is around 6 litres/cow/day under field conditions. However, the both farms in Ambewela managed by the private sector have recorded an average production of 18-20/l/cow/day which is very encouraging (Bandara, 2010). This region was identified as major milk shed area under the initial dairy development programs of the island. However, at present the dairy industry is restricted due to increase vegetable cultivation by the farmers. Therefore further development of Dairying in the region is questionable.
The total milk production of the area contributes around 8-9% of the total milk production in the country (Livestock statistics 2007). Manure is also considered as a secondary source of income for the dairy farmers in the hill country, due to high demand for cow dung for vegetable cultivation. The common grass available in the region is *Panisetum clandestinum* known as “Kikiyu” has a high protein content but low in energy. Therefore energy rich concentrates are essential to obtain higher production from the European breeds.

### 2.2.2.2. Mid Country

Mid country is situated 450m – 1,200m above sea level and the ambient temperature range is between 21°C - 32°C and the low humidity favor the high yielding animals under intensive management certain extent. The home garden production system is popular in this region. In low lands, the farmers grow paddy in up-lands and their home gardens mainly consist of export agricultural crops. Therefore, crop stock integrated system is common in the area under intensive as well as semi intensive management system. The animals feed on grass along the roadsides and in home gardens. The *Panicum maximum* (Guinea A), which has spread allover the area is the most common fodder given to the animals. Crop residues and tree fodder are the other sources of fodder. This areas has a large extent of marginal tea lands which has a high potential for dairy development sin the climate and other resources are available. Among the animals European breeds, their crosses with Indian or local indigenous animals are common in the region but Buffalos are hardly use for milk production. The average daily milk production of cows in the region is 4-6 litres/cow/day. Good milk collections net work is being in place and two medium scale processing plants belong to MILCO and to a private company are in operation.

### 2.2.2.3. Low Country Wet Zone

Low country wet zone lies between 0 - 450m above sea level and the ambient temperature ranges between 29°C-38°C. The farmers, involved in dairy production are small holders. They mainly grow paddy, vegetables and pasture or fodder is scarcely cultivated. Animals are fed with common grass found in the area under coconut and rubber lands or along the roadsides and in uncultivated paddy fields. The farming systems depend on the available resources and in town areas there are few urban dairies are found. The urban dairies supply fresh milk to the consumers in the city. The animals are fed in public places and on road sides and supplement with concentrates during the milking time. Also, they are confined during the night and fed with cut grasses. In most cases animals milked twice a day. In this region Indian as well as European cross bred animals is common and the average daily production is comparatively higher. Buffalos also used for milk production in the area to a certain extent and milk is mainly used for curd production. The buffalo are either indigenous or Indian breeds or their crosses (majority). Here animals are reared under intensive or semi-intensive management system.
2.2.2.4. Dry Zone

The elevation of the dry zone varies from 0m - 450m above sea level and the ambient temperature ranges between 21\(^\circ\)C – 35\(^\circ\)C. Two thirds of the national cattle population is found in the dry and the dry intermediate zones of Sri Lanka but the milk production is relatively low. The cattle breeds are predominantly local and Indian crosses. In the area three different systems of management is widespread. They are commonly categorized in to Village base, tank based and jungle based system and the former commonly consist of small holders and the latter two are large scale farmers having large number of animals. The large scale farmers mainly used government own lands for grazing cattle. Though, during the past, vast areas of lands have been identified and declared for cattle grazing, at present most of the traditional grazing lands have been used for other development projects and human settlements. Furthermore, the tank reservations that were mainly used for grassing of animals have been encroached by the people for cultivations and other purposes. This has caused great difficulties to the cattle farmers in the area and therefore, farmers reduce the number of animals they keep or many are leaving the industry. The common practice in the area is extensive management system and no concentrates given to the animals. Animals generally graze in the scrub jungles and other natural grasslands such as villus and damana. In addition, in the village areas animals are fed in fallow paddy lands and few farmers feed the animals with cut grasses in the night. Normally animals are confined during the night to avoid cattle theft and large herd owners do not feed them in the night. Normally, the average daily milk production varies from 1-2 litres/cow/ day and short lactation length is usual among many animals. In the dry zone, feed scarcity is common during the dry season and animals are fed with non-conventional feeds to a certain extent. However, many farmers do not use other feed resources to feed their animals due to lack of knowledge in scientific feeding. Most farmers mainly interested in having more animals due to better income from selling of surplus animals and milk production is considered as less important.

Nearly 67% of the total cattle population of Sri Lanka is concentrated in the dry and the dry intermediate zones and contributes around 47% to the national production (Livestock statistics 2007). According to the present situation, a high potential for milk production is evident in the area provide the management system is changed with introduction of planned breeding strategy. Moreover, the existing large herds could be used as valuable base breeding stock in future breeding programs and therefore, for the existence of the dairy industry animals in this region has to be preserved.

2.2.2.5. Coconut Triangle (CT)

The coconut triangle spreads 0-450m from the sea level and the average ambient temperature is between 24\(^\circ\)C – 29\(^\circ\)C. The part of the region comes under the wet zone while the rest under the dry zone. The main crop found in the area is coconut and in addition paddy and low country vegetables are grown in areas where irrigation facilities
are available. This region is one of the traditional cattle farming areas and animals are grazed under coconut palms is common. Animals are used for milk production, transport, land preparation, controlling weeds, and providing manure to the coconut palms. The breeds, which can be found in this region, are European and Indian crosses, particularly Sahiwal, Friesian or Jersey crosses. The average farms size according to the number of animals per unit varies but higher number of animals per farmer is common in dry region of the coconut triangle. The average daily milk production is about 4 litres/cow/ day. The semi intensive management system is the common practice in any production system in the area. Animals are fed with considerable amounts of concentrate depending on the productivity of the individual animals. Buffaloes are also popular in the coconut triangle and the milk is generally converted to curd to meet the local demand. The majority of the buffalos are local indigenous type while cross bred local types with Indian breeds such as Murrah, Nili-Ravi and Surthi also found in the area. The majority of the NLDB farms are located within the CT. Coconut triangle has a high potential for dairy development due to vast resources found in the area and to its close proximity to the urban areas with better infrastructure facilities.

2.2.2.6. Jaffna Peninsula

The elevation varies form 0 m - 450 m above the sea level and the average temperature is around 28°C. The Jaffna peninsula is a special area for dairy development since majority of farmers are Sri Lankan Tamils and dairy cow is considered as sacred animal. Therefore, the dairy cows are given special care by the farmers and intensive management system of dairying is common in many places. The animals are Indian crosses with local breeds and cross bred animals with European breeds are too found in the area. They feed the animals with homestead grasses and post harvest crop residue and many non-traditional feeds and kitchen refuse as well as other feeds consumed by people.

2.2.3. Animal resources

2.2.3.1. Farm Animal Species used for Dairy Production

Milk is secreted by mammals to nourish their young ones, and milk of animals like cattle, buffalo, goat, and sheep, are being commonly used as food for human beings. Of these animals, cattle and buffalo are reared as dairy animals in Sri Lanka while goat is hardly used for milk production. Dairy industry depends entirely on the ability of animals to produce milk for human consumption. The milk yield of animals varies greatly according to the species, breed and the environment in which they live. The composition of milk does not vary widely as the yield of different species, but the proportions of the constituents vary considerably. In Sri Lanka, neat cattle are considered as the main milk producer while buffalos are used for draught purposes and to a lesser extent for milk production in the past. However, during recent times, buffalo is gaining popularity as a dairy animal due to the inherent characters of milk (with high fat & SNF) they produce more efficiently than neat cattle under dry farming systems in the country.
Dairy animals provide not only food for the producers, but also a range of other products & benefits which could be utilized by the livestock owner such as draught power, meat, manure & hides etc. to earn an additional income. In addition, dairying acts as insurance to the farmers during crop failures due to drought & excess rains during harvesting season. In addition, cattle has a cultural as well as traditional value to the farmers.

2.2.3.2. Distribution of cattle and buffaloes

The data available on cattle and buffalo populations in the country are scanty and discrete. According to the 2007 livestock statistics, the total neat cattle and buffalo populations are 1.2 million and 0.3 million respectively. They are distributed in different agro climatic regions of the country. As shown in the table 4, the animal population in the country has reduced substantially during the last few years and the trend is continuing at present too.

![Figure 2. Distribution of Cattle and Buffalo population (2007)](image)

The pattern of distribution of the national herd among the various parts of the country shows that almost 2/3 of the population is concentrated in the dry and the dry intermediate zones Figure 2, but they produce about 40 percent of the total milk production. The balance 60 percent comes from the wet zone, including up country and mid country where cross-bred and pure-bred cattle are reared. The buffaloes also contribute around 25 percent to the total collection of milk, which are used for curd production and not for direct consumption as fresh milk or other processed milk. According to the available statistics, the average milk production per animal in the island is less than 1 litre/day (Chandrasiri, 2009) and is very poor under any given standard.
Table 4. Cross bred Cattle & buffalo in Dry Zone of Sri Lanka (2004-2009)

<table>
<thead>
<tr>
<th>Category of Animal</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neat Cattle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milking at any given time</td>
<td>217,168 (30.4%)*</td>
<td>222,880 (30.6%)*</td>
<td>223,580 (30.7%)*</td>
<td>238,610 (32.0%)*</td>
<td>249,315 (33.5%)*</td>
<td>237,675 (33.6%)*</td>
</tr>
<tr>
<td>Dry cows</td>
<td>284,235</td>
<td>288,871</td>
<td>287,664</td>
<td>289,664</td>
<td>283,205</td>
<td>269,106</td>
</tr>
<tr>
<td>Other</td>
<td>212,715</td>
<td>216,185</td>
<td>215,267</td>
<td>216,778</td>
<td>211,944</td>
<td>201,393</td>
</tr>
<tr>
<td>Males</td>
<td>183,205</td>
<td>186,194</td>
<td>185,403</td>
<td>186,705</td>
<td>182,541</td>
<td>173,454</td>
</tr>
<tr>
<td>Calves</td>
<td>269,582</td>
<td>273,980</td>
<td>272,816</td>
<td>274,732</td>
<td>268,605</td>
<td>255,233</td>
</tr>
<tr>
<td>Total</td>
<td>1,166,905</td>
<td>1,188,110</td>
<td>1,184,710</td>
<td>1,206,489</td>
<td>1,195,610</td>
<td>1,136,861</td>
</tr>
<tr>
<td>Buffaloes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milking at present</td>
<td>53,060</td>
<td>54,620</td>
<td>55,930</td>
<td>57,580</td>
<td>63,117</td>
<td>77,912</td>
</tr>
<tr>
<td>Dry cows</td>
<td>49,688</td>
<td>50,606</td>
<td>51,630</td>
<td>52,146</td>
<td>51,082</td>
<td>58,776</td>
</tr>
<tr>
<td>Other</td>
<td>77,016</td>
<td>78,439</td>
<td>80,027</td>
<td>80,826</td>
<td>79,178</td>
<td>91,102</td>
</tr>
<tr>
<td>Males</td>
<td>59,626</td>
<td>60,727</td>
<td>61,956</td>
<td>62,575</td>
<td>61,299</td>
<td>70,531</td>
</tr>
<tr>
<td>Calves</td>
<td>62,110</td>
<td>63,258</td>
<td>64,538</td>
<td>65,183</td>
<td>63,853</td>
<td>73,470</td>
</tr>
<tr>
<td>Total</td>
<td>301,500</td>
<td>307,650</td>
<td>314,081</td>
<td>318,310</td>
<td>318,529</td>
<td>371,791</td>
</tr>
</tbody>
</table>

(*) The percentage of cows in milk at any given time

Source: Sri Lanka livestock statistics 2007

The milch cow population in the country in 2004 was 70.4% of the total population and the percentage of cows in milk at any given time in the same year was 30.4%. The percentage of milk cows in the Smallholder sector shows only a little increase during the past few years as shown in Table 4 while the average production per animal has decreased at the same time. The short lactation length (6-8 months) has been reported too but no proper records are available due to lack of record keeping by the farmers. This is an indication of the poor efficiency in milk production attributed to many reasons such as poor feeding, breeding and management. As far as the buffaloes are concerned the situation is much similar to that of cattle.
2.2.3.3. Animal genetic resources (ANGR)

The success of dairying depends on the availability of genetic resources and the environment. Indigenous cattle in Sri Lanka, although well adapted to harsh environments, are poor producers of milk. The improvement of genetic potentials of indigenous cattle through selective breeding is difficult, and therefore, the genetic gains that could be expected would at best be not very significant. Furthermore, their numbers have been drastically reduced due to the genetic improvement programs based on cross breeding carried out in the country. Therefore, conservation of indigenous cattle has become more important than using them for genetic improvement.

However, the indiscriminate breeding of indigenous cattle with Indian and European cattle through Artificial Insemination (AI) as well as natural mating during the past have resulted a large number of non-descriptive type cross-bred animals with enormous bio-diversity within the national herd. They are crossed with various European breeds as well as Indian breeds imported to the country from time to time. At present, pure-bred animals are found only in the Government farms of the National Livestock Development Board (NLDB) and the two farms belongs to the private sector in Ambewela in the up country of Sri Lanka.

