DAIRY FARMING

Dr Avtar Singh, Dr B.K. Joshi
Dr M.L. Kamboj and Dr Shiv Prasad

भाकृअनुप
ICAR

Indian Council of Agricultural Research
New Delhi
www.icar.org.in

Dairy Farming

Dr Avtar Singh, Ph.D., ARS
Principal Scientist
Animal Genetics and Breeding, Dairy Cattle Breeding Division
National Dairy Research Institute, Karnal 132 001 (Haryana)

Dr B K Joshi, Ph.D., ARS
Director
National Bureau of Animal Genetic Resources
Karnal 132 001 (Haryana)

Dr M L Kamboj, Ph.D., ARS
Senior Scientist
Livestock Production and Management, Dairy Cattle Breeding Division
National Dairy Research Institute, Karnal 132 001 (Haryana)

Dr Shiv Prasad, Ph.D., ARS
Principal Scientist
Livestock Production and Management, Dairy Cattle Breeding Division
National Dairy Research Institute, Karnal 132 001 (Haryana)

भाकृअनुप
ICAR

Directorate of Knowledge Management in Agriculture
Indian Council of Agricultural Research
Krishi Anusandhan Bhavan, Pusa, New Delhi

First Printed : July 2010
Reprinted : September 2017

ISBN : 978-81-7164-066-9

Price : Rs 500/-

Published by Dr S K Singh, Project Director, Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, Krishi Anusandhan Bhavan, Pusa, New Delhi and printed at M/s Chandu Press, 63, Patparganj Industrial Estate, Delhi-110 092.

Preface

The Indian dairy industry has progressed remarkably during the last three decades from a situation of scarcity to that of plenty. The dairy farmers today are better informed about technologies of efficient milk production compared to their predecessors. The dairying has progressed rapidly with a compound growth rate of over 4 - 4.5 per cent per annum during the last decade. Application of modern technologies and advance management systems in milk production, processing and marketing has brought about a marked change in the dairy scenario in the country. The demand for milk has shown increasing trend but the total cattle population and particularly the indigenous cattle has registered a decline by 6.9% and 10.2%, respectively, during the last inter-censal period from 1997 to 2003. However, there is an increase in the population of crossbred cattle (22.8%) and buffaloes (8.9%) in this period. It is now widely realized that our buffaloes and locally adapted indigenous milch breeds of cattle would have to be genetically upgraded and non-descript cows crossed with the exotic semen to increase their low milk productivity for making them economically sustainable and globally competitive. To make optimal use of scientific tools in improving the dairy animal productivity, it is necessary that these technologies reach the dairy farm managers, extension functionaries and the end-users, viz. dairy entrepreneurs and dairy farmers. Hence, a sincere attempt has been made to compile information from various sources on practical aspects of dairy farming in the form of a book encompassing dairy animal breeds and breeding strategies, feeding management, housing management, milking management, health management, entrepreneurship development and the related aspects in simple language giving necessary details and illustrations. We hope that the present book on **"Dairy Farming"** prepared under the aegis of Agri - Pop series of the Directorate of Information and Publications of Agriculture (DIPA) of the Indian Council of Agricultural Research (ICAR), New Delhi will act as a link between the scientific community and the practitioners of dairy farming.

We sincerely express our deep sense of gratitude to Dr V K Taneja, Vice-Chancellor, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana and former Deputy Director-General (Animal

Sciences), Indian Council of Agricultural Research, New Delhi for his constructive counseling, constant encouragement and valuable guidance for writing this book.

We also gratefully acknowledge the help rendered by Dr T P Trivedi, Project Director, DIPA and his team for timely publication of the book.

The authors feel extremely indebted to Dr Sushil Kumar, Director, Dr S L Goswami, Joint Director (Research), Dr G R Patil, Joint Director (Academic) and Dr P K Nagpaul, Head, Dairy Cattle Breeding Division, National Dairy Research Institute, Karnal for providing necessary facilities for writing this book.

Authors

Contents

Chapter 1

Dairy Production Scenario in India

Dairy farming has remained a very important component of the traditional livestock and agriculture farming system of India since time immemorial and is one of the most important means of providing livelihood and nutritional security to the vast majority of rural masses in our country. The most prevalent dairy production is under mixed farming system integrating crop and livestock production in a synergistic manner. A wide range of milk producers (around 70 million rural households), viz. small and marginal farmers (SMF), landless labourers (LL) and some medium and large dairy farmers, are engaged in dairy farming in India. Dairying has been recognized as an instrument of social justice through bringing economic changes for majority of rural masses in the country. From the traditional dairying, however, the country with its vast dairy animal (cattle and buffalo) resources is poised to become a leading player in the world arena particularly after its emergence as world's leading milk-producing country, accounting for 14.4 % of the estimated 626 million tonnes of the world milk production in the year 2005. The value of output from milk group is highest among all the agricultural commodities, accounting for nearly one-fourth of the value of output from agricultural sector. The livestock activities, among which dairy farming predominates, employ about 8.5 million workers in the country. Milk and milk products account for 9.2 and 12.4% of protein intake in rural and urban areas, respectively, which is higher than the protein intake through other animal products.

Contribution of Livestock and Dairy Sector

The contribution of agriculture in the country's GDP accounts for about 25% of which the share of the livestock sector is about 6.5%. Out of the total contribution from livestock, the dairying contributes more than 65% indicating the significant role of dairying in the socio-economic situation of our country. The dairy sector has helped national economy through emerging as the highest milk producer in the world. Performance of Indian dairy sector in the post-independence era has been quite impressive. Milk production in India increased from a paltry

17 million tonnes in 1950-51 to over 104.84 million tonnes by 2007-08. During the past one-and-half-decade, milk production has grown at a rate of nearly 4% per annum *vis-à-vis* world growth rate of 1.5%. As per the recent estimates of Central Statistical Organization, Department of Statistics, Government of India (2008) the value of output through the milk (Rs 162,136 crore) at current prices was significantly higher than the meat group (Rs 40,399 crore) and milk group accounted for 67 % of the total value of output from livestock sector (Rs 240,601 crore). Exports of dairy and dairy products increased from Rs 13.98 million in 1990-91 to Rs 8,665.64 million in 2007-08, while imports increased from Rs 40.52 million to Rs 569.58 million during the same period. The net trade balance of dairy products has changed from negative to positive and the country is now a net exporter of dairy products. The increased production of milk has also improved the per capita milk availability to 252 g/day in 2007-08, which has now marginally exceeded the recommended nutritional requirement of 250 g by the Indian Council for Medical Research (ICMR). The demand of milk and milk products in India is projected to increase to 142.9 million tonnes in 2015 and further to 191.3 million tonnes in 2020. While the GDP growth rate in agriculture is less than 2 % during the past one decade, the livestock sector has consistently recorded a higher growth rate of between 4 and 5 % despite the fact that the plan outlay for animal husbandry and dairying has been consistently declining over the successive plans.

Dairy Animal Population and Milk Production

India is the richest repository of bovine and bubaline genetic resources—30 breeds of cattle and 10 breeds of buffaloes. However, many of these breeds cannot be strictly considered as breeds in the true sense as there are no breeding society/government agency to define their characteristics related to conformation, growth, survival, reproduction and production characteristics. The defined indigenous breeds constitute around 20 % of the total cattle and 35% of the total buffalo population of the country. Population of cattle and buffaloes in India are 185.18 million and 97.92 million, respectively, including a sizeable population of crossbred cattle (24.68 million; resulted through crossing Indian descript and non-descript cattle with exotic dairy breeds primarily Holstein Friesian and Jersey). There is a need to ensure preservation and enhancement of genetic variability in indigenous breeds while improving them through selection for important economic traits. These large populations of non-descript/descript and crossbred cattle and buffaloes are reared in small holder production system comprising 2-3

animals by small and marginal farmers and landless labourers under different agro-ecological and management systems.

Dairy production system in India is mainly small-holder low-input low-output extensive system. Semi-intensive/intensive dairy farming units are now being established in many places where agriculture has already made a significant breakthrough like in Punjab, Haryana and Western Uttar Pradesh and certain parts of Gujarat and Rajasthan, and are expected to take a lead in this regard. Peri-urban and urban systems of dairying with large number of dairy cattle and buffaloes maintained in *Khatals* in most unhygienic manner and using adverse practices for letting down of milk due to removal/ killing of calf to save milk also exist. Most of these animals end up in slaughterhouses after they get dry, as it is not economical to salvage them to their breeding tracts. The large commercial dairy farms around large cities and towns, which are need-based due to higher requirements of milk and milk products have come up and are resulting in serious environmental degradation problems due to difficulties in disposal of animal wastes which mostly end up in city drains resulting in clogging and flood situations during rains. In this system the animals are managed intensively and feeding is mostly based on concentrates and crop residues. Traditional farming systems which have been a part of our socio-cultural tradition with rural communities inhabiting forests and hilly regions are gradually declining due to non-availability of resource support, especially fodder availability from grazing lands.

The mainstay of Indian dairy sector is still the buffalo. With 53% of the world buffalo population, India produces 63% of the world buffalo milk. The contribution of buffaloes to milk production in the country was 55.9 million tonnes (53% of the total production) in 2007-08 which was higher than that of the indigenous cows with 21.73 million tonnes (21%) and the crossbred cows with 21.74 million tonnes (21%). Goats with a population of 124.36 million contributed about 3.89 million tonnes (3.7%) to the total milk production. The buffalo milk is preferred to the cow milk in certain parts of the country especially the north-western region, and is rich in fat and SNF, has lower cholesterol content, high protein efficiency ratio, higher calcium, iron, phosphorus and vitamin A. The buffalo milk is known for specialty product such as mozzarella cheese and contains higher levels of bioprotective agents like lactoferrin, lysozyme, lactoperoxidase etc.

Milk productivity in Indian cattle is lower compared to that in agriculturally advanced country because of little effort for genetic improvement through selection, shortage of feed and fodder and poor health cover. The milk productivity in India, therefore, continues to be

relatively low and the indigenous cows yield on an average 2.096 kg, crossbred cows, 6.523 kg, buffaloes, 4.443 kg and goats 0.369 kg/day in 2007-08. This relatively low production is because of extensive production systems and dairy animal being maintained subsidiary to crop production as crop production dominates. This however, is a time-tested, sustainable system evolved with low inputs and is characterized by multi-locational productivity and multifarious utility of cattle and buffaloes generally maintained by small and marginal farmers and landless labourers and other economically poor people. In addition to milk, meat, draught animal power (DAP), farm yard manure and fuel, it is extensively being used in urban and peri-urban areas under intensive feeding and management for meeting the needs for milk of city consumers. This system of intensive management is economically and biologically not feasible. The resource availability for intensive dairy farming is limited. Extension and transfer of technology programmes continue to be the weakest link in bringing about a rapid transformation in commercial and economic terms except in cooperative dairy development programmes under Operation Flood, which involves farmers' training programmes, provision of input and services and procurement, processing and marketing of milk and dairy products. A high production of milk needs to be supported by proper arrangements for milk collection, transport, storage, processing, marketing and maintenance cold chain. Credit support and proper pricing based on quality are the crucial issues required to be taken care of. Equipment and machinery for processing and packaging are to be linked up with the production system and benefits of value-additions need to be accrued to the producers to have a positive impact on productivity and quality assurance to the satisfaction of consumers. Appropriate education and training need to be organized to help the existing development machinery to function more efficiently.

Role of Cooperatives

The organized sector in India handles only 15% of the total milk produced. Around 13.9 million farmer members (3.9 million women) are organized into about 177 milk unions, 1.33 lakh dairy cooperative societies (DCSs) which handled around 25.09 million kg milk in 2008-09, and the average daily cooperative milk marketing stood at 20.04 million litres, annual growth has averaged about 6.1% compounded over the last 5 years. Dairy cooperatives now market milk in all metros, major cities and more than 2,000 towns/cities. These DCSs being part of the national milk grid are linking producers with consumers to make milk available during seasonal shortfalls in different regions of the

country. The AMUL Model replicated in different states under Operation Flood (OF) of India has succeeded in eliminating middlemen to a good extent and facilitated direct interface between producers and processors in the areas where cooperatives are functioning. The dairy cooperatives in India are playing significant role and need to be further strengthened on the pattern of AMUL. AMUL had continued to strengthen its structure and has shown that success of marketing depends on the "brand name". Gujarat Cooperative Milk Marketing Federation and its affiliated unions have jointly developed and built nationally and internationally known 'AMUL' and 'Sagar' brands. Other state cooperatives also have built their own brands - Vijaya, Verka, Milma, Nandini, Saras, Parag, Vita and like, which are competing with other national and multinational brands. The dairy cooperatives need to be further empowered by strengthening the rural procurement network, milk quality control, right product mix, financial and commercial discipline, continuity in professional management, human resource development and management. The current opening of trade in milk and dairy products and initiation of large number of private dairy enterprises has resulted in serious competition with dairy cooperatives and thus affected their virtual monopoly in dairy development in the country.

Dairy Products Export

Increased availability of milk during the flush season and inadequate facilities to keep liquid milk without spoilage during transit from rural production areas to urban market has led to the conversion of milk into traditional milk products (like *ghee, dahi, khoa, paneer, kulfi,srikhand, burfi, peda* etc). This helps in long-time preservation of milk solids at room temperature, adding value to the milk and provides considerable employment opportunities especially to rural and peri-urban people. Dairy products in India are produced by both organized and unorganized sectors, and the latter is still playing a dominant role. It is estimated that about 50% of total milk produced in India is converted into traditional dairy products. The traditional dairy products not only have well-established market in India but also have great scope of export to other countries because of the strong presence of Indian diaspora in many parts of the world who demand indigenous dairy products. With growing demand, there is a need to manufacture dairy products in modern dairy plants without compromise on the organolaptic and hygienic quality of the product. Further, the main job of the food industry is to extend shelf-life of dairy foods without compromising with their safety and quality aspects. There is a need to conduct more research

on manufacturing and storage of dairy foods by combining newer technologies with traditional preservation methods. Milk products from the organized sector are marketed through a vast network of wholesalers, distributors and thousands of retailers having separate chains for each brand and company. By far the largest manufacturer of milk foods in the country is the Gujarat Co-operative Milk Marketing Federation (GCMMF), the apex co-operative body of the Gujarat milk co-operatives, which is also the single largest food company in India, with both national and global market presence. As on 31 March 2007, some 832 dairy-processing plants were registered under MMPO (Milk and Milk Products Order – 1992) having an installed capacity of 970 lakh tonnes of milk/day. Private sector accounts for around 63% of the registered units and about 46% of the processing capacity. In recent years, private entrepreneurs including multinational companies (MNCs) have made a large investment in dairy industry leading to competition in milk procurement, which is expected to benefit farmers and milk producers. Some cooperative and private sector dairies have also expanded their manufacturing and marketing activities to include value-added products like ice-cream, cheese, and traditional milk products. Though dairy cooperatives are currently selling 80% of milk procured as fluid milk, the gap between the milk procured and fluid milk marketed has increased significantly.

For increasing the production of value-added dairy products, the infrastructure will need to be further strengthened in public, cooperative as well as at private sectors. The research and educational infrastructure in the country engaged in dairy education and research has to be improved through additional financial and human resources for intensifying research effort for large-scale diversified, quality assured and value-added dairy products. Research inputs are also required for formulating policies and programme to control cost of milk production and processing, facilitate flow of milk to the organized sector and to look after the legitimate interests of various stakeholders in dairy sector at national and international levels. Investigations need to be carried out on the use of milk protein in the treatment of impaired intestinal functions; biological availability of minerals and vitamins in milk and milk products and in weaning foods for infants and determination of cholesterol lowering properties of milk and milk products such as *dahi* and acidophilus milk and mechanism of their action. It is most likely that nutritional factors affect the development and maintenance of immuno-competence through multiple pathways and mechanisms. These need to be thoroughly understood. There is a need for documenting protective role of milk against cancer. Difference between

cow and buffalo milk must be studied from the point of view of processing as fluid milk dairy products and their role in human nutrition and health.

Almost all of the milk and milk products produced in India are traded and consumed in India itself, with export forming a small share. Overall dairy exports constitute less than 1% of total livestock products exported. In spite of the fact that dairy production far exceeds the production and per capita availability of other animal food products, the export of dairy products continue to be of minor significance. This has to be viewed in the context of the fact that most of the production goes to meet the domestic market requirement, which is a trend in the right direction. It also highlights the enormous scope for exporting dairy products to South-East Asia which have a dominant expatriate Indian population. In fact, the share of India in global dairy trade is about 0.6% only. In the years to come, commercialized agriculture will become a reality because of large genetic variability, scientific and technological manpower and processing facilities, the Indian dairy industry will be expected to play an increasingly major role in global market. Although the volume of export of milk products is currently small, India has a large scope of increasing its presence in the world markets and regularly export milk products and long-life milk to countries in West Asia, South-East Asia, South Asia and North America.

Dairy Production Targets

Planned development in any field requires setting up of targets which are potentially achievable and based on resource availability with higher numbers of dairy animals. The resources are thinned out with higher numbers, and productivity continues to record low. With little possibility of culling and elimination of unproductive and low producing cattle, the methods available for controlling cattle population such as castration of low genetic merit males and elimination of scrub bulls are not allowing selection for improving milk production to be effective. Large-scale mechanization is reducing the use of DAP and thus creating problems with excessive males available as there is no alternative for their disposal like in other countries through slaughter for meat. Though there is legal permission to slaughter cattle in some states like Kerala, West Bengal and North-Eastern Region, the number of bullocks is larger than it is currently used for agricultural operations and rural transport. It is necessary that alternative uses of DAP such as generating mechanical power for rural based small-scale industry, use of dung for creating biogas to meet household energy needs and even for small-scale industries are developed, which can help in maximizing the

utilization of DAP. Use of slurry from the biogas can be fed to fish ponds to allow growth of phyto- and zoo-planktons as fish feed and the water from the fish pond be used for irrigation. Manure rising from the biogas plant and further passing through the fish pond will have better nutritive value for the soil and save large area of land currently used for composting cowdung. Rapid multiplication of superior germplasm and improvement of resources, particularly feed and fodder can lead to a logical right-sizing of cattle population with higher productivity. The major problem in elimination of males not needed for breeding or DAP is the most limiting factor due to religious sentiments of Hindu's against slaughtering animals. In the process, however, the conservation of indigenous genetic resources for their positive attributes such as hardiness, disease resistance and adaptability to more stressful environment and poor feed resources should not be ignored. Selection needs to play an important role in our breeding strategy. *In-situ* conservation of indigenous breeds and creation of new breeds through evolutionary crossbreeding suitable to different agro-climatic conditions of the country should be the long-term goal.

Government Sponsored Dairy Development Schemes

To produce milk of diverse quality for meeting the needs of fluid milk for direct consumption or production of dairy products, there is a need to create right infrastructure for satisfactory milk collection, cold chain, which will take care of hygiene, cleanliness, quality of milk and extending its shelf life. Department of Animal Husbandry, Dairying and Fisheries (DAHD&F) has started centrally sponsored scheme for dairy development in potential and non-potential districts and strengthening infrastructure for quality and clean milk production during 11th Plan with an outlay of Rs 225 crore. During 2009-10, an amount of Rs 53.1 crore has been provided for this scheme. Similarly, an outlay of Rs 355 crore has been allocated for central sector dairy development schemes including Dairy Venture Capital Fund (Rs 300 crore), Assistance to Cooperatives (Rs 50 crore) and Delhi Milk Scheme (Rs 5 crore). The Dairy Venture Capital Fund is for providing financial assistance for improving the quality of milk handled by the unorganized sector/small-scale milk producers in rural milk sheds. This will help in milk processing at village level, cost-effective marketing of pasteurized milk, upgradation of quality and traditional technology to handle commercial scale production using modern equipment and management skills. This will also generate more remunerative rural employment opportunities. It is being

implemented through the NABARD. The following components are covered under the scheme:

1. Establishment of small dairy farms.
2. Purchase of milking machines, milk-testers and bulk coolers etc.
3. Dairy-processing equipment for manufacturing indigenous dairy products and their transportation facilities including cold-chain and establishment of cold storage facilities for milk and milk products and establishment of private veterinary clinics.

The NDDB has also started clean milk production (CMP) programme focusing on health and hygiene, house-keeping, society management, village-level bulk milk chilling, rapid transportation of raw milk to dairy plant and accelerated handling at the dairy reception dock in milk-processing plants. The training at every stage of milk chain—producer, village society staff, transporter and dairy dock personnel—is an important component of the CMP programme. The effort is monitored by dairy laboratories equipped with adequate testing facilities and trained personnel.

Integrated Dairy Development Project (IDDP) was launched during 1993-94 in hilly and backward areas to improve the social, nutritional and economic status of disadvantaged class of people. The pattern of funding is 100% grant-in-aid from Central Government for the districts where investment under Operation Flood (OF) programme was less than Rs 50 lakh. There is a maximum allocation of Rs 300 lakh per district under the programme. For establishment of dairy-processing capacity over 20,000 LPD the funding pattern would be 70% loan and 30% grant basis. The XI plan outlay for this scheme was Rs 225 crore. The actual expenditure on this project was Rs 31.62 crore in 2008-09. This project has covered 207 districts in 25 States and a Union Territory and has benefited about 18.79 lakh farm families by organizing them into 26,888 village level dairy cooperative societies (as on 31 March 2009).

The Government of India initiated an action plan in the beginning of 9th Five Year Plan towards formulation of a comprehensive scheme for cattle and buffalo breeding in consultation with state governments and other concerned agencies to consolidate the gains achieved till 8th Plan period, maximize returns on investments and to ensure sustainability of operations as well as quality in breeding inputs and services. These efforts culminated in merger of the ongoing centrally sponsored schemes on cattle and buffalo breeding, namely Extension of Frozen Semen Technology and Progeny Testing Programmes (EFST & PTP) and National Bull Production programmes (NBPP) into a new centrally sponsored scheme the National Project for Cattle and Buffalo

Breeding (NPCBB) which aims at thorough re-organization and reorientation of the cattle and buffalo breeding operations in the country. The objectives of the project include — establishment of appropriate institutional structures to channel and supply high quality breeding inputs and services; setting up national standards for bulls, semen, semen laboratories and AI services to guarantee quality assurance; training of inseminators and professionals based on nationally accepted curriculum and hands-on practices; and regulating and strengthening breeding system in area covered by natural service. The first phase of the project started in October 2000 and 27 states and 1 Union Territory are participating under the project. During the XI Plan, out of outlay of Rs 554 crore for NPCBB, Rs 100 crore has been allocated for 2009-10.

About 170 District Cooperative Unions were established under operation flood (OF). Some of them are incurring huge losses due to low capacity utilization; plant-inefficiency and high cost due to large salaries of staff. The Central Sector Scheme, "Assistance to Cooperatives" was introduced in January 2000 for revitalization of these Unions.

Future Prospects

India possesses more than half of the world's buffaloes and one-sixth of the world's cattle populations but the fact is that the productivity of cattle and buffaloes is still quite low, as compared to the dairy animals of other developed nations. This is an area where our dairy scientists and managers have a great role to play. The vast dairy animal population of the country could prove to be a vital asset for the country as there is a vast scope for improvement of milk production and consequently increased marketable surplus of milk for processing and even export. Purchasing power of the Indian consumers is also on the rise with growing economy and continually increasing population of middle class. Further, low input costs of Indian dairy production as milch animals thrive mostly on crop residues and agro-industrial byproducts coupled with low labour and vast consumption could make our dairy market as one of the most cost-competitive dairy markets in the world. It is a paradox that we expect our animals to be comparable to that in agriculturally advanced countries where higher production is not only owing to higher genetic merit of their animals created through more intense selection over decades but also because of provision of better inputs and services. The lactation yield of Holstein Friesian cattle in USA was 4,000 L per lactation in 1970s and now it is 11,000 L per lactation, and this has resulted from intense selection based on an index combining the performance of grandparents, parents, collaterals and progeny, which has become possible due to the availability of more

effective computation systems; and the genetic progress in milk production per year has gone from a maximum of 2 to 6-7%. This is primarily due to better accuracy of selection of sires and higher intensity of selection, than was possible 50 years back when the computation facilities were not that efficient and herd performance recording did not involve the size of the progeny and the number of herds now involved in progeny testing of bulls.

The emergence of India as a premier milk-producer country in the world could be attributed mainly to the large crossbreeding programmes implemented throughout the country over the last few decades. This perhaps has partially improved the contribution of cattle to the national milk production. However, the buffalo is still contributing the highest percentage of the milk in the total milk production in the country. There are serious limitations in genetic improvement of buffaloes like in cattle due to lack of identification, pedigreeing, performance recording and their use in selection of breeding males. Without properly organized cattle and buffalo breeding programmes through identification of largest number of breeding females, their pedigreeing and performance recording and selection of bulls on the basis of effective size of their progeny, it will not be possible to bring any large genetic improvement in the country. This is also true with respect to the crossbred population as initial gains obtained through introduction of exotic dairy inheritance cannot be sustained unless suitable selection based on the genetic merit of the sires is instituted. Continuous breeding with exotic bulls leads to higher exotic inheritance, which is not sustainable under the management conditions existing in greater part of the country, and it is often seen that higher level of exotic inheritance leads to poor performance not only in reproduction and survival but also in milk production. There are problems in evolving new dairy cattle breeds from crossbred population especially involved in European and Indian breeds due to cytogenetic differences leading to improper pairing of sex chromosomes resulting into lower reproductive performance in crossbred males primarily due to poor libido, semen quality and preservability especially freezability. Population pressure and emerging global opportunities further necessitate that efforts for enhancing animal productivity are accelerated. This calls for continuance of well-proven technologies such as crossbreeding with superior exotic breeds coupled with improvement in the productivity of vast population of generally low producing cattle and buffaloes through selection and using emerging reproduction and molecular bio-technologies. In this connection, there is a great potential for application of multiple ovulation and embryo transfer technology (MOET) for production and faster multiplication

of superior germplasm of elite animals. There is also scope for identifying the unique genes specific to indigenous dairy animal genetic resources using the molecular marker techniques. It is expected that through these technologies a larger number of superior animals per unit time can be obtained by reduction in generation interval which could further increase the rate of genetic progress due to increased intensity of selection. Technologies for raising male buffalo calves economically should be developed, as this potential source of income to the farmers is not being fully utilized at present.

Further, poor condition of roads and erratic power supply remain a major challenge for procurement and supply of good quality raw milk. Also, the raw milk collection system in certain parts of the country is quite underdeveloped. Maintenance of cold chain is still a major handicap. For organized marketing of milk, the milk produced is required to be transported to the processing plant that incurs cold storage and transportation costs which are quite high. Further, majority of producers is unaware about scientific dairy farming, clean milk production and value chain. Seasonal fluctuations in milk production pattern, regional imbalance of milk supply and species-wise variation (buffalo, cow, goat etc.) in milk quality received by milk plants continue to pose serious problems. Above all, the investments in dairy research and development also do not commensurate with the increased returns and future potential.

Dairying in India at present is almost exclusively funded through State. With privatization and globalization of economy, private entrepreneurs have to enter into certain core activities, which, till now, have been handled exclusively by the Central and State Governments. Moreover, the private entrepreneurs have greater credibility, reliability and would have thus better accountability at the field-level dairy/animal husbandry service provisions to the farmers.

For meeting the nutritional requirements of the livestock, particularly high yielding milch animals, there is a need to increase the bio-availability of feeds and fodders by increasing research efforts in the area of fodder production and through improvement of the existing feed resources especially crop residues through mechanical, chemical, micro-biological and bio-technological approaches. Also, it is necessary to improve the productivity of the land for meeting the feed and fodder requirements from the limited area available. There is also a need to encourage farmers' union, NGOs and cooperatives to put common property lands under improved pastoral and silvi-pastoral systems.

At the national level, the current feed and fodder shortage in terms of crude protein (CP), digestible crude protein (DCP) and total

digestible nutrients (TDN) is estimated to be 39.8, 44.3 and 39.6% respectively. With the increase in feed and fodder production, the gap between requirement and availability is projected to narrow down, but 35.2% shortfall in DCP and 26.6% in TDN is likely to continue in 2020. The pressure on land-use for production of foodgrains for human consumption will remain a limiting factor in making additional fodder/feed grains available to dairy animals and other livestock. Therefore, the strategy of developing the dairy animals yielding over 25 to 30 litres per day may not be so sustainable except in a few states, which have reached a higher income level and have surplus/spoiled foodgrains, the latter available from FCI food godowns can have high milk-producing exotic or crossbred dairy animals; while for the other states, maintaining dairy animals yielding 6-7 litres per day through integration of crop-residues, available green fodders and limited supplementation of grains/cakes would be a sustainable strategy. Being the largest producer of milk in the world and a leader in tropical dairying with buffaloes as the key dairy animal with higher production potential, India can play a significant role in the global dairy scenario, especially in the SAARC countries, South-East Asia, Middle-East, Africa and Latin America, where it has already been playing an important role through making available superior buffalo male and female germplasm as well as germplasm of tropically adapted dairy and dual purpose cattle. Moreover, our participation in the global trade, which is presently lesser than 1 % of the overall export of animal products, needs to be increased further. The chemical and microbiological quality of milk and milk products have to meet the stipulated international standards. A large network of quality control laboratories, uniform methods of analyses, and adequate technical personnel to manage quality assurance goals and measures for sanitary and phyto-sanitary monitoring are needed.

Dairy development should be directed chiefly towards stakeholders' involvement and empowerment, entrepreneurship development, employment and income generation. During the process of globalization, the crucial issues like protecting our farmers' interests, promoting entrepreneurs development, saving India from becoming a dumping ground for surplus products of developed countries, checking measures to exploit our un-preparedness in matters such as intellectual property rights, patenting and other STA stipulations, need to be seriously addressed to.

Production of traditional dairy products in the organized and unorganized sector has been increasing over the years. However, product-technology, equipment, lack of suitable packaging materials to

increase shelf life and consumer acceptability are the major stumbling blocks in the way of large-scale adoption of these products by organized sector, although some attempts have been made to improve the situation. In such circumstances, the technologies suiting small-scale processing entrepreneurs will play a crucial role in channelizing the traditional products through the organized sector. Further, milk quality needs improvement in terms of microbial load as well as pesticide residues, heavy metals, drugs residues etc. to conform to international standards for international trade. Presence of Indian brands needs to be further strengthened in the international market for further growth and to keep pace with the best in terms of efficiency and quality.

In the era of fast computers, information technology and cyber-technology, the dairy industry need to gear up to take full advantage of these technologies by integrating all the functions and inter-relationships of the organization and become commercial force in influencing the market and help change management of the national and international market. The NDDB and AMUL launched on 30 January 2002 www.cooperative.org or www.nic.coop. The NDDB website www.nddb.coop carries comprehensive information on the state Cooperative Dairy Federations all over the country. www.indiadairy.com and www.indairyasso.org provide information on dairy related activities and publications. Dairy industry must take full advantage of cyber-technology and information communication.

Further, the future approach/ policies should be centered on increasing the incomes of small-holder dairy production system since about 70% of milk comes from small/ marginal/ landless labourers. The cattle population is more equitably distributed than land. We should not forsake small-holder centered approach for intensive large farm production approach which may create large income disparity and unemployment and let both co-exist depending upon resource availability. The need of the hour is that the government and NGOs install a structure and mechanism to gather market information and intelligence, monitor trends in international dairy markets, the international prices, import of dairy products, domestic support subsidies and export subsidies provided by developed countries, provide relevant information to the government to take corrective actions such as anti-dumping duties and suitable tariff rates to protect dairy industry from unfair competition. The government may consider setting up an advisory committee on trade-related issues comprising various stakeholders. Also, effective steps need to be taken to bring about structural changes in the laws and systems governing the cooperatives and provide them moral, fiscal material and manpower development support.