2.2.3.4. Breeds of cattle available in the Country

According to the available information, the indigenous cattle known as “Batu Haraka” was exist in the country. They are highly adapted to the local conditions but very poor producers of milk and meat. The productivity of the animals could not improve through selection due to obvious reasons and hence cross breeding with exotic Indian as well as European breeds was the only option. Therefore, many different breeds of Indian origin (Sahiwal, Sindhi, Haryana, Tharpakar, Gir) as well as animals of European origin (Holstein Friesian, Ayrshire, Jersey, Australian Milking Zebu and Shorthorn) have been imported to the country for using in cross breeding programs in the past. At present, Australian Friesian Sahiwal (ASF) is use in breeding programs in the country and a pure herd of AFS is maintained in a Dry zone farm of the NLDB.

In addition to dairy cattle, buffalos also play a very important role in milk production, and they are mainly distributed in dry zone and low country wet zone. There is enough scientific evidence to show that the buffalos are efficient milk producers under tropical climates converting poor-quality feed (Das Guptha, 1975). Further more, buffalo produce quality milk with higher processing value and thus better returns for the farmer. Unfortunately, in the breeding programs of the country during the past, the potential of buffalos have not been recognized and genetic improvement carried out in this species has been very limited. The majority of the buffalos are of indigenous type while a substantial number of the population consists of cross-bred animals of indigenous x Indian origin animals.
2.2.3.5. Dairy cattle breeding in Sri Lanka

Productivity of the animals has to be improved to make dairying a more profitable enterprise and to meet the growing demand for milk. However, milk production being a biological trait regulated by so many factors, the enhancement of productivity is not an easy task. Hence, there should be a continuous effort for the improvement of production potential and productivity of the animals. Production potential of any individuals determined by its genetic make up which decides its maximum production level, and any herd improvement based on genetics of the animal is permanent and will be inherited from generation to generation, though it is time-consuming. However, planned scientific animal breeding program is not exist in the country at present and can be considered as the main reason for poor productivity of both neat cattle and buffalos.

2.2.3.6. Government Involvement in Cattle Breeding

Government involvement in dairy cattle breeding dates back to 1936 with the establishment of Karagoda-Uyanagoda and Polonnaruwa farms, and Ridiyagama farm a year later, by the Department of Agriculture (Bandaranayake, 1970). The first pure-bred temperate breed farm was established in 1941 at Bopattalawa followed by Ambewela farm in the hill country. However, temperate breeds of cattle known as “Cape” were introduced to the hill country many years before by the European settlers in the plantation sector and were used for upgrading local cattle in the region (Mahadevan, 1970). Later, more cattle breeding farms were developed by the Department of Agriculture in the different agro-climatic zones in the country and a range of temperate European dairy breeds (Bos taurus) and Indian Zebu (Bos indicus) breeds were introduced. These farms were established for:

- Serving as nucleus breeding centers to provide improved animals to the livestock farmers
- Rearing imported exotic animals of European and Indian origin for breeding and multiplication
- Upgrading indigenous cattle through cross breeding with exotic breeds
- And to increase milk production and provide extension to the farmers in the country.

During the late 70’s, the total number of breeding farms in the country was 21 and were well developed and geared to fulfill the national requirement. Among the dry zone farms, Thamankaduwa complex in Polonnaruwa district was the largest and consisted of four farms with several large units. The total number of animals reared in Thamankaduwa complex alone was around 30,000 heads of cattle and buffalos. These farms reared cattle breeds of Indian origin such as Sindhi, Tharpakar, Kilari, and Buffaloes Surthi, Murrah, Nilli-Ravi. The sahiwal breed was introduced to these farms in early 80s. The nucleus herds of these farms were well-managed, and scientifically-selected bulls were used for upgrading animals in the dry zone and other parts of the country. In addition progeny
tested bulls were transferred to AI centre in Mid country and semen was distributed all over the country. Those programs have had enormous impact on overall dairy development, particularly genetic improvement, which one experience today. Unfortunately, the contribution of these farms on livestock development at present is negligible, and the only existing unit of the Thamankaduwa complex, manage by the NLDB, has left with few animals, and does not function as a breeding farm any more.

These farms were eventually taken over by the Department of Animal Production and Health (DAPH) in 1978 with the creation of the new department for livestock sector. Few years later, they were handed over to National Livestock Development Board (NLDB) which functions under the same ministry under which the DAPH functions. At present, all the government cattle breeding farms in the country are managed by the NLDB which is responsible for fulfilling the above-mentioned objectives. The DAPH’s activities on breeding are limited to policy making and providing technical support and services to the needy farmer. The two Artificial Insemination (AI) centers (Kundasale in mid country and Polonnaruwa in the DZ) in the country are managed by the DAPH. The bulls use for AI is selected from the NLDB farms based on the ancestor’s records and no progeny test done prior to selection.

In addition to the above agencies, Mahaweli Development Authority of Sri Lanka is also actively involved in dairy cattle breeding in dry zone settlements under their command to a certain extent. They also established many cattle breeding centres in several parts of the Dry Zone in North Central Province and in Uda Walawe scheme in the Hambanthota district. But none of these farms exists today.

2.2.3.7. Present options for the breeder

Practically, a breeder has three different options for increasing milk production by genetic improvement. They are:

1. Replacing local animals with imported exotic animals
2. Selection within the existing animals
3. Genetic improvement through cross breeding.

A. Importation of animals: The alternative of replacing the indigenous stock with genetically superior exotic stock, particularly of European origins, is not a viable proposition, because of nutritional demands and environmental adaptation problems and the poor management practices adopted by farmers. No country in the world has been successful in increasing its milk production by replacing the indigenous animals by imported animals. The importation of costly exotic animals of European origin for increasing productivity should not be promoted. However, importation of animals for development of nucleus herds for use in future breeding programs may be justifiable since need for a genetically-superior breeding animals have become an urgent need at the moment.
B. Selection from the existing animals: The challenge of increasing milk production in Sri Lanka lies primarily in efficient exploitation of genetic diversity exists among and within the existing dairy cattle and buffalos in the country. The indiscriminate breeding strategies adopted during the past decades have contributed to enormous genetic diversity among the national herd, particularly in neat cattle. Therefore, any future breeding program aiming genetic improvement of the existing herd should make use of this valuable genetic resource. For this, the most productive and adapted animals for each agro-climatic zone must be identified scientifically for breeding purposes. Only then it would be viable to increase milk production without further expansion of animal numbers with subsequent effect on land degradation and environment pollution. However, the improvement that can be achieved from selection is somewhat slow, and application of cross breeding simultaneously will speed up the process.

C. Cross breeding for dairy cattle improvement: Crossbreeding will be a simple and quick means of effecting genetic improvement, and this has been a common tool used in our breeding programs during the past. Because of the large population of nondescript zebu type cattle and buffaloes in the dry zone of Sri Lanka, even a minor improvement through cross breeding could bring about a substantial increase in the national milk production (Buvanendran, 1975). For that purpose, the optional and pragmatic approach is cross breeding the existing stock with genetically-superior animals of *Bos taurus*, and *Bos indicus* to a level appropriate and relevant to a particular agro-climatic zone in the country (Buvanendran & Mahandevan, 1975). It has to be stressed that such genetic upgrading needs to be accomplished by suitable improvements in nutrition, animal husbandry practices and management. Economic considerations will also have to be born in mind.

Of the three options, selection within the existing animals combined with cross breeding are the most practical approaches to the present problem faced by the industry. However, during last few decades, dairy cattle breeding were done in a haphazard manner which left us a Non Descriptive Population particularly in neat cattle through the country. Therefore, long-term, well-planned, flexible breeding strategies designed by experienced animal breeders should be implemented with the participation of the livestock keepers to realize the full potential of the dairy industry in the country.

2.2.3.8. Artificial insemination service

AI is the most common biotechnology applied all over the world for dairy cattle improvement. The technique was introduced to Sri Lanka in 1951 and since then has been extensively used particularly for dairy cattle (neat cattle) improvement under the supervision and control of the DAPH. The AI coverage, pregnancy diagnosis and calves births of AI’s during last decade is demonstrated in figure 4. According to the available information only less than 15% of the breedable cows is inseminated per year with a success of 26-28%. The highest AI coverage has been reported in the wet zone and the upcountry areas while application of the technique in dry zone has been somewhat neglected (Livestock Statistics, 2007).
Frozen semen for AI is supplied by the DAPH through its AI center at Kundasale and the stud bulls are selected from the NLDB farms. In addition, imported semen also use to a limited extent under close supervision of the Field veterinarians and the selected AI calves are managed under special care. No private sector involvement in AI service in the country. AI is being mainly done by government technicians and to a lesser extent by the private technicians trained and controlled by the range veterinarians throughout the country. However, one of the major reasons for low performance was the inability of the field staff to provide more extensive field coverage. AI has to be carried out every day and government technicians are not available often when services are required. Furthermore, in many instances, it is not possible to provide an efficient service due to poor transport facilities provided to them. Therefore, employment of village-level private AI technicians, preferably selected from committed young farmers following a proper training under the guidance of the DAPH will increase efficiency of the AI service and its coverage.

The other constraint to the expansion of any AI program is lack of a follow up service. Poor detection of heat is another constraint that cannot be solved without active participation of farmers in the whole process. For any service to be attractive, it has to be readily available, efficient, effective and inexpensive. Unfortunately, the present AI service does not meet any of these criteria. The availability of the service depends on the availability of the AI technicians, and also the frozen semen.
For the AI service to be effective and progressive, a concerted effort has to be made to get more cows inseminated per unit area. Use of proven stud bulls is not effective in small-holder farming systems due to obvious reasons. Therefore, AI and progeny testing are the most effective and essential tools for genetic improvement of a large breeding population scattered over a number of small village holdings. However, application of AI has been partially successful due to various constraints attributed to the human factors. Use of natural mating is more appropriate in dry zone where large herds are managed.

2.2.3.9. Feeds and Feed availability

Natural grass is the most common feed available for ruminants in Sri Lanka. Grassland farming is not popular among the livestock farmers due to shortage of land and the poor income derived from the dairy cattle farming at present. Out of the total land area 65610km$^2$ of the country, only around 20% used for agriculture. The rest is consisting of water bodies, forest cover and reserves which are under the control of the government. Among the uncultivated areas that are under the government is used for animal grazing to great extent. The most common grass varieties are Panicum repines, Cynodon dactylon, Axonopus compressus are widely distributed. In addition different Brachiaria spp (some are introduced to the island) (Fig 5) are also available in the coconut triangle and low county wet and dry zone of the country. The most common natural grass found in the upcountry is Kikiyu (Panisetum clandestinum) which has very high protein content but low in energy. Further to that a wild species of Panicum maximum commonly known as ‘Guinea A’ is spreading in a very aggressive manner all over the country except in the higher attitudes. The guinea grass has declared as an invasive species recently and its control can be done through proper utilization only. Guinea grass has been the backbone of the dairy industry of mid country during last few decades and unfortunately very little research has been carried out on this valuable feed resource.

Figure 5. A Brachiaria brizantha grown in Dry zone of Sri Lanka
In addition to the various natural grasses many improved varieties of different grass varieties have been introduced to Sri Lanka and tried under local conditions. Some of them are very promising but hardly cultivated by the farmers. Furthermore, various indigenous as well as introduced fodder and tree fodder varieties are available in the country for feeding ruminants. Many Leguminacea tree fodders such as *Grilicidia maculata*, *Erythrina indica*, *Leucaena leucocephala* and many unconventional tree fodders that can be fed to ruminants are available in substantial quantities in many part of the country for feeding livestock. Furthermore paddy straw is available in everywhere and could be use during feed scarcity.

In addition to the fodder and grasses, a large quantities of various agricultural by products such as rice bran, coconut poonack, broken rice and several industrial by products are available and still imported to the country to fulfill the requirement. Maize (*Zea maize*) was imported to the country till last year in large quantities to use in the animal feed industry. However, according to the present government policy maize importations are minimized since last year and farmers are encouraged to grow them here. The bulk of the above feeds are use for poultry feed industry while around 5% is use as cattle feeds.

There major constraints in feeds and feeding are farmer’s poor knowledge on scientific feeding and the feed scarcity during the dry season in-between two rainy seasons.

![Natural grassland (dry zone) and Guinea grass in mid country](image)

**2.2.3.10. Feeding and Management**

The poor management of dairy cattle is one of the major constraints to increase productivity of the animals. Majority of the animals are managed under poor condition without giving due consideration on basic physiological needs and welfare to achieve high productivity from the potential animals. Many farmers still practice semi intensive system of management. Poor dry cow management results poor fertility performance which is common among the dairy animals. Most of the farmers milk their animals once a
day and clean milk production practices are often neglected. The calves and heifers are highly neglected and therefore high calf mortality (common in buffalos) and late sexual maturity among heifers is a common problem.

Animas are mainly fed with average quality grasses and many farmers do not provide any supplementary feeds due to high cost of concentrates. Furthermore, feed scarcity during the drought affects the animal’s performance and the health badly resulting poor overall productivity. Though, there are various types of non conventional feeds available, only few farmers use them for feeding animals due to lack of knowledge in scientific feeding of dairy animals.

2.2.3.11. Animal health and Diseases

The DAPH and PDAPHs are responsible for prevention and control of diseases of farm animals. Among the notifiable diseases, Black quarter has not been reported from the country in recent time but FMD is reported occasionally. Animals are periodically vaccinated against contagious diseases such as Foot and Mouth (FMD), Haemorrhagic septicaemia and Black quarter by the DAPH at no cost to the farmer. However, common diseases namely mastitis, parasitic infestations and calf-hood diseases namely, Calf pneumonia, Salmonellosis, worm infestations and Navel-ill is common in many herds and the economic losses due to such diseases are not fully recognized. Many farmers neglect treating the affected animals due to high cost involved.