To sum up, dairying in India offers a diversified farm option, a livelihood option, and a commercially viable enterprise for rural youth. However, there is an imperative need to initiate policy measures on milk pricing, support price, land use prioritization and extension of subsidies and privileges at par with the crop sector, and large scale investment for cold chain, health, quality assurance, sanitary and phyto-sanitary monitoring. There is need for reorientation of research priorities and the research efforts should be focused on ecological adaptability and disease resistance of crossbred populations and a breakthrough in genetic up-gradation of buffaloes will provide a big push to the economy. In the last few years, the government has undertaken a few important steps to evolve a vibrant dairy sector in the country. The MMPO (Milk and Milk Product Order) has incorporated concerns related to the quality of milk products. The Tenth Five Year Plan made significant allocations for improvement in the milk quality related infrastructure in the country. Still much needs to be done to evolve an effective price or income-based support system. There is a potential to develop organic dairy business in India, despite the several problems. This can be achieved if there is clear policy support and strategic direction from the central government. Also there is need to involve apex bodies APEDA, IDA etc. in this process for optimum results. Organic dairy can become a profitable business for dairy farmers especially in the rainfed and hilly areas of the nation. The State cooperative federations, which have excellent grassroots level connections with dairy farmers, should be actively involved in this process.

❐

Chapter 2

Breeds and Breeding of Dairy Animals

India is endowed with vast and varied forms of animal genetic resources that have played crucial role in augmenting agrarian economy. There are 30 breeds of cattle, 10 breeds of buffaloes and 20 breeds of goat in the country. The cattle, buffalo and goat population is 408.1 million and contribute over 104 million tonnes of milk produced in the country—the buffaloes contribute the maximum (53%) followed by cattle (42%) and goats (3.7%). There are a large number of well-defined indigenous breeds of cattle, buffalo and goats besides a large population of non-descript animals. A breed is a group of inter-breeding domestic animals of a species. It shows similarity among its individuals in certain distinguishable characteristics (colour, shape, size of body parts). The breeds have been developed as a result of selection and breeding based on the needs of mankind as well as adaptation to agro-climatic conditions of their native home tracts.

Milch Breeds of Cattle

The 30 well-defined indigenous cattle breeds are classified into (i) milch breeds, (ii) dual purpose breeds, and (iii) draught breeds based on their utility. The cows of milch breeds are relatively high milk producer, but their bullocks are poor quality draught animals. The animals of dairy breeds in general, have heavy built with pendulous dewlaps, sheaths and loose skin. The important breeds of this group are Sahiwal, Red Sindhi, Gir, Tharparkar and Rathi.

Sahiwal: Sahiwal, one of the best dairy cattle breeds, have their native home tract in Montgomery district and adjoining places in Pakistan. The Sahiwal cows are also found in Ferozepur, Amritsar, Gurdaspur districts of Punjab. There are quite a good number of breeding herds in Punjab, Haryana, Uttar Pradesh, Chhattisgarh and Madhya Pradesh. The cows are red and light brown in colour, but some animals with white patches are also found. The cows are good milk yielders and under village conditions yield about 1,350 kg in a lactation

of 305 days. Well-bred cows on institutional farms yield on an average 2,400 kg. The average age at first calving is about 39.0 months, which ranges from 29 to 52 months. The average calving interval, service period and dry period of Sahiwal cow are 415, 148 and 156 days respectively. The average fat and SNF content of the milk is around 5.0 and 9.2% respectively.

Red Sindhi: The Red Sindhi cattle are somewhat similar to Sahiwal but have their native habitat in Karachi and Hyderabad districts of Sindh province of Pakistan. It is an important dairy cattle breed in Indian sub-continent. Red Sindhi cattle are maintained on few organized Government farms in India. The animals of this breed are of red colour, which have shades from dark to dim yellow, with white patches on some animals. Udder is capacious and pendulous. The cows are high milk yielders and produce average milk of 1,800 kg ranging from 1,500 to 2,200 kg in 305-day lactation with an average of 4.5% fat and 9.16% SNF. The average age at first calving is 42 months and ranges from 32 to 50 months. The calving interval, service period and dry period range from 425 to 540 days, 105 to 293 days and 112 to 179 days respectively.

Gir: Gir cattle, one of best Indian dairy cattle breeds, are found in Junagadh, Bhavnagar, and Amreli districts of Gujarat. They are also widely distributed in adjoining states of Rajasthan, Madhya Pradesh and northern parts of Maharashtra. A large number of organized farms and *gaushalas* are maintaining the Gir cattle. Mostly they are purely red in colour and some are with patches of red, black and red and black on white skin. The cows have good-shaped udder with well-placed teats. The cows are very good milk yielders with an average yield of 1,400 kg ranging from 1,200 to 2,000 kg in lactation. A few outstanding cows with 26-27 kg peak milk yield in a day and lactation milk yield more than 4,500 kg indicate high genetic potential for milk production. The average fat is 4.40% and SNF content 8.8%. The age at first calving varies from 40 to 60 months with an average of 48 months and inter-calving period from 430 to 490 days with an average of 465 days.

Tharparkar: Tharparkar is an important cattle breed raised primarily for its milking potential. The name Tharparkar has been derived from the place of its origin – the Thar Desert. The home tract of this breed is in the Tharparkar district of southeast Sindh in Pakistan. In India, these animals are now found along the Indo-Pak border covering western Rajasthan and up to Runn of Kutch in Gujarat. The animals with typical characteristics of the breed are found in Jodhpur, Barmer, Jaisalmer districts of Rajasthan and Kutch region of Gujarat.

Some animals are also available in Suratgarh tehsil of Sri Ganganagar district of Rajasthan. Animals are white or light grey. Face and extremities are of a darker shade than the body. In bulls neck, hump and fore and hind-quarters are also dark. Udder is large and well developed in front and rear, and is carried well up at the back. Floor of udder is nearly level and not deeply cut between quarters. Skin of the udder is fine and mellow with a yellow tinge and prominent veins. Teats are long, uniform in thickness and set at even distances. Tharparkar cows calve for the first time at an average age of about 41 months (range 37 to 52 months). The average milk yield is 1,750 kg (range 900 to 2,150 kg), lactation length 285 days (range 240 to 380 days), dry period 140 days (range 115 to 190 days), service period 128 days (range 108 to 190 days) and calving interval 430 days (range 408 to 572 days). The fat content is about 4.88 % (range 4.72 to 4.90%) and SNF 9.2 % (range 8.9 to 9.7%).

Rathi: Rathi cattle take their name from a pastoral tribe of Rajasthan called Raths. Rathi cattle have been developed as a result of admixture of inheritance of Sahiwal, Red Sindhi, Tharparkar and Dhanni cattle breeds with high proportion of blood from Sahiwal breed. These are concentrated in the Bikaner district of Rajasthan.

This is a medium-sized breed with symmetrical body. The animals have brown colour with white patches, and some animals with complete brown or black coal colour with white patches are also found in the tract. Udder and teat are well developed. The cows are docile in nature. Their average lactation milk yield is 1,500 kg, which ranges from 1,050 to 2,000 kg. The average fat is 3.83% and SNF is 8.90%. The average age at first calving ranges from 36 to 52 months with an average of 46 months and inter-calving period ranges from 450 to 620 days with an average of 515 days.

Deoni: Deoni is a very popular dual-purpose breed of cattle of Marathwada region of Maharashtra and adjoining parts of Karnataka and Andhra Pradesh. It is also found in Parbhani, Nanded and Osmanabad districts of Maharashtra and Bidar district of Karnataka. Body colour is usually spotted black and white. This breed has 3 morphological types: (i) complete white animals without any spot on the body (*balankya*), (ii) complete white animals with partial black face (*wannera*) and (iii) black and white spotted animals (*Shevera*). This breed is considered to have admixture of Gir, Dangi and local cattle blood. Udder is moderately developed. The animals are docile and calm. The age at first calving ranges from 30 to 51 months with an average of 45.5 months. The milk yield in Deoni cows ranges from 636 to 1,230 kg with an average of 940 kg. The lactation length ranges from 170 to 293 days with an

IMPORTANT MILCH AND DUAL-PURPOSE CATTLE BREEDS

SAHIWAL

THARPARKAR

RED SINDHI

GIR

DEONI

RATHI

HARIANA

KANKREJ

ONGOLE

JERSEY

HOLSTEIN-FRIESIAN

KARAN SWISS

KARAN FRIES

average of 260 days. The calving interval averages 450 days (range 430–470 days). The milk contains 4.3% fat, 9.7% SNF and 14.0% total solids. Deoni bullocks are preferred for heavy work.

Hariana: Hariana is a prominent dual-purpose breed of northern India. Its native breeding tract encompasses large parts of Rohtak, Sonepat, Bhiwani, Hisar, Jind and Gurgaon districts of Haryana. These animals are also reared in Jodhpur, Alwar and Bharatpur districts of Rajasthan and Meerut, Bulandshahr and Aligarh districts of Western Uttar Pradesh. Hariana cattle are white or light grey in colour. Hariana cattle have compact and proportionately built body. Legs are moderately long and lean with small, hard and well-shaped feet. Udder is capacious and extends well forward with a well-developed milk vein. Teats are well developed, proportionate and medium sized. Age at first calving ranges from 35 to 60 months, with an average of 52 months. Average milk yield is around 1,000 kg with a range of 690 to 1,750 kg. Lactation length is about 270 days, ranging from 240 to 330 days. The average service period is 230 days (range 125 to 305 days), dry period 255 days (range 135 to 570 days) and calving interval 480 days (range 415 to 560 days). The fat content ranges from 4.3 to 5.3% with an average of about 4.5%, and SNF is around 9.1%.

Kankrej: Kankrej is one of the heaviest breeds of cattle in India, and is found in southeast Rann of Kutch comprising Mehsana, Kutch,

Ahmedabad, Kaira, Sabarkantha and Banaskantha districts of Gujarat, and Barmer and Jodhpur districts of Rajasthan. It takes its name from the name of a geographical area in north Gujarat. The colour of the animal varies from silver-grey to iron-grey or steel-black. Forequarters, hindquarters and hump are slightly darker than the rest of the body in males. The average age at first calving is 47.3 months (range 34 to 56 months). Average milk yield is around 1,750 kg (range 1,100 to 3,200 kg.). Lactation length averages 295 days (range 275 to 350 days) and calving interval is around 490 days (range 410 to 640 days). Milk fat is around 4.8% (range 4.66 to 4.99%).

Ongole: The Ongole breed takes its name from the geographical area in which it is reared. It is also called the Nellore breed since the Ongole taluk was earlier included in the Nellore district. The breeding tract extends all along the coast from Nellore to Vizianagaram and Chittoor, Kurnool, Cuddapah, Anantapur, Nalgonda, Mehbubnagar and Khammam districts of Andhra Pradesh. The Ongole cattle have a glossy white coat called padakateeru by the breeders. Males have dark grey markings on head, neck and hump, black points on knees and pasterns, black muzzle, black eye-lashes with a ring of black skin around eyes. Calves are generally white but sometimes are born with reddish-brown patches or reddish-brown colour. As they grow up to 6 months or 1 year, coat colour changes to white or grey as in adults. Ongole cattle are large and heavy animals with loosely knit frames, great muscularity and long limbs. They have a majestic gait. Udder is well formed with well-placed and well-developed teats. Hind portion of udder is well developed. Skin is smooth and is of medium thickness, mellow and loose. The age at first calving in Ongole cows ranges from 35 to 60 months (average 48 months). Average milk yield is 688 kg (range 475 to 1,000 kg) in a lactation period of about 230 days (range 160 to 270 days). Average dry period is 260 days (range 145 to 400 days), average service period 190 days (range 128 to 310 days), average calving interval 500 days (range 420 to 720 days), and average milk fat is 4.2% (range 4.1 to 4.8%).

Exotic Breeds of Cattle

Exotic dairy breeds of cattle have been used for crossbreeding for improving the milk production potential of indigenous cows in India. Military dairy farms were the first to introduce some well-known European breeds such as Shorthorns, Ayrshires and Holstein-Friesians about 50 to 60 years ago. The major exotic breeds that are being used in planned crossbreeding projects presently are Holstein-Friesian, Jersey and Brown Swiss.

Holstein-Friesian: This breed was developed in the northern parts of Netherlands, especially in the province of Friesland and is the best breed of dairy cattle. This is the most widely distributed breed of dairy cattle in temperate zone, as well as in some tropical countries. As a matter of fact, now we have several different distinct genetic groups/strains within this breed such as the American Friesians, Israeli Friesians, the Russian Friesians (the Black Pied cattle) etc. The Holstein cattle are ruggedly built and they possess large well-developed udders. It is the largest dairy breed and mature cows weigh around 700 kg. The heifers in well-managed herds can be bred at 18-20 months when they weigh around 500 kg. The animals have typical markings/ patches of black and white. Their average milk production ranges between 6,500 and 9,000 kg per lactation. The superior cows have milk yield of even more than 11,000 kg per lactation. However, the fat content in milk is however low, i.e. 3.45%. The SNF content in milk is 8.56%.

Jersey: Jersey breed is also widely distributed in Europe and America. In India, this breed has acclimatized well and is widely used in cross-breeding with indigenous cows. They are economical producers. Jersey is the smallest dairy breed and hence is more suited for crossbreeding with zebu cattle. Mature Jersey cows weigh around 450 kg with a range of 370 – 540 kg. Heifers grow rapidly and mature early, calving as early as at the age of 24 months sometimes. The typical body colour of Jersey cattle is reddish fawn. The average milk production of Jersey cows is 5,000 to 7,000 kg with a fat and SNF content of around 5.3% and 9.42% respectively. The highest recorded milk yield was 11,381 kg in a lactation.

Brown Swiss: The place of origin of the Brown Swiss breed is the mountainous region of Switzerland. Though considered less refined than other dairy breeds, it is famous in its home tract for its hardy nature and good milk production, next to Holstein-Friesian. The animals of this breed are quite docile and easily manageable. They were originally developed as dual-purpose cattle good for both draught as well as milk. The Brown Swiss heifers are rather slow maturing. However, this breed seems to be more suitable than other *Bos taurus* breeds for introduction in tropics. In India, excellent crossbred cattle have been produced by crossing this breed with recognized Indian breeds of cattle. The Karan Swiss cattle of the National Dairy Research Institute, Karnal, and Sunandini of Kerala are the examples. The average production per cow is about 5,500 litres (range 4,500–8,500 kg) with an average fat and SNF content of 4% and 9.06% respectively. The maximum milk production recorded is 14,024 kg in 365 days.

Red Dane: The typical body colour of this Danish breed is red, reddish brown or even dark brown. It is also a heavy breed; mature males and females weigh up to 950 kg and 600 kg respectively. Red Dane combined well with Hariana cattle (at CCS Haryana Agricultural University, Hisar) and Sahiwal cattle (at Punjab Agricultural University, Ludhiana). Lactation milk yield of Red Dane cattle varies from 3,500 to 6,500 kg with a fat content of 4% and above.

Crossbred Cattle Strains

For bringing rapid improvement particularly of non-descript cattle, the crossbreeding of indigenous cattle using frozen semen of bulls of exotic dairy cattle breeds (Holstein-Friesian, Brown Swiss, Jersey, Red Dane and Ayrshire) resulted in developing various crossbred cattle strains. Karan Swiss, Karan Fries, Frieswal, Sunandini are some of the high producing crossbred cattle developed at organized farms and under village conditions.

Karan Swiss: Karan Swiss cattle breed has been developed at the NDRI, Karnal, by crossing Brown Swiss with Sahiwal and Red Sindhi zebu cows. The frozen semen of superior Brown Swiss Bulls was imported from the USA. The average age at first calving of Karan Swiss is 32 to 34 months (2 to 3 months less than that of Sahiwal/Red Sindhi cows). Average lactation milk yield in 305 days or less was about 3,500 kg with best 305 day lactation milk yield of 7,096 kg. The average service period, dry period and intercalving period are 117, 85 and 404 days respectively. The average fat is 4.16% and SNF content 9.20%

Karan Fries: Karan Fries cattle breed has been developed at the NDRI, Karnal by crossing Holstein-Friesian with Tharparkar cows. The Karan Fries cows calve for the first time at the age of 30 to 32 months and yield 3,400 to 4,200 kg milk in 305 days lactation. Elite animals (top 30%) yield more than 5,000 kg in 305-days. The average service period, dry period and inter-calving period are 123, 104 and 401 days, respectively. A peak milk yield of 46.5 kg in a day has been recorded with a best lactation milk yield of 8,338 kg in 305 days. The elite cows are used for production of bulls for future breeding on institutional farms and farmers' animals. The average fat is 4.10% and SNF content 8.92%.

Frieswal: Frieswal cattle breed was developed by crossing Holstein-Friesian with Sahiwal cows at Military Dairy Farm in technical collaboration with Project Directorate on Cattle (Indian Council of Agricultural Research), Meerut (Uttar Pradesh). The breeding programme using imported semen of superior Holstein-Friesian bulls and crossbred bulls was designed in such a way that the cows produced were with 62.5% inheritance of Holstein-Friesian. The average age at

first calving of Frieswal cows is around 36 months. Average lactation milk yield in 300 days lactation is 3,000 kg. The average service period, dry period and inter-calving period are 160, 115 and 425 days respectively. The fat content of milk ranges from 3.5 to 4.5% and SNF 8.5 to 9.5%.

Sunandini: A high yielding crossbred cattle strain named Sunandini was developed as a result of crossbreeding programme launched under Indo-Swiss Project using frozen semen of Brown Swiss bulls on non-descript local or graded Red Sindhi or Sahiwal cows of rural households in Kerala. The crossbred cattle strain was further improved through introduction of exotic inheritance of Jersey and Holstein-Friesian cattle breeds. Attempts were made to retain 50 to 62.5% of exotic cattle inheritance. The average production performance of recorded crossbreds in the village herds range from 1,400 to 1,800 kg depending upon managemental and agro-climatic condition. Age at first calving is around 35 months and calving interval averages about 450 days. *Inter-se* mated Sunandini crossbred cows are further being improved through selective breeding using superior breeding bulls identified on the basis of their daughters' performance under field conditions.

Milch Breeds of Buffaloes

Murrah, Nili-Ravi, Bhadawari, Jaffarabadi, Surti, Mehsana and Nagpuri are the 7 well-defined Indian dairy breeds of buffaloes. Apart from providing milk, the buffaloes are also used for carting, ploughing and other agricultural operations.

Murrah: The breeding tract of Murrah breed is Rohtak, Hisar and Jind of Haryana state and Nabha and Patiala districts of Punjab state. The breed characteristics are massive body, neck and head comparatively long, horns short and tightly curved, udder well developed, hips broad, and fore- and hind-quarters drooping. The colour is usually jet black, sometimes white markings on tail, face and extremities are found. The bullocks are good draught animals though slow and powerful. The average milk yield per lactation is 1,500 to 2,500 kg, and the heritability of this trait is 0.2 to 0.3. The age at first calving is 45 to 50 months in villages but in good herds it is 36 to 40 months. The inter-calving period is 450 to 500 days. The average fat in milk is around 7.0 (range 6.8 to 8.3%).

Bhadawari: This breed is found in Bhadawar Tehsil in Agra district and Etawah district of Uttar Pradesh and Gwalior district of Madhya Pradesh. The body is of medium size and of wedge shape. The colour of the body varies from blackish copper to light copper, which is peculiar to this breed. The average milk production is 800 to 1,100 kg with an

average fat content of 8.0%. The average age at first calving is 48 months (range 45–50 months). The bullocks are reputed as good draught animals with heat tolerance.

Jaffarabadi: The breeding tract of this breed is Kutch, Junagadh and Jamnagar districts of Gujarat state. The body is long but not so compact. The udder is well developed. The colour is usually black. The average milk yield is 1,000 to 1,200 kg. These animals are mostly maintained by traditional breeders called Maldharis, who are nomads. The bullocks are heavy and are used for ploughing and carting.

Surti: The breeding tract of this breed is Kaira and Baroda districts of Gujarat. The body is well shaped and medium sized; the barrel is wedge shaped. The colour is black or brown. The peculiarity of the breed is that there are two white collars, one round the jaw and the other at the brisket. The milk yield ranges from 900 to 1,300 kg. The age at first calving is 40 to 50 months with an inter-calving period of 400 to 500 days. The heritability of the trait is 0.2 to 0.3. The peculiarity of this breed is very high fat % in milk (8 to 12%). The bullocks are good for light work.

Mehsana: The breeding tract of this breed is Mehsana, Sabarkantha and Banaskantha districts of Gujarat state. This is supposed to has been evolved out of crossbreeding between the Surti and the Murrah. The body is longer than in Murrah and the limbs lighter. The udder is well shaped. The colour is usually black to grey with white markings often on face, legs or tail-tips. The average milk yield is between 1,200 and 1,500 kg per lactation. The breed is supposed to have good persistency. The inter-calving period ranges from 450 and 550 days. The bullocks are good for heavy work but are rather slow.

Nagpuri: The breeding tract of this breed is Nagpur, Akola and Amrawati districts of Maharashtra. This is also called as Ellichpuri or Barari. The milk yield is 700 to 1,200 kg per lactation. The age at first calving is 45 to 50 months and intercalving period is 450 to 550 days. The bullocks are good for heavy trotting work but slow in movement.

Nili-Ravi: The breed is found in Sutlej valley in Ferozepur district of Punjab state and in the Sahiwal district of Pakistan. The frame is medium sized. The peculiarity of the breed is the wall eyes. The udder is well developed. Usually the colour is black with white markings on forehead, face, muzzle and legs. The milk yield is 1,500 to 1,850 kg per lactation and the heritability for this trait is 0.2 to 0.3. The intercalving period is 500 to 550 days. The age at first calving is 45 to 50 months. The bullocks are good for heavy trotting work.

There are several other less common breeds such as Toda in Nilgiri, Parlakmedi in Orissa and Pandharpuri and Marathwada in Maharashtra

IMPORTANT MILCH BUFFALO BREEDS

MURRAH

NILI RAVI

SURTI

JAFFARABADI

MEHSANA

NAGPURI

state. Their population is very small and is found only in isolated pockets but distinct because of their morphological traits.

Breeding Strategies for Sustainable Dairy Cattle and Buffalo Production

The new input-based high yielding technologies in agriculture and animal husbandry have brought about a spectacular growth in production in certain select areas of the country. Therefore, it is now imperatively being felt that the country should develop strategies so that available resources in all the agro-ecological zones of the country be exploited judiciously and utilized sustainably for further enhancing the animal productivity. India has been divided into 15 agro-climatic regions based on physiography and climate, and these zones are further sub-divided into 126 agro-climatic sub-zones. As there may be considerable variations in agricultural patterns within a zone, different "Farming systems" were identified, classified and mapped in each agro-climatic zone. Mixed farming is practiced in nearly all Agro Ecological Zones. The principal objectives of the farmers engaged in mixed farming include: (i) complementary benefit from an optimum mixture of crops and livestock farming, (ii) spreading income and covering risks over both crops (primary) and livestock (secondary) production, and (iii) scope to adjust crop : livestock ratio to social and economic needs and opportunities.The FAO under the Domestic Animal Diversity Information Systems (DAD-IS) is also laying emphasis on studying the animal production systems prevalent under different agro-ecological zones.

According to the FAO, all input-output relationships, viz. biological, climatic, economic, social, cultural and political factors, which combine to determine the production of a particular livestock enterprise at a particular location is referred as animal production system (APS). APS ranges from very little animal husbandry to very intensive management systems where farmers control feed, climate, disease and other factors. Animal production system in India can be subdivided mainly into dairy, meat, wool, draught production apart from skin and hide production and dung production. In this section, we shall focus on breeding strategies for sustainable dairy cattle and buffalo production systems in India. Broadly low input, medium input and high input dairy production systems have been classified.

Low-input (Extensive) Dairy Production System: In this production system one or more rate-limiting inputs impose continuous or variable severe pressure on livestock, resulting in low survival, reproductive rate or output. This system is characterized by low input

use and low productivity. Resource-poor small and marginal farmers and landless labourers maintain majority of the livestock across all the states and agro-climatic regions under low-input animal production system. The farmers maintain only 1-3 cattle/ buffaloes under this system. Around 95% of the animals belong to locally adapted breeds or non-descript populations surviving due to their better adaptation to the local ecology, use of crop by-products and low requirement in terms of feed, fodder, health care, housing and labour. Milk production and draught animal power are the main production activities. Under this system, most of the output (milk) is consumed by the family and less than 50% of the milk is marketed.

Medium-input (semi-intensive) Dairy Production System: In this production system, management of the available resources has the scope to overcome the negative effects of the environment, although it is common for one or more factors to limit output, survival or reproduction in a serious fashion. The medium dairy farmers having better resources compared to poor farmers provide input and management of medium level under this system. Farmers generally maintain a mix of local cattle/ buffaloes, a few crossbred cattle and some buffaloes belonging to a good dairy breed under this system. Small and medium family farms where more than 50% of milk is marketed belong to this category.

High-input (intensive) Dairy Production system: In this system all rate-limiting inputs to animal production are managed to ensure high levels of animal survival, reproduction and output. Output is constrained primarily by managerial decisions. The farms following intensive production system are using technology and inputs developed locally or imported, and the production of these farms approaches the western standards. Intensive system of animal production for cattle and buffaloes is mainly restricted to state/ central government livestock farms at SAUs and ICAR institutes and some farms run by the NGOs and progressive commercial farmers. Under this system, crossbred cattle and buffaloes having higher levels of productivity are maintained with intensive management in terms of breeding, feeding and health care. Large commercial farms or companies maintaining large herds (more than 50 heads) of cattle herds belong to this category and all the milk produced is marketed as liquid milk or in the form of various milk products.

Breeding Strategies

Crossbred dairy cattle under different production systems

A large number of half-bred and higher crosses of crossbred animals were produced through crossbreeding at organized farms and under field

conditions in different agro-climatic zones of the country. The crossbred animals are reared mainly under semi-intensive and intensive animal production systems. Accordingly, the breeding policy for existing crossbred animals under semi-intensive and intensive animal production systems is suggested as follows:

Breeding policy for crossbred animals after F_1 generation under semi-intensive animal production system: Under this production system, it is advisable to restrict exotic inheritance between 50 and 62.5%. Therefore, the F_1 crossbred females under semi-intensive production system can be bred with the semen of genetically superior progeny-tested crossbred males having exotic inheritance between 50 and 75% produced through inter-se-mating among crossbred animals. Holstein-Friesian is the breed of choice in the irrigated plains. Jersey is the breed of choice for crossbreeding in hilly terrain and coastal areas.

Breeding policy for crossbred animals after F_1 generation under intensive (high input) production system: High input production system is mostly available in milk-shed areas around peri-urban and industrial towns where a good market for milk and milk products is available and adequate quantity of quality feed and fodder resources exist. Under intensive production system, higher levels of exotic inheritance between 62.5 and 75% can be sustained. The F_1 females in field can be bred with the semen of genetically superior progeny-tested males of exotic breeds with high progeny test index to produce progeny with 75% exotic inheritance. Further, the progeny tested crossbred males having exotic inheritance between 50 and 75% produced through inter-se-mating can be used to sustain the exotic level between 62.5 and 75%. Holstein-Friesian is the breed of choice in the irrigated plains. Jersey is the breed of choice in hilly terrain and coastal areas for crossbreeding. The semen of exotic bulls of high transmitting ability for milk yield and milk constituents should be used. The crossbreeding of non-descript zebu cows with semen of exotic dairy cattle breeds will result in 5 to 8 times more milk production compared to that of non-descript cows, reducing age at first calving and shortening calving intervals in crossbred progenies.

Local non-descript cattle under low-input production system

The local non-descript cattle are reared mainly under low-input production system where quality feed and fodder resources are not available in sufficient quantity. The farmers are resource poor, and they have inadequate infrastructure facilities. Marketing facilities for sale of milk and milk products are poor. The non-descript cattle can be

genetically improved by grading up using either elite pedigreed or progeny tested bulls of well known indigenous breeds like Sahiwal, Tharparkar, Red Sindhi, Gir, Deoni, Hariana, Ongole, and Kankrej available in the breeding tract. These breeds are maintained on several organized government and non-government farms. The bulls to be used for this purpose should be produced from superior dams, which have more than 2,000 kg as lactation yield for milch breed of Sahiwal, Tharparkar and Gir cattle and more than 1,500 kg for dual type cattle breeds of Hariana, Kankrej and Ongole etc.

This will improve the milk yield by 500 to 800 kg in the first generation. By use of zebu bulls of high transmitting ability for grading up subsequently the milk yield can be improved to the extent of 5 to 10% per annum. In a period of 5-6 generations of continuous grading up, the non-descript stock will be transformed into well-defined purebreds.

Well-defined indigenous dairy cattle breeds under medium to high input production system

The animals relatively with high producing ability belonging to well-defined indigenous dairy and dual-purpose cattle breeds are maintained under intensive production system at organized farms and mainly under semi-intensive management system in farmers' herds. These breeds can be genetically improved through selective breeding. High-pedigreed bulls (with high EPD) and genetically proven bulls should be utilized for the purpose in the breeding tracts of different zebu cattle breeds, for example, Gir and Kankrej for Gujarat; Rathi, Nagori and Tharparkar for Rajasthan; Hariana for Haryana, parts of Punjab, Western Uttar Pradesh and Rajasthan; and Ongole for Andhra Pradesh.

By selective breeding, it is expected that genetic improvement in milk production will be achieved ranging from 1 to 1.5% per annum in herds at organized farms and 8-10% per annum in farmers' herd.

Well-defined buffalo breeds under medium to high input production system

The relatively high yielding buffaloes of well-defined buffalo breeds are maintained under intensive production system at organized farms and mainly under semi-intensive management system in farmers' herds in the breeding tracts of different buffalo breeds. Selective breeding is practiced for bringing about genetic improvement in buffalo breeds. Existing organized farms of Murrah, Surti, Mehsana, Nili Ravi, Nagpuri, Bhadawari and Jaffarabadi buffalo breeds need to be strengthened for production of genetically superior breeding bulls.

In certain pockets of Gujarat, Rajasthan and Karnataka, Surti is recommended to be the breed of choice. Murrah is generally the breed of choice in Haryana, parts of Punjab, and Western Uttar Pradesh besides few pockets in Punjab where Nili Ravi has sizable population and it also needs to be improved through selective breeding. The genetic improvement in indigenous buffalo breeds for higher milk production, reduction in age at maturity, reduction in service period, dry period and calving interval will lead to higher economic returns to the farmers.

By selective breeding, through networking of multi-herds of a particular breed, it is expected that genetic improvement in milk production will be achieved ranging from 1 to 1.5% per annum in herds at organized farms and 8-10% per annum in farmers' herds.

Local non-descript buffaloes under low to medium input production system

The low producing, local non-descript buffaloes are generally reared under low to medium input production system in areas where feed and fodder resources and milk and animal marketing facilities are moderately available. The production potential of low producing non-descript buffaloes can be increased rapidly through mating with superior sires of improved breeds like Murrah, Surti and Mehsana. Surti is recommended for Karnataka, Kerala, parts of Gujarat and Rajasthan, Nili Ravi for few pockets of Punjab, Murrah for Haryana, parts of western Uttar Pradesh and Punjab. In other parts of the country where sufficient feed and fodder resources are available, Murrah is recommended for grading up of non-descript buffaloes.

This programme is expected to increase the milk production of village non-descript buffaloes by 2 to 3 times in early generations of grading up. The grading up of non-descript buffaloes yielding on an average 500 kg with improved buffalo bulls having genetic potential of 2,000 kg or more will yield an average of 1,250 kg in first generation. Thus through grading up with superior breeds in 4 to 5 generations, the low producing non-descript buffaloes can be replaced with relatively high producing buffaloes conforming to the characteristics of well-defined breeds.

Methodologies of Performance Evaluation and Selection of Animals

Methodologies developed for selection of females, based upon their expected producing ability, and young males, based on their expected predicted difference using pedigree information, physical attributes and subsequently evaluating them on the basis of their progeny performance

etc., could be utilized for improvement of cattle and buffalo herds maintained on organized farms of central/ state government and other developmental agencies. For bringing effective genetic improvement, rigorous selection pressure must be ensured on the basis of milk production of cows. Here it is very important to increase the herd replacement rate and minimize involuntary culling on the basis of reasons other than milk production. For this, proper herd management practices such as suitable housing, proper adoption of reproductive health management practices, adequate availability of quality feed and fodder, timely disease control measures to minimize the mortality need to be employed. Since large proportion of genetic gain is resulted through proper selection of superior breeding bulls, it should be ensured that the young bulls are the progenies of elite mating and subsequently be progeny tested on large test population associating multiple organized herds or farmers' herd. Elite cows for nominated mating may be chosen from organized herds or from farmers' herd.

The strategies for undertaking large scale genetic improvement programmes on widely distributed population of cattle and buffaloes in the country require huge number of genetically superior breeding bulls. According to an estimate in 2005, to cover even 30% breedable bovine population in the country for breeding through AI 1,050 proven bulls of crossbred cattle, 5,700 proven bulls of well-defined indigenous cattle breeds and 11,400 proven buffalo breeding bulls are required . Therefore, for accomplishing the huge task of bringing about genetic improvement of cattle and buffalo genetic resources in the country through above proposed breeding methodologies, the following action plan for properly implementing the programmes is suggested:

1. Identification and establishment of breeding services organization (Centre/ State level) for overall monitoring and implementation of breeding programmes.
2. Identification of operational areas/ regions for the breed/genetic group/animal population to be improved upon.
3. Infrastructure development in the operational areas including establishment of AI centres, animal health centres, milk procurement and extension centres fully equipped with trained man power i.e. veterinary, para-veterinary staff so as to enlarge network of breeding facilities for covering large number of breedable bovine animals.
4. Establishment and strengthening of breed nucleus herds/bull mother farms, young bull rearing centres, semen collection and cryo-storage banks.
5. Establishment of databank to carry out activities on animal identification and performance recording linked with progeny

testing programme for selection of large number of high genetic merit bulls.

6. Networking of breed-specific organized government/ private cattle and buffalo farms and large progressive farmers' herds for testing of large number of breeding bulls and linking with performance recording and progeny testing of bulls under farmers' herd in village conditions.
7. For faster multiplication of superior germplasm and large-scale dissemination, selected organized nucleus breeding herds should adopt open nucleus breeding system with or without MOET (Multiple Ovulation and Embryo Transfer) and other emerging reproductive and genetic techniques.
8. Formation of the milk producers' co-operative unions/breed societies/NGOs for active participation of farmers/ breeders in the activities on breed development and improvement as their own programme.

Milch Breeds of Goats

The goat is regarded as poor man's cow. The goats are adaptable to varying environmental conditions and have tremendous ability to survive on sparse vegetation unsuitable for feeding of other livestock. Goats are the source of income and occupation for a large number of rural people, especially the economically and socially backward classes of the society in India. The goat is mainly a meat animal in India and a few breeds are milch breeds which provide small quantity of milk. India possesses 22 well established breeds of goat apart from non-descript local goats. The important dairy goats are Jamunapari, Beetal, Jhakrana, Zalawadi and Surti. A few exotic dairy breeds like Alpine, Saanen, Toggenburg and Anglo-Nubian have been used in crossbreeding with local breeds of goats to improve the milk production.

Jamunapari: This breed is found in Etawah, Agra and Mathura districts of Uttar Pradesh and the tracts lying between of the Chambal and Jamuna rivers. The goats of this breed are the largest in size, tall and leggy. The breed has no uniform colour but animals having a white coat with markings of tan are common. They are dual purpose goats giving both milk and meat. The body weight of an adult male (buck) and female (doe) ranges from 50-85 and 40-60 kg respectively. The average body length and height of an adult buck and doe is 127 and 116 cm and 91 and 77 cm respectively. The average milk yield is around 1-2 kg per day with a maximum of 350-550 kg in a lactation period of 250 days. The lactation length varies between 210 and 275 days. A good animal yields 2.5-3.5 kg milk per day. This breed has

IMPORTANT MILCH GOAT BREEDS

JAMUNAPARI

BEETAL

JHAKRANA

SURTI

ZALAWADI

contributed to the development of famous Anglo-Nubian breed of goats in England.

Beetal: This breed is found mainly in Gurdaspur and Amritsar districts of Punjab. This breed resembles Jamunapari but is slightly smaller in size. The adult buck and doe weigh around 40-70 and 35-50 kg respectively. An adult Beetal buck measures 125 cm in body length and 90 cm in body height. The corresponding values for a doe are 105 cm and 75 cm respectively. The milk yield is around 1-1.5 kg per day. The lactation length varies between 160 and 200 days. The maximum milk yield of 834 kg in a lactation period of 287 days has been recorded in this breed.

Zalawadi: This breed is found in Zalawad district of Kathiawad. It is also found in western Mehsana and Radhanpur in Gujarat. The Zalawadi are generally large size goats with straight screw shaped horns. The adult animal weighs around 50-65 kg. This goat is a good milker and kids only once in a year. The good animals yield around 2-3 kg milk per day with an average of 200 kg in 150 days.

Jhakrana: This breed is distributed mainly in Jhakrana and in surrounding villages near Behrar in Alwar district of Rajasthan. Jhakrana goats are large size animals. The breed is quite similar to Beetal goats in physical characteristics, but is comparatively larger in

size. The body weights of adult goats are 58 and 44 kg for male and female respectively. This goat breed is known for its milk production. The average lactation milk yield is about 120-135 kg in a lactation period of 110-125 days.

Surti: This breed is distributed in Surat and Baroda districts of Gujarat and Nasik and Mumbai areas of Maharashtra. This is a medium-size white goat having well-developed udder. The adult weight is around 25-35 kg. This is a good milch breed yielding around 1.5-2.0 kg of milk per day with a lactation yield of 120-170 kg in around 115-150 days.

Exotic milch goat breeds

Alpine: This milch breed has originated in the Alps in France. Its coat colour varies from black, fawn to white. The preferred colour is black with white markings on each side of the belly and face with white legs below the knees. Alpine females are excellent milkers. The average body weight is 65-85 kg in the bucks and 50-65 kg in the does. The average body length of a mature buck and doe is around 88 and 72 cm while the height is around 76 and 70 cm respectively. The average daily milk yield is around 2.5 kg with an average lactation yield of 720 kg in 245 days. The good milkers yield 3-5 kg milk per day. The highest recorded milk yield is 2,316 kg in 300 days. The milk butter fat % is 3-5%.

Saanen: This breed has its home tract in Saanen Valley of Switzerland. It is regarded as the "milk queen" of goat world. Its coat colour is white or sometimes cream or grey and fawn at the spine. The udders are usually shapely and well huge. A mature doe and a buck weigh around 55-65 kg and 70-95 kg respectively. The daily average yield is 2-5 kg per day during a lactation period of 8-10 months. The world lactation record in goats (305 days) is held by a Saanen goat in Australia with a yield of 3,084 kg milk with 3.3% fat.

Toggenburg: This hardy milch breed originated in Toggenburg valley of Switzerland. The coat colour varies from deep chocolate to pale-drab. There are light fawn or white markings down on each side of the face and from the knees or hocks to the feet, around tails, rump and thighs. The average yield is 2.0 kg with 3.4% butter fat. The lactation yield is 400 kg in 200 days. The adult female (doe) weighs around 40-50 kg and adult male (buck) weighs around 55-65 kg. The highest recorded milk yield was 2,614 kg in a lactation period of 305 days in USA. The breed is a better suited for adaptation in India.

Anglo-Nubian: The Anglo-Nubian breed has been evolved by crossing of Nubian of Egypt, Jamunapari of India and old English type goats. There is no fixed colour. The udder is capacious but pendulous

and teats are large. They are consistent milkers with higher fat (5%) compared to other breeds. This breed is known as the Jersey of goat world. On an average they yield 1 kg milk per day. The lactation yield is about 300 kg in 300 days. The mature females weigh around 45-60 kg and males weigh approximately 55-80 kg. The record milk of 2,124 kg was produced in 305 days by an Anglo-Nubian female in California.

Breed improvement in goats

The best approach for bringing about genetic improvement in different dairy breeds of goats is through selective breeding, i.e. mating of best females with best males for milk production. The high producing elite females (does) and elite males (progeny of elite females) can be identified in the field and retained at central nucleus farm. Further selection can be made at the Central farm. The farm-bred males can be re-distributed in the field for improving the farmers' goats. The crossbreeding of indigenous goat breeds with Alpine and Saanen breeds of exotic goats tried at the National Dairy Research Institute (NDRI), Karnal, has been met with a limited success.

Chapter 3

Managing Dairy Animals for Optimum Productivity and Health

Most of the indigenous cattle breeds in India except a few milch breeds like Sahiwal, Rathi, Gir and Tharparkar have low milk yield under the management conditions they are maintained. In an effort to improve their milk production, crossbreeding of indigenous tropical breeds (*Bos indicus*) with temperate dairy breeds (*Bos taurus*) has been extensively undertaken to combine high milk yield and early maturity of European dairy breeds with hardiness, disease resistance and adaptability of local cattle breeds. As a result of this, a large number of crossbred animals have been produced, and their milk production has registered a marked improvement. These animals with their high production potential require considerable management skills to realize their high genetic production potential.

Role of Management

Production performance of a cow is partially a measure of her genetic potential, which in interaction with the environment in which she is kept determines the actual performance. Researchers have shown that the economically important traits like milk production, growth rate and reproductive efficiency parameters have low to moderate heritability and the genetics accounts for only about 20-35% of the differences in actual performance of dairy animals and the remaining 65-80% is contributed by the environment. Environmental factors that directly influence a cow's performance include types of housing, milking procedure and techniques, feeds and feeding systems, health care, incidence of mastitis and its treatment and physical environmental conditions. The genetic potential of a cow can be expressed only through elimination of these factors through sound and effective management.

Management of Young Calves

Successful rearing of young calves is the key to success of dairy farming enterprise. Calves are the future replacement stocks for cows

and breeding bulls. It is, therefore, important that they are reared economically to have proper growth and maximum survival and freedom from mortality and morbidity and to ensure early maturity. Success of dairy farming also depends on fast reaching of breedable age and with minimum elimination due to mortality and culling, the latter due to poor growth resulting from poor care and management and high incidence of internal and external parasites. This is more important for buffalo calves where the poor management and lack of provision of milk through suckling causes very high mortality especially in male calves. Mortality of calves (0-1 month) should be kept below 5% by proper following of package of practices and milk feeding schedule. Healthy calves with higher growth rate and low mortality rate are essential for higher profits from dairy farming as this will allow large replacement and sale of productive and relatively younger animals. Taking care of calves during the milk-feeding phase is possibly the most management-intensive facet of the dairy operation. Health of a calf, development of its digestive tract function and growth and development of its body during this period also influence its subsequent reproduction, survival and lactation performance.

Management of Neonatal Calves

- If weaned at birth, the newborn calves must be cleaned with a clean dry towel or clean and dry hay/straw. This apart from drying stimulates respiration and blood circulation in calf and improved survival.
- Remove mucus from the nose and mouth to assist breathing and holding up the rear legs of the calf, let the head hang down to release any water in the lungs, mouth and nose.
- Cut the navel chord leaving two to three inches from its attachment to the placenta, squeeze out the contents, dip the navel in tincture of iodine or any other strong disinfectant or alcohol, legate it using clean thread to prevent local infection. This procedure is important for prevention of navel-ill and helps the umbilicus heal quickly.
- Feed the calf with colostrum within one to two hours after birth. The optimum time for absorption of antibodies through calf's small intestine is in the first six to eight hours. The quantity of colostrum fed to the calf should be about 10% of its body weight. It is essential that the calf receives enough colostrum during the first 12 to 24 hours to prevent infection. The colostrum is high in nutritive value; it contains antibodies IgG and Ig from the cow's immune system which forms passive resistance against many infections.

- In general, after calving the calf should be removed from the dam to an isolated pen which should be dry and clean. Straw for bedding must be clean and dry and should be changed regularly. In some cases the farmers rearing crossbred dairy cattle, leave the calf to suckle milk directly from the dam during the first three to four days before being separated from it. This may not be possible in buffaloes and indigenous cows, as the maternal instinct in these animals is very strong making it impossible to separate the calf once the dam-offspring bonding (imprinting) has been established.
- Feed whole milk/milk replacer twice a day as per feeding schedule. If a bucket is used for feeding, it should be thoroughly cleaned before reuse to avoid digestive disorders due to poor hygiene.
- Train the calf to take creep feed made of concentrate and green forage/hay at about one week of age. Solid food stimulates rumen development. In the pen, clean water must be available all the times.
- Calves should be numbered using an ear-tag or tattoo. Dehorning and removal of extra-teats if any should also be done in the first few weeks.
- The calves must be guarded against common health problems normally encountered during this period such as navel-ill, diarrhoea (white scours) and respiratory infections (pneumonia).

Feeding Young Calves

The feeding of weaned calves after initial colostrums period should be as per the following feeding schedule:

Age	Whole milk	Skim milk	Concentrate mixture (kg)	Green fodder
5-30 days	1/10th b.wt*.	—	—	—
1-2 month	1/15th b.wt.	1/25th b.wt.	0.120	*ad lib.*
2-3 months	1/25th b.wt.	1/15th b.wt.	0.250	*ad lib.*
3-4 month	—	6.5 kg	0.650	*ad lib.*
4-5 month	—	6.5 kg	1.000	*ad lib.*
5-6 month	—	5.0 kg	1.500	*ad lib.*

* body weight.

From 6 months onwards the calves may be offered a good-quality green fodder free choice along with the supplementation of 1.0 to 1.5 kg of concentrate mixture per calf daily. The deworming of the growing calves should be done regularly. De-worm the calf against gastro-intestinal parasites roundworm, tapeworm and flukes. Also, eliminate

external parasites such as ticks by spraying/dusting. The following calf deworming schedule may be followed at the dairy farm.

Age of calf (day)	Name of medicine	Dosage
3rd	Piperazine adipate	1 g/4 kg Body weight
7th	Piperazine adipate	1 g/4 kg Body weight
8th	Sulmet course for 3 days	1st day — 30 ml
		2nd day — 15 ml
		3rd day — 15 ml

Later on, whenever infestation of endoparasites is suspected broad spectrum anthelmintic drugs like albendazole, fenbendazole or thiobendazole should be used at the rate of 5-10 mg/ kg body weight depending on the severity of infestation. The growing calves may also need to be protected from ectoparasites by periodically spraying of animals and calf houses. All female calves should be vaccinated against brucellosis (strain 19) at three to eight months of age.

Calves over 6 months of age

- Vaccinate against FMD (foot-and-mouth disease), hemorrhagic septicemia (HS) and/or anthrax every six months.
- De-worm against gastro-intestinal parasites such as roundworms, tapeworms, liver flukes and also eliminate external parasites such as ticks/mites, by spraying.
- Problems in this period include internal and external parasites, pneumonia, diarrhoea and bloat. Use of ivermectin, a broad-spectrum anthelmintic which covers both the external and internal parasites, can help in reduction of mortality and morbidity especially in young buffalo calves where such incidence is high and results in heavier mortality than in cattle calves.

Dairy Heifer Management

Heifer is a female animal from one year of age up to first calving. The heifers are future cows of the herd. On good dairy farms, at least 20-25% of the cows must be replaced every year with freshly calved heifers. Therefore, proper nutrition and management of heifers is necessary to provide adequate number of healthy and genetically superior herd replacements. Under Indian conditions the goal of dairy farmer should be to raise well grown heifers that calve at an average age of about 30 months in crossbred cows, 36 months in indigenous cows and about 36 months in buffaloes.

The nutrition during the growing and pre-pubertal period shall mainly comprise *ad lib.* feeding of good-quality green fodders supplemented with some amount of concentrates, so as to obtain a daily growth rate of 500-550 g in crossbred heifers and 450-500 g in heifers of indigenous cattle breeds and buffaloes. The heifers may be fed mostly on roughages and allowed to remain lean until pregnancy. During the later half of pregnancy it should be fed at a higher plane of nutrition to achieve rapid growth, which could cause maximum development of ducts and alveoli in the heifer's udder.

The system of loose housing of heifers is generally followed in most parts of the country except in areas of heavy rainfall and coastal areas. For better growth of the heifers they need to be protected from summer heat and direct solar radiation stress especially under Northern Indian conditions. Provision of shade and water sprinkling or splashing during hotter parts of the day twice or thrice daily, provision of ceiling fans in the sheds or provision of mist cooling devices and wallowing especially in buffalo heifers are some of the practices to be followed for the protection of heifers from heat stress. For the protection from cold stress in winters, the heifers are offered a well balanced nutritious diet. In severe cold weather conditions, the allowance of concentrate mixture may be increased by 0.5 to 1.0 kg per heifer daily so that their growth is not adversely affected.

Heifers having stunted growth, maturing too late, having anatomical defects or bad disposition should be regularly culled from the herd. Heifers needed to be protected against ectoparasites ticks, lice etc. by spraying with insecticides like 1% malathion at monthly intervals. The floors, walls and roofs of the heifer sheds should also be sprayed to make them free from ecto-parasites. The heifers reaching the expected age of puberty should be observed for signs of heat every day and should be bred with the semen of superior bulls on second heat. Attainment of 60% of mature body weight (about 300 kg) is the stage at which the heifers should be bred. The advanced pregnant heifers should be trained for milking by taking them to the milking parlour along with the milking cows and allowed to go through the milking routine. This will give them an opportunity to get adapted to the milking routine. Such heifers will not get excited and thus will not have any difficulty in milking after calving.

Good care in feeding and management of heifer results into an earlier age at maturity. Heifers should be fed good quality green fodder/ hay/straw supplemented with concentrates and mineral supplement. The following guidelines should be adopted for the management of heifers from 6 months of age until first calving:

- Growth and body condition of the heifers must be monitored closely. A growth rate of 500-600 g per day should be ensured.

- Heifers must be vaccinated regularly against important infectious diseases prevalent in the region.
- Deworm all the heifers against internal parasites strategically after getting worm burden assessed on a sample of animals in the herd.
- Heifers should be kept in manageable groups and the grouping should be done based on the age and body weight of the heifers.
- Heifers must be well protected from inclement weather conditions and free access to clean drinking water must be ensured. The floor must be clean, dry and non-slippery.
- A close eye must be kept on heifers to determine the age at maturity.
- Optimum breeding weight for smaller (Indian) breeds of cattle can be 225-250 kg and that for larger breeds should be 275-325 kg. The optimum breedable weight in heavy breeds should be reached by 15-18 months and in smaller breeds it should be reached by 22-25 months.
- An optimum combination of age and body weight should be considered for breeding the heifers. Breeding very young heifers is also not recommended but body weight should be given greater importance.
- Around 20-25% of the average milking herd should be replaced every year. Replacement animals should be selected from those with the highest potential for milk production.

Pregnant heifers – pre-partum (24–36 months)

- Feed good-quality roughages with concentrate supplement as per the requirement. Mineral supplement may be fed to pregnant heifers to prevent metabolic diseases such as milk fever.
- Vaccinate against FMD, HS and other diseases as per the recommended programme for a specific region.
- De-worming for external and internal parasites should be carried out regularly but at least twice during pregnancy.
- Signs that the cow is approaching parturition are that it becomes uneasy and separates from the herd. Signs of calving include enlargement of the udder and belly and swelling of the vulval labia and discharge from the vulva.

At parturition

- During later part of the pregnancy especially couple of months prior to calving, it is necessary to build body reserves through intensive feeding of high energy and high protein concentrates which will help the animal to meet the extra needs of energy during later part of pregnancy when the calf is fast growing and early part of lactation

when the nutrient requirement is high for regaining of the weight lost at parturition and to meet the additional need for recovery in body weight and high level of milk production.

- The calving area may be prepared so as to ensure clean, dry, quiet and isolated environment for the cow. Also ensure to keep a constant watch on the cow nearing calving so as to provide help if the cow shows signs of difficulty during birth of the calf.
- Signs of calving include enlargement of the vulva, distention of the teats and udder, relaxation of ligaments at the side of the tail-head and restlessness. Other indicators are a marked increase in the amount of mucous discharge from vagina and increasing frequency of abdominal and uterine contractions.
- After initiation of symptoms of parturition especially contraction of uterus if the water bag has not protruded for over 20 hours, the cow may require assistance in calving from a veterinarian.
- If there has been no expulsion of the fetus or any contractions for more than two hours after the rupture of the water bag (allantoic sac), veterinary assistance will be required.
- During this period, there is the possibility of milk fever, uterine prolapse, or downer cow syndrome which should be properly attended to through veterinary assistance.

Soon after calving

- Natural expulsion of the placenta should occur within three to eight hours after calving or within 12 hours. If the placenta is retained over 12 hours, the cow will require assistance from a veterinarian.
- Colostrum should be fed to calf as soon as possible (within 2-3 hours).
- Remove the fetal membrane from the pen floor; clean the pen and the hind quarters of the dam to reduce risk of infection.
- Feed the cow with good quality of food *ad lib*. The feed should be palatable because during this period the cow has less appetite and may remain under stress. Giving high energy food, e.g. sugarcane cake *(gur),* helps in making additional energy available to the cows required for involution of uterus and maintaining high productivity.
- During this period, there is possibility of retained placenta, metritis, milk fever, uterine prolapse and mastitis, which must be promptly attended to through veterinary assistance.

Feeding of Milch Animals

Feeding management of dairy animals during the entire period of lactation is vital for optimizing milk production. Proper management

of the dairy animals during first few days after calving and during early lactation is of particular importance. The following management practices are recommended:

- Soon after calving the animal must be fed laxative feed and warm gruel made of broken grain mixed with jaggery and *ajwain*. This helps in involution of uterus and provides energy to recoup which was lost during calving and improves milk yield. The animal at this time must be managed separately. Special care may be taken regarding emptying the udder as frequent emptying may result in occurrence of milk fever especially in high yielding animals and those poorly managed during later part of pregnancy.
- Feeding management during early lactation must focus on attaining higher peak milk production and better persistency. This could be achieved by:
  i. feeding the animal with higher energy diets; and
  ii. maximizing dry matter intake.
- Monitor the body weight and condition regularly during early stages of lactation. It must be ensured that the animal does not lose excessive condition during this phase, as this may result in fat infiltration of liver also called 'fatty liver syndrome' because of mobilization of body reserves.
- Attempt must be made to return the animal in the positive energy balance as soon as the long phase of negative energy balance results in poor persistency of milk production and lower reproductive efficiency. This can also be achieved by improving the quality as well as quantity of the feed.
- After the peak milk production has been attained, the feeding must be based on the level of milk production.
- The milk is most economically produced when feeding is based predominantly on abundant amount of green fodders. All attempts must therefore be made to ensure supply of green fodders/silage/ hay round the year. Concentrates should also be supplemented whenever necessary depending on the level of milk production and milk composition.
- A combination of leguminous and non-leguminous fodders is the best to meet the maintenance and production requirement of a cow weighing up to 400 kg and yielding up to 8 litres of milk with only 1 kg concentrate supplementation. In case of non-leguminous fodder feeding, it would be necessary to give additional half-kg concentrate at the time of milking to induce let-down of milk.
- In dairy cows producing higher quantities of milk (more than 20 litres/days), no suitable combination of concentrates and fodders

(even at high intake levels) can sustain this level of production without the mobilisation of body reserves. Such cows can also be supplemented with oils/fats in their diets at 300 g per day level.

- Moderate levels of milk can be sustained on a suitable combination of green and dry fodders supplemented with desired amounts of concentrates. While feeding a mixture of straw and green fodders, it will be desirable if 1 kg of straw is mixed with every 4-5 kg of chaffed green fodder for each 100 kg body weight.
- If plenty of quality green fodder is not available and the ration is based on low quality straws/stovers than additional concentrate feeding will be required.
- The feed intake of lactating dairy cows yielding medium level of milk in dry matter equivalent is about 2.5 kg DM (dry matter) per 100 kg BW (body weight). The DM intake in high yielding animals could go up to 3.5% or even higher.
- In non-producing adult cows, the DM requirement is about 2.0% of their body weight.
- For optimum level of production the protein availability of total ration should be adjusted at 13-14%. Leguminous fodders (like berseem, lucerne) contain about 12-14% CP, non-leguminous fodders (like maize, sorghum, oats and grasses etc) contain about 7-8% CP. The dry fodders like wheat and paddy straws contain only 3-4% CP. The CP content of concentrate mixture should be adjusted to provide about 13-14% CP in the total ration.
- Roughages must be chaffed. However, very fine chaffing may be avoided, as it may affect the regurgitation process and roughage digestion in rumen adversely.
- Grains in concentrate mixture should be coarsely ground/broken; else part of it may pass off undigested in faeces. It is desirable to mix the concentrate mixture in wetted straws before feeding.
- Availability of clean drinking water must be ensured to the milch cows.
- Due care should also be taken to feed the advanced pregnant cows and buffaloes as the feeding management at this critical stage will determine the productivity in the ensuing lactation and ensure adequate build up of body reserves for use during early lactation when the energy intake of the animal is low to meet the requirement of milk production, because of the incapability of an animal to consume the required quantity of feed.
- A suitable combination of berseem along with oats, maize, wheat/ paddy straw and concentrates (based on the level of production) is most practical strategy of feeding dairy cows and buffaloes during

winters. The total DM content of such ration should be about 22% and the CP content about 14%. The respective DM and CP contents of the above feeds are – berseem 12 and 14%, oats 15 and 10 %, maize 16 and 10%, straws 90 and 4%, and concentrates 90 and 20% respectively. Cultivation of improved varieties of fodder crops have the potential to improve the yield of the fodder and prolong the availability period also. The important varieties of fodder maize are African Tall, Vijay Composite, berseem–BL 10, BL 22; and of oats are OS 6, OL 9.

- If enough green fodder is not available and straws are to be fed, the quality of these straws can be improved by treating them with urea/ ammonia.

Management of Dry Cows

The cows and buffaloes need a dry period between two lactations to build up body reserves and allow the development of foetus. Very often management neglects dry animals, which decreases the profit in due course of time. Therefore, good feeding and management practices should be adopted for dry animals to ensure optimum productivity from these animals once they come into production after calving. The following points must be kept in view for their management:

- The average length of pregnancy for dairy cows is 283 days (with a variation of 10 days on either side). The cow should be dry for 45-60 days. The date to begin dry period is calculated back from expected date of calving.
- Conditioning for the dry period is done during last few weeks of lactation. Research shows that body fat is replaced most efficiently during late lactation than during the dry period. Cows should not be too fat or too thin at the end of the lactation. Adjusting the concentrate to roughage ratio can control weight. Give thin cows a higher level of concentrate and fat cows lower level of concentrate.
- Follow proper procedure to dry off the cow to avoid udder problems. The following procedure is recommended for this purpose.
- Milk the cow every other day for several days.
- Do not feed concentrate/grain, reduce water and forage intake for one or two days. After the feed has been reduced for the recommended time, stop milking the cow. Routine treatment for mastitis at drying off is recommended. Treat the cow for mastitis at the last milking. Watch the udder for abnormal swelling for two or three weeks after drying off.
- Separate dry cows from the milking herd. They may be grouped with the breeding heifers. Allow dry cows to get plenty of exercise.

- Do not overfeed or underfeed them. Feed mainly good-quality roughages and recommended concentrate. Limit body gain to not more than 45 kg from late lactation to the next calving. When dry cows get too fat, there is more problem with ketosis, depressed appetite, milk fever and displaced abomasum. Fat cows also have problem at calving time.
- During last few days of the dry period, watch the cow closely for signs of calving. Ensure safe delivery in a calving pen. Calving pen floor should not be slippery and should have proper bedding of dry straw. Ensure that the placenta is expelled within 48 hours after calving.
- After calving watch the cow for signs of milk fever, ketosis, or other health problem. Provide freshwater and hay/soft roughages/wheat bran after calving.

Maintenance of Dairy Records

Maintenance of proper records helps in efficient management of a dairy farm. Record keeping is essential for evaluation of the performance and for taking corrective measures so as to maximize profits. Application of computer has very crucial role in dairy farm record management.

The following records should be maintained at a dairy farm:

i) Date of birth and pedigree information (at least parents and preferably grandparents) of the animals.
ii) Records on growth.
iii) Reproduction records (oestrus, breeding, pregnancy diagnosis and calving).
iv) Milk production records (daily).
v) Health and veterinary record (vaccination/ drenching with anthelmintics, dusting/spraying/ dipping for the prevention of parasites).
vi) Treatment of diseases and disorders.
vii) Feeding item records (daily consumption of green fodder, straw and concentrates) estimated values.
viii) Periodic test of milk fat, SNF and other quality parameters such as bacterial counts, antibiotic and pesticide residues.

Besides above records, complete farm business records (purchase of feed, seed, fodder, fertilizers, veterinary medicines, irrigation, implements, electricity and fuel expenses, sale of milk, animals, skin, manure, labour wages etc.) should also be maintained.

Some important applications of farm records

i) In making decision about culling of animals.

ii) In reducing feed cost.
iii) In proper utilization of land and labour.
iv) Comparing performance with standard values.
v) Proper breeding of herd.
vi) Proper claims from insurance companies.

Labour efficiency

Expenditure on labour is next to the cost of feeding in annual cost of keeping a cow. To reduce this expenditure, management must ensure:

i) Proper planning of dairy farm buildings.
ii) Proper grouping of different buildings of the dairy enterprise.
iii) Selection of proper equipment.
iv) Proper training and demonstration to be given about the expected task assigned to the labour.
v) Take care of welfare and give incentives to improve efficiency of labour.

Computer application in management of dairy farm

Management of a dairy enterprise has always required versatility. The successful manager should know accounting, finance, cattle breeding, feeding, marketing, personal management etc. Most dairy operations in India are too small to economically employ a person from each of these fields of expertise, but should hire consultants from various areas, who can help in providing software (programmes) or can help in developing computer programmes for specific uses at the dairy farm.

It is suggested that for modern dairy farm management a computer controlled management system is highly desirable, having a main frame computer in its main office and having terminals at different dairy units for entering, storing and retrieving information. The computer unit and the software shall only be purchased after testing its utility in an actual operation and after establishing its profitability at the dairy enterprise. Size of data to be handled in a year is another important aspect to be considered while buying computer hardware/software.

❐

Chapter 4

Body Condition Based Feeding and Management

The nutritional plane to which an animal has been exposed over a reasonable period of time is reflected by the extent of fat stored in the body or muscle mass that has been diminished. This may be assessed visually and expressed as condition score. Body condition scoring (BCS) is an easy-to-learn tool for dairymen to evaluate the status of their dairy animal/herd nutrition and improve milk production, reproductive performance and health of their cows. Body condition is the reflection of the fat reserves carried by the animal. The cow can use these reserves when she is unable to store enough energy from feed to satisfy energy demands of the maintenance and production functions. In high producing dairy cows, this normally happens during early lactation, but it may also happen when cows get sick or are fed poor quality of feeds. After a period of weight loss, cows should be fed more than requirements of milk production and maintenance to restore normal body condition. To score the dairy cows, the five-six- and ten-point scales have been suggested by different workers. But, the five-point scale is commonly used, which often is divided into ½ to ¼ point increments. After each checkpoint is observed and score is recorded, a general BCS is assigned to the cow, with a score of one being emaciated, two being thin, three being average, four being fat, and five being obese. Using this scale, a body condition score change of one point is equivalent to a difference of 57 to 60 kg to body weight in heavier breeds.

In a herd, body weight or heart girth is usually monitored to quantify weight of animal, but these techniques have a number of disadvantages. First, weigh scales are cumbersome, expensive and difficult to transport. Second, weight only does not reflect an animal's condition; an animal with a large frame may have a higher body weight when at a low level of body reserves than other animal with a small frame, but abundant reserves; animal must therefore be individually identified to record seasonal weight change. Third, live weight may show

large variations due to changes of gut and bladder fill, pregnancy and parturition. Moreover weight changes reflect tissue hydration rather than significant alterations of protein or fat content. Measuring the heart girth requires that individual animals be restrained and results vary according to posture, positioning and tension of the tape, coat thickness and gut fill.