2.2.4. Infrastructure and institutional support

In Sri Lankan dairy industry has traditionally been a small farmer dominated subsistence farming activity, which was well integrated to the domestic agriculture. The government institutions play a vital role in dairy industry and its development in the country while private sector involvement confines to milk collection and marketing at present. The government initiations of dairy industry can be traced back to 1930s, when the first cattle breeding farms were established. During the early 50s, the Department of Agriculture, through its Division of Animal Production and Health, had initiated programmes to promote milk production, aimed at meeting the demand for milk products in the urban areas. In 1958 the National Milk Board was formed to promote dairy development and milk marketing. In 1972 the National Livestock Development Board was formed to perform a similar function in respect of meat, but it had to take the function of operating cattle breeding farms, as state sector involvement in the promotion of meat marketing was not politically acceptable. However, the gradual development of state sector institutional mechanism in the livestock industry has been influenced largely by the “small farmer support syndrome”, with a heavy emphasis on officer-dominated service delivery.

The open economy policy applied by the governments since late 1970s made the livestock industry, market oriented enterprise. Although this policy paved the way for a few large scale producers to emerge particularly in the poultry industry and in milk and
meat processing industries, the institutional mechanism has not been effective enough in passing the benefits of the open economic policy to the average farmer (Daniels 2009). Despite the expansion of Government and semi government (NLDB, MILCO and Mahaweli Authority) institutional mechanisms in the dairy sector since the mid 1970s, one finds that the farmer is getting increasingly marginalized in the context of increased input costs and poor returns. The government institutes act as a service provider to the industry and the private sector involves in milk collection, processing and marketing. The private sector only interested in profit making and gives less emphasis on village level milk production. In addition, there is a widespread distribution of milk producer’s societies at village level and no regional or national level organizations or federations.

As indicated in the table below, the institutional infrastructure available for the dairy industry appears to be fairly comprehensive. The major institutions public as well as private sector involved in dairy industry and their functions are given in the tables 5A-D below:

Table 5. Institutions and nature of their intervention in the dairy industry in Sri Lanka

<table>
<thead>
<tr>
<th>Institution</th>
<th>Nature of Intervention</th>
<th>Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry of Livestock and Infrastructure development (MLI)</td>
<td>Policy formulation, resource mobilization, monitoring of progress.</td>
<td>Top-down. Stakeholder consultation present to a reasonable extent</td>
</tr>
<tr>
<td>Central Department of Animal Production and Health (DAPH), Peradeniya, and affiliated bodies such as Veterinary Research Institute (VRI), Veterinary Hospital etc</td>
<td>Technical support for policy implementation, animal health and disease control systems, veterinary research, production of vaccines, technical support for animal breeding, enforcement of laws and regulations, human resource development and training, monitoring and evaluation and dissemination of information.</td>
<td>Top-down functional approach. Limited stakeholder consultation</td>
</tr>
<tr>
<td>Provincial Departments of Animal Production and Health (Provincial DAPHs)</td>
<td>Policy/programme implementation through field veterinary units with an emphasis on animal health and breeding. Extension services through farmer contact and limited training. Provincial level planning and programme implementation. Implementation of special projects determined at the central level.</td>
<td>Top-down service delivery with a limited farmer participation and stakeholder consultation.</td>
</tr>
<tr>
<td>Institution</td>
<td>Nature of Intervention</td>
<td>Approach</td>
</tr>
<tr>
<td>-------------</td>
<td>------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Faculties of Agriculture, UP, UR, URR, UW, US, UU, E, UJ</td>
<td>Academic degrees for development of higher level expertise and skills for the livestock industry. Livestock related research and dissemination of information through publications.</td>
<td>Structured academic approach. Limited consultation of stakeholders. Informal institutional relations.</td>
</tr>
<tr>
<td>5 B: Public Enterprises</td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Livestock Development Board (NLDB)</td>
<td>Breeding and supply of improved varieties of livestock to farmers.</td>
<td>Coconut plantations-based business operation with limited capability to meet demand for animals. Limited interaction with stakeholders.</td>
</tr>
<tr>
<td>Milk Industries of Lanka Company Limited (MILCO)</td>
<td>Procurement and processing of milk and production of value added milk products. Institutional support for dairy farmer organizations.</td>
<td>Operate as a business organization wide geographical spread and close contact with farmer groups.</td>
</tr>
<tr>
<td>Mahaweli livestock enterprise of the Mahaweli Authority of Sri Lanka</td>
<td>Promotion of livestock farming among settler communities through maintenance of cattle and goat farms for multiplication and distribution.</td>
<td>Vertically integrated business unit with relatively high farmer contact. Limited plans for expansion.</td>
</tr>
<tr>
<td>5 C: Cooperative Sector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Various Cooperative Societies including MILKFED</td>
<td>Provision of management and technical know-how to member societies. Promotion of procurement of milk and value added milk products. Welfare schemes for members.</td>
<td>Organizations with varying degree of farmer contact, which had received considerable assistance from the government.</td>
</tr>
<tr>
<td>5 D: Private Sector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy industry: Nestle Lanka Ltd., Kotmale Dairy, Nel Farm, Ariyakelle Farm, Richdale Dairy, Lanka Milk Foods Ltd.</td>
<td>Procurement and processing of milk, packaging and marketing milk products</td>
<td>Market driven business operation in a competitive environment</td>
</tr>
</tbody>
</table>
Dairy Development Milk Procurement and Processors’ Association (DDMPPA)  
Acts as a representative of producer’s interests and active in the promotion of product quality and farm gate prices.  
Promote collective action to improve the bargaining power of the producers.

Animal feed industry: Master Feeds, New Bemards, Nutrena Feeds, prima  
Manufacture and market animal feeds.  
Market driven business entities.

Extracted from: Improved Services to the Livestock Sector in Sri Lanka, Government of Sri Lanka/ FAO project TCP/SRL/0160 (A), Final report Vol.1

2.2.4.1. Ministry of Livestock Development (MLD)

The subject of Livestock production was under the ministry of Agriculture for over three decades and was disintegrate in late 70’s and brought under a new ministry of Animal production and Health. Since then, with the change of several governments, the subject of livestock was assigned to different ministries and at present, it’s comes under the MLD. As agriculture and livestock are closely linked and mutually dependent, one would expect the policy making, function of the ministry to pay special attention to the issues that are common to both agriculture and livestock. However, there is no official link with the ministry responsible for agriculture development. The MLD controls all the government institutions (DAPH, MILCO, & NLDB) engaged in livestock production and estate infrastructure development in the country. At present the MID & the DAPH mainly focus its activities on dairy development and provide funds and infrastructure facilities to the dairy sector through various other institutions including private sector and Non Governmental Organizations (NGO’s).

2.2.4.2. Department of Animal Production and Health (DAPH)

The DAPH came in to existence in 1978 when the subject of livestock development which was one of the divisions of the Department of Agriculture was reorganized by the government to brought under a separate department. The DAPH, which now functions under the MLI is the principal state agency providing technical support to the development of the livestock industry. The department provides technical expertise and guidance to the provincial DAPHs which are entrusted the responsibility of livestock development and extension. In addition, the department is responsible for non-devolved subjects such as veterinary research, animal disease control, regulation of standards pertaining to import of animals and animal products, as well as breeding of animals. DAPH is also playing a key role in developing human resources in the livestock sector. Since, swine and poultry production in the country is mainly controlled by the private sector, DAPH concentrate its activities in development of dairy sector at present.

DAPH has a functionally differentiated structure with five technical divisions and two support service divisions. The Director-General of DAPH who is assisted by an
Additional Director-General, heads the department. A Director heads each of the functional divisions. These include Finance, Administration, Livestock Planning and Economics, Veterinary Research, Animal Breeding, Animal Health, and Human Resources Development. Of these functional divisions, the veterinary research is carried out by the Veterinary Research Institute (VRI), which is headed by the Director, Veterinary Research. The departmental structure also has made provision for a separate unit under the name Laws and Registrations Implementing Unit. The officers of this unit comprising Asst. Director (Poultry Development), Registrar (Animal Feed) and Registrar (VDCA) reports to the Director-General.

2.2.4.2.1. Provincial Departments of Animal Production and Health (PDAPH)

The Provincial Councils established under the 13th Constitutional amendment of 1987 provided for a substantial devolution of power. Under the system of Provincial Councils a number of subjects earlier handled by the agencies of the central government have been devolved to the Provincial Councils. The livestock development and extension were among the subjects devolved to the Provincial Councils. The central DAPH which handled the development and extension aspects of livestock earlier, retained subjects like research, technical support services and regulatory functions and passed on all the implementation functions to the Provincial Councils. In order to handle these functions efficiently a Provincial Department of Animal Production and Health (PDAPH) was set up in each province. This department comes under the provincial ministry responsible for the subject of livestock. The PDAPH is headed by a Provincial Director who is normally a veterinarian.

There are several objectives that determine the functions of the provincial DAPH. They include: maintain animal health, Improve genetic potential of animals, farmer education and develop human resources and other services to the farming community. A brief description of the service divisions coming under the DAPH is given below.

2.2.4.2. 2. Veterinary Research Institute (VRI)

The Veterinary Research Division of DAPH functions as a separate institute under the name Veterinary Research Institute (VRI). The key functions of this Division (VRI) involve veterinary research, vaccine production, and disease investigation. The objective of the institute is to plan and execute research projects, develop improved techniques and products and provide specialized services according to the needs of the livestock industry. It has several divisions (see annex4) to cover the entire livestock sector and located in the central province.

2.2.4.2. 3. Veterinary Investigation Centre (VIC)

The Veterinary Investigation Centre is the main service arm of VRI for animal disease diagnosis. The centre carries out island wide disease diagnosis covering all types of livestock as well as ornamental fish, the disease diagnosis is carried out in association with district level VIC’s (12) spread out in different parts of the country. The centre
performs the statutory function of confirmation of contagious diseases as well. Other activities undertaken by the centre includes training of Veterinary Interns, Field Veterinarians and Farm school students. The centre provides its services to a wider clientele that include institutions like NLDB, Mahaweli Livestock centre, private companies, field veterinarians of provincial DAPHs and farmers.

2.2.4.2. Veterinary Vaccines Centre

The history of vaccine production by the Veterinary Laboratory under the Dept. of Agriculture dates as far back as 1937. However, the centre does not fully function at present and therefore most of the vaccines (FMD & HS) that are commonly used in controlling cattle diseases are imported to the country.

2.2.4.2.5. Artificial Insemination Centre

There are two AI centers are functioning in the island which are located in Central and North central provinces. They produce frozen semen from the bulls managed at the station brought from the NLDB farms. The AI program of the country including semen preservation, storage and transport to the various part of the country is done by the center under the guidance of the DAPH.

2.2.5. Education and training in dairy production

Education and training on different disciplines of the dairy industry is carried out by several institute such as ICEAPH, practical Animal husbandry schools managed by the DAPH and the State Universities. Universities offer undergraduate as well as graduate level courses on the different subjects related to the industry while conducting research on dairy management, milk production, collection, processing & marketing. In addition some of the Technical colleges and the farm schools of the Department of Agriculture (DA) offer practical courses on animal husbandry which emphasis on dairy production.

2.2.5.1. Institute of Continuing Education in Animal Production and Health (ICEAPH)

Institute of Continuing Education was established at Gannoruwa in 1988 under the Department of Animal Production and Health for the purpose of providing continuous in service training for departmental staff. The ICE functions under the Human Resource Development Division of the department and has facilities to provide residential training for a batch of 25 at a time. All training courses provided by the institute are free of charge, as the institute’s objective is to upgrade the knowledge and skills of departmental employees and thereby contribute to the development of the livestock industry.

2.2.5.2. School of Animal Husbandry

The Department of Animal Production and Health has established two schools of Animal Husbandry one at Karandagolla near Kandy district and the other at Sippukulama in the Anuradhapura district for the purpose of providing a comprehensive training to the youth in animal husbandry. These two schools conducted a two year Diploma program in
Animal Husbandry and offer courses to provide practical skills in poultry, dairy, and goat farming and fodder development.

### 2.2.5.3. Graduate level training in the field of Livestock production

The Faculty of Veterinary Medicine and Animal Science (FVMAS) occupies a significant place in the livestock industry as it is the only faculty in a Sri Lankan university that produces veterinarians. The faculty has been in existence for over three decades and has acquired professional competence in teaching and research in the discipline of veterinary science and in producing veterinarians who are absorbed by DAPH and the private sector. Being a faculty of a state university the Faculty of Veterinary Science depends entirely on government grants for its survival and delivers its services free of charge. Further to FVMAS, there are seven faculties offering degrees in BSc Agriculture and produce around 1000 graduates every year with practical as well as academic knowledge in Animal production related subjects including dairy production, farm management and economics. The graduate studies are carried out by the Postgraduate Institute of Agriculture, FVMAS, and University of Ruhuna. The graduate degrees are based on theory and research component which is compulsory. The average number of students engaged in graduate studies in a year is around 75-100.