The BCS provides a measure of fat cover on the dairy cow irrespective of body size. It is recorded by assigning a score to the amount of fat observed at several skeletal checkpoints on the cow. These checkpoints include spinous processes, transverse processes, hooks, pins, and tail head. Ultrasonic assessment of subcutaneous fat indicates that BCS correspond closely to the actual measurement of the subcutaneous fat, indicating that accurate measurement of fat cover can be made by simply evaluating fat cover variation on the check points of animal.

When to score dairy cattle?

For consistent herd evaluations, a single individual should score cattle over successive years. The subjectivity of scoring systems may result in variation among individuals assigning scores. It is important to evaluate body condition throughout the year. A general thumb rule is every 90-120 days and specifically 30 days prior to breeding, 90 days post breeding, 100 days prior to calving and at calving. Scores should be evaluated based on the stage of lactation (days of milk or dry).

How to score the dairy cattle?

A condition scoring chart has been developed at the NDRI, Karnal, for crossbred cattle using 6-point scale and considering 7 critical points over the body of a cow. It is also effective for scoring indigenous cattle and buffaloes. The final body condition score of the animal is the average score obtained based on the individual point scores.

Point	Score	Description
I. Vertebral column (chine, loin and rump region)	1	Individual spine very prominent and sharp to touch.
	2	Spines prominent, ends sharp but covered with thin layer of muscular tissue.
	3	Spines not prominent but can be felt individually by slight pressure of hand.
	4	Spines not clear individually rounded in shape can still be felt with firm pressure.

contd

Point	Score	Description
	5	Difficult to palpate, covered with thick layer of fat.
	6	Spines buried under fat, very difficult to palpate.
II. Transverse process (TP) of lumber vertebrae	1	Very distinct and sharp to touch, no muscle covers.
	2	Distinct but less sharp, little muscle cover.
	3	Can be observed but not very sharp, not detectable individually.
	4	Rounded and can be felt only with some pressure.
	5	Rounded with thick muscle layer, TP can be felt with firm pressure.
	6	Thick fatty deposition in lumber region. TP very difficult to palpate.
III. Prominence of pins/hooks	1	Very sharp to touch, no detectable muscle tissue.
	2	Sharp but covered with a little muscular tissue.
	3	Hooks/pins relatively smooth covered with some fatty tissue.
	4	Hooks/pins well rounded with fatty tissue clearly evident.
	5	Hooks/pins nearly flattened, fatty tissue present all round.
	6	Hooks/pins buried under fatty tissue.
IV. Gut fill effect and formation of shelf	1	Definite shelf formation clearly evident, gaunt clearly tucked in.
	2	Shelf formation prominent.
	3	Moderate shelf evident.
	4	Slight shelf evident.
	5	No shelf evident.
	6	Bulge clearly evident.
V. Tail head region	1	Deep cavity under tail head, clearly visible, Tail vertebrae clearly visible.
	2	Depression not marked. Tail vertebrae easily palpable.
	3	Depression shallow, vertebrae palpable under some pressure.

contd

Point	Score	Description
	4	No depression visible under tail head, slight fatty tissue palpable under tail head.
	5	Individual vertebrae palpable only with firm pressure, accumulation of fatty tissue all around the tail head area.
	6	Tail head buried under fatty tissue.
VI. Depression between back bone and hooks/ back bone and pin bones	1	Depression very deep, skin drawn tight over pelvis with no tissue in between.
	2	Depression deep with only a slight layer of tissue in loin area.
	3	Depression still evident but not as deep.
	4	Flattened slight fatty tissue detectable.
	5	No depression, fatty tissue clearly visible.
	6	Heavy deposits of fat over loin area/no depression.
VII. Ribs	1	Individual ribs sharply prominent, no detectable fat covers over ribs, ribs sharp to touch.
	2	Ribs prominent covered with thin layer of muscular tissue.
	3	All the ribs not clearly visible, ribs covered with thick layer of muscular tissue.
	4	Ribs not clear, palpable only with little pressure.
	5	Ribs palpable only with firm pressure.
	6	Ribs very difficult to palpate, heavy deposits of fat all round the rib region.

A simplified version of the above chart is also given below to facilitate easier scoring operation:

Body condition scoring chart simplified for easier operation

Score	Evaluation	Description of animal
1.	Very poor	Animal emaciated, deep cavities under tail head, no muscle cover between pelvis and skin, all the bones very prominent.
2.	Poor	Animal appears weak, cavity under tail-head marked; deep depression in loin area, some muscle mass evident all over the body.

contd

Score	Evaluation	Description of animal
3.	Moderate	Shallow cavity in tail-head region seen, slight fatty tissue also evident, Pelvis can be felt easily, depression in loin region still evident. Ends of transverse processes of lumber region can be palpated with some pressure.
4.	Good	Fatty tissue can be felt all over the animal body (chine, loin and rump region). Skin appears smooth but pelvis can be felt. Ends of transverse processes can be felt but thick layer of tissue in the region evident. Only a slight depression evident in loin area.
5.	Fat	Folds of fatty tissue present all over, pelvis felt only with firm pressure. Transverse processes difficult to palpate. No depression in the loin area visible.
6.	Very fat	Tail head buried in fat tissue, skin distended, pelvis cannot be felt even with firm pressure, fat accumulation over transverse processes evidence. Bony structure not palpable.

Body condition scoring and heifer management

Body condition scoring (BCS) has useful applications for feeding management of heifers. Excessive condition on young prepubescent heifers often causes fat deposition in the udder and inhibits milk secreting cell formation in the immature mammary gland. Thus, a body condition score of 2.0-2.5 is desirable for heifers up to breeding age. After the heifers are bred, their body condition score may be increased to 3.0-3.5.

First calvers need to be managed differently than their herd mates. They will calve at 100-150 kg less body weight than mature cows. So, their concentrate allowances must be adjusted accordingly to maintain the correct forage to concentrate ratio and to prevent problems related to digestive disorders and fattening. The lactation curve of a first calver does not show the early high peak compared to higher parity cows and they also show greater persistency of lactation. This indicates that heifer does not need high energy diet as their older herd mates towards the replenishments of body fat reserve. But, first and second calvers need additional energy for growth throughout mid and late lactation and dry period. To ensure that the additional nutrients needed for growth are provided, the standard recommendation has been to feed more concentrate to these cows. During mid and late stage of lactation the first calver should get 10% and second calver 5% more concentrate than that required for milk production to obtain desired body condition. High milk yielding cows can produce large amounts of milk even during

their first lactation if they are properly fed. If special care is not taken, they will begin their second lactation with lowered body weight and thus lack adequate energy reserves. Genetically superior heifers would give poor second lactation performance due to inadequate feeding and management and may get culled from the herd.

Dry Period

In a six-point score programme, the optimum BCS for dry cows is 3.5 - 4.0. To achieve satisfactory health and performance in early lactation, body condition scores must fall between minimum of 3.0 and maximum of 4.5. The cows calving in a condition score of more than 4.5 are at greater risk of fat cow syndrome such as difficult calving, retained placenta, metritis, mastitis, displaced abomasum, ketosis and milk fever. The immune response of such cows is also usually inadequate to combat the stress of calving and appetite is also low to allow in meeting the nutritional demands of early lactation and compensation of growth. Another situation that occurs when the cow starts lactation is that without sufficient energy reserves, the condition score is around 3.0. This cow may experience fewer health problems at calving but her later productive and reproductive performance will be poorer than expected. The cow starting lactation in thin condition lacks adequate energy reserves and will have lower peak yield. Peak yield is directly related to total lactation yield in a mature cow.

It is a fact that cows replenish body condition (fat reserves) more efficiently while lactating than during dry period because of limitations of feed intake due to pregnancy. A well managed feeding programme combined with frequent observation is required to achieve desired condition score without over-fattening the dry cows.

Early Lactation

The peak milk production is attained at 4-6 weeks of lactation. The DM intake of cows in early lactation will be about 10% less than cows at the same level of production in mid lactation and peak yield is reached at about 9-11 weeks. This situation puts the cow in negative energy balance for several weeks in early lactation. This means the feed energy intake is less than the milk energy output. The cow uses available body fat reserves to meet the deficiency and it affects her milk yield and subsequent reproductive performance.

The mature cows calving in desired body condition with a score of 3.5-4.0 and in good health can be expected to lose 0.5 to 1.0 kg body weight per day during first 60-80 days of lactation. Within the first two months of lactation, average mature cows will drop between 0.5 and

1.0 point in condition score, stabilize BCS near 3.0 by the tenth week and begin to regain lost condition by around 3 months. This coincides with optimum period of observation of regular oestrus activity, mating and conception.

Very high producing cow may drop to a condition score near 2.5 before stabilizing having lost up to 1.5 kg of body weight per day. This may continue up to four months of lactation. This may negatively affect the cow's coming in heat, which may cause delayed conception. The cows with good production that demonstrate lower condition loss in early lactation are very efficient feed converters. The cows that do not lose condition at this early lactation are the poor producers. Low energy intake in early lactation can lead to high rates of mobilization of body energy reserves with a loss in weight ranging from 1.5 to 2.0 kg per day. This increases the risk of excessive urination of fat reserves and may lead to ketosis, increased susceptibility to diseases, delayed return to oestrus and reduced fertility.

The feeding programme for cows in early lactation must therefore be carefully managed to achieve maximum DM intake and feed digestibility.

The following recommended feeding management practices will help maximize DM intake, eliminate the risk of cows going off-fed, and reduce the cow's dependence on body energy reserves:

- The CP content of the ration should be in the range of 13-16% of the DM. Ideally 40% of the protein should bypass rumen microbial degradation and provide amino acids that are limiting to milk production. To ensure high milk yield the ration should contain over 65 % TDN.
- Challenge feed *ad lib.* concentrate to the freshly calved cows increasing gradually to the recommended maximum level, by third week of lactation. Feed concentrate is given after feeding of forages. Also ensure to feed concentrate in 3-4 installments every day.
- Ensure to feed high quality forages. Ensure chaffing of forages to maintain adequate particle size (1-2 cm) and process coarse concentrate to stimulate rumen function and better feed consumption.
- Use molasses to improve the intake of unpalatable dusty feed. Buffers such as sodium bicarbonate can be successfully used at the level of 0.75 to 1.0% of total DM intake to improve digestibility and intake of high concentrate ration.
- In addition, feeding rumen micro-organism protected fat at the rate of 0.3- 0.4 per animal per day in ration helps increase the energy density while reducing the need to rely on starch as the primary

source of energy. While adding fat to the ration, calcium and magnesium levels need to be raised to 1.0 and 0.3% respectively. Attention should be given to provide bypass protein and functional fibre in the ration. Adding 6 to 12 g niacin in the ration during the feeding and throughout the early lactation will improve fibre digestibility.

Mid-lactation

By this stage of lactation, condition score should reach 3.0-3.5 for high producing cows and 3.5-4.0 for average producing cows. At this stage, it should be confirmed that the cows have required body weight that was lost in early lactation. All cows bred during lactation should be pregnant by mid-lactation. Attention should be taken that low milk producing cows should not exceed a condition score of 4.0, and will need to be fed carefully to prevent fattening.

Late Lactation

At approximately 270 days of lactation, an average cow should have a score of 4.0. During this period, low producing cows tend to become over conditioned (fat), showing scores at or above 4.5. This occurs more often when poor producers are fed concentrate together with high producers. Feeding should be done according to the milk yield of the cow. In herds where extended calving interval prolongs the period of low production, many cows will become over fat. In this situation breeding management needs to be improved. Very high producing and persistent cows, like the first calvers, with normal calving interval, may be difficult to get a desired condition score of 4.0 while still milking. For these cows, it may be necessary to continue to feed extra concentrate during dry period to fully recharge their energy reserve before they calve.

❐

Chapter 5

Housing of Dairy Animals

The aim of housing dairy animals is to provide a conducive environment for effective growth, reproduction and milk production. In planning and designing of suitable shelters/housing structures for dairy cattle, consideration should be given to comfort and maintenance of health of the animals along with economic use of labour for various dairy farm operations like feeding, cleaning, milking of cows and maintenance of farm sanitation.

For the better production and health of animals, the following points need to be considered in planning and construction of dairy cattle shelters:

- Sufficient area should be available to all categories of animals. The floor should be sloped sufficiently for effective drainage.
- Adequate ventilation to provide effective temperature and humidity control should be ensured in the animal shed.
- The space allowances for cattle housed in groups should be calculated in relation to total environment, age of animals and size of group. The group size should not exceed more than 50-60 animals and preferably should be between 35 and 40.
- When the cattle are fed in group there should be sufficient manger space to avoid undue competition for feed and fodders.

Type and Systems of Housing

Mainly there are two systems of housing for cattle: loose housing system and the conventional closed housing systems (barns). Each system has its own advantages and disadvantages. The final decision can be based upon the climatic variables such as maximum and minimum temperature, relative humidity, wind velocity, solar radiation, rain etc. in a particular area. In loose housing, animals are usually kept loose in an open paddock in group of 40-50 animals throughout the day and night except during milking and some other specific purposes like treatment, breeding etc., when the animals are required to be tied. This housing system generally provides continuous feeding manger along with covered standing space, open paddock which is enclosed by brick

wall or railing and has a common water trough. Local shady trees are planted in the open area in the loose houses. A separate structure of calf pens, milking byres, calving pens, bull pens etc., are required in this system. Thus keeping in view the cost of buildings and the investment required a loose housing system may be preferred. Such system is ideal for areas of low rainfall such as Punjab, Haryana, Rajasthan, Western Uttar Pradesh and parts of Gujarat, Madhya Pradesh and Maharashtra. Even in other places this system can be used after making small modifications so as to protect animals from excessive rains. Such houses are cheaper to construct, easier to expand at short notice, more congenial to efficient management, less prone to fire hazards to animals and helps cleaner milk production as a special milking barn/parlour is attached. On the other hand in the conventional closed system there is greater protection during winter but proportionally the cost is high. As a matter of fact detailed studies have not been made on the loose housing system so far and its superiority to the conventional system cannot be proved. However in view of the cost of buildings and the investment required a loose housing system may be more feasible.

Table 5.1. Floor, Feeding Manger and Watering Space Requirements of Dairy animals

Sr. No.	Type of animal	Floor space per animal (m^2)		Feeding (manger) space per animal (cm)	Water trough space/ animal (cm)	Mode of housing
		Covered area	Open Area			
1	Young calves (< 8 weeks)	1.0	2.0	40-50	10-15	Individual or in groups of below 5
2	Older calves (> 8 wks)	2.0	4.0	40-50	10-15	Groups of below 15
3	Heifers	2.0	4.0-5.0	45-60	30-45	Groups of below 25
4	Adult cows	3.5	7.0	60-75	45-60	Groups of below 25
5	Adult buffaloes	4.0	8.0	60-75	60-75	Groups of below 25-30
6	Down calvers	12.0	20-25	60-75	60-75	Individual
7	Bulls	12.0	24.0	60-75	60-75	Individual
8	Bullocks	3.5	7.0	60-75	60-75	Pairs

*Based on ISI Standards for housing in India; **The actual length and width of water trough may be decided as per the strength of group and size of the paddock; wks, weeks.

The loose housing system, however, may not be wholly suitable for all agro-climatic zones in India. The climatic conditions in India vary from region to region. Housing of the dairy cattle is therefore to be planned and designed as per the agro-ecological conditions prevailing in a particular area. There are some lacunae in the loose housing system for replication under different agro-ecological regions which can be modified to suit requirement for different regions of the country.

Heavy rainfall area: The design of typical loose housing structure for the adult animals would be similar to general loose housing system except additional provision of covered resting area in one side of the paddock, which will provide sufficient dry area for the animals during rainfall and provide protection against strong wind. The floor of the resting area should be slightly elevated from open paddock and one side should be closed with brick wall which will work as wind break.

Hot dry area: The suitable design of loose housing structure for hot dry area could consider covered resting area in the middle of the open paddock with thick tree shade. This would provide indirect shaded area which saves the animals from direct solar radiation during hot sunny day. All the sides of the resting area should be left open to facilitate free air passage.

Temperate high altitude area: In temperate area, partially loose housing along with the closed conventional system of housing is desirable. In this system, due attention is given to protect animals from heavy snow fall, rain and strong wind. Tail to tail system of conventional barn, completely roofed and enclosed with side wall is suggested with adequate provision of tying, feeding, watering and milking inside of the barn. Open paddock area with continuous manger on one side along with covered standing space is provided attached to the barn for housing during warm/comfortable weather.

In addition, the following important aspects also need attention while deciding about the housing structure for dairy animals:

Slope/gradient: Sufficient slope in the paddock is important for maintaining clean and dry sheds. The slope in the open paddock should be 1: 60 for effective drainage of rain water. The slope of the standing space should be 1: 40.

Drainage: The slope in the drain should be 1 in 40. There should be shallow drain in open paddock for complete drainage of rain water. The common drain of the dairy farm should be sufficiently sloped and with optimum width for effective drainage of dairy washing etc. Open drain in dairy farm is preferable than closed underground drain which develops frequent blockage.

Roofing: The lactating dairy animal's sheds should preferably be a double roofed structure with a separate roof over the middle gallery (feeding passage). This roof should cover at least 1.83-2.44 m (6-8 feet) on either side of the midrib, 4.88-5.89 m (16-18 feet) in height and slant towards the edges. The standing space on the either sides should have separate roof, a gap of about 0.30 m (1 foot) to facilitate smoother passage of the air and to provide better ventilation and lighting. The roof should have a height of at least 4.57 m (15 feet) towards the midrib and 3.66 m (12 feet) at eaves of projection and cover 3.66 m (12 feet) on either side. These roofs are to be supported on pillars, which can be built of cement mortar, cast iron pipes or hard wooden posts. A provision for fan with mist cooling could be installed to protect the animals from severe heat stress during summer. For protecting the animals from cold stress during winter wind breaks on the windward side and comfortable bedding by rubber mats or surplus/ soiled paddy / wheat straw/cow mattresses etc. should be made.

The roofs of the calf shed, heifer's shed and dry animals shed may preferably be of asbestos sheets and may be constructed at a height of 3.66-4.37 m (12-14 feet) above the floor. The slope of these roofs should be 12° to 18°. The eaves of the roofs should project out at least 50 cm away from the walls/pillars. These roofs are to be supported on pillars, which can be built of concrete, cast iron pipes or hard wooden posts.

Flooring: The flooring under the roofed area of milking animal shed, calf shed, heifers shed, dry animal sheds should be made of RCC or paved with cement concrete flooring tiles. The surfaces of RCC floors should be made rough and non-slippery by making grooves with the impression of a piece of expanded metal or suitable wire mesh on the surface while the concrete is still wet. The grooves shall be formed in square of 15 cm × 15 cm in adult animal shed and in squares of 10 cm × 10 cm in calf shed. The floors should have a gradient of 1 in 40 towards the drains. The U-shaped drains of 30 cm width and 6 to 8 cm depth should be provided at the ends of covered area. The slope of the drains shall be 1 in 100 and it shall lead through two settling chambers to the septic tank constructed with a length, width and depth of 5, 5 and 10 feet (1 foot = 0.30 m) respectively. About one-half to one-third of the open area towards the other end of the milking animal paddocks, calf's paddock, heifer's paddock and dry cows animal paddocks should preferably be sand-bedded and the remaining one-half to two-thirds should be brick paved. The floors of the straw store, chaff cutter shed and implements room may be brick paved whereas the floors of the milk storage and feed grinding, mixing-cum-storage room should be made of RCC.

Walls: The covered areas and the open areas of the milking animal shed, calf shed, heifer shed and the dry animal shed should be enclosed by 1.52 m (5 feet) high brick walls, which are 22.5 cm thick. The height of walls along with which mangers are to be constructed inside the sheds should be 91 cm (3 feet) so as to allow for comfortable feeding from outside the sheds. The walls of milking cows and milking buffalo paddocks should have 3.05 m (10 feet) wide centrally placed gates opening towards the road and the walls of calf shed, heifer sheds and dry cows and dry buffaloes sheds should have 1.83 m (6 feet) wide centrally placed gates opening towards the road. The gates should be made of iron or strong wood. The height of straw store walls should be 6.09 m (20 feet). The covered part of the calf pen / shed should have walls on three sides up to the roof with door in the wall facing the open area. The fourth side (behind the manger) may be left open in summers and a tarpaulin curtain may be hanged from the roof in winters. During winter nights calves can be kept into this room and the doors closed. During daytime the calves can move through the opened doors into the open area to have the benefit of sunshine.

Boundary wall/fence and gates: The boundary wall/ fencing material should be low-priced and locally available. The effective height of the outer boundary wall for calf and adult may be 1.2 m and 1.5 m respectively. The boundary may be made by brick wall or iron railing. The provision of suitable size gates is also to be made in the boundary wall. The gates in a dairy farm vary in size. The width of the gate leading from sheds to sheds to be about 1.0 to 1.2 m. The gate, which leads from paddock to road, is to be 2.5 m. The main gate of the farm premises should be bigger in width, i.e. 5.5 to 6 m, for easy entrance and exit of tractors, trolleys and other large vehicles.

Orientation of the house (shed): The animal houses provide protection to the animals from various climatic variables, e.g. rainfall, ambient temperature, strong winds, snow, frost etc. The shelter should be oriented to provide maximum protection to the animals. In coastal area, the sheds should be oriented across the prevailing wind direction to protect the roof from being blown off by strong wind at the same time to provide sufficient air movement in the shed. In humid regions, buildings should be oriented to avail natural air movement and sunlight and the orientation of the structure should be east to west in coastal areas and north to south in the dry hot areas. The shed should provide 2.5 to 3.0 m per animal for giving maximum protection in small-holder and commercial herds.

The following ancillary structures must also be provided.

Bull Pens

A bull pen should have a shaded resting area of 12 to 15 m^2 and a large exercise area of 20 to 30 m^2. The walls of the pen must be strong and at least 1.5m high. The gate must be designed so that the bull cannot lift it off its hinges and there should be at least two exits from where the herdsman can escape. A service stall where the cow can be tied prior to and during service is also to be provided close to the bull pen in case of natural service.

Calf Pens

Calves are best housed individually in pens or in raised cages having slatted floors. The minimum internal dimensions for an individual calf pen are 120 cm × 80 cm for a pen where the calf is kept up to two weeks of age, 120 cm × l00 cm where the calf is kept to 6-8 weeks of age and 150 cm × 120 cm where the calf is kept from 6-14 weeks of age. The front of the pen should be made so that the calf can be fed milk, concentrates and water easily from buckets or a trough, fixed outside the pen so that the calf can be moved out of the pen without lifting. The calf should be given fresh, clean water or preferably has easy access to water. The calves should have access to good-quality forage as soon as possible to stimulate rumen development.

Mangers and water troughs

The mangers should be constructed along the side wall in the covered area. The water troughs can be constructed along the partition walls of different sheds in loafing area. The mangers and water troughs can be made of bricks lined with cement concrete. The inner surfaces of the mangers and water troughs should be rounded off and finished smooth, and the tops of walls should be arched. The water troughs should be provided with railing on its sides so that the animals may not try to step in water trough and contaminate water. The space requirements and dimensions of the mangers and water troughs should be as follows:

Type of animal	Manger space per animal (cm)	Water trough space per animal (cm)	Dimensions of manger/ water trough (cm)		
			Width	Depth	Height of inner wall
Adults	60-75	6.0-7.5	60	40	50
Calves	40-50	4.0-5.0	40	15	20

Milking Systems

Milking byres: Before deciding the designing and lay out of the

milking parlours it is necessary to keep in view the milking practice in vogue. In developed countries, where labour is scarce and expensive, machine milking has become very widespread and it is also practiced on many large commercial dairy farms in India. Milking machine not only reduces labour requirement and eliminates the drudgery of hand milking, but in most cases performs a better milking operation than hand milking. However, most of the small dairy farms have a surplus low-priced labour and the number of cows milked at these farms is small to economically justify the installation of a milking machine. Furthermore, machines are expensive, and require power and maintenance as compared to hand milking.

Milking machine operates with a uniform vacuum of 360- 380 mm of mercury, provides a massaging effect on the teats and is easily cleaned. The milking machine simulates nursing by the calf. Two vacuum lines lead to the teat cups. A pulsator supplies an intermittent vacuum to one line @ 45 to 60 pulses per minute. The line, connected to the shell of the teat cup, causes the teat inflation to alternately expand and collapse. This massaging action promotes normal blood circulation in the teat. The second line maintains a continuous vacuum on the teat and carries the milk either to a stainless steel bucket or through a pipeline directly to the milk chiller.

Bucket Milking System: Bucket Milking Machine is the simplest and least expensive to install, but the milk must be hand carried to the milk cooling tank. This type of system is often chosen for the small and medium size herd and where the cows are milked on a level floor of a stable or milking shed. The labour of carrying the milk to the cooler can be avoided by installing a transfer system. This consists of a 30 litre receiving tank, including a built in filter, mounted on wheels so that it can be moved around in the byre. It is connected to the cooler with a plastic hose and the milk is drawn to the chiller by vacuum from the milker pump.

Pipeline Milking System: These parlours transport the milk through a pipe direct from the cow's udder to the milk chiller. Pipeline milking systems are usually installed in milking parlour where the operator stands below the level of the cows. Although they are expensive, they save labour and are usually designed to be cleaned-in-place, a feature that not only saves labour but helps ensure good sanitation. They may also be installed in tie-stall barns but the extra pipeline needed makes the system more expensive.

On commercial farms where several cows are milked at the time, a milking parlour becomes a feasible investment. Several types of milking parlours are in use in dairy farms throughout the world.

Abreast Parlour: The abreast parlour allows cows to enter and leave individually. The cow standing is 1.0 m × 1.1 m wide when a bucket milking machine is used or when hand milking is practiced, while 0.7 m × 0.8 m is adequate when a pipeline milking system is installed. In both cases the width for the milker should be 0.6 m × 0.8 m. The main drawback with the abreast parlour is the relatively long distance to walk between milking points, and cows obstructing the milker, since they share the same floor space.

Tandem Parlour: The tandem parlour also allows for individual care of the cows. It is used mostly for smaller commercial herds and for herds with high yielding cows. The parlour capacity in terms of cows milked per hour and labour efficiency can compare to that of a small herringbone parlour. The main drawbacks with this type of parlour are its larger space requirement and more expensive construction when compared to other types of parlours of similar capacity.

Walk-through Parlour: In walk-through or chute parlours cows enter and leave in batches. They have been used mainly for small herds. Their narrow width can be an advantage where a parlour is to be fitted in an existing building, but it is inferior to other types in most other respects, however, it is cheaper to construct than a tandem parlour.

Herringbone Parlour: The herringbone parlour layout results in a compact working area and allows feeders to be fixed to the side walls. Four stands on each side of the pit, is the minimum size of this type for high labour efficiency. The popularity of the herringbone parlour is mainly due to its simplicity and its high capacity measured in number of cows milked per man-hour. However, the risk of cows kicking the milker is greater in this type than in parlours where the milker stands alongside the cow.

Collecting Yard: The cows are normally assembled in a collecting yard (holding area) before milking. This may be a portion of the yard that is temporarily fenced off with chains. The collecting yard should have a minimum size of 1.1 to 2.0 m^2 per cow. Large horned cows and a small herd number will require the largest space per cow. Provision must be made for water for the cows awaiting their turn to enter the parlour. The area should slope away from the parlour 20 to 100 mm/m. This not only improves drainage but also encourages the cows to face the entrance. The collecting yard should be paved for easy cleaning and to allow for sanitary conditions in the parlour. A roof is desirable for shade and to avoid wet cows entering the parlour in the rainy season.

Entrance and Exit: An entrance into the parlour that is straight without any turns will ensure a smooth and convenient milking operation. Once trained, cows and heifers walk readily into the parlour.

An exit leading into an uncrowded area facilitates animal flow. A straight exit is desirable but not as important as a straight entry. If exiting alleys are needed they should be narrow (70 - 90 cm depending on cow size) to keep the cows from turning around.

Milk Room and Cooler: Sanitation is the primary consideration in the handling of milk whether it is from one or two cows belonging to a small holder or from a commercial herd supplying milk for the city. In either case an adequate supply of potable water is essential for cleaning the milking equipment immediately after use. Hot water (85°C) mixed with a chemical detergent is required for effective cleaning and cold water is used for rinsing. Milk should be handled in a separate area that can be easily cleaned and is free of insects, birds, rodents and dust. The small holder producing milk only for his own household, may be able to process, curdle, or consume his milk within a short time hence cooling is not necessary. Whether the cows are hand or machine milked, a separate milk room adjacent to the milking stalls or milking parlour is needed. This room should be well ventilated and designed with a concrete floor sloped 20 mm/m to a drain and with masonry walls having a smooth, water resistant surface that can be easily and thoroughly cleaned.

Milk is strained and cooled in this room in preparation for sale. As soon as the cow has been milked the bacteria in the milk starts to multiply, but cooling of the milk to about 4° C within 2 hours will drastically reduce bacterial growth. However, proper cooling is a very difficult problem for the small-scale producer. The only practical solution may be for the individual farmers in an area to bring their milk to a central collection depot for cooling immediately after milking. On dairy farms of sufficient size and where power is available, the milk can be cooled by cold water circulated between an evaporative water cooler and a milk cooler (plate heat exchanger), through which the milk is passed until it is adequately cooled. Where milk is stored and transported in cans, cooling can be accomplished by immersing the full cans in a water-filled refrigerated cooler or by passing cold water through a coil, which is immersed in the can. The large-scale dairy farm, having a pipeline milking system, and the milk collection by a road tank van, will require a refrigerated cooler and holding tank.

Manure Handling

Careful waste management is needed to utilize the fertilizing qualities of the manure, urine and other wastes, to maintain good animal health through sanitary facilities, to avoid pollution of air and water and to provide good hygiene around the farm. The method of manure disposal depends on the type of wastes being handled. Solids can be

stacked and spread on fields at the optimum time of year, while liquids must be taken to fields via channels or collected in tanks.

Manure from a livestock production unit may contain not only faeces and urine, but also straw or other litter materials, spillage from feeding and water. Manure is handled as solid when the dry matter content exceeds 25%. In this condition the manure can be stacked up to a height of 1.5 to 2.0 m. This condition of the manure is only obtained when urine is drained away immediately and a prescribed amount of bedding like straw or sawdust is used. Manure with less than 20% solids has the consistency of thick slurry. It should be collected in a tank or pit but is too thick to handle effectively with pumps. It must be diluted with water to less than 15% solids before it can be pumped with a centrifugal pump. If diluted to use irrigation equipment for spreading liquid manure, the solids must be below 4%. The amount of manure as well as the composition varies depending upon factors such as type of feed, milk yield, body weight, stage of lactation and health of the animal.

Table 5.2 Manure Production in Cattle

Weight of cow (kg)	Faeces (kg/day)	Urine (kg/day)	Total manure storage capacity*	
			kg/day	m^3/day
50	2.7	1.2	3.9	0.004
100	5.2	2.3	7.5	0.009
250	14	6	20	0.025
400	23	10	33	0.045
600	35	1 5	50	0.065

**These values are for manure only, no bedding is included. Washing water used in the milking parlour is usually 50 litres/head/day.*

Farm Workshop Facilities

A workshop provides a focal point at the farm for the repair and maintenance of machines, implements and structures. It also provides a place where tools can be stored in an orderly manner, a store for supplies and spare parts, and a shelter where work can be carried out during inclement weather. A facility of this type should be available on every large farm. The size and design of a workshop, however, should be commensurate with the size of the farm and the work to be done in the shop. The workshop facilities should be cost effective and should realize enough savings from timely maintenance and repairs. Some farm operations like feeding and milking are very sensitive to prolonged

interruptions and having facilities to complete repairs on the farm can reduce delays to the minimum.

Planting of Trees

Locally growing shady trees such as neem, banyan, *peepal* or acacia should be planted in the animal paddocks to provide the animals with congenial microclimate and protect them against thermal stress. *Subabool* trees may also be planted around the farm buildings keeping a distance of 2 m between them to act as a wind break and these may be turned into a hedge after attaining a height of about 2 m (6 feet). The loping of this tree can also be used as a fodder for the animals.

Handling Dairy Farm Waste

Objective of handling livestock waste is to control odours, flies and rodents etc. Normally a dairy cow weighing 450 kg is expected to produce 18 kg manure daily or 6.8 tonnes of manure annually. With the increasing cost of chemical fertilizer and increasing awareness about the benefits of natural fertilizers, the animal manure has become more valuable. The manure should be properly converted into compost and sold. This will check pollution and increase the farm income.

Chapter 6

Health Management

Maintaining animals in good health is essential to ensure high production. Farm managers should design and construct suitable physical conditions, to provide adequate amounts of balanced ration, to reduce exposure to disease-inducing agents through sanitation, and to increase immunity to specific pathogens through vaccination. Sound management, in addition to reducing the chance of injury or exposure to potential pathogens, provides conditions that enhance the animals' ability to build or acquire immunity to prevalent diseases. The overall health of animals on any dairy farm is regulated by management practices. The most effective routine procedures which can be used to maintain good animal health are:

- Health records of all animals in the herd should be maintained.
- Follow a planned programme for mastitis control. Mastitis is one of the major causes of economic losses in crossbred dairy herds in India.
- Keep accurate reproductive records.
- Regular examination of cows having breeding or calving problems.
- Follow a planned programme of calf health care.
- Follow a planned programme of vaccination.
- Follow a control and prophylaxis against external and internal parasites.
- Minimize exposure to potential disease causing agents.
- Promote resistance in animals that might be exposed to potentially infectious agents through good nutrition and active immunization.

Guidelines for minimizing the incidence of disease at dairy farms

- Provide adequate space for all animals.
- Avoid any temperature extremes and sudden changes in farm practices.
- Ensure adequate ventilation.
- Practice good sanitation. Manure should be removed as often as practical.
- Isolate all new animals for a sufficient period before allowing entry into the farm.

- Ensure that animals always have adequate amounts of an appropriately balanced ration.
- Provide ample amount of drinking water.
- Protect feed and water from faecal contamination.
- Test feed ingredients for nutrient content and for the presence of spoilage or toxins.
- Supervise parturitions and provide assistance if required.
- Ensure that neonates receive colostrum soon after birth.
- Immunize young animals against endemic diseases and provide booster treatments for older animals as appropriate.
- Keep animals of different age groups separately.
- Control internal and external parasites.
- Observe all animals regularly for abnormal behaviours or other signs of disease.
- Begin treatment quickly whenever a disease is detected.
- Isolate sick animals.

Healthcare Practices of Dairy Animals

Maintaining dairy animals in proper health is essential for obtaining desired productivity from each animal and for higher profitability from dairy farming enterprise. Animals can be kept healthy if they are purchased from the healthy herd and are quarantined before entry into the herd. Further they are to be kept under proper sanitation, management and feeding and use of appropriate vaccines for the prevention of diseases is made so that losses from diseases could be minimized.

Signs of ill Health

The animals that are not in good health, will show several behavioral changes and other symptoms, which can be observed by any experienced person. Every farmer should be aware of the common signs of illness of dairy animals so that he/she is able to identify the unhealthy animals at an early stage. Some of such symptoms are described below:

1. The general posture of the animal, its movement and behaviour will change in illness. The animals separating from the herd, showing weariness, lack of alertness and keeping head down are likely to be sick.
2. Stoppage of rumination and off-feed are the earliest signs of ill-health. The muzzle and nostrils will be moist and devoid of any discharges in healthy animals. Sunken eyes with fixed staring look, redness in the eyes, paleness or yellow coloration of eye membrane are indicative of disease. The dung in healthy animals is semi-solid

in consistency with a dark green colour. Urine of healthy animals is clear and straw coloured. If variation to deep yellow, bloody or coffee colour is noticed it can be a sign of disease. The skin of healthy animals should be soft, elastic and pliable and the hair coat should be glossy and lustrous.

3. Change in quality and quantity of milk produced is an early indicator of disease. Milk yield in dairy cows fall when they fall sick. The purulent and creamy discharges from the reproductive tract are indicative of diseased reproductive tract.
4. Change in the normal rectal temperature indicates illness. The average normal temperature of cattle is 101.5 °F and the normal rectal temperature of buffaloes ranges from 98.3 °F in winter to 103 °F in summer.
5. Variation in the nature and rate of pulse can be indicative of ailments. The normal pulse rate varies from 50 to 60 counts per minute in cattle and 40-50 counts per minute in buffaloes.
6. The rate of respiration and the manner of breathing deviate in diseased conditions and ailments of respiratory system. The normal respiration rate varies from 20 to 25 counts per minute in cattle and 15-20 counts per minute in buffaloes. Incidence of coughing, whistling, crackling and grunting with pain are the signs of diseases of the respiratory system.

Package of health management practices for calves

Age/ days	Colostrum	Treatment	Preventive against
1	2-2.5	Use of antibiotics and/or nutritional formula as suggested by a trained veterinarian	Calf scours
1	-	Sealing navel chord	Navel ill
2	2.5	Vitamin A concentrate 1 ml vitablend or other similar supplement	Night blindness
3	2.5	Piperazine adipate 1 g/4 kg live weight	Ascariasis
5	2.5	Piperazine adipate 1 g/4 kg live weight	Ascariasis
6-9	-	Sulmet course for 3 days 1st day — 30 ml 2nd day — 15 ml 3rd day — 15 ml	Coccidiosis

Besides above practices, use mineral + vitamin supplements like TM-5 or aurofac daily, rovimix in oil once a week (10,000 IU of vitamin A).

Later on whenever infestation of endoparasites is suspected broad spectrum anthehelmintic drugs like albendazole, fenbendazole or thiobendazole should be used @ 5-10 mg/ kg body weight depending on the severity of infestation. The growing calves may also need to be protected from ectoparasites by periodically spraying of animals and calf houses.

Common diseases and control measures against them

The disease conditions commonly affecting cattle and buffaloes, their causes, modes of transmission, symptoms and the measures for their prevention and control are given in Annexure 5.1.

Vaccination for the prevention of diseases

Vaccination is a procedure for artificially inducing active immunity in animals against specific infectious diseases by introducing biological agents called vaccines into their systems. The vaccine is an antigenic substance from a particular microorganism. A vaccine when introduced into the animal system produces antibodies in the animal against the disease and thus protects the animal from the attack of that disease. A chart showing the programme for vaccination at a dairy farm is presented hereunder:

Name of the disease	Type of vaccine	Time of vaccination	Duration of immunity imparted
Foot and mouth disease	Polyvalent tissue culture vaccine	At about 6 months of age with a booster dose 4 months late. Thereafter yearly once in the month of September-October	One season
Haemorrhagic septicaemia	Oil adjuvant vaccine	Once in a year (pre-monsoon period)	One season
Black quarter	Polyvalent vaccine	Once in a year (pre-monsoon)	One season
Tuberculosis	B.C.G. vaccine	At about 6 months of age to be repeated every 2-3 years	One to two years
Brucellosis	Strain - 19	Calfhood vaccination in case herd is suspected of infection	Life long

Annexure 5.1. Common diseases and their control measures

Name of disease with synonyms	Cause	How contacted and transmitted	Principal symptoms	Prevention and control
Foot-and-mouth disease (*Muh-khur*)	Small filterable virus of 7 types	Contact with infected animals or material contaminated with discharge from lesions	Salivation, sores on feet, tongue and inside of mouth, stamping of feet, lameness, off-feed, drop in production	Segregation and other sanitary measures, pre-seasonal vaccination with polyvalent vaccine
Haemorrhagic septicaemia (*Galghotu*)	A bacteria – *Pasteurella bovisepta* in cattle and *Pasteurella bubalisepta* in buffaloes	Ingestion through contaminated food, water and pastures, contact with infected animals, organism usually present in the respiratory tract of apparently healthy animals and causes disease when the animal's resistance is lowered	Sudden attack, high fever, painful, hot swellings on throat, neck and dewlap, swollen tongue and laboured breathing	Segregation, avoidance of infected pasture, feed and water sources, pre-monsoon vaccination, adequate sanitation
Black quarter or black leg (*Sujua*)	*Bacteria-Clostridium chauvoel*	Water and food contaminated with blood and excretions	Lameness, swellings over shoulders and thighs, high temperature, death in three days	Annual vaccination before rainy season
Brucellosis	Bacteria – *Brucella abortus*	Food, water etc. contaminated by discharge and aborted foetus	Incidence of abortions during 7^{th} to 9^{th} months of pregnancy, full-time still births, retained placenta etc. in the herd	Elimination from herd of carriers, calfhood vaccination at 6 months of age
Anthrax (*Gorhi*)	Bacteria – *Bacillus anthracis*	Water and food contaminated with blood and excretions or	History of sudden death, high fever, rapid breathing,	Annual vaccination before rainy season

Name of disease with synonyms	Cause	How contacted and transmitted	Principal symptoms	Prevention and control
		by wound infection	swelling over body – especially around neck.	
Mastitis (*Than pakka*)	Infectious mastitis is due to the entrance of bacteria into the gland. Non-infectious mastitis is due to improper milking, injury, burns, chilling etc.	Bacteria from dirty floor, milker's hands, cow's body etc. enter into udder through injuries on udder and teats	Uneasiness in cow when milked, udder swollen, hot and painful in acute cases, milk whey-like with milk clots or even blood clots, temperature of animal rises.	Follow proper dry hand milking, washing or wiping of udder and teats with mild antiseptic before and after milking. Clean barns and sheds, prevent overcrowding in cow sheds
Milk fever (*Zichighi-ka bukhar*)	A metabolic disorder– due to acute fall in calcium (and magnesium) level possibly due to draining of the same at the onset of lactation through milk	Occurs generally during the early stages of lactation	Loss of appetite, constipation, general depression, animal lies prostrate with its head resting on the chest wall and the nose pointing towards the flank, temperature sub-normal, and animal may develop nervousness and die in 6-24 hours if unattended	Feed mineral supplements to high yielders during late pregnancy and early lactation. To prevent further secretion of milk – stop milking
Tuberculosis (*Kashaya rog*)	A bacteria – *Mycobacterium tuberculosis*	Infection occurs either directly or indirectly from infected animals, their secretions or excretions –bacteria enter system by ingestion or inhalation	Usually lungs and lymph glands are affected. In cows the udder becomes infected sometimes. There may be loss of weight, swelling of joints, a chronic cough and	Segregation and other sanitary measures

Name of disease with synonyms	Cause	How contacted and transmitted	Principal symptoms	Prevention and control
			laboured breathing	
Calf scours	Mostly *Escherichia coli*	Overfeeding, underfeeding, feeding from dirty pails, feeding milk at temperature below body temperature, housing in unclean pens are predisposing factors	Severe diarrhoea with light coloured, foul smelling, watery or foamy faeces Many calves are affected at a time and may die quickly	Hygienic calf feeding practices, clean calf pens, segregation of infected calves and disinfection of premises
Pneumonia	Many micro-organisms, inhalation of water or medicine drenched by untrained person, exposure to cold drafts	Generally pneumonia occurs when animals are exposed to unfavourable weather conditions and when their resistance is lowered	Initially chill followed by high temperature, breathing becomes faster and laboured, dry and painful coughing, watery or mucus like discharge from nostrils	Avoid sudden exposure to cold or rain. Avoid overcrowding of animals. Keep animals in neat, clean and dry houses
Bloat (*Aphara*)	Accumulation of gas / foam in rumen	Greedy feeding on lush green fodders, obstruction in esophagus	Greatly distended abdomen especially on the left side	Care in feeding green fodders, feeding after wilting, feeding dry fodders with green fodders
Retention of placenta	As a consequence of abortion, difficult parturition etc.	——	A portion of membrane hangs out from the vulva, chocolate coloured discharge with foul smell, milk yield goes down	Clean the hind quarters of cow with warm water and take care that the hanging part of the membrane does not get pulled out. Seek veterinary aid

Source: Sastry *et al.* (1994). Livestock Production Management

Vaccination is carried out routinely on animal farms so as to prevent the outbreak of diseases in the herd. The vaccination is not done at a locality where the disease has already broken out.

❐

Chapter 7

Reproduction Management

The success and viability of any dairy farming enterprise depends upon the reproduction management of bovines by maintaining fairly high fertility rates/ breeding efficiency. Generally, a calf per year, i.e. a calving interval of 365 days, is considered optimal in bovines. Efficient management of reproduction leads to higher calf crop for future replacements, lifetime milk production and productivity and overall net economic gain. The practices for the routine care, housing, feeding and management of the dairy bulls and for the breeding management of dairy cows and buffaloes have been discussed in this chapter.

Care of Bull and Breeding Management

"*The bull is more than half of the herd*" is a scientifically proven fact because the joint contribution of two bull paths, viz. sire to son and sire to daughter to genetic gain is more than 65%. With the advent of modern reproduction technologies of artificial insemination/frozen semen, a handful of bulls are contributing towards the genetic improvement of large population of cattle the world over. It is, therefore, very essential to select and breed high genetic merit bulls for quick genetic improvement in dairy cattle and buffaloes. It is, thus, desirable that genetically superior bulls be kept in active service for a longer period of time. Following scientific housing, feeding and management practices are essential for the optimum utilization of outstanding sires for maximum harvest of quality semen.

Selection of Bull: The process of selection, rearing and use of breeding bulls is very important for optimum fertility and this also depends on whether they are intended for natural breeding or AI. In all cases, however, breeding bulls must be superior not only in their genetic potential but also in their reproductive characteristics. They must have normal and well-developed reproductive organs, produce excellent quality semen, have good libido and be able to mount and service females efficiently. Bulls should be selected using dam's milk yield and pedigree as the criteria. Young bulls selected should be from superior mother/dam and proven/high pedigreed sire. Any physical congenital

defects in ancestors should also be noted while selecting a young bull. Pedigree records of both sire and dam should be checked thoroughly so that there is no history of any hereditary disease. No male should be selected with abnormalities of sex organs such as hypoplasia of one or both the testicles. No bull should be used in AI programme until it has been tested for venereal disease, genetic abnormalities and declared free of detectable infection.

Care of Young Bull: After selecting young bulls on the basis of the performance of pedigree and collateral relatives, they should be reared intensively by providing growing ration. When the bull calf is about 9-12 months of age, a light weight ring should be put in his nose which may be replaced with a strong, large ring when it is mature. Young bull should be trained for handling by caretaker. The bulls should be kept near the collection shed during semen collection for imparting training for donating semen.

Care of Mature Bull: Mature bulls should be controlled by a nose ring with caution. Young and mature bulls should be allowed exercise regularly for at least 2-3 times a week so that they do not put on fat. This will also check overgrown hooves and swollen/inflamed joints. Hair should be regularly clipped with a pair of scissors, leaving up to one centimeter length of hair.

Feeding Management: Bull should be fed 2 kg dry matter per 100 kg body weight with 12-14% crude protein 65-70% TDN. A young bull is usually fed 1-2 kg of concentrate mixture having 15-16% protein with *ad lib*. roughage. However, excessive feeding should be avoided or the bull will become paunchy. Excessive fatness in mature bulls should be avoided as it reduces libido and may cause stress and strain on their feet and legs.

Health Management: There should be regular screening and treatment of sick animals, control of flies and ticks. Periodically prophylactic measures should be taken against foot-and-mouth disease, rinderpest, haemorrhagic septicaemia, black quarters and anthrax using a regular schedule of vaccination. Spraying, deworming and control of ecto- and endo-parasites should be carried out. Bulls should be tested regularly against, TB, JD and brucellosis.

Maintenance of Sexual Libido: The degree of excitement increases both quantitative and qualitative seminal characteristics. Several factors which affect the libido are age, feeding, exercise, overuse, semen collection at unusual place, using unsuitable fittings, faulty feeding, obesity, chronic defects of legs, back, penis etc. Intensity of sexual behaviour is low during the period of physiological stress caused by debilitating disease, climatic stress or physical injuries. Similarly, vitamin

A deficiency and low phosphorous diet may reduce the expression of sexual behaviour. Certain conditional stimuli like sound of gate opening, whistling etc., also contribute to enhance the libido. False mounts, changing the teaser etc., may lead to higher stimulus for ejaculation. Libido as well as quality of semen declines in extreme climatic conditions like peak summer or winter.. During summer bulls should be housed in cool and ventilated dry sheds. Showering with cold water during hot part of the day and protection against direct and reflected radiation should be provided. The bulls should be provided with soft bedding in winter to avoid the frost bite in Northern India. The buffalo bulls require protection from cold as well as high temperature stress, hence warm bedding in winters and showers/wallowing in summers must be provided to achieve better semen quality and quantity.

The volume of semen produced per ejaculate varies from 2 to 5 milliliters in young bulls to 5 to 15 ml in older ones. A normal sample should contain 1 to 3 billion (10^9) sperm per milliliter, with over 60% of the sperms being alive and showing vigorous motility. Many specialized tests are available for evaluating a sample of semen, including microscopic, biochemical and computer-based methods.

Artificial Insemination: The advent of artificial insemination (AI) has considerably enhanced the scope of propagating the superior germplasm of domesticated animals. Earlier the use of AI was considered as a means of controlling venereal diseases and using bulls unable to mate successfully. With the development of semen extenders, a single collection of semen could by extended by 100 times or more to increase number of progeny from a single superior sire. Progress in the science of low temperature biology has made it possible to store a wide variety of living cells for a prolonged period. Developments in successful freezing and storage of semen further stimulated the adoption of AI especially in cattle. Fertility depends on the quality of spermatozoa at the time of collection and subsequent method used for the processing and preservation.

With the adoption of AI, one ejaculate from a bull can be used to serve 400 to 500 cows and therefore one bull can produce sufficient semen for inseminating more than 50,000 cows per year. With current technologies of semen preservation this means that the top 1% of bulls in the world can be selected and used on cows which are widely separated in space and time. Also, farmers do not have to bear the costs or undergo the hazards of rearing breeding bulls and can have access to a wide range of bulls. Many of the infectious reproductive diseases can also be controlled by the use of AI.

Frozen semen offers a wide range of benefits such as:

1. There is virtually no wastage in utilization of frozen semen.

2. After the collection of required number of doses, the bull can be disposed off.

Other benefits of AI include the use of bulls of better breed with high production potential, use of semen over a longer period, services available at door step of farmers, control of spread of reproductive diseases, implementation of progeny testing and other dairy improvement programmes, preservation of semen from a battery of bulls simultaneously and transport of frozen semen even across the continents.

The AI has several disadvantages also. The overhead costs of establishing and maintaining AI centres, equipment, personnel and their training are high. It requires a good infrastructure such as a network of AI centres, semen distribution, field inseminators and, if frozen semen is used, a regular supply of liquid nitrogen. The farming community must also be educated in heat detection and timing of service and a reliable system of communication with the AI service should be in place. A possible hazard is transmission of undetected genetic defects or diseases.

The fertility obtained from AI is influenced by a variety of factors. The factors which are within the control of the AI centre producing the semen include the level of fertility of the bull, the original characteristics of the particular ejaculate and the procedures used in its processing, packaging and storage. Once the semen leaves the AI centre its quality will also be influenced by the procedures used in transport, storage and handling in the field. Any deficiency even in one link in this chain of events can make a particular dose of semen completely ineffective.

Housing of bulls: A bull pen should have enough moving space. Sufficient ventilation, comfortable floor and roof are the criteria of a good animal house. Tiles or asbestos corrugated sheets provide good roofing material. A bull should be provided an opportunity for exposure to sunshine and natural exercise. Floor should be non-slippery and have provisions of drains for urine and dung. The paddocks should have partition walls up to about 6' height, so as to prevent unnecessary sexual excitement from other bulls. The bull pens should have strong doors. There should be a gap of 3'-4' below the roof for ventilation. There should be proper provision for feeding and water troughs in bull pen. A pipe at the height of about 1.5' above the manger should be fixed, so that the animal can eat through the space between pipe and manger and at the same time they will not be able to stand in manger and thus minimizing wastage of fodder. Floor space requirements for a bull are given below:

Floor space (covered) (sq ft)	Floor space (open) (sq ft)	Feeding space (manger length) (cm)	Watering space (cm)
120-150	200-300	120-180	60-75

Ringing the Bull: When the male calf is about 9-10 months of age, a light weight ring of about 1.5 to 2" in diameter should be put in his nose. It should be made of some non-rusting material such as copper or aluminum. When the bull is older, this ring should be replaced with a stronger and larger ring (3").

Service: A bull should not be used regularly for service until 15 to 16 months of age. There should not be more than two services per week till the bull is 16 months old. Young bulls should be brought regularly for imparting training for donating semen. For an adult bull, there is a common practice to limit to 1-2 collection per week. Though semen volume and sperm concentration are reduced by frequent ejaculation, the collections up to 14 times per month does not seem to affect fertility in most cases.

Cleaning and grooming: The bulls are generally aggressive and furious. Regular handling by way of cleaning, grooming, etc. will make them manageable. Regular grooming aids in augmenting blood supply to the skin which results in better semen output.

Exercise: It is usually accepted that the exercise is beneficial for general health. The bulls in better physical condition produce more and better semen if they were taken out for exercise regularly. Many types of exercising devices can be constructed to force the bulls to take exercise. The bulls should be allowed exercise for at least 2-3 times in a week. Overgrown hooves and swollen/inflamed joints resulting from close confinement may prevent a bull from giving a normal service.

Handling vicious bulls: It sometimes happens that a bull become vicious. Certain vices may develop due to improper handling, close housing, confinement in dark, lack of exercise, abnormal surroundings etc. They develop certain vices like masturbation, viciousness, sluggish breeder and lack of sexual desire. The bulls should always be handled kindly and never be teased. The attendant handling the bull should never show any fear of the animal. All care should be taken to make the stalls and free fence surrounding the pen strong and reliable, so that the bulls will not have an opportunity to realize his own power. If the bull is very vicious, two men should lead him, one on each side.

Reproduction Management of Dairy Cow

After milk production, reproduction is the most economically important trait in dairy animals. Therefore, the maintenance of a high fertility rate is basic to the success of any dairy farming enterprise. The practices adopted for breeding management of dairy cows and buffaloes should aim at improving higher breeding efficiency. Breeding efficiency is the measure of capacity of an adult cow or buffalo to reproduce. It is

measured in terms of number of services taken by a cow or buffalo per conception, length of calving interval, percentage of non-returns and by percentage of pregnancies in a breedable period.

Puberty and sexual maturity: The stage of life in which animals become sexually mature and the secondary sexual characteristics first become clearly visible is known as puberty. In cow and buffalo heifers this is the stage of first estrus (heat) and in the bull calf it is the stage when it starts giving semen with viable sperms. The term sexual maturity means that the heifers are capable of reproduction. At this stage reproductive organs undergo a marked increase in size.

Puberty occurs before mature body size is attained. Under good feeding, a calf attains puberty approximately at 66% of adult body size. Breed, genotype, climate and level of feeding influence the age at puberty. The time of onset of puberty appears to be a function more of body size than of age. The sudden increase in size and weight of reproductive tract associated with puberty involves hormonal action. The average age at maturity of dairy cattle and buffaloes is given as under:

Breed/ species	Age of maturity (months)
Purebred exotic cattle	18-22
Crossbred cattle	22-26
Zebu cattle	28-34
Buffaloes	30- 36

Estrus cycle: Every 21±3 days from the time of puberty, the cow prepares for a pregnancy. A mature ovum is liberated from the ovary, the cervix becomes receptive to the spermatozoa, the female exhibits behavioral changes and attraction to receive the male in copulation, the uterus and fallopian tubes produce the secretions, which are conducive to the transport of ovum and sperms and the endometrial lining of the uterus prepares to receive and nourish a fertilized ovum. The events listed above in sum total are known as estrous cycle.

The estrus cycle has two major phases, viz. estrogenic phase and progestational phase. The estrogenic phase or the period of follicle includes the proestrus and estrus and lasts about 4 days of the cycle. The progestational phase or the luteal phase includes the metestrus and the diestrus and lasts for about 17 days.

The estrus or the heat is the period in which the animal exhibits sex desire. The length of estrus period is between 8 and 24 hours in cows with an average of 18 hours. In buffaloes the estrus period varies between 5 and 27 hours with an average of 20 hours. During summer the buffaloes have very short estrus periods.

Symptoms of heat: The cows in early stages of heat will show activities like smelling other cows, attempting to mount other cows and bellowing. They will be restless and their vulva becomes moist, red and slightly swollen. After a time lapse of 6 to 8 hours the heat will become more pronounced. The cow will stand to be mounted by other cows or bulls. Due to this, this period is termed as 'standing heat'. This extends for 14 to 16 hours and the cow shows other symptoms like bellowing, nervousness, anorexia, reduction in milk yield, clear mucus discharge and dilated pupil of eye.

Detection of cows in heat: The heat detection work may be carried out twice daily, once early in the morning and once in the evening. Disturbances like noise, visitors or other activities on the farm may be avoided at the time of detecting heat. Use of heat detection chart and breeding history of the cow should always be made while detecting heat. Parading of a teaser (vasectomized) bull especially amongst the buffaloes in early morning and evening hours by a skilled person will greatly enhance the heat detection rate. The heat detection rate can also be improved by keenly observing the expected cows and buffaloes while milking and while leaving the milking barn can improve heat detection rate. The other aids suggested to improve heat detection include the use of chin ball markers, heat mount detectors and pedometers.

Observing cows for at least 30 minutes twice each day is necessary to properly detect heat. If possible, additional periods should be added to ensure proper heat detection. It is important that the person detecting heat be solely occupied by this activity so as not to be distracted from this essential responsibility.

Estrous expression during 24 hours

Time of the day	Cows showing heat signs
6 AM to noon	22%
Noon to 6 PM	10%
6 PM to midnight	25%
Midnight to 6 AM	43%

The actual percentage of cows in heat during a 24-hour period can be influenced by the season of the year, with more cows showing heat at night during hot weather and more cows showing heat during the day during cold weather. Housing conditions also can have an effect on the distribution of heat during a 24-hour period. The important point to remember is that heat can occur at any time. The duration of heat is usually shorter in tropical cattle breeds (average 10 hours) than in temperate breeds (average 15 hours). The expression of heat signs is also

influenced by environmental factors such as temperature and humidity, social factors such as the dominance order of an animal in a herd and the presence of disease or painful conditions in the animal's legs or hooves. Heat detection is an important factor in the fertility of dairy cattle and buffalo. The cheapest and most easily applicable method of heat detection is visual observation. In using this method, however, it is essential that the observer is aware of what to look for, and is motivated.

Artificial insemination (AI) and time of breeding: AI is the technique in which semen with living sperms are collected from the male animals and introduced into the female genital tract at proper time by mechanical means. The semen is collected from the bulls commonly by the artificial vagina technique. Its suitability for insemination is judged by physical, microscopic, chemical and bacteriological tests. The good quality semen is extended further with appropriate diluents to increase its utility in fertilizing more females. The freshly diluted liquid semen is then used for inseminating the cows and buffaloes in heat or preserved in frozen state for future use.

Time of breeding: The time of breeding cows naturally or by AI is very important as it greatly influences the conception rate. The best time to breed cattle is from the middle of standing heat and six hours following that. Three or four hours preceding or succeeding this excellent period also gives good results. As a routine practice, if a cow is seen showing early heat in the morning, it may be inseminated in the evening. If heat signs are first manifested in the evening, the cow may be bred next day morning. A cow is expected to show heat in 30-40 days after calving. Cows that fail to show heat even after 50 days have generally some problems and need to be examined.

Maintaining Breeding Records: It is essential that accurate breeding records are maintained. Essential records to maintain reproductive performance are:

- Calving date
- Breeding date
- Pregnancy check date (s)
- Due date
- Dry date

Each farm should have some person(s) primarily responsible for maintaining the records. In most cases this is the person who also takes the lead in checking for heat at least three times per day. An excellent way to encourage accurate heat detection is to offer incentives to those given this responsibility.

Breed heifers in such a way that they calve around 28-30 months of age. Heifers may produce more milk if they weigh from 325 to 375 kg

after calving. Weight at calving is more highly correlated with first lactation milk production than age at calving. It is essential to follow a sound heifer feeding and rearing programme to meet the 30-month age and 325-375 kg weight standards. Rebreeding following calving should start at 45 days postpartum in herds with average heat detection and conception rates. Starting this early allows breeders to see that most cattle are successfully bred and pregnant to maintain a 12 to 13 month calving interval.

Optimum time to breed/inseminate the heifer/cow: In cattle and buffaloes, the shedding of the ovum from the ovary (ovulation) occurs after the end of the heat period, at around 12 hours in cattle and 14 hours in buffalo. The optimum time for mating is therefore during the latter part of heat or immediately after the end of heat. This is because the sperms from the male need to spend a minimum of six hours in the female reproductive tract to acquire the capability to fertilize an ovum (termed capacitation). The sperm can survive for 24 hours in the female tract and the ovum can remain alive for 12 hours after ovulation.

Thumb rules for optimum time to breed/inseminate the heifer/cow

- Breed the cows in the afternoon when they are observed in heat in the morning.
- Breed the cows observed in standing heat in the afternoon the next morning.
- It is better to follow with another insemination 6-10 hours after first insemination.
- Avoid breeding too early or too late.
- A herd conception rate of 1.5-1.8 services per conception is desirable.
- The cows should be re-bred at the first oestrus after 40 days postpartum for best results. Early breeding would result in short lactation and delay in breeding would prolong calving interval.

Pregnancy and parturition: Fertilization of the ovum occurs in the oviduct (fallopian tube) and the resulting embryo enters the uterus after four days. The embryo undergoes rapid cell division and growth. Implantation or attachment to the lining of the uterus occurs progressively during the period of 25 to 35 days after fertilization. The embryo is called a fetus from 45 days after fertilization.

The mean duration of gestation is 285 days in zebu cattle and 280 days in exotic dairy breeds (range 270-290). In buffalo the mean gestation length is 310 days for river types and 316 days for swamp types (range 300-330).

The standard method for diagnosis of pregnancy is palpation of the genital tract through the rectum by a veterinarian, which is usually done from about 50 days after AI/mating. The criteria used for determining pregnancy by rectal palpation in buffalo are similar to those in cattle but due to the longer gestation length each palpable feature is first discernible about two to four weeks later during pregnancy. Other modern methods such as measurement of hormone levels in blood or milk and ultrasound scanning can also be used for pregnancy diagnosis.

At the end of gestation the process of calving (parturition) is initiated. It consists of three stages: dilatation of the birth canal (2-6 hours); expulsion of the fetus (30-40 minutes); and expulsion of the fetal membranes (2-6 hours). Under normal conditions, the process of calving should be completed in about 8 to 12 hours in cattle and 6 to 8 hours in buffalo.

Postpartum period: After calving, the reproductive tract of the cow goes through a period of recovery called involution, during which the uterus returns to its non-pregnant size and state. This is usually completed in 25 to 35 days. However, this process can be delayed if the uterus becomes infected after calving. This can happen if the cow calves under dirty unhygienic conditions or if it has an abnormal delivery such as dystocia, retained placenta or prolapse of the uterus.

The sexual cycles are also suppressed during the early postpartum period. The hypothalamus in the brain, the pituitary gland under the brain and the ovary in the abdomen that govern the hormonal mechanisms controlling the sexual cycle gradually recover their cyclic functional status and the cow should normally show signs of heat within 30 to 60 days after calving.

Culling of Undesirable Animals

Culling is permanently removing cows from the herd. Culling is necessary to improve performance of the herd thereby improving returns every year. The most common reasons for culling are:

- Low milk production
- Reproduction problems
- Diseases
- Udder problems
- Slow growth rate (in growing phase)
- Old age

In a well managed farm, the total animals culled for reasons other than milk production, should be low thereby giving a chance to cull low

producing animals, which will be replaced by high producing animals. This can improve milk production level of the herd every year. However, if more and more animals with reasons other than milk production are culled out, this leaves no chance to cull lower producers and offers no chance to improve the herd milk production.