### 2.2.5.4. Farmer training

There are various farmer training programs (mostly short term), field classes and workshops on different aspects of dairy industry is carried out by the DAPH, MILCO, and Universities as required. In addition Vidhatah (Ministry of Science and technology) and various NGOs, also organize training programs for the farmers through out the country. These training programs include different aspects of dairy cattle management, clean milk production and milk processing (cottage level), fodder conservation and animal health.

#### 2.2.5.4.1. Human resources for dairy development

The Provincial DAPHs cover a fairly large geographical area comprising two or more administrative districts. Table 6 demonstrates the number of trained personal attached to the provincial departments through out the country. They suppose to cater the entire livestock industry in areas assigned to them including poultry and swine. Majority
of them are veterinarians and the Livestock officers are with agriculture back ground. LDI’s are mostly diploma holders in Animal Husbandry. In addition a substantial number of trained personal on dairying related discipline are employed by MILCO, Mahaweli Authority, NGO’s and the private institutions and the majority of them are with Agriculture back ground.

### Table 6. Human resources attached to the DAPH

<table>
<thead>
<tr>
<th>Category of Staff attach to DAPH</th>
<th>1997</th>
<th>1999</th>
<th>2000</th>
<th>2002</th>
<th>2003</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterinary surgeons</td>
<td>205</td>
<td>301</td>
<td>301</td>
<td>350</td>
<td>303</td>
<td>476</td>
<td>476</td>
<td>476</td>
<td></td>
</tr>
<tr>
<td>Veterinary research Officers</td>
<td>24</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>18</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Livestock Officers</td>
<td>29</td>
<td>17</td>
<td>17</td>
<td>16</td>
<td>13</td>
<td>15</td>
<td>20</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>LDI</td>
<td>695</td>
<td>594</td>
<td>607</td>
<td>592</td>
<td>680</td>
<td>618</td>
<td>618</td>
<td>695</td>
<td></td>
</tr>
<tr>
<td>Research Officers</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Research Assistants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Extracted from Livestock statistics 2007

2.2.6. Government funded projects (ongoing) to promote dairy production in Sri Lanka

The following projects were initiated and implemented throughout the country by the PDAPH under the supervision of the DAPH with financial assistance of the Ministry during the past few years to promote the dairy industry in the country.

2.2.6.1. Establishment of Dairy Villages

Establishment of dairy Villages was a popular program among the dairy farmers carried out by the PDAPH. The government is very well aware and considered the small dairy farmer as the backbone of the industry. A large number of farmers involve with dairying as a means of self-employment and source of income generation even the prevailing farm gate price is not attractive to them. These smallholder dairy farmers operating at subsistence level face the problems of marketing, inadequate input supplies and support services. Many people particularly the younger generation does not like to take up dairy farming and this will jeopardize the future industry. Therefore, the dairy village program was initiated by the Ministry to strengthen the small holder by minimizing the problems face by them and retained them in the industry through better organization among them at village level. Further to that it is expected to narrow down the consumer producer distance while dairy farmers enjoying a reasonable share of domestic milk market and uplift their living standards substantially. Under the said program it is planned to promote local sales of fresh milk and milk products with the
assistance of farmer organizations and private sector entrepreneurs. Over 165 dairy farms have been established island wide during last few years and furthermore to come in near future (Kiri Gammana Pivisuma, 2010).

2.2.6.2. Facilitation and promotion of liquid milk consumption

Popularization of Liquid milk consumption among people is being promoted by the PDAPH, MILCO and NLDB separately. The main objective of this program is to popularize fresh milk consumption among people and to support the local dairy industry. Many milk stalls have been established in town areas including close proximity to the leading schools in the country. This program was initiated 2-3 years ago and it has become very popular in city areas but shows less success in rural areas.

2.2.6.3. Other programs

In addition to the above programs government have initiated three further programs; namely, Cattle salvage program to protect the breedable animals, to promote Milk based value added products and to develop Animal feed resources for dairy cattle.

2.2.7. Research in Dairy farming

The VRI, coming under the DAPH has the mandate to carry out research in livestock production. In addition The FVMAS and Agriculture Faculties attached to the State Universities are also engaged in research on various aspects of dairy production, milk processing and marketing and related disciplines. During the past few decades considerable amount of funds (local as well as foreign) have been spent on agriculture and livestock research. The Council for Agricultural Policy in Sri Lanka (CARP) is the Apex body that facilitates Agricultural research including research on Livestock production and related fields. In addition National Science Foundation (NSF), also fund projects on livestock production but during last two years, not many projects were funded by both institutes due to shortage of funds.

The research on dairy cattle breeding were initiated by Mahadevan, 1951, to investigate the suitable cross breeding strategies to dry intermediate zone of Sri Lanka. Later, Buvanendra, 1971 investigate the possibilities for improving milk production through pure breeding and cross breeding in the mid and hill country regions and since then practically nothing has been done in animals breeding. At present studies are needed to raise the efficiency of breeding systems involving the small herds of integrated farming systems. However, conducting experiments on dairy cattle breeding are extremely difficult. They are long term, requiring a commitment of resources for ten years or more, and require sustainable numbers of animals for reasonable accuracy. A proper recording system has to be in place and the active participation of the farmers is essential. The lack of expertise in animal breeding and the financial assistance and multi-disciplinary approach that need for breeding research are other constraints to the animal breeding research in the country.

However, numerous research have been done by the various institutions in the country on livestock feeds and feeding, animal health and at present much studies are
being done on milk processing and related subjects. However, it is believed that the impact of research on the farming systems and the rural community has been low due to the following reasons (Perera, et al 2009):

- Research projects were focused mainly on problems of fundamental and academic nature, were design based on the priorities and perceptions of the researchers and were usually laboratory oriented;

- Most scientist had little or no direct contact with the farming community, and therefore had little knowledge about the farming environment and the farmers needs and aspirations;

- And such projects failed to generate and transfer appropriate technologies that were applicable for solving the farmer’s problems and could be adopted and sustained using resources available to small farmers.

Therefore, Council for Agriculture Research in Sri Lanka (CARP), the Apex body controlling research in the country, has adapted as policy to promote applied research on dairy farming at present.

2.2.8. National Livestock Development Board (NLDB)

The NLDB is the only institute that manages cattle (neat cattle & buffalo) breeding farms in the country. It was established in 1973 under the provisions of the State Agricultural Corporation Act no. 11 of 1972. The Board started its operations in 1974. The principal objective of setting up the NLDB was to serve as a Meat Marketing Board. However, due to opposition form religious and various political groups for the government entering the meat trade, it took over the function of breeding animals of improved genetic potential for distribution among farmers. Initially the NLDB collected animals from farmers for upgrading and subsequently a herd of animals was imported for breeding and multiplication. In 1992, all the farms belonging to DAPH were transferred to NLDB on a government directive. The Board managed 31 farms. At present distributed in three regions viz. Upcountry, mid-country, Coconut Triangle and Dry Zone with a total extent of 15000 ha. However two farms of the upcountry were handed over to the private company and NLDB manage only two major farms (Bopathtalawa and the Rosita farm) in the area at present. The milk produce in these farms are sold as fresh milk in the Colombo area and the excess is given to the MILCO. The total milk production of the NLDB is around 8600 liters per day. According to the objectives at its establishment, NLDB suppose to multiply and distribute breeding animals to the farmers in the country. However, due to the change of its policy to become a profit making enterprise, NLDB has completely forgotten its role in dairy development in the country. Therefore, it’s contribution to the dairy development at grass root level is insignificant.

2.2.9. Milk Collection, Processing and Marketing

The milk industry has formal as well as informal market. The formal milk collection, processing and marketing is mainly control by the private sector. However, it
was dominated by MILCO for many decades until Nestle step-in to milk industry in 1978. At present, MILCO and Nestle are the major milk processors in the country and they collect around 300,000 liters per day from various parts of the country. In addition there are many other new players namely, Lucky Lanka Pvt Ltd, Fontera, Araliya, Rich Life, Kothmale, Newdale and some milk producers’ cooperatives. The informal market is mainly operating in rural areas and in certain urban areas and mainly engages in fresh milk collection and distribution within a close range.

2.2.9.1. Milco Private Ltd (MILCO) and its role in the Local Milk Industry

MILCO is a government institute, responsible for the milk collection, processing and marketing of milk products in the country. It was established in 1986 as a government owned company by converting the former National Milk Board (NMB) to a private company. The NMB was established in 1954-recognizing the importance of having a national level state institution to promote the milk industry. Prior to that two leading Milk Producer’s Cooperative Societies were involved in milk collection and marketing and they went in to self-liquidation and the Milk Board became a monopoly. The Milk Board had set up four processing plants in Colombo, Polonnaruwa, Ambewela and Digana to handle milk processing. However, Polonnaruwa processing plant was leased to Nestle Company on a long term lease and return back to the MILCO in 2009. At the beginning, a separate body call milk-shed company was formed to handle milk collection and later dissolved it in 1988 and procurement of milk was taken over by MILCO.

In the latter half of 1997 MILCO was taken over by an Indian company and the name of MILCO was changed to “Kiriya”. However nothing achieved under the new setup and due to the conflict between the employees and the management of the company finally forced the Indian Company to withdraw in 2000 and the government took over the business and re-named the company MILCO.

The organizational structure of the MILCO is given in the annex 4. The milk collection by the company is organized under seven regions. Each region is placed under a Regional Manager (RM) who reports to the manager in charge of the milk collection. The field staff reporting to the RM consists of Development Officers (DO) dairy centre managers and the extension officer (EO). Both the DO’s and the EO’s perform similar functions and as these officers and their staff are expected to work closely with the dairy farmers and FMSS

Currently MILCO collects about 150,000 liters of milk per day, which constitutes about 50% of the milk supply in the formal sector. The total capacity of the MILCO is around 210000 liters per day and the details of its processing plants are given in the table 7.

MILCO has a well established collection net work with 72 chilling centers covering major milk producing areas. Milk is mainly supplied to these centers by the
Farmer Managed Societies (FMS’s) numbering over 1500 organized by the MILCO itself. These FMS’s supply around 65,000 liters or 43% of the milk procured by MILCO at present. Other suppliers include cooperatives, middlemen who collect milk from the farmers and private suppliers who own animals.

Table 7. Capacity and the products of the government owned MILCO

<table>
<thead>
<tr>
<th>Factory</th>
<th>Province</th>
<th>Capacity liters/day</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambewela</td>
<td>Central</td>
<td>120000</td>
<td>Spray dried milk and butter</td>
</tr>
<tr>
<td>Digana</td>
<td>Central</td>
<td>25000</td>
<td>Yogurt, cheese, sterilized milk, pasteurize milk</td>
</tr>
<tr>
<td>Polonnaruwa</td>
<td>North Central</td>
<td>40000</td>
<td>Condensed milk</td>
</tr>
<tr>
<td>Colombo</td>
<td>Western</td>
<td>60000</td>
<td>Yogurt, Butter, sterilized and pasteurize milk, ice cream, liquid milk</td>
</tr>
</tbody>
</table>

2.2.9.2. Farmer Managed Societies (FMS’s)

Though the company is in the dairy business, MILCO does not have an explicit mission statement or clearly defined goals towards which the efforts are directed. The main strategy followed by MILCO to reach its target of collecting 500,000 L of milk per day by 2010 (which never achieved) is to build a partnership with FMSS and increase the capacity of the members to increase their output. A farmer managed society covers an area of one village. In the case of estates (Estate sector) one FMS correspond to a division of an estate. The objective of forming FMS is to increase the quantity as well as quality of milk and provide a good price to the farmer. The FMSS also expect to promote farmer participation in managing the societies in transparent manner. At present an FMSS is paid a commission of 25 cents per litre of milk collected. The FMSS have a formal structure and procedures to govern their business and protected by a set of by-laws that were formulated by the MILCO. A management committee appointed by the members is responsible for the management of the FMSs. According to the rules governing membership of FMS a farmer who is engaged in the business of value added milk products could not obtain the membership. At present the supply of milk by an average is in the region of 2-5 litres per day. Unless the present level of supply by a farmer is increased significantly it is unlikely that MILCO can reach any target procurement levels in future.

2.2.9.2.1. Benefits to the farmers who supply milk to the MILCO

Until recent time, the core business of MILCO was collection, processing and marketing of milk and nothing was done to increase milk production at grass root level or
Dairy Production, Quality Control and Marketing System in Sri Lanka 241

to promote living condition of the farmers. However, at present, as part of its strategy to attract the dairy farmers, MILCO provide several facilities to them. These include free facilities to transport milk to the chilling centers incurring a monthly expenditure of nearly one million rupees, provisions of drugs for cattle on interest free loans, provision of cans, trays and jugs on easy payment schemes, and making cattle feed available to farmers at subsidized rates. MILCO has established a feed mixing plant at Polgahawela with a capacity of 15 MT per day to meet this need. Further steps have been taken to make milk testing, machines available to collecting centers and maintain by them at their cost.

In addition to the above benefits, an insurance scheme is being in place for the dairy farmers which offer substantial benefit to the dairy farmers financially. Under this program, MILCO provide 0.75 cents while farmer contributes 0.25 cents for each liter of milk supplied. This program is highly appreciated by the farmers and helps the MILCO to retain its suppliers to a great extent.