It is suggested that the following categories of animals should be culled at the earliest suitable opportunity to minimize the losses and to improve milk production level of the herd:

i) Animals with the lowest estimated relative producing ability.
ii) Animals producing 30% or more below herd average in their first lactation.
iii) Animals producing 20% or more below herd average.
iv) Cull the animals that are low producers (bottom 15 to 20% of the herd).
v) Animals those are confirmed repeat breeders.
vi) Animals those have repeated health problems.
vii) Animals with poor udders and/or feet and leg problems.
viii) Nervous and/or hard to handle animals.

Indices of Reproductive efficiency

A high reproductive efficiency of dairy farm can be maintained by setting realistic indices as given below and implementing a sound reproductive health management programme for dairy cows and buffaloes maintained at the farm:

- The average calving interval between 13 and 14 months in indigenous cows and crossbreds and 14-15 months in buffaloes.
- Breeding efficiency below 1.7 services per conception and less than 35% returns after 60 days.
- Postpartum interval to first standing heat between 30 and 40 days.
- Postpartum interval to first breeding not more than 70 to 85 days.
- Repeat breeders of 8 to 10% or less.
- Anestrous cases after 60 days postpartum be 2 to 15%.
- Abortions of 1 to 2% or less.
- Retained placenta of 5 to 10% or less.
- Metritis of 5 to 10% or less.
- Culling percentage for reproductive failure below 15%.
- Cystic follicles of 10% or less.

Use of Embryo Transfer Technology (ETT)

Embryo transfer technology has considerably influenced the cattle breeding programmes in the developed countries during the last three

decades. The major application of multiple ovulation and embryo transfer (MOET) has been in augmenting the reproductive potential of female stock and thus resolving the problem of low reproduction (less than one calf a year) rate in dairy cattle. In developing countries like India where infrastructure for progeny testing under field conditions is almost absent, MOET schemes can be introduced at organized farms for evaluation of cows and bulls and for large-scale production of required number of quality bulls. Studies revealed that annual genetic gain by using MOET in a herd were higher than the conventional breeding schemes, and MOET can be used as a supplement to conventional progeny testing schemes. Under this technology, the genetically superior cows (donors) are superovulated with hormones like PMSG (pregnant mare's serum gonadotropin) or FSH (follicle stimulating hormone) to produce an increased number (5-30) of ova during its heat. These ova are fertilized with the semen of a superior bull (preferably progeny-tested) *in vivo* and embryos are flushed out non-surgically or surgically on 5-7 day. The embryos are graded and good quality embryos are transferred to the already synchronized (using prostagladins) reproductively normal females (recipients). This results in 3-10 calves in a year, and increases the accuracy and intensity of selection of dam to daughter and dam to son paths. This technology has the potential to help the breeder or dairy farmer to use top 10-20% of the genetically superior cows of the herd for producing the high pedigreed replacements for future.

Over the past 20 years, the role of embryo transfer technique (ETT) has grown from that of being research tool to becoming an economically important component of dairy industry. The ETT has made possible the availability of genetically superior embryos developed from superior parents. Like semen banks, embryo banks can be established by cryopreserving the embryos which could be transferred in the recipients at appropriate time in a herd. Several factors affect the success rate of MOET. These factors include response of the cow to superovulatory treatment, recovery rate of superovulated ova, the quality of resulting embryos and skill and method used in handling and transferring the embryos. Oestrus synchronization in the recipient herd is very crucial in increasing the pregnancy rate of transferred embryos. Further, it should be ensured that the reproductive health of the elite donor is not influenced by repeated superovulations and proper rest of 3-4 months is given to the donors. Eventually, the donor should be made pregnant by proper AI. The major advantage of MOET is that we can exercise better control on the components of production system, viz. feeding, breeding, animal health, labour cost etc. and it is possible to rank

asnimals based on overall economic efficiency. However, the major disadvantage of MOET is increased level of inbreeding due to the selection of related animals and the risk of disease in the herd. The risk of disease can however, be minimized by keeping separately various age and sex categories of animals. In foreign countries, ETT is being used on a commercial scale. In India, the technology is available at NDRI, Karnal, NDDB, Anand and BAIF, Pune.

❐

Chapter 8

Clean Milk Production

Clean and high quality milk can only be produced by healthy cows, i.e. cows free of udder infection managed and milked under clean and hygienic environment. Cows with udder infection/ mastitis are incapable of producing high quality milk because the quality of milk cannot be improved after extraction from the cow. The production of high quality milk requires an effective mastitis control programme in addition to adoption of proper hygiene during the milking process. Once milk leaves the cow, the preservation of milk quality requires cleanliness, sanitation and careful handling. Maximum benefits are derived only when these traits are applied to all aspects of milk production system: cows, cow environment, milking system, milking practices or procedures and milk storage or cooling system. A deficiency in any part of the overall system will result in decreased milk quality.

The key words in controlling bacteria in milk are cleanliness, sanitation and cooling. Cleanliness applies to the cow, cow environment, milking area, milking utensils/ equipment, personnel involved in milking and the milk storage area. Sanitation applies to the milking system and bulk tank. Cooling refers to the temperature of milk after it leaves the cow and how quickly it is cooled.

The key areas contributing to elevated bacteria counts in milk and practices which can help inhibit bacterial growth are discussed here.

A regular routine of milking must be followed. Dairy cows respond with higher production when milked regularly at about same times each day. Milking interval between any two milkings should be about equal. The day time interval can be somewhat shorter than the night interval.

Personnel

Dirty clothes and dirty hands increase the risk of contamination of the cow and milking system. Wear clean clothes during milking. Wash hands prior to starting milking and frequently during milking. Be sure to wash hands after handling any cow known or suspected of being infected and after contacting any part of the cow or her environment.

Cleanliness at Dairy Farm

- **Cow environment**—A dirty, muddy cow environment, including poorly maintained free-stalls or cow-sheds, will increase both udder infections and result in higher somatic cell counts and bacterial counts. The cow environment should be clean, dry and comfortable at all times. Dry conditions inhibit bacterial growth. Poor or inadequate ventilation contributes to poor quality milk through enhanced bacterial growth (high relative humidity), cow immune system depression (stress from any source) and off-flavors (poor air quality in shed and milking area).
- **Cow cleanliness**—The goal should be to maintain cows in clean condition. Clean cows reduce milking time, labour usage, udder infections and bacterial contamination. Use water and a good sanitizing product to wash teats prior to milking. A sanitizer is not a substitute for clean udders. The sanitizers are quickly deactivated by organic matter, such as manure. Chlorine and iodine based sanitizers are generally used for udder wash. Pre-milking teat dipping has also been suggested as a means of sanitizing teats with minimal wetting of the udder.
- **Udder drying**—Water draining and dripping off the udder during milking transports bacteria into the milk supply and to the teat end where the risk of entry into the udder is increased. Use clean towel for wiping the udder of individual cows. Dip the towel in proper disinfectant solution and squeeze extra water before using the same towel on the other cow. Individual towels are a better option.
- **Good housekeeping**—Keeping the entire milking centre clean reduces the risk of contamination of milking equipment and the cows' teats. Bacteria are easily transferred from the environment to the cow by the milker's hands or the milking machine. A clean milking area and milk room have lower number of bacteria present. A clean milking environment is thus a clear reflection of the good quality milk. It is also recommended that the milking machine should be sanitized immediately after each milking, within one hour of milking time. The sanitizing solution should be circulated for 3-5 minutes and maintained between 95°F and 110°F throughout the cycle.
- **Post milking teat dipping**—Dipping teats is a known requirement for an effective mastitis control. Healthy teats will have fewer bacteria present because of greater ease of sanitizing the teat prior to milking. An effective teat dip will dilute or remove the residual milk film from the teat surface. This results in reduced opportunity for bacterial growth and reduced incidence of new infections. Dip

teats with an effective disinfectant solution after every milking. Start each milking with a fresh supply of uncontaminated disinfectant solution and a clean dipping device. Teat dip applicators should be washed after every milking.

- **Clean the milking system and utensils**—The milking utensils (hand milking situations) and equipment including milking machines must be clean and in hygienic condition. Improper cleaning apart from deteriorating the quality of the milk hastens the deterioration of rubber liners and allows minerals from the wash water to accumulate in the milking system. Both situations make cleaning and sanitizing of the milking system more difficult. Use a complete wash cycle with appropriate cleansers or chemicals at the appropriate concentration after every milking and wash and clean milking equipment properly.
- **Use proper cleaning chemicals**—Most chemicals have a fairly narrow temperature range for maximum effectiveness. Be sure the water temperatures and optimum chemical temperatures are matched.
- **Check water quality**— Wash the animals and the udder thoroughly before each milking with clean water.
- **Cool milk quickly**—If the milk is to be retained at the household for over 2 hours then cooling is essential as the milk quality can deteriorate very quickly at environmental temperature. To enhance the milk quality, the milk should be cooled to 5°C or less within 1 hour and thereafter it should be stored at 4-5°C.

Production of clean milk requires looking at and evaluating nearly every aspect of the milk production system. Production of high quality milk with low bacteria counts requires continual attention to numerous details. One should never be satisfied while meeting only the minimum performance standards and should instead strive for further improvement.

Mastitis Management

Improper milking management is likely to result in higher incidences of udder diseases at dairy farms. Total economic loss due to mastitis in cows and buffaloes has been estimated to be Rs 6,038.7 and Rs 4,831.0 million, respectively, due to sub-clinical mastitis and Rs 2,856.4 and Rs 2,345.9 million due to clinical mastitis giving a total economic loss of Rs 16,073 million per year. These losses include (i) the value of milk production lost (70%), (ii) the value of cows lost by premature culling (14%), (iii) the value of the milk discarded or downgraded (7%), and (iv) the treatment and veterinary expenses (8%).

The incidence of mastitis can be reduced by adopting suitable udder health management programme, which in turn is based on two main principles, viz.

a. Elimination of existing infection.
b. Prevention of new infection.

Elimination of existing infection can be achieved by antibiotic therapy both during dry and lactation period. On the other hand, prevention of new infection can be achieved by adopting a suitable udder health management programme. The major principles of mastitis control programme are as under.

The disease may be classified under two headings:

1. Clinical mastitis
2. Sub-clinical mastitis.

Early detection at sub-clinical stage is one of the measures to minimise the incidence of clinical mastitis. These unseen infections are detected by several methods, including the direct microscopic somatic cell count and the California Mastitis Test (CMT). The use of the CMT on the entire herd at monthly intervals can be extremely useful as an aid in detecting herd mastitis problems. Individual and total quarter infections can be determined and the level of herd mastitis can be monitored. This test provides information that can aid in determining faulty milking procedures or equipment function, as well as the effectiveness of teat dips and dry cow treatment programme.

When mixed with milk, the CMT chemical or reagent reacts with leucocytes (white blood cells) that are usually present in large numbers when an infection occurs. When this reaction occurs, the reagent-milk mixture thickens or a gel is formed in proportion to the number of leucocytes present indicating the severity of the inflammation. The greater the reactions the higher the CMT score.

CMT reaction scores

CMT score	Average somatic count (cells per ml)
N (negative)	100,000
T (trace)	300,000
1	900,000
2	2,700,000
3	8,100,000

Treatment of CMT Positive Cows: During lactation, it is not generally recommended to treat all animals suffering from subclinical mastitis that is detected by the CMT alone. If it is suspected that a

subclinical case of mastitis may progress to clinical, prompt therapy should be started. Clinical cases require early therapy. Laboratory culturing of milk from affected quarters is necessary to provide the required information to prescribe proper therapy.

In India, Sodium Laurel-sulphate and Teepol Test (SLST) was developed at the National Dairy Research Institute as a diagnostic measure for sub-clinical mastitis. The test solution is prepared by dissolving 4 g of sodium laurel-sulphate in 100 ml of 15% (v/v) teepol (general grade B-300), i.e. sodium laurel sulphate 4 g, teepol-15 ml and distilled water 85 ml. Two ml of test solution is added to the equal volume of freshly drawn milk sample in a specially designed paddle and is mixed thoroughly by vigorous shaking of the paddle in horizontal plane for 20 seconds.

Adoption of Proper Hygienic Measures

The following package of practices as given below are very useful for the control of mastitis in dairy herds.

Maintenance of proper hygiene is the most important management practice in mastitis control, as it affects the degree of exposure and population of microbes in the environment surrounding the cow. Most of the new infections take place during preparing the animal for milking and during the process of milking itself. So, a hygienic and clean milking byre / place is very essential to reduce the infection rate. Teat hygiene is another important factor of reducing the exposure to infection. It may be achieved by using pre- and post-milking teat dip. Post-milking teat dipping or spraying the teats with disinfectants is of special value as it removes most of the residual contamination and most importantly encourages healing of the teat sores and lesions and also prevents the growth of the pathogens in teat ducts. An effective teat dip if correctly used can reduce the incidence of new udder infection by 50 to 90%.

The sanitary measures can be summarized as follows:

1. Teat washing with disinfectant solution and wiping with individual clean towels, prior to each milking.
2. Disinfecting of hands of milkers and milking machine clusters before milking.
3. Teat disinfection after each milking by dipping or spraying all teats in disinfectant solution.

Suitable udder disinfectants for this purpose are as follows:

- Iodophor solution containing 0.1 to 1.0% available iodine.
- Sodium hypochlorite (4% solution).

To ensure effectiveness of these disinfectants the udder must be washed cleanly to remove all the organic matter before applying disinfectant solution.

Proper milking procedure

Proper milking of dairy animals is important regardless of whether hand or machine milking is being followed. Rapid and full hand milking is desirable as this ensures harvesting of more milk and simultaneously prevents teat injury which might result as a consequence of improper milking method (fisting etc). Milking management becomes more important when machine milking is used. In addition to proper disinfecting of milking machine, the following points should be keep in mind:

- Establish and maintain a regular milking schedule in a stress-free environment.
- Ensure that teats are clean and dry prior to milking.
- Check fore milk and udder for mastitis using strip cup or California Mastitis Test (CMT).
- Attach the milking unit properly.
- Minimise machine stripping and avoid liner slips.
- Avoid over milking.
- Fluctuation in vacuum levels must be minimal.
- Optimum vacuum must be ensured.
- Pulsation rate should be maintained within permissible limits.
- Teat liner must be checked for rupture etc. and must be replaced after recommended number of milkings.
- Milk the infected animals in the end, when all the other animals have been milked.
- Daily inspection of milking equipment should be a routine activity.

Dry cow therapy

The dry period offers a valuable opportunity to improve udder health while cows are not lactating. On the other hand, the initial 2-3 weeks and the last 2-3 weeks of gestation period are very vulnerable to new infections. The procedure of dry cow therapy may be carried out as follows:

- Dip all the teats in an effective teat dip after complete milking and dry them completely.
- Disinfect each teat end with alcohol soaked cotton swab and infuse a single dose of a recommended antibiotic. Long acting antibiotic preparations like benzathine cephapirin, benzathine cloxacillin, benzathine penicillin, erythomycin, novobiocin etc., can be used

successfully. A partial insertion method of administration is better than complete insertion.

- Immediately after treatment dip all the teats in an effective teat dip again.
- The target of dry cow treatment is the group of pathogens residing in the udder, i.e. *Streptococcus* sp., *Staphylococcus aureus* and *Corynebacterium pyogenes*. To check the new infection that occurs in the few days before calving a second treatment during the final 1 or 2 weeks period of pregnancy may be practised but with great care as there is high degree of susceptibility during this period.

Besides therapy, dry cows should be provided with an environment that is as clean and dry as possible. It is also important to provide adequate space, ventilation and lighting to ensure cleanliness and comfort. Clipping of the hair on the udders, flanks and inside the hind leg also helps to reduce contamination. Adequate balanced feeding of dry cows with vitamin E and selenium is effective in preventing mastitis infection at calving and early lactation as they enhance the defence mechanism. This is also helpful to ensure high milk yield in the ensuring lactation.

Quick diagnosis and appropriate therapy of affected animals during lactation

Early detection of mastitis, preferably in sub-clinical form itself, is the key to the successful treatment of the disease. This can be better done by screening all quarter samples using California Mastitis Test (CMT) and monitoring somatic cell count (SCC) at least once a month regularly. Use of strip cup is another easy test for detecting clinical mastitis. The antibiotic therapy should be done after conducting the sensitivity test.

Segregation and culling of chronically infected animals

As soon as the mastitis is confirmed, the cow must be segregated from rest of the herd and milked and treated separately besides adopting proper hygienic measures. Selective culling of the cows with chronic mastitis (three or more occurrences during one lactation) should be practised.

Monitoring udder health status

Implementing an effective udder health monitoring system is another key principle of mastitis control. It involves the following two components:

- Monitoring udder health at herd level: Bulk milk tank somatic cell count can be used for this purpose.

- Monitoring udder health of individual cows: Individual cow SCC can be used along with CMT.

For proper monitoring good record keeping is essential. Based on the current udder health status the appropriate control measures should be undertaken.

❐

Chapter 9

Organic Dairy Farming

There has been a global shift in the agricultural production system towards organic agriculture in recent years. The intensification of husbandry practices and heavy dependence on the use of chemical fertilizers, pesticides, antibiotics and other inorganic products has raised concerns among many quarters about the quality of the produce and the sustainability of the agricultural production systems including dairy production. The current rise in the organic animal husbandry and consumption of the organic animal products are attributable to the factors like the successive food scares (BSE, *E. coli*, *Salmonella* etc.) and the concerns about the livestock welfare under high inputs based intensive production systems. Consumption of genetically modified (GM) products, fears of pesticides, insecticides, fertilizers, chemicals, antibiotics and other medicinal residues in non-organic foods and generalized belief that the organic products are more nutritious, healthy and tasty, and potential scope of high-value niche markets for small scale farmers and entrepreneurs are the some of the other reasons responsible for a paradigm shift towards organically produced dairy foods.

The organic production is a holistic approach based upon a set of processes resulting in a sustainable ecosystem, and the basic aim being optimizing the health and productivity of inter dependent commodities of soil life, plants, animals and the people. Animal husbandry fulfills a central role in organic farming by making use of crop byproducts and adding manure as an important fertilizer to the land to maintain its productivity.

Potential of Organic Dairy Farming in India

India has a huge potential of organic milk production. The dairy production practices in India are not highly intensive as in other developed countries in dairying. Some of the agro-climatic regions of the country like rainfed areas of Rajasthan, Gujarat, Madhya Pradesh, the hilly areas of Himachal Pradesh, Uttarakhand, Jammu and Kashmir, Tamil Nadu and all of North-Eastern region are best suited for organic milk production. In fact the production practices followed in many of

these areas are very natural and the milk presently being produced is almost organic. There are some areas in the country (especially mountain areas) and communities (certain tribes) where the green revolution technologies have so far not reached and they have not adopted the use of agro-chemicals. These areas have been classified as "organic zones". The North Eastern region of India provides considerable scope and opportunity for organic farming due to least utilization of chemical inputs, where it is estimated that 18 million hectares of such land is available which can be utilized for systematic organic production. The small farmers of these areas producing a few litres of milk daily are not in a position to market it as organic milk due to ignorance and due to unavailability of local market for organic produce. The Trans-Gangetic plains region of Punjab, Haryana, Western Uttar Pradesh and parts of Rajasthan has witnessed the most intensification of crop husbandry by way of intensive crop rotations and the heavy use of inorganic fertilizers and agro-chemicals. However, even in this region the dairy farming has not received much intensification as has been the case with advanced countries and therefore is amenable to conversion to organic with little effort. To tap the organic milk produced in interior rural areas; the cooperative organization should come forward for certifying, procurement, processing and marketing of organic milk.

Favourable Features for Switching to Organic Dairy Farming

The dairy husbandry practices though dependent upon crop residues and use of agricultural by-products for feeding of dairy animals in India are in most cases traditional and do not rely on the heavy use of veterinary drugs, antibiotics, synthetic hormones, probiotics, growth promoters or the use of any other inorganic materials. Our local breeds of cattle and buffaloes being hardy and resistant to many diseases do not need heavy dependence on veterinary drugs. Many natural preventive and control therapies (ayurvedic, homeopathic) are available with proved effectiveness in several disease conditions. Our conventional dairy production system can, therefore, be easily converted into organic system with the little effort by restricting the use of chemical fertilizers and agro-chemicals in fodder crops and feed crops production. The cost of organic milk production in India is expected to be almost equal to or slightly higher than our present milk production cost as the conversion to organic production will not entail much additional costs. The milk productivity is also unlikely to be affected. The efforts in organic crop, vegetable and fruit etc. farming being initiated of late in the country are unlikely to succeed in the long run without integrating these enterprises with organic dairying in view of recycling of nutrients

mandated under organic management. The organic milk and milk products are expected to command at least 25-50 % higher market value and thus there is a great scope for increasing farmers' income, employment and natural resource conservation apart from being a potent source of export revenue.

Immense commercialization of agriculture has had a very negative effect on the environment, farm diversity, farming communities, farm animals, food quality, and the lives and health of consumers in India, and now it is the appropriate time to switch over to organic farming and integrate it with organic dairying as India at present is not only self-sufficient but also have surplus foodgrains. The conversion to organic production may be far easier for Indian farmers in comparison to their European counterparts where conventional production system has reached to a very high level of input dependence, overuse of antibiotics, pesticides, feed additives etc. The low input based Indian dairy sector has better opportunities to convert to organic production since majority of Indian farmers are organic farmers not by choice but by default.

Demand for Organic Milk and Milk Products

The consumption and demand for the livestock products including the milk and milk products are income elastic and the domestic market for organically produced animal origin foods in India is also likely to increase as the per capita income grows and quality consciousness for food items increases among the consumers. The burgeoning middle class population and increasing urbanization with changing food habits shall also act as the driving forces for increased consumption of organically produced foods in future. The organic milk is likely to command 25-30% higher price to the producer and the processed organic milk and milk products are fetching 25-50% higher market price as compared to conventional milk and milk products.

Organic Dairy Farm Management Practices

Realizing the importance of organic farming the Government of India took a major initiative by launching the National Programme for Organic Production (NPOP) through APEDA (Agricultural and Processed Foods Export Development Authority, 2005), Ministry of Commerce and Industry, 2000 and formulated National Standards for Organic Production. The standards and procedures have been formulated in harmony with international standards such as those of Codex and IFOAM (International Federation of Organic Agriculture Movements) and keeping the Indian requirements in mind. The general principles on which these standards are based are that the management

techniques in animal husbandry should be governed by the physiological and ethological needs of the farm animals. Conversion may be accomplished over a period of time. Breeds should be chosen which are adapted to local conditions. Breeding goals should not be in opposition to animal's natural behaviour and should be directed towards good health. The livestock should be fed 100% organically grown feed of good quality. All feed shall come from the farm itself or be produced within the region. The prevailing part (at least more than 50%) of the feed shall come from the farm unit itself or shall be produced in co-operation with other organic farms in the region. For the calculation purpose only, feed produced on the farm unit during the first year of organic management, may be classed as organic. This refers only to feed for animals which are being produced within the farm unit and such feed may not be sold or otherwise marketed as organic. In those cases, where it is impossible to obtain certain feeds from organic farming sources, the certification programme shall allow a percentage of feed (15% for ruminants) consumed by farm animals to be sourced from conventional farms.

Management practices should be directed to the well being of animals, achieving maximum resistance against disease and preventing infections. Natural medicines and methods, including homeopathy, ayurvedic, unani medicine and acupuncture shall be emphasised. When illness does occur, the aim should be to find the cause and prevent future outbreaks by changing management practices. Where appropriate the certification programme should set conditions based on the farm's veterinary records to minimise the use of medicines. The certification programme should make a list of medicines specifying the withholding periods. Species shall be chosen which do not require mutilation. Exceptions for mutilations shall only be given so that suffering can be kept to the minimum. Transport and slaughter should minimise stress to the animal. Transport distance and frequency should be minimised.

Food Safety Issues for Promoting Organic Dairying

Contaminants in animal feeds, milk and milk products: The perception of consumer on quality and safety of food has changed in recent past because of increased awareness on health and competitive global market. These changes are demanding adequate legal, social and ethical responsibility of the food producers to offer safe and quality food to the consumer. The quality parameters for majority of the milk produced in India needs improvement in terms of keeping quality, safe limits of spoilage and pathogenic organisms, non-microbial contaminants such as pesticides, drug residues,

microbial toxins and industrial chemicals and toxic compounds and detergent/ sanitizers etc.

Antibiotic residues in milk: Antibiotics are extensively used in dairy cattle management for preventing and curing disease like mastitis, brucellosis etc. which are prevalent in tropical countries like India. The substantial excretion of these residues in milk is attributed to indiscriminate use, lack of medication records, use of unapproved drugs, contaminated milking equipment, purchase of treated cows, failure to observe withdrawal period in lactating animals. Many drugs are retained in the animal body for longer times than indicated by label discard times. Consequently, milk samples remain positive for residues. These residues in milk are allergic, carcinogenic and cause development of antibiotic-resistant pathogenic strains. The presence of antibiotic residues in milk supply can have adverse effects during processing of dairy foods in terms of starter failure, poor ripening of cheese and efficiency of dye reduction test. Many studies conducted on milk and milk products samples collected from different regions of the country have also reported the prevalence of antibiotic residues.

Pesticide residues in milk: Use of pesticide has polluted the fodder and animal feed concentrates, resulting in contamination of milk and milk products, eggs, meat and meat products consumed by human beings. DDT and BHC residues monitored in samples collected from the states of Haryana, Punjab, Uttar Pradesh and Delhi, indicate that there is definitely a decline in content of above residues in milk but their existence cannot be ruled out because they are persistent in nature and get recycled into the biosystem through soil, water and manure. The organophosphate pesticide compounds which are readily decomposed by physico-chemical and enzymatic processes in plant and animal systems are less persistent. However, some of the less popular and fat soluble organophosphorous pesticides like acephate, diazinone, phorate, chlorpyriphos and malathion etc. have been detected in foods with high fat content including dairy products. Normally the milk and milk products get contaminated with residues of organophosphates if the animals are fed on a feed, which is treated with pesticides during storage or feed manufactured from the plant material treated during its growth.

Heavy metals: Bioaccumulation of heavy metals in tissues and their secretion in milk has evoked a great concern in recent years. Mercury, lead, cadmium and arsenic are the common heavy metals detected in milk samples at various locations in India. The carry-over rates for heavy metals from feed to milk have been found to be from 10 to 50 % when normal levels of toxic metals are ingested by the animals. Normal contents of lead, cadmium and mercury in milk and milk products are

low because mammary gland acts as a biological filter against flow of heavy metals to the milk. However, if the lactating animals are fed with highly contaminated feeds and fodders with heavy metals or maintained in an industrially polluted area, there is a need to regularly monitor the levels of heavy metals in their milk and milk products.

Mycotoxins: Fungi have always benefited mankind over the years but some of them produce highly poisonous secondary metabolites called mycotoxins, which evoke pathological changes in man and animals. Of these mycotoxins, aflatoxins are a group of extremely toxic compounds, i.e. hepatocarcinogenic, mutagenic and teratogenic. Four major aflatoxins B_1, B_2, G_1, and G_2 have been isolated from feeds. It is well established that dairy animals consuming rations contaminated with aflatoxins excrete aflatoxin M_1 (hydroxylated AFB_1), which is formed in the liver in the presence of mixed function oxidases. The carry-over rate from feed to milk is 1-6% but the milk toxin retains the toxicity and carcinogenicity of the original toxin consumed by the dairy animal. In general, the ratio of level of AFB_1 in feed to that in milk is 300:1. Aflatoxin can be detected in milk 12-24 hours after the ingestion of AFB_1. After 3-6 days of constant ingestion of AFB_1, a steady state of excretion of AFM_1 in milk is achieved. Market survey reports indicate contamination of feeds with aflatoxins in many parts of the country.

Minimizing the Contaminants in Milk: Switching to Organic Farming

During the post independence period intensive cropping systems have been followed in many parts of the country based on high yielding varieties using inorganic fertilizers and pesticides for meeting the demand of foodgrains. At present we are not only self-sufficient but also have surplus of foodgrains. This is the proper time when it is appropriate to switch over to organic farming and integrate with rearing of dairy animals organically. Thus it is possible to minimize the level of contaminants in milk by reviving organic farming.

Status of Organic Dairying in Major Milk Producing Countries of the World

The organic dairy farming though started much earlier, got fillip in the 1980's mainly due to increased consumer awareness of food safety issues and environmental concerns. In 1981 the organic farmers coordinated internationally in the worldwide organization called IFOAM, which prepared guidelines and processes for organic production. The principles for organic production are concerned with preservation of soil fertility, avoiding pollution at all levels, producing

foods of optimum nutritional quality, utilization of local resources and labour, reducing the use of non-renewable resources to a minimum, providing domestic animals with good conditions of life and self-sustenance of farmers through the farm outputs.

Dairy cows fit well with the organic way of production and many cattle farms can convert to organic farming without any major investment. It is expected that by the year 2010, the agricultural farms under organic production in Europe will be 30%. In Denmark 8.4% of the dairy farms are organic herds having a market share 22% for liquid milk with 10% of the milk production being organic since 2000. In Australia, 10% of the total farms are organic and organic milk accounts for more than 6% of the total milk production.

In India the organic dairy farming has not yet taken off in a substantial way though a beginning has been made in Rajasthan where Moraraka Foundation (an NGO) active in promoting organic farming since 1993; has started procurement of milk daily from the farmers registered as organic crop producers and selling this milk in Jaipur as organic at 25-50 % higher rate. Maharashtra Organic Farmers Federation (MOFF) has also set up a few organic dairy farms, which are producing certified organic milk. Many other commercial organic dairy farms are in the process of being set up in different parts of the country and a sizable quantity on organic milk and some organic milk products shall be produced and shall be available for sale in big cities in near future.

Comparative Performance of Organically Managed and Conventional Dairy Herds

The researches conducted in major organic milk producing countries have focused mainly on comparing the milk production levels, health problems, animal welfare, reproduction and profitability under organic production and conventional production systems. Many authors have reported lower milk yields ranging from 10 to 18% under organic production system as compared to conventional production system. Studies indicated that the conversion to organic dairying is accompanied by a temporary decline in output (about 10%) in the first year and it returns to normal production level in the second year.

However, no major differences in health aspects in organic and conventional dairy farming have been identified with similar milk yield levels. The mastitis and fertility problems were the most important issues for organic dairy farming and these were also the two most important reasons for culling. The studies on incidence of health parameters are at variance in different countries and more studies need to be done. The studies conducted in Sweden indicate lower incidence of mastitis,

retention of placenta and ketosis in organic herds as compared to that in conventional herds, whereas the incidence of mastitis was higher in organic than in conventional dairy production in the UK and Germany and less in Norway, Sweden and Denmark. Other studies indicated that the use of veterinary medicine in organic herds assessed by individual cow or bulk tank somatic cell counts were not different from conventional herds.

Control of external and internal parasites has been reported as a major concern for organic dairy producers as control of these disease-causing agents in conventional production system relies on routine application of anti-parasite agents. The restriction of the use of these agents in organic production system requires major changes in management practices. Surveys from Switzerland, Norway, Sweden, Germany and the UK suggested that organic dairy herds do not have more fertility-related problems than conventional herds. The results of comparison of reproductive performance between organic and conventional dairy herd management showed that the calving interval was similar for organic and conventional management while days open were larger for conventional than for the organic dairy farms.

Performance of Organically Managed Buffaloes

A pilot study on the development of organic milk production system was initiated at the NDRI, Karnal in 2007. Under this study, nine freshly calved buffaloes are being managed under organically as per practices suggested under National Programme for Organic Production. The fodder and feed required for these buffaloes is being grown organically and the performance of fodder and feed crops, productive and reproductive performance of buffalo, health, behaviour and the milk quality are being recorded. The residual levels of pesticides, heavy metals in fodder and feeds and in milk and residual levels of antibiotics in milk are being periodically monitored. The initial results of organically grown fodder and feed crops and the buffalo performance are encouraging. The yield of organically grown maize, sorghum or *jowar*, berseem and wheat crops was 144, 107, 505, 10.4 quintals per acre respectively. The mean daily milk yield of the buffaloes was 8.5 kg (ranging from 5.44 kg to 11.7 kg) with the overall peak yield of 15.5 kg.