2.2.9.3. Quality control of milk

The responsibility of assuring the quality of milk collected from the farmers determining payments due to farmers in every 15 days and supplying the milk to the processing centres are the main functions of the dairy centre manager. There are 72 dairy centres with chilling facilities spread throughout the seven regions. The milk collected at the collecting centres (over 2500 through the country) run by the FMSS is transported to the chilling centres where the quality of milk is tested and the price to be paid to the farmer is determined. According to the present system a sample of milk supplied by each farmer is tested and a record is maintained at the collecting centres by the manager appointed by the society. The poor quality milk is rejected at the collecting centre itself and farmers are discouraged to supply of spoiled milk. Milk is collected only in the morning and therefore farmers do not milk their cows in the afternoon. The farmers are paid their dues every two weeks according to an average price per litre determined on the basis of the quality of milk supplied by the farmer during the two weeks. Milk preservation is done by chilling (4°C) process at the chilling centre and no preservatives are allowed to use. A strict control over the milk adulterations carried out by the MILCO and milk is tested for various adulterants (urea, salt) at the chilling centre and at the factory where milk is processed. In addition, determination of fat, SNF, Rezusurine test to determine keeping quality, acidity test and the relevant microbial tests are carried out at the factory to determine the quality of milk and contaminated milk is rejected.

2.2.9.4. Private organizations involved in Milk collection and processing

Nestle Lanka has been engaged in supporting the Sri Lanka dairy sector since early 1980’s and the major competitor to the MILCO. Today, Nestle Lanka is the country’s single largest private sector collector of fresh milk, procuring an average of 115,000 litres of milk every day from 13,000 local dairy farmers. The milk processing plant of the company has a capacity of 2,00,000 liters per day and has invested in 107 chilling centres
to date and plans to invest in 8 more before the end of this year.

Nestle Lanka will also provide the dairy farmers with training and development, support and assistance by way of sharing sustainable dairy farming best practices, providing aid and information on livestock health, breeding, milking, hygiene, sterile handling and storage, developing pasture and feed with further incentives for artificial insemination; and distributing highly sought after equipment and supporting material such as milk churns and hampers containing cattle feed.

In addition to the major processors, there are 5-6 private sector institutes which process raw milk collected from specific areas in the country and each unit collects around 15,000-25,000 liters of milk per day. The details of these institutes are given in Table 5D. The Lanka Dairies is the only company that process milk produce from their own farms and is located in the Upcountry. The processing plant has a capacity of 25000 liter per day. They process UHT milk, Yogurt and cheese in their plant and distributed through the Super markets in urban areas.

Most of these private processors have their own marketing strategies to dispatch products to the consumer and, they are operating within their market share in the business. Therefore they do not take much effort to develop the industry at grass root level. However, since recent time some of them provide additional services to the suppliers in certain areas in a small way which is encouraging.

2.2.9.5. Marketing of Processed milk and milk products

Since demand for milk is exceptionally high in the country, there is no difficulty in disposing them. However, heavy advertising is the main instrument that decides the market share of the different organizations. The milk processed by MILCO is distributed to the consumers through the agents from different regions. The consumer demand for MILCO products is extremely high and therefore, supply is interrupted or may not available in adequate quantities in certain parts of the country continuously.

In addition to the major processors, there is few non-formal small scale processors scattered in different parts of the country. They are mainly covering the rural areas where milk collections by major and medium level processors are absent. They usually produce fermented milk products aiming rural community. They collect milk from the near by suppliers without any quality control measures adapted and their market share is negligible.

Buffalo milk is mainly collected by the traditional milk producers in the rural areas and was popular cottage industry in the Southern Province. Milk is mainly used for “Curd” production which is a traditional fermented milk product. Due to higher farm gate price (LKR 55-65 per litre) major processors avoid purchasing buffalo milk. Many small scale buffalo farmers process their own milk at home and sell them within the village. The process of curd by the farmers and the processors done in a very traditional way and generally no hygienic practices are adapted. In recent times many medium scale curd
producers has emerged and they produce quality products introduce in an attractive manner for the urban markets at a higher price.

2.2.9.6. Farm gate price of the Milk

The price of the milk is based on the Fat and the SNF content of the individual milk supply to the collecting centre. At present MILCO is paying around 35.00 LKR a liter of milk with 4.6% fat and 8.3 SNF and others pay around 5 LKR above the MILCO price to attract farmers. The MILCO price is determined by the Minister in charge of livestock sector with consultation of the line ministries (Ministry of Trade). However, the farm gate price of milk is still based on the world market price of the powdered milk.

2.2.9.7. Fiscal Assistance and Insurance for the Dairy sector

The central bank of Sri Lanka has adapted a policy to provide farmers with credit facilities with low interest rate under a special program. According to this program farmers are provided with funds for various activities of dairy farming including capital for purchasing animals and housing etc. Funds are disbursed through the state as well as private commercial banks. The credit facilities are supervised by the field veterinarians in relevant veterinary range.

In addition to the credit facilities a livestock insurance scheme has been offered by the Agricultural and Agrarian Insurance Board and the Ceylinco Insurance Company Ltd. This insurance scheme covers cattle, buffaloes and goats. At present, not many farmers make use these facilities due to lack of knowledge and due to uncertainties prevailing in the industry.

2.2.9.8. Government policy on dairy development

The government has given a high priority for the development of the dairy sector in the country to achieve 50% self sufficiency by the year 2015 (Budget speech 2006). Therefore, in addition to the policies of the previous governments new policies were adapted. Prior to the liberalization of the economy in the mid 1970s, the import of dairy commodities to Sri Lanka was relatively small. However, this pattern changed after the economy was opened in the mid 1970s, and the dairy imports, mainly the full cream and skimmed milk powders, started to increase very rapidly (Daniels 2009).

1. The government adapted policies during the initial stages of the dairy industry:

- To promote the supplies and services to the livestock through strengthening the institutional support for dairy development which was continued by the successive governments

- To institutional strengthening as a means of promoting dairy development was complemented with an administrative decision for banning slaughter of female cattle and buffaloes in 1987. This administrative decision has been made in to a law with effect from November 2007.
2. Fiscal and monetary policies on dairy development

a) Special credit programmes

- As non-availability of credit was identified as a limiting factor in the dairy development, the supply promotion policies for expanding on-farm dairy production was complemented with several concessionary credit programmes since the early 1970s.

- Similarly, the newly-introduced credit scheme for milk processing where loans up to 300 million rupees is made available at concessionary rate of interest to promote private sector participation in the milk.

- Several tax concessions, tariff reductions and value-added tax (VAT) exemption on certain capital goods for dairy production also available as further fiscal incentives.

- Similarly, VAT on locally-manufactured dairy products was removed from 2008 as a further incentive.

- Tax holidays for varying periods were also offered both under the Inland Revenue Act and the Board of Investment (BOI) Law for new companies engaged in dairy production, provided they satisfy certain minimum criteria on investment, employment of labour and plant/project location.

- VAT and duty on semen and breeding animals for dairying had been removed since 2007 as an incentive for private cattle breeders.

3. Trade and tariff policies

- Reduction of tariff rate on imported milk powder even after economic liberalization have been adapted by each government and milk powder was at times duty free or was taxed very low rate of 5 per cent even during the closed economic regime.

4. Raw milk pricing policy

- The farm gate price is influenced by the price of milk that MILCO paid to the farmers in the market is used by successive governments to change producer prices. Also, the policy makers since recently have taken the raw milk price as a major issue, and as such the price revisions were made with the annual budget proposals and as a result farmers now receive between LKR 35 a litre of milk based on its constituents.

2.2.9.9. Legal issues affecting the industry

The three main legislative enactments that have a bearing on cattle and buffalo development in Sri Lanka are the Animal Disease Act No 59 of 1992, the Animal Feed Act no 15 of 1986, and the Animals Act No 46 of 1988. Implementation of these acts has been vested with the Director General of DAPH.
The Animal Disease Act governs the import, export, quarantine and movement of livestock and poultry, as well as animal disease control. The veterinary drug control authority (VDCA) has been established in accordance with section 32 of Animal Diseases Act for the following purposes: a) control of import, export, manufacture, sale and use of veterinary pharmaceuticals and biologicals; b) promotion of research and clinical trials; and c) to ensure the effective and safe use of veterinary pharmaceuticals and biological products.

The animal feed act is to regularize the production, distribution and sale of animal feeds and to formulate regulations to supervise and control matter thereof. The line ministry and DAPH are expected to ensure the implementation of provisions under this act and make necessary amendments depending on situation of the industry at any given time. The Animals Act No 46 of 1988 governs slaughter and transport of animals.

3. CONSTRAINTS TO THE DAIRY INDUSTRY

3.1. Poor organization among farmers

The sector is predominantly smallholder based with several thousand non-commercial or smallholder subsistence farmers scattered across the island. They are tend to be among the poorest of the rural poor and are struggling to earn a living from animal production due to low prices, high costs and the inability to break out of the vicious circle of low productivity and low profit margins. They have weak bargaining power, are poorly organized and difficult to service. The present farmer organizations are village based and no district or national level organization. Most of them supply only few liters (2-5) to the society. Hence, the farmers are not in a position to bargain or influence on the farm gate price of milk. Even the present price per litre paid to the farmer is not sufficient to encourage them to increase productivity.

3.2. Unavailability of good breeding animals, long term breeding strategy and qualified animal breeders in the country

The non-availability of proven animals in the country has badly affected the industry. The practical barriers that encounter in animal breeding aggravate the situation further. With the present demand for milk and milk products, farmers are looking for high-yielding animals and ready to pay a high price for them. There are instances of cheating by selling inferior animals at high prices. This may definitely have an adverse impact on the dairy industry in the future. Moreover, the country will not be able to make use of full benefit of the present situation (high demand for milk and increasing price of milk products) and many people will leave the industry. Therefore, shortage of superior animals for breeding purposes is a major issue that encountered by the industry at present.

3.3. Constraints to Dairy Cattle Breeding

Poor knowledge of farmers, lack of qualified animal breeders in the country, misunderstanding of production systems, lack of information on animal genetic
resources, poor extension service, collapse of the government farms causing unavailability of proven animals for breeding, lack of participation of private breeders or associations, lack of field research with participation of farmers, choice of erroneous technology and inefficiency of AI program are some of the major issues in dairy cattle breeding in the country. Though the industry equipped with a well-develop infrastructure and communication system, poor planning and implementation due to the above constraints hinders any progress in genetic improvement of dairy cattle.

3.4. Low productivity of the Animals

Production of the animals is at extremely low level compared to major livestock producing and exporting countries. The reasons for low productivity attributed to basic reasons such as poor genetic, improper management and husbandry and health. In most of the cases animals are under fed during dry cow period and during the early lactation. This affects the animal’s fertility badly and increase cost of production and reduce milk production too. Poor calf and heifer management also a major constraint to the industry and calf losses and late sexual maturity among animals under normal management is very common. The farmers with large herds in the dry zone face severe problems due to unavailability of communal gazing lands and forced to leave the industry causing declining national cattle population.

Furthermore, poor productivity resulting economic losses due to common animal disease such as mastitis, Pneumonia, Salmonella and external and internal parasites have never given due consideration owing to lack of information.

3.5. Poor feeding and under utilization of existing feed base

Poor utilization of forage-based feeding systems for ruminant livestock. The under-utilization of non conventional feeds including leguminous fodder trees, which grow prolifically in many areas due to lack of awareness by the farmers have been reported in many instances. The locally available non conventional feeds and agricultural by products such as paddy straw, sugar cane tops and other ago-industrial by products are not properly used at present.

3.6. Marketing problems

Imported items, particularly dairy products, are very solidly entrenched in the domestic market. They have strong brands backed by powerful advertising campaigns and extensive distribution networks and therefore easily penetrated the market even in rural areas. Shortage of fresh milk, inefficiencies in the milk collection, processing and marketing system, are major factors that affect the local dairy industry. There are numerous factors contributing to these inefficiencies including: Quality failures at many points in the milk procurement-processing-marketing chain resulting from poor equipment, lack of training, under-capacity of the processing plants, inadequate quality assurance systems, and weak pricing signals etc. This severely limits the ability of local milk to compete with imported dairy products which lead to perception amongst
consumers that imported milk products are of superior quality to local products. Lack of market information and most of the dairy companies (except MILCO & Nestle) do not provide direct support services to their milk suppliers and not interested in village level

3.7. Lack of private sector participation

Dairying is still not sufficiently profitable to finance its own expansion, access to external finance is very limited, and it is not seen as an attractive investment option by outsiders. Therefore, the private sector mostly involve in milk collection, processing and marketing, and do not support the grassroots level development and expect DAPH to provide necessary services and supplies to the farmer so that they could collect milk at a cheaper price.

3.8. Poor coordination among the many institutions

As mentioned earlier many different institutes are involved in the dairy industry while DAPH is being the apex body of livestock industry. However, the extent to which these institutions can make a positive impact on the industry would depend on how far these institutional interventions can make the right services available at the right time at the right place to the farmer in a manner that the farmer or producer will be motivated to produce the right product for the market. As the private sector institutions are basically profit driven their actions are likely to have some negative implications for the farmer. In such a context it is expected that the public sector institutions will play their role to safeguard the interest of the producer.

As things stand at present one cannot observe much relationship that is mutually benefiting between these institutions. One could also observe an unhealthy competition among the few actors in the milk processing industry to procure milk from the small farmers, which has not given any price benefit to the farmer. It is believed that this competition has affected the quality of fresh milk, as some actors tend to purchase low quality milk once rejected by a competing buyer.

The vast majority of professional staff engaged in livestock sector institutions (mainly public sector) trained originally as Veterinary Surgeons. Therefore, it inevitably leads to an institutional culture which is focused on animal health rather than production.

4. Suggestions to Improve the Dairy Industry

As far as the natural resources, infrastructure facilities including animal resources, technology, trained human resources and the government policies are concern, Sri Lanka has an enormous potential for dairy development within the country. However, what we have achieved in the country since inception of the milk industry (early 1950s) is negligible and extremely average low productivity of the animals itself provide a strong evidence for that effect. Furthermore, the constraints listed above have been the same for last few decades and nothing substantial has happened with all the planning and activities
carried out in the dairy sector in the country. Therefore, it clearly shows that there is an urgent need to change the approach and the policies that are adapted in view of improving dairy industry to achieve at least 50% self-sufficiency in milk production by 2015 as expected by the government. Since each and every constraint mentioned above are linked to the dairy industry the common solutions that could be applied to overcome them are suggested below.

4.1. Strengthening the farmer organizations

The dairy industry is dominated by the small farmers and most of them are among the poorest of the society. They produce over 90% of the milk collected in the country and will continue as same in the future too. Therefore, small farmer cannot ignore under any circumstances in the development process of the dairy industry. The only way to increase milk production at grass root level is nothing but strengthening the small farmer and this has to be done by organizing strong farmer’s societies leading to national level. The existing societies are still not geared towards increasing productivity and farmers have not changed their attitude either with the existing situation. This is mainly due to lack of market information and poor knowledge of the farmer on future potential of the industry. They are unaware of the consumer preference to produce quality milk according to the market requirements. Therefore, farmer education on market behavior through formation of strong farmer organization is vital for the improvement of the industry.

4.2. Genetic improvement of animals through organized breeding strategies

Unavailability of breeding animals is another burning issue in dairy industry today. Genetic improvement of animals followed by adoption of better management practices and providing marketing facilities are extremely important in rearing dairy cattle for increasing milk production. As far as the animal genetic resources are concerned, there is an enormous diversity among the national herd which could be effectively used for future breeding programmes. However, in the context of breeding program, an accepted national breeding policy based on breed and/or cross breed genotype recommended for the different zones, and supply of adequate number of stud bulls for natural mating and AI, are the main requirements for the program to be successful. The quality of the available bulls needs to be critically evaluated under local conditions and upgrading of the “quality” has to be considered in the context of national herd improvement program. The dairy cattle improvement through breeding is time consuming and depends on many factors. Therefore a long term plan with active participation of the farmers and the qualified breeders supported by the government institutions is in utmost importance for any future breed development programme.

On the national basis, it is estimated a large number of stud bulls of various breeds and cross breeds will be required for natural breeding each year. The total numbers of animals for breeding in NLDB farms have reduced to less than ten thousand animals, and
it has been difficult to produce their own replacement stock. Therefore, a strategy to produce more suitable animals has to be developed with private farmers having appropriate number of breeding animals. Farmer participation in breeding of suitable animals is a vital component of any breeding program of the future. Therefore, guaranteed buy-back of bull calves derived from recognized breeding farms under the supervision of the expert breeders may be a useful future strategy.

4.3. Make AI service more affective and efficient

The only foreseeable short term solution to the breeding problem lies on efficient AI service with wider coverage to serve the animals distributed through out the country. However scientifically proven bulls should be used for semen collection. These can be achieved by reorganizing the existing dairy farms belonged to the NLDB and promoting private breeders association to produce proven bulls under strict monitoring and control by experts. AI service has to be reorganized and should make use of trained village level technicians selected from the farming community itself and increase the coverage under the supervision of the field veterinarians. A thorough study has to be carried out to ascertain the reasons for the ineffectiveness of the AI service and proper practical remedies should be taken to overcome them.

4.4. Promote innovative approach to marketing of milk

Due to the scattered nature of small-holder dairy farms and the heavy dependence of Sri Lanka consumers on milk powder, our milk collection as well as converting milk to powder cannot sustain in the long run under the new challenges of increasing global oil prices and the need to have an environmentally-sustainable system of milk production. Also, milk is a highly perishable commodity which requires refrigeration and the maintenance of a cold chain until final consumption of many dairy products, and therefore, storage and distribution are very energy intensive.

It should be the policy of the government to promote dairy products and milk marketing systems which require low energy intensive technologies and reducing the distance between the dairy producer and the consumer.

Also, the service delivery was not adequate to support the dairy development needs of the small farmers. These deficiencies had negative impacts on the programmes of increased public spending and other fiscal measures provided by the government to encourage dairy development.

4.5. Promote commercial dairying

It is important to adapt policies to create a set of entrepreneurs in dairying who will be able to demonstrate best management practices of dairying, utilizing local feed resources for low-cost milk production and who will adopt scientific breeding for producing the required number of quality breeding animals for the dairy industry including the smallholders.
The facilitation of Private Finance Initiatives can be another useful policy instrument for promoting commercial dairy farms. The state lands under the National Livestock Development Board can be developed with private finances and be commercialized for a greater benefit, while retaining the state ownership of the entity. Such initiatives can import superior dairy animals and genetics for upgrading the local dairy stock, transfer production and processing technology to the local dairy sector and introduce innovative marketing and management methods.

4.6. Farmer participatory research approach

In order to understand the multifaceted problems of the farmers, a multidisciplinary approach is required. Furthermore, active participation of the farmers in the process of problem definition, adaptive research and in generation and transfer of appropriate technologies is essential.

4.7. Make dairying competitive

The key challenge for the whole sector is reducing cost of milk production and increasing productivity of the large number of smallholders, which is the dominant group of the dairy sector. Policies to help the small farmers produce milk on pasture, forage and other locally available feed raw materials, acquire technologies to bring in efficiencies for dairying, and thereby increasing the competitiveness of the local dairy producers to move beyond present subsistence dairy production.

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Role of National Dairy Development Board (NDDB) in strengthening Regional Cooperation

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**Conclusion**
1. **INTRODUCTION**

1.1. South Asia comprises diverse areas in terms of natural resources, comparative advantages, human resources, economic growth and rural urban systems with their own characteristic inter linkages. The region has quite a few pockets that have similar dairying systems and are generally driven by small holder milk producers. Dairying in the region is generally competitive and it contributes significantly to both nutrition and the livelihoods of smallholder milk producers. Therefore, there is scope for strengthening regional cooperation in dairy development where by SAARC countries could share their learnings and best practices for mutual benefit and also identify opportunities to promote trade.

2. **EFFORTS BY NDDB INDIA TO PROMOTE REGIONAL COOPERATION IN DAIRY DEVELOPMENT**

2.1. India’s National Dairy Development Board (NDDB) has been contributing to efforts for promoting regional cooperation in dairy development through various initiatives. They include:

- South-south workshop “Smallholder Dairy production and Marketing: Opportunities and Constraints” (Anand, India, March 2001);
- Joint FAO/NDDB international workshop “Livestock and Livelihoods: Challenges and Opportunities for Asia in the Emerging Market Environment” (Anand, India, November 2003);
- FAO/NDDB Partnership for execution and implementation of the project South Asia Pro-Poor Livestock Policy Programme (SAPPLPP);
- Dialogue under the initiative of the International Dairy Federation (IDF) with some of the emerging dairy nations (including Bangladesh and Nepal) to identify issues related to their respective dairy sectors.

2.2. **Orientation programmes for personnel from Bangladesh**

- Productivity enhancement & dairy development (2000-01 and 2002-03);
- Dairy development and related activities (2003-04);
- Cooperative dairying in India, current trends and challenges and strategies that are being planned and implemented to uphold the interests of milk producers (2008-09);
- Cooperative dairying in India and related activities (2010-11).

2.3. **Orientation programmes for personnel from Bhutan**

- Dairy development in India (2004-05);
- Bull and dairy animal management, dairy processing technology and procurement and technical inputs (2005-06);
• Progress of dairy cooperatives in India and challenges ahead (2007-08);
• Guidance in assessing milk quality and improving microbial quality of product such as cheese & butter through quality assurance (2007-08);
• Yoghurt making, through classroom sessions and hands on experience at a modern dairy plant (2008-09);
• Cooperative dairying in India, including various aspects of animal breeding, feeding and management (2009-10).

2.4. Orientation programmes for personnel from Nepal
• Dairy development and related activities (2002-03, 2003-04)
• Cooperative dairying in India, current trends and challenges and strategies that are being planned and implemented to uphold the interests of milk producers (2006-07, 2008-09 and 2010-11)

2.5. Orientation programmes for personnel from Sri Lanka
• Cooperative dairying in India (2006-07).

3. POTENTIAL FOR PROVIDING ORIENTATION/ TRAINING TO PERSONNEL OF SAARC COUNTRIES IN AREAS RELATED TO THE NATIONAL DAIRY PLAN, PHASE I.

3.1. The demand for milk in the SAARC region appears to be growing at a faster pace in comparison to the growth in milk production. India and Pakistan have the ability to meet growing demand by harnessing their potential to increase milk production through an increase in productivity, particularly over the long term. The other countries in the region may have to consider the merits of a strategic blend of public and sector specific policies that can provide opportunities for both boosting milk production and opting for imports of dairy commodities, such that it does not dampen the effort and incentive to increase domestic milk production.

3.2. In India, efforts to increase bovine productivity and thereby contribute to increasing milk production are envisaged under the National Dairy Plan (NDP) which spans the next 15 years. The first phase of NDP, is proposed to be implemented between October 2011 and September 2017. NDP I would be pursued through the adoption of focused scientific and systematic processes in provision of technical inputs supported by appropriate policy and regulatory measures. The objectives of NDP-I are:

• To help increase the productivity of milch animals and thereby increase milk production to meet the rapidly growing demand for milk and;
• To help provide rural milk producers with greater access to the organised milk-processing sector.
3.3. The key components under NDP I are:

- Animal breeding:
  - Increasing the production of High Genetic Merit (HGM) bulls (for use in semen stations) through progeny testing and pedigree selection programmes;
  - Increasing the production of disease free high quality semen doses (by both expanding existing semen stations and setting up new ones with the required scale and size);
  - Setting up a pilot model for viable doorstep AI delivery services through a professional service provider [who would deploy trained mobile AI technicians to perform AIs following Standard Operating Procedures (SOPs)];
  - Producing a substantially higher number of genetic merit bulls of required breeds for use in semen production;
  - Strengthening the policy and regulatory framework that can provide the impetus for achieving success in breeding programmes;
  - Strengthening capacity building, training and professional development levels, from milk producers to field staff to professionals engaged in breeding.

- Animal nutrition
  - **Ration Balancing Programme (RBP):** Milch animals are usually fed one or two locally available concentrate feed ingredients, grasses and crop residues. This often leads to imbalanced feeding -- resulting in proteins, energy, minerals and vitamins being in excess or deficient. Imbalanced feeding also adversely affects the health of animals and income from milk production since about 70 per cent of the total cost of milk production is on account of feed. There is a need to educate milk producers on ration balancing -- through trained village based local resource persons - so that the nutrients requirement of a milch animal is fulfilled in an optimum manner, thereby improving milk production efficiency and economic returns from dairying. The trained local resource person will provide advice on Ration Balancing based on centrally developed and standardised user-friendly computerised software. It is expected that the scientific approach to feeding of milch animals will also lead to reducing methane emissions.
  - **Fodder Development:** NDP I would support demonstrations and farmer training programmes for improved fodder use and conservation on land already under fodder through an increased use of certified / truthfully labelled fodder seeds. It will also support demonstrations for
conservation of green fodder through silage making and enrichment/densification of biomass for use in fodder deficit areas and the use of mowers for securing crop residues from the farmers’ field left by combine harvesters, which otherwise are wasted.

- Strengthening capacity building, training and professional development at all levels, from milk producers to field staff to professionals engaged in animal nutrition.

- Promoting and strengthening village based milk procurement systems: Efforts to increase milk production through an increase in productivity would need to be supported by expanding existing village based milk procurement systems, and setting up new ones, to collect milk in a fair and transparent manner and make timely payments to milk producers. NDP I envisages investment on items such as milk cans, bulk milk coolers for a cluster of villages, associated weighing and testing equipment and related IT equipment for expanding milk collection and bulking at the village level.

- NDP I also envisages continued investment to train the Boards of Directors of milk unions in business and governance practices, facilitate farmer orientation programmes and offer training to technical staff of dairy cooperatives in various areas including clean milk production. NDP I also provides for investment in capacity building, training and professional development at all levels, from milk producers to field staff to professionals involved in promoting Producer Companies*.

(*A Producer Company combines the institutional strengths of Mutual Assistance and the Cooperative Principles within the liberal regulatory framework of Company law. Producer Companies have to observe and practice the unique features of cooperatives. Since Producer Companies will be registered under a Central Act, they will have the flexibility to operate with greater professionalism and autonomy and would not have the constraints faced by cooperatives which function under state cooperative laws.)

3.4. SAARC countries could seek opportunities for orientation/ training of their personnel in the different areas that have been explained above.