Quality of Organically Produced Milk vis-à-vis Conventional Milk

Studies conducted to investigate the relative presence of pesticide residues in organic as compared to conventional products show lower presence of pesticide residues in organic milk, although organic milk may not be completely pesticide free. A possible presence of pesticide

residues in foods may be due to environmental contaminants. As regards mycotoxin, aflatoxin M_1 levels in organic milk have been found to be lower than that in conventional milk. The level of conjugated lenoleic acid (CLA), which is one of the beneficial fatty acids, was 60% higher in organic milk than in conventional milk. A Newcastle study published in the *Journal of the Science of Food and Agriculture* showed that the cows that ate grass and clover instead of grain exhibited higher levels of CLA, alpha linoleic acid (ALA), alpha tocopherol (vitamin E) and carotenoids (beta-carotene, lutein and zeaxathin) in their milk than conventionally reared cows. However, no major differences have been established in terms of milk composition between conventional and organic production.

Cost of Organic Milk Production

While comparing the cost of milk production and income from organic dairy farms and conventional farms, the studies from Denmark and Canada indicated the overall costs to be 13 and 19% lower for organic production as the costs of fertilizers and pesticides were nil and the expenses related to purchase of cattle feed and animal health were greatly reduced. As a result the net income was higher for organic farms. However, this difference could be due to the existence of considerable premiums and subsidies, and their disappearance would radically change the picture. The purchase of livestock and feed were lower for organic farms and the maintenance cost of machinery and equipment were higher. The organic farms incurred lower expenses for inputs for crops (fertilizers, pesticides, seeds etc.) but paid more for wages.

Compared to conventional farming, which has been benefited by the research and scientific developments of the last few centuries, the commercial organic farming is just at the take off stage. Sustained and systematic research efforts in organic farming would possibly have the effect of improving practices and, in turn, performance. As a result, costs would be reduced, as has been the case for conventional dairy production.

Need for Research in Organic Dairy Farming

In spite of the many advantages in organic milk production and the tremendous potential in the country the research and development effort in this sector has so far not received the required attention. Research work needs to be initiated earnestly on the organic feed and fodder production practices and performance, the dairy animal performance and economics under organic management in different potential regions of the country. The health and efficacy of alternative therapies for the

control of various diseases of dairy animals managed under organic system of management. The National Standards of Organic Production (2002) pertaining to dairy animal production need testing and validation and necessary refinement/modification based on local research. The quality of milk produced under organic and conventional production system need to be evaluated with respect to its composition and nutritional quality as well as the levels of various chemical residues and contaminants. A package of practices needs to be developed which is suitable for different dairy animals in different potential regions. These research efforts are further needed to be supplemented with the developmental initiatives for the extension of the technology, the training of the farmers for adoption and entrepreneur development coupled with the setting up of procurement, processing and marketing network in potential regions.

❐

Chapter 10

Entrepreneurship Development in Dairy Farming

The dairy farming in India as traditionally practiced under mixed farming mode along with crop farming has been supplementary to the major occupation of crop farming. The traditional system of cattle keeping served the purpose of requirement of cattle and buffalo males for farm work, utilization of crop byproducts which otherwise shall go waste, utilization of surplus family labour, meeting the family requirement of milk and milk products, generation of some income from the sale of surplus milk and milk products and animals. The keeping of a few dairy animals also served as an insurance against crop failure. In recent years however, we are witnessing a trend towards the specialized dairy farming and the commercialization in dairying enterprise in which the major share of income of a farmer is derived from dairying. Several reasons can be attributed to this development. The major driving force behind this trend has been liberalization of the economy and globalization of trade with the signing of WTO agreement. This led to the enhancement of milk processing capacity manifolds owing to entry of many big business houses in the milk sector and setting up of a large number of milk processing plants. The other factors responsible for the promotion of commercial dairying are the shrinkage of land holdings and the displacement of labour from crop farming due to mechanization, introduction of high yielding crossbred cows and the easy accessibility of improved technology.

In view of these developments, dairying with high yielding crossbred cows and improved buffalo breeds is receiving a lot of emphasis and there is an ample scope for developing the dairy farming on commercial lines as a business in most parts of the country. Dairy farming as a small and medium scale primary occupation has received considerable focus and attention among farmers and rural unemployed youth for self and gainful employment. According to one estimate, India's dairy sector is expected to double its production by the year 2020 in view of expanding potential for export to Europe and the West. In India today cost of

production of per litre of milk is the lowest in the world. With WTO regulations expected to come into force all the developed countries which are among the big exporters today would have to withdraw the support and subsidy to their domestic milk products sector which shall further increase their cost of milk production. To take advantage of this situation, the multinational companies are now venturing into milk production and processing which shall give further impetus to commercialization of dairy production in the country.

The dairy farming if adopted with dedication is capable of giving a return on the investment to the tune of 20% or more which few other occupations are capable of. The dairy farming is the most profitable venture when done in sub-urban areas or in areas around the metropolitan cities where there is a ready market of the milk, and one can get relatively high rates of the milk produced. The major requirements for the setting up of a dairy farm are the availability of land for the construction of sheds for the animals and for the production of fodder and availability of capital for the purchase of dairy animals, construction of dairy sheds and allied structures and for the purchase of equipment and machinery. It would be better if the entrepreneur has land for at least construction of the cattle sheds in his own name and the land for the production of fodder can be taken on lease or the fodder can be purchased from the market. The capital required could be raised through loans from nationalized banks which can be repaid in easy installments. This chapter attempts to discuss the basic principles and guidelines essentially to be followed for the establishment and successful routine management of a commercial dairy farm. The chapter strives to evaluate the techno-economic viability of a model dairy farm. The suggested model can be replicated with suitable modifications under most parts of the country.

Requisites of a Successful Dairy Farmer

Anyone opting to go in for dairy farming must have a genuine love for the welfare of cows and buffaloes as dairying requires long hours of tiring and harsh work without there being any holiday. Further to be a successful dairy farmer one must have a good knowledge about all aspects of scientific management of dairy animals as well as management of dairy business. The selection, breeding, feeding, management, housing and healthcare requirements of high grade crossbred cows and genetically superior buffaloes are different in many respects from our traditional methods of cattle rearing. The dairy production on commercial scale with a high degree of mechanization and automation of operations necessitates a thorough understanding of the basic and applied aspects of animal

management as well as the knowledge of operation and maintenance of farm machinery and equipment. Therefore the aspiring entrepreneur must acquaint himself with the essentials of scientific dairy cattle and buffalo management through training from agricultural universities, Krishi Vigyan Kendras, central institutes or any other competent agency before venturing into this business. Alternatively, services of professionals in the field can be hired if one is interested to set up a medium to large farm. Further one should have the practical experience of working with the animals and the ability to do the job on the farm with one's own hands is a must if one wants to prosper in dairying.

Dairy farming is best suited both for uneducated and the educated unemployed rural youths as they may already be possessing some experience of working with the animals and they may also be owning some land for setting up the dairy farm. Dairying is a capital-intensive enterprise and the required capital for the purpose may not be available with these rural youth. However, the required capital can be raised through loans from the banks and other development agencies by prospective dairy entrepreneurs.

With the proliferation of milk processing plants in the country in recent years owing to liberalization of economy, many people from business and industry have shown keen interest in setting up of large dairy farms. These business firms have the required capital with them and are in a position to hire technical services to manage the farm. Some such firms have already set up modern commercial dairy farms in different parts of the country and are successfully running their dairy business. The success of these farms shall serve as a big motivation and a guide to others who may be willing to enter into this field.

Location of the Dairy Farm

Commercial dairy farms can be set up near the cities where there is an assured market of milk round the year or in the milk-shed areas of milk processing plants. Nearness to market is important as the nearer the market the lesser the transportation charges and the lesser the losses due to spoilage of highly perishable milk and milk products during storage and transportation. Ideally the large dairy farms should be located nearer to towns but not in towns itself as in urban areas the conditions are neither ideal nor economical for production of milk. Land may not be available or available at high rentals for animal sheds and for fodder production. The producer has to purchase the feed items at higher prices. Yet many city dairy owners earn handsome money, as they can sell milk at high prices to the consumers directly often circumventing the middlemen.

In rural areas the cost of fodder and labour, the major inputs for milk production, are comparatively lower but so is the demand and prices of milk. The villages located close to cities on highways leading into cities are ideally suited for dairy business. In fact most of the commercial milk producers in the country belong to this category who market milk readily in cities by themselves. The cornerstone of successful dairying is the elimination of middlemen from marketing of milk, and producers devise a marketing mechanism so that they directly sell the milk and value-added milk products to the consumers. The other important requirement for setting up of a successful commercial dairy farm is the land for fodder cultivation. The land should be well fertile with assured irrigation facilities, so that all the seasonal fodder crops could be successfully raised and abundant good quality green fodders are available for animal feeding throughout the year. The place where the dairy farm is to be set up should have a source of good quality freshwater for animal drinking and for cleaning, washing etc. at the dairy farm.

Choice of Dairy Animal

The potential entrepreneur may start the dairy farm either with the crossbred cows or with improved breeds of buffaloes or a rightful combination of both high yielding crossbred cows and buffaloes. The important economic characteristics to be considered while selecting the dairy animal are:

Crossbred cows: The half-bred cows are the economical producers of milk under good feeding and management conditions. They are high producers of milk with production levels of 4,000 to 5,000 kg milk in standard lactation quite attainable. The half-breeds cows can further be upgraded to 62.5 and even up to 75% of exotic inheritance in subsequent generations as the husbandry practices get stabilized and the farmer gets experience in management of high grade cows. These high grade cows can produce, under Indian conditions of feeding and management, on an average of about 5,000 to 6,000 kg milk in a lactation period. The average milk fat content of crossbred cows is low (3.5 to 4.0 %) as compared to buffaloes and indigenous cows. They grow at a faster rate and mature early and come into production at about 28 to 30 months of age. They breed comparatively regularly if proper care is taken and produce one calf every 13-14 months. They are more amenable to modern husbandry practices such as calf weaning and machine milking. These are available in sufficient numbers in many parts of the country at reasonable prices.

However the price of cow milk is lower than the buffalo milk due to lower milk fat content. There may be lower consumer preference for

fresh cow milk. The higher grades of crosses though producing higher milk may not be adapted to all climatic conditions prevailing in the country. The male crossbred cattle calves fetch little market value; however, they can be used for draught purpose also.

Buffaloes: Good milch breeds of buffaloes like Murrah, Nili-Ravi, and Mehsana are available in the country, which are economical producers of milk and are suitable for commercial dairy farming. Elite buffaloes belonging to these breeds can yield 3,000 kg of milk in a lactation period. The buffalo milk is rich in fat content, which usually ranges from 6.0 to 9.0% and therefore is more in demand for making butter and ghee and is priced higher than the cow milk. Buffaloes can be maintained on more fibrous feed residues and hence have more scope for reducing feed costs. Buffaloes are well adapted under the diversified agro-climatic conditions of the country and are less likely to suffer from mastitis, milk fever and ectoparasites as compared to high-grade crossbred cows. The buffalo males after weaning and other unwanted animals such as infertile and old animals fetch good price as meat animals. The buffalo males are also good draught animals. However, the major consideration unfavourable to dairying with buffaloes is the comparatively higher calf mortality, slower rate of growth, late maturity and higher calving interval (15-18 months).

From the foregoing discussion it is evident that the choice of dairy animal shall depend on the demand of milk and market price of the milk. It would be worthwhile to conduct a market survey of the potential area where the farm is to be set up regarding the consumer preferences for cow or buffalo milk and the comparative prices offered. However it would be advisable to initially start with both cows and buffaloes in the 50: 50 ratios and subsequently depending on the demand and price of milk increase the number of cows or the buffaloes as the case may be. However, at a large dairy farm integrated with a milk processing plant or situated in the milk shed area of a milk processing plant with a high level of mechanization and automation keeping of high milk producing crossbred cows is likely to be more economical than the buffaloes.

It has been conclusively established that Holstein-Friesian crosses perform better than other exotic cattle crosses in Northern Indian conditions where adequate green fodder can be made available to cows throughout the year and the cows are protected against summer stress. In hilly regions and coastal areas Jersey crosses may be more suitable. The cows with a level of 62.5 or even 75% exotic cattle inheritance can be commercially more viable under favourable climatic conditions provided they are maintained under scientific feeding, management and proper healthcare. In fact many large farms with high level of

mechanization including mechanical feeding, cleaning, machine milking coupled with electronic animal identification and computerized data recording being set up in different parts of the country are maintaining only the high grade crossbred cows.

Number of Animals to Start With

An average farm family desirous of venturing into a commercial scale dairy farming as a specialized occupation may initially start with about 20 dairy animals preferably 10 crossbred cows and 10 buffaloes. Such a farm unit shall provide full time employment to two workmen and shall generate sufficient income to sustain a middle class family. Further construction of modern animal housing facilities, mechanical fodder chaffing, machine milking, milk chilling and other infrastructure shall be better utilized and economically viable if the farm size comprises at least 20 lactating cows. The size of the farm can be raised gradually to 50 animals or more in the proportion of 25 cows and 25 buffaloes as the farmer stabilizes in dairying.

The established business firms having the necessary capital for investing in dairy production and who are in a position to hire technical personnel for the management of the farm may set up large dairy farms starting with 100 to 200 high grade crossbred cows and a same number of superior buffaloes and gradually raise the farm size further as per requirement. It will be prudent to start from a small size as a large number of animals with desired production levels may not be available or difficult to procure at the same time. Further the farm bred cows will be always better producers than the purchased cows.

Land Required

The land is required for the construction of dairy sheds and other farm structures as well as for the production of fodder. The land required for fodder production depends on the carrying capacity of the land. On an average 4 to 5 dairy animals along with their followers can be maintained on an acre of well fertile agricultural land with assured irrigation facilities. Now-a-days with the availability of total mixed rations (TMR) in the market, the requirement of land for fodder cultivation can be reduced. However, the farm productivity is higher and the cost of milk production is lower if farm grown good quality green fodders are available in plenty.

The land required for the construction of dairy sheds and ancillary structures including milking parlour, maternity pens, straw store, feed store, implements room, milk room, chaff cutter shed, manure pit, roads and alleys between and office etc. works out to be about 500 sq. ft. per

animal for a dairy unit of 20 animals. The land required is reduced to about 350 sq ft per animal if the herd strength is increased to 50 animals as the area required for the milk room, roads and alleys, chaff cutter shed, office, implements room does not increase proportionately. Per animal area will be further reduced if the farm size is further increased.

Feeds and Fodder Required

Feeding is the major component of cost of milk production, accounting for 55-60% of the total cost of milk production. Therefore, judicious feeding is the most important pillar of economical dairying. The dairy animals must be fed with a balanced ration incorporating all the nutrients (energy, proteins, minerals and vitamins) in right proportions keeping in view the requirements of the animal. At the same time, feeds and fodders selected for feeding should not be costly.

Dairy cows and buffaloes of an average body weight of about 500 kg require between 12.5 and 15 kg of dry matter daily. This DM should be fed through green fodders, concentrate mixture and dry roughages. Preferably two-thirds of the total requirement of dry matter should be met through seasonal cereal and leguminous green fodders and dry roughages. For better productivity feeding of both cereal and leguminous fodders in 50: 50 ratio should be preferred. The remaining one-third of the DM should be fed through concentrate mixture having 16 % CP and 70 % TDN. So as to economize feeding, the concentrate mixture should be homemade as the concentrate mixtures available in the market are costlier and their quality in most cases leaves much to be desired. It may be mentioned that the cost of milk production is always less if major chunk of the daily ration of the dairy animal comprises green fodders as concentrates are a costly feed item. However, in situations where land for fodder cultivation is not available or insufficiently available or the market rate of fodder are very high as in and around cities and the milk is sold at a higher rate, the concentrates and the wheat straw may form major part of animal diet supplemented with some amount of green fodder (5-10 kg per animal per day) which is absolutely necessary.

As a thumb rule a cow producing an average of 12.5 kg and a buffalo producing 10 kg of milk should get about 40 kg green fodder, 2 kg dry fodder (wheat straw) and 5 kg of concentrate mixture daily. The daily ration of a dry cow or buffalo shall comprise 40 kg of green fodder, 5 kg of dry fodder and 2 kg of concentrate mixture. High producing cows (more than 15 kg per day) may be fed additional feeds containing by-pass proteins and fats to further improve their milk yield.

Labour Required

The dairy farming is a labour intensive enterprise as compared to crop production and other allied enterprises. It has been estimated that on an average one person can look after all activities of 10 milking animals along with their followers excluding the work of harvesting of fodder. Some routine activities such as milking (machine as well as hand milking), heat detection, care of down-calvers and neonates etc. require experienced and dedicated workers. Therefore in case one decides to set up a new farm about a half of the workers should have earlier experience of working at a dairy farm. Two or three workers have to be trained for the specialized jobs at the dairy farm such as AI, first aid, identification, de-worming etc. Besides, at large farms technically qualified persons in the field of dairying will have to be hired such as the farm manager, veterinarian, stockmen and the ministerial staff.

Machinery and Equipment

The machinery and equipment required depends on the level of mechanization desired and the scale of operation. However, some machinery and equipment are essentially required such as the chaff cutter machine, milking pails, milk cans and minor implements. On farms maintaining more than 20 milch animals, machine milking may be economical and more convenient as compared to hand milking. Installation of fans and mists cooling devices in animal sheds for protection against heat stress is also a must if one wishes to keep high yielding crossbred cows. Dairy farms with 50 or more milch animals may also require a milk cooler, electricity generator set and a utility vehicle for the procurement of farm supplies and marketing of produce besides a tractor with implements for the cultivation of fodder crops and their harvesting, transportation chaffing, processing etc.

With this background a scheme for a Model Dairy Project consisting of 50 dairy animals (25 crossbred cows and 25 buffaloes) has been prepared and is presented here. The proposed dairy farm shall be situated anywhere in the plains of Northern India close to a city on well fertile agricultural land with assured irrigation water facilities.

Techno-Economic Parameters

Milking cows

- Freshly calved cows in their second or third lactation should be purchased from Government farms or from the well-established commercial dairy farmers at a price of Rs 40,000 each.
- Production level of these half-bred Friesian crosses should range

from 4,000 to 4,500 kg with an overall average of 4,250 kg in a standard lactation period of 300 days.
- The period between successive calvings should be on an average 13-14 months.
- 70-75% of the cows should be in milk at any time throughout the year.
- Surplus male calves will be disposed of at 3 months or at the earliest possible.
- All adult cows at the farm shall be insured and the mortality in adult cows, if any shall be compensated by the insurance company.
- The milk produced will be sold at the local market at a rate of Rs 18/kg.

Milking buffaloes

- Murrah buffaloes in their second or third lactation should be purchased from its breeding tract in the districts of Rohtak, Jind, Jhajjar and Hisar at a price of Rs 50,000 each.
- The average daily milk production of these buffaloes should be about 10 kg with an average lactation length of 300 days.
- The period between the successive calvings of these buffaloes should be 15-16 months and 60-65% of the buffaloes in milk throughout the year.
- The buffalo milk will be sold in the local market at a price of Rs 24/ kg.

Land required

- A total of 14 acres of well fertile land with assured irrigation facilities will be required for fodder production at a level of about 750 quintals per acre per year.
- The cost of construction will be Rs 150/sq ft for the stores and milking parlour, Rs 120/ sq ft for the area covered under sheds and Rs 50/ sq ft for the paddocked area and Rs 25/ sq ft for the brick paving of the road, passage and manure pit.

Feeds and fodders

- Farm grown green fodders will be required @ 50 kg per milking as well as dry cow/buffalo per day and the cost of production of green fodder at the farm will be taken as Rs 60/ quintal including the rental value of the land (Rs 20,000/ acre).
- The dry fodders mainly the wheat straw will be required @ 2 kg / cow/day for the milking cows and buffaloes and at the rate of 4 kg per day per dry cow and dry buffalo. It will be purchased from the market during wheat harvesting season at a rate of Rs 300/ quintal.

- The concentrate mixture will be required @ 6 kg /cow/day for the milking cows and buffaloes and at the rate of 2 kg per day per dry cow and buffalo. It will be home made, and its price will be taken as Rs 12.00/ kg.

Labour

One unskilled person will be required to look after 10 milking cows/ buffaloes and their followers. Therefore 5 persons will be required to take care of all the activities of 50 cows/buffaloes dairy unit including the harvesting of fodder. The farmer shall provide additional labour required at times by himself and his family.

The labourers will be hired locally at the rate of Rs 30,000 per person per year.

Machinery and Equipment Required

Sr No	Name of machinery / equipment	Approximate price (Rs)
1.	Two bucket milking machines	150,000
2.	One feed grinder with motor	50,000
3.	One chaff cutter with 10 HP electric motor	75,000
4.	Mistess cooling system in milking cows and buffaloes shed	30,000
5.	Twenty milk cans of 40 litres capacity	40,000
6.	Ten milking buckets	5,000
7.	Four hand driven carts for concentrate dispensing	5,000
	Total	Rs 355,000

Economic Feasibility

Capital investment (Rs in lakh)

Cost of animals (25 cows and 25 buffaloes)	:	22.50
Construction cost of buildings	:	12.71
Cost of equipment	:	3.55
Total capital investment	:	38.76

Fixed expenses (Rs in lakh)

Interest on capital invested @ 10 % per annum	:	3. 87
Depreciation on buildings @ 3.0 % per annum	:	0.38
Depreciation on equipments @ 10.0 % per annum	:	0.35
Insurance @ 4 % of value of cows and buffaloes	:	0.90
Total fixed expenses	:	5.50

Recurring expenses per year (Rs in Lakh)		
Cost of farm grown green fodder	:	5.74
Cost of purchased dry fodder	:	1.60
Cost of concentrate mixture	:	10.86
Labour charges	:	1.50
Animal healthcare and reproduction @ Rs1,500 / animal/year	:	0.75
Miscellaneous expenses (repairs, electricity bill, phone bill, purchase of chains, ropes etc) @ Rs 2,000/ animal / year	:	1.00
Total recurring expenses	:	21.45

Total Yearly Expenses (B+C) = 5.50 + 21.45 = 26.95

Income (Rs in lakh)		
Sale of cow milk (15 × 19 ×365 ×18)	=	18.72
Sale of buffalo milk (10 ×16 × 365 × 24)	=	14.02
Sale of manure @ Rs 1,500 adult unit	=	0.82
Sale of 10 buffalo males at 10 months of age @ Rs 2,000/each	=	0.20
Total sale proceeds	=	33.76

Net income per year (Sale proceeds-Total expenses)	= Rs 6.81 lakh
Net income/month	= Rs 56,750
Net income/milch animal/year	= Rs 13,620
Net income/acre land/year	= Rs 48,643
Rate of turnover/year	= 25.27%

Based on above calculations, a capital investment of about Rs 38.76 lakh is required for the setting up of the said dairy farm. The total amount of initial investment has been deemed to have been taken on a loan from any bank at an interest rate of 10% per annum. The farm will generate a net income of about Rs 6.81 lakh per annum with an annual rate of turnover of about 25.27%. Thus there will be sufficient surplus income with the farmer after meeting his family needs and to repay the loan in easy installments.

So as to make commercial dairy farming economically sustainable and successful venture, the following points merit special attention of the dairyman.

- Start with really high yielding cows/buffaloes as feed cost per kg of milk comes down as the yield of animal's increases.
- It is better to purchase the animals in two batches. The second batch should be purchased when the animals of first batch are in late stage of lactation so that the production level is maintained more or less uniform throughout the year.
- The dairy building should be made of locally available cheap construction materials and very costly building structures and expensive sheds should be avoided.
- The cost of milk production is lower if cows are fed on good quality abundant green fodders and homemade quality concentrate mixture.
- The market price of the milk is the major determinant of the profitability of dairy farming. The removal of middlemen in milk marketing and selling the milk directly to consumers is therefore a must for sustainable and viable dairy farming.
- Large commercial dairy farms to be set up only near the cities to take advantage of the higher milk prices or the large farms are to be integrated with milk processing.

❐

ANNEXURE - I

Semen Banks of Cattle and Buffaloes in India

Species	Year	Breed	State	Name of Semen Bank	No. of Bulls	Semen Straws Produced
Cattle	2001	Amritmahal	Karnataka	State Semen Collection Centre, Hessaraghatta, Bangalore Urban	3	–
Cattle	2003	Amritmahal	Karnataka	State Semen Collection Centre, Hessaraghatta, Bangalore Urban	10	69875
Cattle	2003	Amritmahal	Karnataka	Centralized Semen Collection Centre, Birur, Chikkamaglur	8	–
Cattle	2001	Deoni	Karnataka	Livestock Breeding & Training Centre, Munirabad, Raichur	3	–
Cattle	2003	Deoni	Maharashtra	Frozen Semen Bank, Aurangabad	1	9370
Cattle	2003	Deoni	Karnataka	Livestock Breeding & Training Centre, Munirabad, Raichur	3	142579
Cattle	2001	Gir	Gujarat	Semen Bank, Rajkot	6	16190
Cattle	2003	Gir	Gujarat	Semen Bank, Rajkot	5	22140
Cattle	2005	Gir	Rajasthan	Frozen Semen Bank, Bassi, Jaipur	2	5399
Cattle	2001	Hallikar	Karnataka	State Semen Collection Centre, Hessaraghatta, Bangalore Urban	16	–
Cattle	2003	Hallikar	Karnataka	State Semen Collection Centre, Hessaraghatta, Bangalore Urban	18	155000
Cattle	1998	Hariana	Haryana	Semen Production & Bull Production Centre, Hisar	23	22000
Cattle	1998	Hariana	Haryana	Semen Bank, Mehendargarh	3	6000
Cattle	1998	Hariana	Haryana	Semen Bank, Yamunanagar	2	16000
Cattle	2001	Hariana	Orissa	Frozen Semen Bank, Madhupatna (Khapuria), Cuttack	7	–

Species	Year	Breed	State	Name of Semen Bank	No. of Bulls	Semen Straws Produced
Cattle	1999	Hariana	Haryana	Semen Production & Bull Production Centre, Hisar	23	12000
Cattle	2000	Hariana	Haryana	Semen Production & Bull Production Centre, Hisar	23	50000
Cattle	2001	Hariana	Haryana	Semen Production & Bull Production Centre, Hisar	16	56000
Cattle	2001	Hariana	Haryana	Semen Bank, Yamunanagar	1	11000
Cattle	2000	Hariana	Haryana	Semen Bank, Bhiwani	4	136000
Cattle	1999	Hariana	Haryana	Semen Bank, Yamunanagar	1	16000
Cattle	2000	Hariana	Haryana	Semen Bank, Yamunanagar	1	18000
Cattle	1999	Hariana	Haryana	Semen Bank, Bhiwani	4	160000
Cattle	2000	Hariana	Haryana	Semen Bank , Narnaul	3	97000
Cattle	1999	Hariana	Haryana	Semen Bank , Narnaul	4	104000
Cattle	2001	Hariana	Haryana	Semen Bank, Bhiwani	3	–
Cattle	2001	Hariana	Haryana	Semen Bank, Mehendargarh	3	–
Cattle	2005	Hariana	Rajasthan	Frozen Semen Bank, Bassi, Jaipur	1	3470
Cattle	1999	Kangayam	Tamilnadu	District Livestock Farm, Hosur, Dharmapuri	17	24825
Cattle	2000	Kangayam	Tamilnadu	District Livestock Farm, Hosur, Dharmapuri	12	45515
Cattle	2001	Kangayam	Tamilnadu	District Livestock Farm, Hosur, Dharmapuri	9	70290
Cattle	2002	Kangayam	Tamilnadu	District Livestock Farm, Hosur, Dharmapuri	7	51090
Cattle	2003	Kangayam	Tamilnadu	District Livestock Farm, Hosur, Dharmapuri	7	72365
Cattle	2004	Kangayam	Tamilnadu	District Livestock Farm, Hosur, Dharmapuri	0	65870
Cattle	2001	Kankrej	Gujarat	Semen Bank, Mehsana	4	3675
Cattle	2001	Kankrej	Rajasthan	Frozen Semen Bank, Bassi, Jaipur	1	–
Cattle	2003	Kankrej	Gujarat	Semen Bank, Mehsana	3	2650
Cattle	2003	Khillari	Maharashtra	Frozen Semen Bank, Pune	2	30500
Cattle	2003	Khillari	Karnataka	Centralised Semen Collection Centre, Dharwad	22	158235
Cattle	2001	Malvi	Madhya Pradesh	Central Semen Station (Frozen Semen), Bhadbhada, Bhopal	5	1015
Cattle	2001	Nagori	Rajasthan	Frozen Semen Bank, Bassi, Jaipur	1	–
Cattle	2005	Nagori	Rajasthan	Frozen Semen Bank, Bassi, Jaipur	1	7110

Species	Year	Breed	State	Name of Semen Bank	No. of Bulls	Semen Straws Produced
Cattle	2001	Ongole	Andhra Pradesh	Frozen Semen Bull Station, Nandyal, Kurnool	6	69525
Cattle	2001	Ongole	Andhra Pradesh	Frozen Semen Bull Station, Karimnagar	2	645
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Srikakulam	–	80
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, East Godawari	–	2906
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, West Godawari	–	3937
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Krishna	–	3429
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Guntur	–	3556
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Prakasham	–	2150
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Nellore	–	2550
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Ananthapur	–	2385
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Mahboobnagar	–	4285
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Hyderabad	–	4980
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Medak	–	615
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Nizamabad	–	813
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Adilabad	–	970
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Warangal	–	10190
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Khammam	–	647
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Nalgonda	–	801
Cattle	2004	Ongole	Andhra Pradesh	Frozen Semen Bull Station, Visakhapatnam	–	2525
Cattle	2004	Ongole	Andhra Pradesh	Frozen Semen Bull Station, Karimnagar	–	14630
Cattle	2004	Ongole	Andhra Pradesh	Frozen Semen Bull Station, Nandyal, Kurnool	–	50595
Cattle	2004	Ongole	Andhra Pradesh	District Frozen Semen Bank, Vijayanagram	–	45
Cattle	2005	Ongole	Andhra Pradesh	Frozen Semen Bull Station, Nandyal, Kurnool	10	115866

Species	Year	Breed	State	Name of Semen Bank	No. of Bulls	Semen Straws Produced
Cattle	2005	Ongole	Andhra Pradesh	Frozen Semen Bull Station, Visakhapatnam	2	3245
Cattle	2005	Ongole	Andhra Pradesh	Frozen Semen Bull Station, Karimnagar	6	4568
Cattle	2001	Rathi	Rajasthan	Frozen Semen Bank, Bassi, Jaipur	2	–
Cattle	2005	Rathi	Rajasthan	Frozen Semen Bank, Bassi, Jaipur	2	5769
Cattle	2003	Red Kandhari	Maharashtra	Frozen Semen Bank, Aurangabad	3	29673
Cattle	2003	Red Sindhi	Himachal Pradesh	Semen Bank, Bhangrotu, Mandi	1	24243
Cattle	2003	Red Sindhi	Himachal Pradesh	Intensive Cattle Development Project, Palampur, Kangra	2	8510
Cattle	2001	Red Sindhi	Orissa	Frozen Semen Bank, Madhupatna (Khapuria), Cuttack	2	–
Cattle	2001	Red Sindhi	Orissa	Frozen Semen Bank, Bhavanipatna, Kalahandi	10	2000
Cattle	2001	Red Sindhi	Tamilnadu	District Livestock Farm, Hosur, Dharmapuri	8	27525
Cattle	2004	Red Sindhi	Andhra Pradesh	Frozen Semen Bull Station, Visakhapatnam	–	13060
Cattle	2002	Red Sindhi	Tamilnadu	District Livestock Farm, Hosur, Dharmapuri	6	34555
Cattle	2003	Red Sindhi	Tamilnadu	District Livestock Farm, Hosur, Dharmapuri	3	68595
Cattle	2004	Red Sindhi	Tamilnadu	District Livestock Farm, Hosur, Dharmapuri	–	64515
Cattle	2001	Sahiwal	Andhra Pradesh	Frozen Semen Bull Station, Nandyal, Kurnool	25	375995
Cattle	2001	Sahiwal	Madhya Pradesh	Central Semen Station (Frozen Semen), Bhadbhada, Bhopal	10	10680
Cattle	1999	Sahiwal	Punjab	Semen Bank Kapurthala	2	23154
Cattle	2000	Sahiwal	West Bengal	Frozen Semen Bull Station Laboratory, Haringhata Farm, Nadia	–	37673
Cattle	2003	Sahiwal	Haryana	National Dairy Research Institute, Karnal	–	49650
Cattle	2000	Sahiwal	Punjab	Semen Bank Kapurthala	2	21998
Cattle	2001	Sahiwal	Punjab	Semen Bank Kapurthala	1	22405
Cattle	2001	Sahiwal	Punjab	Semen Bank Ropar	2	5406
Cattle	2002	Sahiwal	Punjab	Semen Bank Kapurthala	1	17334
Cattle	2002	Sahiwal	Punjab	Semen Bank Ropar	2	11481