4. OPPORTUNITIES FOR PERSONNEL FROM SAARC COUNTRIES TO AVOID TRAINING IN PLANT OPERATIONS

4.1. NDDB has a national centre for training supervisors and operators in the technical skills required for dairy plant operations as well as for operations of Bulk Milk Coolers installed in the villages. This facility could be availed by personnel from SAARC countries.
5. OPPORTUNITY FOR PERSONNEL FROM SAARC COUNTRIES TO AVAIL TRAINING AT THE CENTRE FOR ANALYSIS AND LEARNING IN LIVESTOCK AND FOOD (CALF)

5.1. Recognising that accurate and reliable analytical services support the food and feed industry, NDDB has set up in Anand, the Centre for Analysis and Learning in Livestock and Food (CALF). CALF has scientists with expertise in varied fields such as food technology, microbiology, biochemistry, chemistry, nutrition, veterinary science and genetics. The various sections of CALF – chemical, instrumentation, microbiology and disease diagnostics – are designed to meet the international standards for laboratories. There are segregated areas for different testing processes. The instrumentation section has capabilities to carry out analysis of food and feed materials for chemical contaminants and trace elements meeting Codex standards and guidelines. Adequate sample storage facilities to ensure sample integrity and custody before, during and after analysis have been provided. CALF follows the Quality Management System based on ISO:17025 to ensure operational integrity and confidentiality including protection of proprietary rights of the customer. CALF’s technical competency for testing melamine in milk products is at par with other international laboratories.

5.2. CALF conducts training programmes in food and feed analysis and its services could be extended to laboratory, and other related, personnel from SAARC countries who wish to avail such training.

CONCLUSION

5.3. NDDB, India has been contributing in various ways to strengthen regional cooperation between SAARC countries. It would be happy to continue contributing to such effort by offering orientation/ training/ capacity building programmes to personnel of SAARC countries in different areas related to animal breeding, animal nutrition, milk procurement, institution development, quality and analysis and dairy plant operations.
Role of National Dairy Research Institute (NDRI) in Technology and Human Resource Development for SAARC Region

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Livestock farming is an integral part of rural livelihood in the SAARC region. The region accounts for 76% and 18% of the world buffalo and cattle population, respectively. Also, more than 1/3 of the ovine stock in the world is inhabited in this region. Milk production in SAARC region is close to 150 million tonnes- more than 1/5 of the total milk production in the world. Being a buffalo dominant region, 93% and 70% of the buffalo milk and meat in the world, respectively, is produced in the SAARC nations.

Dairying in SAARC countries has some striking commonalities. The region is rich in livestock diversity. Besides being buffalo dominant, it is the native tract of very good cattle breeds like, Sahiwal, Tharparkar and Rathi. Unlike the large commercial dairy herds in the developed nations, the milk production in this region is dominated by smallholders possessing generally 2-3 dairy animals, or slightly larger herd of 5-6 animals as in Sri Lanka. Given the commonalities in the livestock resources and production system, the challenges faced in dairy development in the SAARC region are also of similar nature, such as, low milk productivity, feed and fodder shortages, inadequate livestock support services, high rate of livestock mortality and morbidity, low level of value addition, etc.

In this context, India being a leader among SAARC nations in terms of dairy production, the National Dairy Research Institute through its research, teaching and extension activities can play an instrumental role in augmenting dairy development not only in India but also in other SAARC countries. Under the aegis of Indian Council of Agricultural Research, the Institute conducts basic and applied research with the objective to enhance animal productivity and also to develop cost effective technologies for the benefit of the consumers, the industry and the farmers. The Institute, having the status of Deemed University, is contributing significantly to the human resource development through its undergraduate and post-graduate teaching /training programmes for Indian and international students.

Before presenting the important activities and achievements of the Institute for promoting dairy development in the SAARC region, a brief overview of the history of this premier dairy research institution follows.

**NDRI: Historical Perspective**

The foundation stone of the edifice of National Dairy Research Institute was laid with the establishment of Imperial Institute for Animal Husbandry & Dairying at Bangalore on July 1, 1923. The Institute at its early stage at Bangalore was established primarily as a centre for Dairy Education. A two-year training course for the award of Indian Diploma in Dairying (IDD) was started at the Institute and later several other courses were added. In 1936, it was expanded and renamed as Imperial Dairy Institute. It was in 1955 that its Headquarters were shifted to Karnal, and rechristened as National
Dairy Research Institute. The Institute was brought under the wings of the Indian Council of Agricultural Research in 1966 in order to provide greater operational autonomy in research management functions. In 1989, status of Deemed University was conferred to the Institute for further strengthening the academic programmes for human resource development. Presently with its two regional stations, Bangalore in south and Kalyani in eastern India, the Institute conducts research in the areas of dairy production, processing and management and provides high quality education in the field of dairying, which has no parallel in Asia.

**Research and Development**

The R&D activities of the Institute mainly focus on three fundamental facets of dairying i.e. production and management of dairy animals for better productivity, innovating suitable milk processing technologies and equipments, and providing the dairy farmers and entrepreneurs with information about existing market demands and practical management inputs for making dairying a self-sustaining, profitable business. Research, both in basic and applied aspects, in various disciplines constitute the core activity of the Institute.

Continued research efforts on genetic improvement of dairy animals has resulted into development of superior strains of dairy cattle namely 'Karan-Fries' and 'Karan-Swiss' which are suitable for Indian agro-climatic conditions both at organized farm and field levels. These synthetic strains have been evolved by crossing the Tharparkar and Sahiwal as indigenous breeds with Holstein-Friesian and Brown Swiss, respectively, using scientific breeding methodologies. The young bulls of Sahiwal and Karan-Fries cattle and Murrah buffaloes produced through nominated matings are progeny-tested to select genetically superior bulls with higher breeding values. As a part of the germplasm dissemination programme, frozen semen from high pedigreed and progeny-tested bulls is distributed to different state government establishments, NGOs and other developmental agencies. Advanced genome techniques are used to identify animals with better production and reproduction attributes. Molecular interventions for augmenting reproduction, clean milk production and post-milking improvement of milk quality, development of suitable animal-shelter management systems and environmental aspects of dairy development have helped to work out a well defined package of practices for different production categories of animals. Faster multiplication of superior animals using Embryo Transfer Technology and other Embryo Bio-techniques constitutes the core research efforts in the area of Animal Biotechnology at the Institute. By refinement of this technology, it was made possible to produce more than 10 calves from an elite female in one calendar year. NDRI has the distinction of producing first test tube buffalo calf of the world, 'Pratham', using a highly sophisticated technique of in vitro fertilization and Embryo Transfer. The technology has now been extended to develop goat as a model animal for advanced research in transgenic animal production. The country's first in vitro goat kid was born at NDRI. The most remarkable breakthrough in the recent past has
been the birth of world’s first cloned buffalo calf at NDRI through development of a new technique called ‘Hand–guided cloning’ technique. This single research achievement has again put NDRI on world map. Research in animal physiology has helped in detailed endocrine profiling of animals to ameliorate heat stress, better reproduction management and inducing lactation which essentially augment the production level of animals.

The nutritive value of poor quality roughages and agro-industrial by-products used as animal feed has been improved significantly by employing chemical and physical methods. Improved varieties of fodder crops and their cultivation methods have been developed at the Institute. Wheat, as a dual-purpose crop, has been successfully tested at this Institute. Research on balanced feed formulation has resulted in development of complete and enriched feed/ mineral blocks for sustaining production level in high producing animals. Research is being carried out for manipulation of rumen fermentation and increasing the efficiency of nutrient utilization by animals. Bypass protein technology has been developed for meeting the nutrient needs of high yielding animals. Feeding strategies to enhance conjugated linoleic acid (CLA) in bovine and buffalo milk have also been worked out.

In the area of dairy processing research, the Institute has developed technologies for the manufacture of a variety of indigenous dairy products like khoa and khoa-based sweets, chhana and chhana-based sweets, srikhand, rabri, paneer, long-life lassi, extended shelf-life rice kheer and Milk-cake, etc. Several innovative ready-to-reconstitute formulations for the manufacture of khoa, gulabjamun, rasogolla, kulfi, ras malai, basundi, kheer, dalia, gase-gase payasam, paneer-curry and Cheese-poorie are available for adoption at industrial scale. The formulated foods evolved at this Institute include whey-based lassi and flavoured drink, bajra lassi, bajra biscuits, weaning foods based on whey/skim milk, soy-butter milk softy, malted milk food, whey-based soups and low-fat spreads. New functional dairy products (or 'health foods') such as probiotic cheese and dahi, sports drinks, low cholesterol ghee, herbal ghee, ice-cream and burfi for diabetics, and a formulation for cardio-vascular health have also been developed. A food-grade bacteriocin based bio-preservative formulation has also been developed for enhancing the shelf life of paneer and khoa. Equipments have been designed for both small scale dairy operations and mechanized production. Some of the equipments suitable for adoption by the Indian dairy industry are continuous paneer, ghee, khoa and rasogolla-making machines.

A kit developed for the detection of various adulterants in milk is in high demand among dairymen across the country. A bio-sensor based kit for detection of antibiotic-drug residues in milk, a test of detection of the presence of synthetic milk in normal milk and a colour-based enzymatic test for detecting soya milk in milk have been evolved. In the field of nanotechnology, gold nanoparticles using new reducing agent for their potential applications in lateral flow have been successfully prepared. The Institute
maintains a National Collection of Dairy Cultures (NCDC) that supplies starter cultures to the industry and institutions across the country.

Recent developments in Biotechnology have opened up new and exciting possibilities both in Dairy Production and Processing. Some of the magic tools of Biotechnology such as Genetic Engineering, Somatic Cell Cloning, Establishment of Stem Cells, Hybridoma Technology, Transgenics and Bioprocess Engineering are currently being explored to develop commercial products and processes that use living systems to provide value added, clean, wholesome and nutritious high quality products which are within the reach of the common people. The success of these programmes would prepare dairy industry in the SAARC countries to face the newer challenges of global competition. It would permit greater value addition to processed products by improving the nutritional and therapeutic attributes and ensure higher returns to the farmer.

In the areas of dairy management and extension a composite management index for bovines as a determinant for enhancing milk production has been developed. Economic feasibility report for dairy farms and milk plants, and impact of developmental programmes including constraint analysis for dairy and crop production system have been evaluated. Bench-mark surveys and cost studies using various knowledge and Management Information System (MIS) have been conducted for estimation of cost of milk production, and understanding the behavior of milk producers and consumers.

**Human Resource Development**

The first formal Dairy Technology course was started in India at NDRI in 1957. Over the past five decades, the Institute has produced more than 2,154 Dairy Diploma holders, 1,197 dairy graduates, 1,984 post-graduates at Masters Level and 920 at Doctorate level in different disciplines of Dairying. Deemed University status was conferred on the Institute in 1989, for further strengthening its academic programmes. The programmes of NDRI Deemed University are constantly reviewed and updated to impart requisite knowledge levels to the graduates to make them academically proficient in meeting the emerging global challenges. Supplementary to the classroom teaching, one-year in-plant training in an industrial environment providing an opportunity to the NDRI students to manage dairy processing jobs in a commercial milieu is an outstanding feature of the B. Tech (Dairy Technology) programme. A Placement Cell of the Institute provides career guidance, training and placement services for the students. NDRI postgraduate students provide the core faculty for the State Agricultural Universities in Dairy and allied disciplines and also serve the ICAR, CSIR and other National Laboratories as scientists. Alumni of this Institute occupy responsible positions in dairy industry and in R&D institutions and universities, both in India and abroad.

The Institute offers well-structured comprehensive courses and the students are in high demand also in non-dairying organizations such as medical institutions, pharmaceutical industry, finance sector, etc. Many of our graduates have established
themselves as leading entrepreneurs, who have set up their own dairy enterprises dealing with dairy equipment design and fabrication, dairy products manufacture and IT industry. The Institute has also been recognized as Centre of Advanced Studies in the disciplines of Animal Genetics & Breeding and Dairy Technology to further strengthen its HRD activities. The valuable scientific expertise that the Institute has gained in tropical dairying is being shared with the scientific community through specially designed international training courses. There are 30 such courses offered, covering contemporary knowledge base for addressing problems related to animal breeding, feeding, milk processing and marketing.

The Institute continues to attract international students from a host of countries such as Nepal, Bangladesh, Afghanistan, Iran, Iraq, Rwanda, Myanmar, Mauritius, Sri Lanka, Vietnam, Ethiopia, Holland, Egypt and many other countries for training and education in Dairying. Advanced training imparted to the faculty members under various collaborative programmes has immensely helped in improving the quality of research, teaching and consultancy.

**Strengthening Regional Cooperation**

The key areas in which the SAARC nations can benefit from the available livestock resources, technical expertise and research infrastructure to strengthen regional cooperation in the development of the livestock sector are:

- Undertaking collaborative livestock research programmes
- Human Resource Development through student exchange programmes and capacity building and sharing of technical expertise, by way of faculty exchange programme
- Developing Livestock Gene Bank through exchange of germplasm
- Co-ordinated efforts to eradicate the trans-boundary animal diseases
- Harmonization of Food Laws with Codex and amongst SAARC countries
- Promote trade of livestock products through regional trade agreement
- Protect regional interest in future WTA negotiations, specially preventing the unfair and discriminatory trade barriers against the products of SAARC countries

The National Dairy Research Institute envisions to usher in a White Revolution in the SAARC region in close collaboration with the livestock research and development institutions in the other SAARC nations.
Recommendations of the consultation meeting on Dairy Production, Quality Control and Marketing System in SAARC countries

A consultation meeting on “Dairy Production, Quality control and Marketing system in SAARC countries” was organized by SAARC Agriculture Centre (SAC) in collaboration with National Dairy Research Institute (NDRI), Karnal, Haryana, India on 25-26 May 2011. The consultation meeting was carried out according to SAARC Agriculture Centre (SAC) work plan -2011 with the following objectives:

1. To review the existing dairy production system in the SAARC countries
2. To compare the dairy diversity among the member countries
3. To identify the strength and weakness of the present scenario
4. To recommend measures for improving the existing production system in individual member countries to address the need of 21st century.

At the onset of the meeting, Prof. Dr. A. K. Srivastava, Director and Vice Chancellor of National Dairy Research Institute, Karnal, India chaired the inaugural session whereas eminent Veterinary Scientist, Dr V K Taneja, Vice Chancellor, Guru Angad Dev Veterinary and Animal Sciences University (GADVASU) graced the occasion as chief guest and Dr K M Bujarbaruah, Vice Chancellor, Assam Agricultural University (AAU) was as special guest and Dr. Abul Kalam Azad, Director, SAC as Guest of Honour. About 50 eminent dairy scientists from member states, NDRI, National Bureau of Animal Genetic Resources (NBAGR) and Central Institute for Research on Buffaloes (CIRB), India were present in the inaugural session.

Dr. Abul Kalam Azad, Director, SAC elaborated the objectives of the consultation meeting. He further emphasized that SAARC Member countries have large population of cattle and buffalo, but in most of the countries the production is far below their national requirement. The quality Control of dairy products, marketing system and strengthening of value chain is very important for the SAARC countries. Sharing of knowledge, experience and recommendations on dairy production, quality control and marketing system in SAARC countries would help the planners, policy makers, extension workers and farmers to enhance quantity as well as quality dairy production in the region. Dr. Azad also illustrated the activities of the Centre as well in his speech.

Dr V K Taneja emphasized that India and Pakistan together account for 83% of the cattle population of SAARC countries and out of the total milk production of 145 million tones, India’s share is 73%, while Pakistan’s contribution is 22% and remaining 5% is contributed by other six nations. He further emphasized that India and Pakistan should
come forward and help other SAARC countries in strengthening dairy sector in bringing about quantitative and qualitative improvement in the region.

Dr K M Bujarbaruah, in his speech reiterated the need to look for concrete steps for gearing up production in the dairy sector in the region and said technology alone was not enough. He also emphasized that for regional cooperation and collaboration on dairy production a common platform needs to be formed.

Inaugural session was followed by two technical sessions under the chairmanship of Dr K M Bujarbaruah, Vice Chancellor, Assam Agricultural University (AAU) and Animesh Banerjee, former president of Indian dairy association respectively. About 25 dairy experts and scientists from member states, NDRI, NDDB, National Bureau of Animal Genetic Resources (NBAGR), Central Institute for Research on Buffaloes (CIRB), India were participated in technical session and contributed their valuable inputs. Six focal point experts from Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka presented their country status report. In addition, one paper each from NDRI & NDDB was also presented.

Dr. A. K. Srivastava, Director, NDRI, India presented the Dairy Development Scenario in India. He provided a historical perspective of how dairying has made a quantum jump of more than six times increase in milk production over the last 45 years from 17 million tonnes to about 110 million tonnes in 2011. He elaborated the overall livestock scenario of India compared to other SAARC countries. He highlighted that milk production was the most important livestock product contributing to 72% of the total livestock output in India. He further informed that 23% of rural family income comes from sale of milk and milk products. He emphasized that the strengths of the Indian Dairy Scenario in terms of (i) growth in milk production is around 3.5-4%; (ii) large mega biodiversity and the fact that the country housed the maximum bovine and buffalo population in the world and (iii) that India had an approximately four times the growth rate of global average milk production. He also informed that all the three farming systems viz zero input-low output, low input-moderate output and intensive input- high output systems exist in dairy sector in the country. He also pointed out that the cost of the milk production in the country was lowest in the world highlighting the development of cooperative network in the country which also contributed to the enhancement of income of millions of dairy farmers in the country.

The focal point for Bhutan Dr. Dhan. B. Rai, Program Director, National Livestock Breeding Programme provided a detailed description of the dairy scenario in Bhutan and also highlighted the importance of subsistence farming system being practiced by over 90% of the population which was engaged in livestock rearing in Bhutan. He informed that in addition to local cattle, crossbred cattle and the native Nublang breed of cattle, mithun crosses as well as Yak also contributed milk to the farming community with a break-up of 42% milk coming from crossbred cattle, 32% from local cattle, 7% from Yak and 12% from mithun crosses. Bhutan is a Himalayan kingdom with altitudes up to 7500
metres above the sea level and producing 22,882 metric tonnes of milk, excluding the amount consumed by the producers. Since there was a great demand of milk and milk production due to rising incomes in Bhutan, the country was also importing milk products from India, he added.

Mr. Babu Kazi Panta, Director, National Dairy Development Board from Nepal provided a detailed account of dairy development in Nepal which was also mainly small farmer driven. He also provided an interesting observation that 70% of the farmers reared cattle while 50% of the populations had buffaloes. Most of the milk came from the small farmers who owned 1-5 cows/ and or buffaloes. He highlighted that there was an adequate network of dairy cooperative system in the country. For improving crossbreeding the country had also resorted to purchase of exotic germplasm of cows for crossbreeding with local breeds. He informed that Nepal farmers followed three different systems of feeding- (i) Straw based systems, (ii) Straw and grass and (iii) Green fodder based system. The average indigenous cow produced 400 litre per lactation as compared to the buffaloes which produced two and half times more. He also provided the information on the different native cattle viz Acchami, Lulu, Pahadi and Terai breeds in addition to Yak, all of which contributed small quantities of milk.

The focal point from Bangladesh Dr. Muhammad Shamsuddin, Professor of veterinary science, Bangladesh Agricultural University provided the Bangladesh scenario of dairy development. He informed that dairy production was mainly carried out by around 3.6 million farming households who held a total of 24.5 million cattle and 0.9 million buffaloes. Of these cattle 10 million were lactating cows which included 3.5 million crossbred cows. On an average Bangladesh produced milk which contributes to 6% to the annual economic growth in the country. However, since the milk consumption was increasing by 3% annually, there was an urgent need for enhancing the milk production in the country, because the average growth rate of milk produced was a modest 2% he added. He provided the information on the cost of the production of milk and also the cost to the consumers and stated that primary producers gets only 52% of the cost at which it was sold. He emphasized community dairy veterinary approach for increasing dairy productivity and also mentioned milk production can be increased rapidly if marketing, veterinary services and technology supports are made available.

Dr. Haleem U. Hasnain, former member of Animal Science, Pakistan Agricultural Research Council from Pakistan provided an overview of dairy development in Pakistan and highlighted importance of small farmers as a major source of overall milk production and milk production contributed 53% to the agricultural GDP and 12% to the national GDP. The total milk produced in Pakistan was 44 million metric tonnes annually from 33 million cattle and 30 million buffaloes. He also stated that there was some degree of seasonality in milk production since the buffaloes generally calve during the autumn months. He highlighted the importance of two very important dairy breeds of cows viz Sahiwal and Red Sindhi which were very well adapted to the tropical environment and
produced 1500-2200 litres per lactation. In buffaloes the Nili Ravi and Kundi buffaloes were native to Pakistan producing milk ranging from 1800-2400 litres/lactation with yield of + 6% fat content. He mentioned an interesting observation of the dairy development in Periurban areas especially around big cities of Pakistan viz Karachi and Lahore where greater profitability through sale of milk was observed, although it led to the production of large number of unused manure which had considerable potential for biogas production, he added. A.I. in the country covered only 10% of the animal and only 3% of the total milk produced in the country was processed. He also stated that traditionally dairying in Pakistan is a way of life and not an industry.

Finally, the focal Point from Sri Lanka Dr. A. Gunawardena, Senor Professor of Animal Science, University of Ruhuna narrated the dairy development in his country stating that contribution of dairying to the livestock sector was about 40%. He pointed out that 0.4 million farmers are engaged in dairy development in Sri Lanka and the country imports 80% of its milk and milk products requirements. Increased cost of importing milk has necessitated accelerated growth in dairy development in his country, he added. Of the total milk produced, buffaloes contributed 25% of the total milk and most of these buffaloes were crosses with Murrah and Nili Ravi. Since the climate of the country was congenial for milk production, exotic herds of Freisian and Jersey were also available in the country. The total cattle and buffalo population was 1.2 million and 0.3 million respectively he added. However, the main problem for dairy development was infertility in more than 50% in cattle and buffaloes livestock.

From all these presentations the following common constraints emerged with specific reference to dairy production:

1. SAARC Member countries have a rich biodiversity of dairy livestock, but in most of the countries the milk production/animal is very low.
2. There is a paucity of fodder production.
3. A majority of bovine population is non-descript.
4. Most of the milk was produced by small and marginal resource poor farmers.
5. Access to Veterinary health care for dairy farmers is inadequate.

There were also two presentations delivered by Dr. A.K. Srivastava, Director, NDRI, India on "Technological and human resource development at NDRI" and Mr. Ravi Shankar, Executive Director, National Dairy Development Board (NDDB), India on "Role of NDDB in strengthening regional cooperation in dairy sector". Both the presentations emphatically agreed to the fact that there are commonalities among SAARC countries in the kinds of problem being faced in the area of dairy development whether it is production, quality control or marketing. Both they emphasized in getting technical help in the areas of

A. Breed development planning and AI delivery
B. Ration balancing and fodder development  
C. Strengthening governance in traditional dairy cooperatives  
D. Quality milk production  
E. Basic and advanced food analysis technique  
F. Improving Processes, increasing shelf life and packaging of indigenous products.  
G. Planning in establishment of feed plants, processing plants, testing laboratories and food safety plan with respect to dairying.  

Finally, all the experts discussed deliberately about all the country status report and have drawn few recommendations on different thematic areas for increasing quality dairy production in SAARC countries.

In the concluding session, under the chairmanship of Dr Ramesh Chand, Governing Board Member of SAC and Director, National Centre for Agricultural Economics and Policy Research (NCAP), India following recommendations have been advocated for adoption by the member states in order to enhance quantity as well as quality dairy production in the SAARC region:

**Dairy Production**

1. SAC network should be expanded to gather and disseminate the information on animal breed, feed and other aspects of dairy production. Each SAARC member state should nominate a focal point to supply such information to SAC.

2. The conservation and utilization of animal genetic resources should be coordinated among SAARC countries by formulating necessary policies by the respective member states.

3. Cooperation among SAARC countries should be extended on use of vaccines and diagnostics to control trans-boundary animal diseases.

4. Infrastructure and public investment for dairying need to be enhanced by each member state commensurate with the contribution made by this sector to national GDP.

5. SAARC countries need to prepare a dairy vision covering all aspects.

6. Active steps should be taken for increasing dairy productivity by exchange of germplasm, human resource development and other means.

7. Member state should consider adoption of buffalo as a means of increasing milk and meat production.
8. Various options and means should be exploited to improve availability of feeds and fodders for quality nutrition of dairy animals.

9. Veterinary services in all SAARC countries are weak. This needs immediate improvement and also it should be made available on-farm.

10. In order to cover risks associated with dairying, innovative insurance need to be developed and made available.

Quality Control and Marketing

1. There is need to revise the standards for fat and SNF of cow and buffalo milk based on research data.

2. Develop consumers awareness programmes related to zoonotic diseases of public health concerns.

3. Create price incentives to milk producers for quality milk production, in terms of hygiene, somatic cell count, microbial load and chemical contaminants etc.

4. Promote milk processing to minimize adulteration.

5. Training of manpower for quality milk production at farm level and its testing for quality assurance is required. NDRI in India can take a lead in this direction.

6. Every SAARC Country should have an effective national regulatory body to ensure the quality of milk and milk products and there should be effective implementation of the same.

7. As poor testing facilities are existing in most of the SAARC countries, there is strong need to strengthened quality control programme through well established quality control labs, mobile testing laboratories, milk adulteration detection kit etc.

8. Every member state should have their own extension programme for clean milk production, on the pattern of multinational companies like Nestle.

9. Maintenance of cold chain during the collection of milk should be strengthened

10. Each member state should have a network of quality control laboratories, uniform method of analysis, adequate technical personnel to manage quality assurance goals and measures for sanitary and phyto-sanitary monitoring.

11. Each member country should establish a central/ referral dairy testing laboratory for dairy quality control and facilitating dairy import and export. The laboratory should adopt ISTA accreditation at the earliest.
Policy Issues

1. Each Member should have an Apex level national policy making organization on dairying.

2. Public sector investment should be increased and an investment friendly regulatory framework should be developed to ensure public private partnership in each member state.

3. A centre of excellence for dairy science and technology should be established in the SAARC region with affiliated branches in all the member countries for research and human resource development in dairy technology.

4. The “SAARC dairy development board” should be established by SAARC Agriculture Centre with the mandate of developing dairy industry in the region.

5. Each member state should have infectious as well as trans-boundary animal disease control programme and institutional mechanism.

6. There is urgent need that the technologies available in the region should be put to the farmer through effective research -extension linkage.

7. There is urgent need to promote the exchange program for students and faculty among SAARC countries in dairying.

Role of NDRI & NDDB, India

The expertise and experiences of NDDB and NDRI should be utilized in technological and human resource development in regional context.
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