Species	Year	Breed	State	Name of Semen Bank	No. of Bulls	Semen Straws Produced
Cattle	2003	Sahiwal	Punjab	Semen Bank Kapurthala	1	17873
Cattle	2003	Sahiwal	Punjab	Semen Bank Ropar	3	5845
Cattle	2001	Tharparkar	Rajasthan	Frozen Semen Bank, Bassi, Jaipur	1	–
Cattle	2004	Tharparkar	Andhra Pradesh	District Frozen Semen Bank, Medak	–	1465
Cattle	2004	Tharparkar	Andhra Pradesh	District Frozen Semen Bank, Nizamabad	–	1670
Cattle	2004	Tharparkar	Andhra Pradesh	District Frozen Semen Bank, Adilabad	–	125
Cattle	2004	Tharparkar	Andhra Pradesh	District Frozen Semen Bank, Warangal	–	3100
Cattle	2004	Tharparkar	Andhra Pradesh	District Frozen Semen Bank, Khammam	–	2000
Cattle	2004	Tharparkar	Andhra Pradesh	District Frozen Semen Bank, Nalgonda	–	3073
Cattle	2004	Tharparkar	Andhra Pradesh	Frozen Semen Bull Station, Karimnagar	–	137845
Cattle	2003	Tharparkar	Haryana	National Dairy Research Institute, Karnal	–	2242
Cattle	2005	Tharparkar	Rajasthan	Frozen Semen Bank, Bassi, Jaipur	1	17723
Cattle	2003	Umbalachery	Tamilnadu	Exotic Cattle Breeding Farm, Eachenkottai, Thanjavur	2	3248
Cattle	2004	Umbalachery	Tamilnadu	District Livestock Farm, Abishegapatti, Tirunelveli	–	5167
Buffalo	2001	Jaffarabadi	Gujarat	Semen Bank, Rajkote	11	61885
Buffalo	2003	Jaffarabadi	Gujarat	Semen Bank, Rajkote	6	74240
Buffalo	2001	Mehsana	Gujarat	Semen Bank, Mehsana	24	250355
Buffalo	2001	Mehsana	Gujarat	Semen Bank, Himatnagar, Sabarkantha	13	135830
Buffalo	2003	Mehsana	Gujarat	Semen Bank, Mehsana	15	105000
Buffalo	2003	Mehsana	Gujarat	Semen Bank, Himatnagar, Sabarkantha	13	84795
Buffalo	2003	Mehsana	Gujarat	Semen Bank, Surat	2	17475
Buffalo	2001	Murrah	Andhra Pradesh	Frozen Semen Bull Station, Banvasi, Kurnool	65	862098
Buffalo	2001	Murrah	Andhra Pradesh	Frozen Semen Bull Station, Visakhapatnam	69	549235
Buffalo	2001	Murrah	Andhra Pradesh	Frozen Semen Bull Station, Karimnagar	74	12600
Buffalo	1998	Murrah	Haryana	Semen Bank, Bhiwani	9	–
Buffalo	1998	Murrah	Haryana	Semen Bank, Fathehabad	1	12000
Buffalo	1998	Murrah	Haryana	Semen Bank, Gurgaon	6	56000

Species	Year	Breed	State	Name of Semen Bank	No. of Bulls	Semen Straws Produced
Buffalo	1998	Murrah	Haryana	Semen Production & Bull Production Centre, Hisar	17	146000
Buffalo	1998	Murrah	Haryana	Semen Bank, Jind	5	–
Buffalo	1998	Murrah	Haryana	Semen Bank, Karnal	5	–
Buffalo	1998	Murrah	Haryana	Semen Bank, Kurukshetra	4	–
Buffalo	1998	Murrah	Haryana	Semen Bank, Mehendargarh	14	15000
Buffalo	1998	Murrah	Haryana	Semen Bank, Lakaria, Rohtak	4	9000
Buffalo	1998	Murrah	Haryana	Semen Bank, Yamunanagar	8	43000
Buffalo	2001	Murrah	Karnataka	Livestock Breeding & Training Centre, Munirabad, Raichur	19	–
Buffalo	2001	Murrah	Karnataka	Centralised Semen Collection Centre, Dharwad	7	–
Buffalo	2001	Murrah	Madhya Pradesh	Central Semen Station (Frozen Semen), Bhadbhada, Bhopal	14	65835
Buffalo	2003	Murrah	Maharashtra	Frozen Semen Bank, Pune	11	190290
Buffalo	2003	Murrah	Maharashtra	Frozen Semen Bank, Aurangabad	5	95023
Buffalo	2001	Murrah	Orissa	Frozen Semen Bank, Madhupatna (Khapuria), Cuttack	2	3000
Buffalo	2001	Murrah	Rajasthan	Frozen Semen Bank, Bassi, Jaipur	14	–
Buffalo	1999	Murrah	Tamilnadu	Exotic Cattle Breeding Farm, Eachenkottai, Thanjavur	13	97630
Buffalo	2000	Murrah	Tamilnadu	Exotic Cattle Breeding Farm, Eachenkottai, Thanjavur	6	81950
Buffalo	2001	Murrah	Tamilnadu	Exotic Cattle Breeding Farm, Eachenkottai, Thanjavur	6	78189
Buffalo	1999	Murrah	Tamilnadu	District Livestock Farm, Abishegapatti, Tirunelveli	43	197629
Buffalo	2000	Murrah	Tamilnadu	District Livestock Farm, Abishegapatti, Tirunelveli	35	122358
Buffalo	2001	Murrah	Tamilnadu	District Livestock Farm, Abishegapatti, Tirunelveli	41	172190
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Srikakulam	–	605
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Vijayanagram	–	3130
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, East Godawari	–	34516

Species	Year	Breed	State	Name of Semen Bank	No. of Bulls	Semen Straws Produced
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, West Godawari	–	30343
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Krishna	–	60681
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Guntur	–	9124
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Prakasham	–	38695
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Nellore	–	24040
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Chittoor	–	87
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Cuddapah	–	14905
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Ananthapur	–	22339
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Kurnool	–	10468
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Mahboobnagar	–	10226
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Hyderabad	–	4221
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Medak	–	6609
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Nizamabad	–	3210
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Adilabad	–	1050
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Warangal	–	18194
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Khammam	–	6155
Buffalo	2004	Murrah	Andhra Pradesh	District Frozen Semen Bank, Nalgonda	–	12161
Buffalo	2004	Murrah	Andhra Pradesh	Frozen Semen Bull Station, Visakhapatnam	–	424639
Buffalo	2004	Murrah	Andhra Pradesh	Frozen Semen Bull Station, Karimnagar	–	336820
Buffalo	2004	Murrah	Andhra Pradesh	Frozen Semen Bull Station, Nandyal, Kurnool	–	298075
Buffalo	2004	Murrah	Andhra Pradesh	Frozen Semen Bull Station, Banvasi, Kurnool	–	782305
Buffalo	2003	Murrah	Haryana	National Dairy Research Institute, Karnal	–	123533
Buffalo	1999	Murrah	Haryana	Semen Production & Bull Production Centre, Hisar	54	78000

Species	Year	Breed	State	Name of Semen Bank	No. of Bulls	Semen Straws Produced
Buffalo	1999	Murrah	Haryana	Semen Bank, Gurgaon	5	46000
Buffalo	2000	Murrah	Haryana	Semen Production & Bull Production Centre, Hisar	68	145000
Buffalo	2000	Murrah	Haryana	Semen Bank, Gurgaon	4	41000
Buffalo	2001	Murrah	Haryana	Semen Production & Bull Production Centre, Hisar	75	333000
Buffalo	2001	Murrah	Haryana	Semen Bank, Gurgaon	4	78000
Buffalo	2001	Murrah	Haryana	Semen Bank, Yamunanagar	13	127000
Buffalo	2000	Murrah	Haryana	Semen Bank, Bhiwani	9	140000
Buffalo	2000	Murrah	Haryana	Semen Bank, Jind	5	244000
Buffalo	2000	Murrah	Haryana	Semen Bank, Karnal	4	36000
Buffalo	2000	Murrah	Haryana	Semen Bank, Kurukshetra	5	156000
Buffalo	2000	Murrah	Haryana	Semen Bank, Yamunanagar	8	82000
Buffalo	1999	Murrah	Haryana	Semen Bank, Bhiwani	9	156000
Buffalo	1999	Murrah	Haryana	Semen Bank, Jind	5	272000
Buffalo	1999	Murrah	Haryana	Semen Bank, Karnal	4	156000
Buffalo	1999	Murrah	Haryana	Semen Bank, Kurukshetra	5	256000
Buffalo	1999	Murrah	Haryana	Semen Bank, Yamunanagar	8	45000
Buffalo	2000	Murrah	Haryana	Semen Bank , Narnaul	7	100000
Buffalo	1999	Murrah	Haryana	Semen Bank , Narnaul	14	110000
Buffalo	2001	Murrah	Haryana	Semen Bank, Bhiwani	6	–
Buffalo	2001	Murrah	Haryana	Semen Bank, Jind	5	–
Buffalo	2001	Murrah	Haryana	Semen Bank, Mehendargarh	6	–
Buffalo	2003	Murrah	Karnataka	Livestock Breeding & Training Centre, Hessaraghatta, Bangalore	9	–
Buffalo	2003	Murrah	Karnataka	Centralised Semen Collection Centre, Dharwad	4	–
Buffalo	2003	Murrah	Karnataka	Livestock Breeding & Training Centre, Munirabad, Raichur	19	259201
Buffalo	2002	Murrah	Tamilnadu	Exotic Cattle Breeding Farm, Eachenkottai, Thanjavur	14	92993
Buffalo	2002	Murrah	Tamilnadu	District Livestock Farm, Abishegapatti, Tirunelveli	49	144820
Buffalo	2003	Murrah	Tamilnadu	Exotic Cattle Breeding Farm, Eachenkottai, Thanjavur	15	155831
Buffalo	2003	Murrah	Tamilnadu	District Livestock Farm, Abishegapatti, Tirunelveli	55	94040
Buffalo	2005	Murrah	Rajasthan	Frozen Semen Bank, Bassi, Jaipur	22	24523

Species	Year	Breed	State	Name of Semen Bank	No. of Bulls	Semen Straws Produced
Buffalo	2005	Murrah	Andhra Pradesh	Frozen Semen Bull Station, Banvasi, Kurnool	43	607145
Buffalo	2005	Murrah	Andhra Pradesh	Frozen Semen Bull Station, Nandyal, Kurnool	52	473607
Buffalo	2005	Murrah	Andhra Pradesh	Frozen Semen Bull Station, Visakhapatnam	92	536361
Buffalo	2005	Murrah	Andhra Pradesh	Frozen Semen Bull Station, Karimnagar	59	535920
Buffalo	2004	Murrah	Tamilnadu	Exotic Cattle Breeding Farm, Eachenkottai, Thanjavur	–	107810
Buffalo	2004	Murrah	Tamilnadu	District Livestock Farm, Abishegapatti, Tirunelveli	–	51935
Buffalo	2001	Surti	Gujarat	Semen Bank, Surat	15	87130
Buffalo	2001	Surti	Karnataka	State Semen Collection Centre, Hessaraghatta, Bangalore Urban	31	–
Buffalo	2001	Surti	Karnataka	Centralised Semen Collection Centre, Dharwad	24	–
Buffalo	2003	Surti	Maharashtra	Frozen Semen Bank, Pune	9	119930
Buffalo	2003	Surti	Maharashtra	Frozen Semen Bank, Aurangabad	3	35195
Buffalo	2003	Surti	Maharashtra	Frozen Semen Bank, Nagpur	8	71080
Buffalo	2003	Surti	Gujarat	Semen Bank, Surat	7	67640
Buffalo	2003	Surti	Karnataka	Livestock Breeding & Training Centre, Hessaraghatta, Bangalore	22	–
Buffalo	2003	Surti	Karnataka	Centralised Semen Collection Centre, Dharwad	10	–
Buffalo	2003	Surti	Karnataka	Semen Collection Centre, Koila Farm, Dakshin Kannada	10	–
Buffalo	2005	Surti	Rajasthan	Frozen Semen Bank, Bassi, Jaipur	2	3638

❐

ANNEXURE - II

List of Farms of Cattle Breeds

Breed	Name	Location	City	State	No	As on date
Amritmahal	Amritmahal Cattle Breeding Station	Ajjampura	Chikkmagalur	Karnataka	1267	29/07/2004
	Jersey Cattle Breeding Farm	Kodagu	Kodagu	Karnataka	4	29/07/2004
	Livestock Breeding Farm	Dharwad	Dharwad	Karnataka	2	29/07/2004
	Livestock Breeding Farm	Hessarghatta	Bangalore	Karnataka	10	29/07/2004
	Livestock Breeding Farm	Koila	Dakshina Kannad	Karnataka	8	29/07/2004
Dangi	Cattle Breeding Farm	Igatpuri	Nasik	Maharashtra	44	28/06/2002
Deoni	Cattle Breeding Farm	Deoni	Udgir	Maharashtra	129	18/05/2002
	Deoni Cattle Breeding Farm	Gudgarpalli	Nalgonda	Andhra Pradesh	18	31/12/2005
	Govt. Livestock Farm	Mahanandi	Karimnagar	Andhra Pradesh	8	31/12/2005
	Buffalo Breeding Farm	Tegur	Dharwad	Karnataka	1	29/07/2004
	Livestock Breeding & Training Centre	Kurikuppi	Bellary	Karnataka	2	29/07/2004
	Livestock Breeding & Training Centre	Munirabad	Raichur	Karnataka	3	29/07/2004
	Livestock Breeding Farm	Dharwad	Dharwad	Karnataka	1	31/03/2000
Gangatiri	State Livestock Farm	Arajilines	Varanasi	Uttar Pradesh	117	31/03/2001
Gaolao	Cattle Breeding Farm	Hetikundi	Vardha	Maharashtra	189	31/03/2003
	Govt. Bull Rearing Centre	Nagpur	Nagpur	Maharashtra	3	05/08/2003
Gir	Bull Mother Farm	SAGP, Bidaj	Kheda	Gujarat	15	31/03/2004
	Calf Rearing Centre	Ramsar	Ajmer	Rajasthan	26	31/03/2004

Breed	Name	Location	City	State	No	As on date
	Cattle Breeding Farm	Kopardem	Kopardem	Goa	67	15/03/2001
	Cattle Breeding Farm	Bhutwad	Rajkot	Gujarat	184	31/03/2004
	Cattle Breeding Farm	GAU	Junagadh	Gujarat	342	31/03/2004
	Cattle Breeding Farm	Kopargaon	Ahmednagar	Maharashtra	13	27/06/2003
Hallikar	Hallikar Cattle Breeding Farm	Kunikenahalli	Tumkur	Karnataka	87	29/07/2004
	Livestock Breeding Farm	Hessarghatta	Bangalore	Karnataka	15	29/07/2004
Hariana	All India Co-ordinated Research Project (AICRP)	Haringhata	Nadia	West Bengal	27	06/03/2002
	Cattle Breeding Farm	Minaura	Tikamgarh	Madhya Pradesh	181	31/03/2002
	Gaushala	Bhiwani	Bhiwani	Haryana	268	31/12/1999
	Gaushala	Jind	Jind	Haryana	348	31/12/1999
	Germ Plasm Unit	CCS HAU	Hisar	Haryana	312	31/12/1999
	Govt. Livestock Farm	Hisar	Hisar	Haryana	548	31/03/2006
	Kurukshetra Gaushala	Hisar	Hisar	Haryana	372	31/12/1999
	State Cattle Breeding Project	Sector-II	Hisar	Haryana	116	31/12/2000
	State Livestock Cum Agriculture Farm	Nilgaon	Sitapur	Uttar Pradesh	45	02/05/2000
	State Livestock Farm	Babugarh	Gaziabad	Uttar Pradesh	251	31/03/2001
	State Livestock Farm	Hastinapur	Meerut	Uttar Pradesh	142	31/03/2001
	State Livestock Farm	Niblet	Barabanki	Uttar Pradesh	40	31/03/2001
	State Livestock Farm	Saidpur	Lalitpur	Uttar Pradesh	482	31/03/2001
Holstein Friesian	All India Co-ordinated Research Project (AICRP)	Haringhata	Nadia	West Bengal	133	06/03/2002
	Cattle Breeding Farm	Bagthan	Siramaur	Himachal Pradesh	18	01/05/2003
	Cattle Breeding Farm	Bhangrotu	Mandi	Himachal Pradesh	34	01/05/2003
	Cattle Breeding Farm	Kopargaon	Ahmednagar	Maharashtra	136	31/03/2003
	Cattle Breeding Farm	Champhai		Mizoram	14	31/07/2004

Breed	Name	Location	City	State	No	As on date
	Cattle Breeding Farm	Patiala	Patiala	Punjab	64	31/03/2004
	Central Cattle Breeding Farm	Hessarghatta	Bangalore	Karnataka	141	31/03/1994
	Central Cattle Breeding Farm	Andeshnagar	Lakhimpur	Uttar Pradesh	60	31/03/1994
	District Livestock Farm	Ooty	Ooty	Tamilnadu	53	31/03/2003
	District Livestock Farm	Udhagamandalam		Tamilnadu	51	31/03/2004
	Exotic Cattle Breeding Farm	Eachenkottai	Thanjavur	Tamilnadu	3	31/03/2004
	Exotic Cattle Breeding Farm	Salboni	Midnapur(W)	West Bengal	10	06/03/2002
	H.F.Project	Anand	Kheda	Gujarat	171	31/03/2004
	Hallikar Cattle Breeding Farm	Kunikenahalli	Tumkur	Karnataka	5	29/07/2004
	IDC Project	Kheda	Kheda	Gujarat	143	31/03/1999
	Khillar Cattle Breeding Farm	Bankapur	Haveri	Karnataka	2	29/07/2004
	Livestock Breeding & Training Centre	Hessarghatta	Bangalore	Karnataka	4	31/03/2000
	Livestock Breeding & Training Centre	Munirabad	Raichur	Karnataka	1	29/07/2004
	Livestock Breeding Farm	Hessarghatta	Bangalore	Karnataka	2	29/07/2004
	Livestock Research Station	Navsari (GAU)	Valasd	Gujarat	48	31/03/2004
	State Cattle Breeding Project	Sector-III	Hisar	Haryana	85	31/03/2002
Jersey	All India Co-ordinated Research Project (AICRP)	Haringhata	Nadia	West Bengal	15	06/03/2002
	Bull Mother Farm	SAGP, Bidaj	Kheda	Gujarat	10	31/03/2002
	Cattle Breeding Farm	Bagthan	Siramaur	Himachal Pradesh	2	01/05/2003
	Cattle Breeding Farm	Bhadbhada	Bhopal	Madhya Pradesh	209	31/03/2002
	Cattle Breeding Farm	Aurangabad	Aurangabad	Maharashtra	38	31/03/2003
	Cattle Breeding Farm	Tathawade	Pune	Maharashtra	283	31/03/2003
	Cattle Breeding Farm	Patiala	Patiala	Punjab	20	31/03/2004
	District Livestock Farm	Abishegapatti	Tirunelveli	Tamilnadu	13	31/03/2004
	District Livestock Farm	Hosur	Dharmapuri	Tamilnadu	7	31/03/2004

Breed	Name	Location	City	State	No	As on date
	District Livestock Farm	Ooty	Ooty	Tamilnadu	10	31/03/2003
	District Livestock Farm	Udhagamandalam		Tamilnadu	7	31/03/2004
	Exotic Cattle Breeding Farm	Eachenkottai	Thanjavur	Tamilnadu	87	31/03/2004
	Exotic Cattle Breeding Farm	Salboni	Midnapur(W)	West Bengal	30	06/03/2002
	Govt. Bull Rearing Centre	Nagpur	Nagpur	Maharashtra	9	05/08/2003
	Govt.Livestock Farm	Kamand	Mandi	Himachal Pradesh	129	01/05/2003
	Govt.Livestock Farm	Kothipura	Bilaspur	Himachal Pradesh	55	01/05/2003
	Govt.Livestock Farm	Palampur	Kangra	Himachal Pradesh	68	01/05/2003
	JCF	Banavasi	Kurnool	Andhra Pradesh	26	31/12/2005
	Jersey Cattle Breeding Farm	Kodagu	Kodagu	Karnataka	50	29/07/2004
	Livestock Breeding & Training Centre	Hessarghatta	Bangalore	Karnataka	55	29/07/2004
	Livestock Breeding & Training Centre	Kurikuppi	Bellary	Karnataka	1	29/07/2004
	Livestock Breeding & Training Centre	Munirabad	Raichur	Karnataka	6	29/07/2004
	Livestock Breeding Farm	Dharwad	Dharwad	Karnataka	15	29/07/2004
	Livestock Breeding Farm	Hessarghatta	Bangalore	Karnataka	19	29/07/2004
	Model Exotic Farm	Bhiwani	Bhiwani	Haryana	26	31/03/2002
	State Cattle Breeding Project	Sector-III	Hisar	Haryana	66	31/03/2002
	State Livestock Farm	Babugarh	Gaziabad	Uttar Pradesh	3	31/03/2001
Kangayam	District Livestock Farm	Abishegapatti	Tirunelveli	Tamilnadu	3	31/03/2004
	District Livestock Farm	Hosur	Dharmapuri	Tamilnadu	163	31/03/2004
	Exotic Cattle Breeding Farm	Eachenkottai	Thanjavur	Tamilnadu	6	31/03/2004
Kankrej	Bull Mother Farm	Ambasan	Mehsana	Gujarat	10	31/03/2004
	Bull Mother Farm	SAGP, Bidaj	Kheda	Gujarat	33	31/03/2004
	Cattle Breeding Farm	Bhuj	Kuchchh	Gujarat	243	31/03/2004
	Cattle Breeding Farm	Mandvi	Surat	Gujarat	265	31/03/2004
	Cattle Breeding Farm	Thara	Banaskantha	Gujarat	296	31/03/2004

Breed	Name	Location	City	State	No	As on date
	Livestock Research Station	Sardar Krushinagar	Banaskantha	Gujarat	250	30/10/2004
	North Cote Farm	Chharodi	Ahmedabad	Gujarat	182	31/03/2004
Karan Fries	National Dairy Research Institute	Karnal	Karnal	Haryana	552	03/02/2003
Karan Swiss	National Dairy Research Institute	Karnal	Karnal	Haryana	74	03/02/2003
Khillari	Buffalo Breeding Farm	Tegur	Dharwad	Karnataka	6	29/07/2004
	Cattle Breeding Farm	Junoni	Solapur	Maharashtra	191	31/03/2003
	Khillar Cattle Breeding Farm	Bankapur	Haveri	Karnataka	74	29/07/2004
	Livestock Breeding Farm	Dharwad	Dharwad	Karnataka	2	29/07/2004
Malvi	Calf Rearing Centre	Dag	Jhalawar	Rajasthan	74	31/03/2002
	Cattle Breeding Farm	Agar	Shajapur	Madhya Pradesh	392	31/03/2002
Nagori	Calf Rearing Centre	Nagaur	Nagaur	Rajasthan	15	31/03/2004
Nimari	Cattle Breeding Farm	Rodia	Khargaon	Madhya Pradesh	138	31/03/2002
Ongole	Cattle Breeding Farm	Chandalwada	Prakasam	Andhra Pradesh	221	31/12/2005
	Composite Livestock Farm	Chintaldevi	Nellore	Andhra Pradesh	261	31/12/2005
	Govt. Livestock Farm	Mahanandi	Kurnool	Andhra Pradesh	153	31/12/1999
	Govt. Livestock Farm	Ramatheertham	Prakasam	Andhra Pradesh	216	31/12/1999
	JCF	Banavasi	Kurnool	Andhra Pradesh	6	31/12/2005
	Livestock Research Station	Germ Plasm Unit, Lam	Guntur	Andhra Pradesh	182	31/12/1999
	Livestock Research Station	Lam	Guntur	Andhra Pradesh	248	31/12/1999
Red Sindhi	Bull Mother Farm	SAGP, Bidaj	Kheda	Gujarat	10	31/03/2004
	Central Cattle Breeding Farm	Chiplima	Sambalpur	Orissa	195	31/03/1995
	District Livestock Farm	Chettinad	Sivagangai	Tamilnadu	3	31/03/2004
	District Livestock Farm	Hosur	Dharmapuri	Tamilnadu	160	31/03/2004
	District Livestock Farm	Pudukottai	Pudukottai	Tamilnadu	15	31/03/2004

Breed	Name	Location	City	State	No	As on date
	Govt. LIvestock Farm	Dhat—Mollem	Dhat—Mollem	Goa	55	15/03/2001
Sahiwal	All India Co-ordinated Research Project (AICRP)	Haringhata	Nadia	West Bengal	54	06/03/2002
	Bull Mother Farm	SAGP, Bidaj	Kheda	Gujarat	45	31/03/2004
	Cattle & Buffalo Breeding Farm	Anjora	Durg	Chhattisgarh	245	31/03/2000
	Cattle Breeding Farm	Bilaspur	Bilaspur	Chhattisgarh	278	31/03/2000
	Cattle Breeding Farm	Emlikheda	Chindwara	Madhya Pradesh	33	31/03/2001
	Cattle Breeding Farm	Wadsa	Gadcheroli	Maharashtra	99	01/04/2003
	Cattle Breeding Farm	Nabha	Patiala	Punjab	55	31/03/2004
	Govt. Livestock Farm	Hisar	Hisar	Haryana	407	31/03/2006
	National Dairy Research Institute	Karnal	Karnal	Haryana	218	03/02/2003
	State Cattle Breeding Project	Sector-II	Hisar	Haryana	28	31/12/2000
	State Livestock Cum Agriculture Farm	Chakganjaria	Lucknow	Uttar Pradesh	269	31/03/2001
	State Livestock Farm	Niblet	Barabanki	Uttar Pradesh	8	31/03/2001
Tharparkar	Cattle & Buffalo Breeding Farm	Rataina	Sagar	Madhya Pradesh	190	31/03/2002
Tharparkar	Cattle Breeding Farm	Pohra	Amaravati	Maharashtra	48	27/05/2003
Tharparkar	Central Cattle Breeding Farm	Suratgarh	Suratgarh	Rajasthan	435	31/03/1994
Tharparkar	Central Cattle Breeding Farm	Andeshnagar	Lakhimpur	Uttar Pradesh	105	31/03/1994
Tharparkar	District Livestock Farm	Chettinad	Sivagangai	Tamilnadu	66	31/03/2004
Tharparkar	GDF	Visakhapatnam	Visakhapatnam	Andhra Pradesh	6	31/12/2005
Tharparkar	Govt. Cattle Breeding Farm	Purnea	Purnea	Bihar	10	31/03/2001
Tharparkar	Govt. Livestock Farm	Mahanandi	Karimnagar	Andhra Pradesh	7	31/11/2005
Tharparkar	Govt. Livestock Farm	Hisar	Hisar	Haryana	102	31/03/2006
Tharparkar	National Dairy Research Institute	Karnal	Karnal	Haryana	30	03/02/2003
Tharparkar	State Cattle Breeding Project	Sector-II	Hisar	Haryana	55	31/12/2000
Tharparkar	State Livestock Cum Agriculture Farm	Bharani	Jhansi	Uttar Pradesh	260	31/03/2001

Breed	Name	Location	City	State	No	As on date
Umbalachery	District Livestock Farm	Korukaai	Thiruvarur	Tamilnadu	308	31/03/2004
Umbalachery	Exotic Cattle Breeding Farm	Eachenkottai	Thanjavur	Tamilnadu	2	31/03/2004
Brown Swiss crosses	Cattle Breeding Farm	Pohra	Amaravati	Maharashtra	126	31/03/2003
Friesian crosses	Cattle Breeding Farm	Kopargaon	Ahmednagar	Maharashtra	63	27/06/2003
	Cattle Breeding Farm	Mampui		Mizoram	10	31/07/2004
	Cattle Breeding Farm	Saiha		Mizoram	17	31/07/2004
	Cattle Breeding Farm	Selesih		Mizoram	39	31/07/2004
	Cattle Breeding Farm	Thingdawl		Mizoram	18	31/07/2004
	Cattle Breeding Farm	Nabha	Patiala	Punjab	56	31/03/2004
	Cattle Breeding Farm	Patiala	Patiala	Punjab	39	31/03/2003
	Central Cattle Breeding Farm	Andeshnagar	Lakhimpur	Uttar Pradesh	236	31/03/1994
	Dairy Demonstration Farm St Mary"s	Kurseong	Darjeeling	West Bengal	1	06/03/2002
	District Cattle Farm	Santaldih	Purulia	West Bengal	2	06/03/2002
	District Livestock Farm	Ooty	Ooty	Tamilnadu	39	31/03/2003
	Exotic Cattle Breeding Farm	Eachenkottai	Thanjavur	Tamilnadu	28	31/03/2003
	Govt. Bull Rearing Centre	Nagpur	Nagpur	Maharashtra	4	05/08/2003
	Hallikar Cattle Breeding Farm	Kunikenahalli	Tumkur	Karnataka	1	31/03/2002
	Livestock Breeding & Training Centre	Kurikuppi	Bellary	Karnataka	5	29/07/2004
	Millitary Farm	Portblair	Portblair	Andaman & Nicobar	56	31/12/1999
	Millitary Farm	Secundrabad	Secundrabad	Andhra Pradesh	624	31/12/1999
	Millitary Farm	Guwahati	Guwahati	Assam	160	31/12/1999
	Millitary Farm	Jorhat	Jorhat	Assam	28	31/12/1999
	Millitary Farm	Ambala	Ambala	Haryana	944	31/12/1999
	Millitary Farm	Dalhousie	Dalhousie	Himachal Pradesh	35	31/12/1999

Breed	Name	Location	City	State	No	As on date
	Millitary Farm	Jammu	Jammu	Jammu & Kashmir	116	31/12/1999
	Millitary Farm	Rajori	Rajori	Jammu & Kashmir	31	31/12/1999
	Millitary Farm	Srinagar	Srinagar	Jammu & Kashmir	118	31/12/1999
	Millitary Farm	Udhampur	Udhampur	Jammu & Kashmir	205	31/12/1999
	Millitary Farm	Bangalore	Bangalore	Karnataka	866	31/12/1999
	Millitary Farm	Belgaum	Belgaum	Karnataka	157	31/12/1999
	Millitary Farm	Gawalior	Gawalior	Madhya Pradesh	134	31/12/1999
	Millitary Farm	Jabalpur	Jabalpur	Madhya Pradesh	324	31/12/1999
	Millitary Farm	Mhow	Mhow	Madhya Pradesh	180	31/12/1999
	Millitary Farm	Ahmednagar	Ahmednagar	Maharashtra	273	31/12/2002
	Millitary Farm	Pimpri	Pimpri	Maharashtra	600	31/12/2002
	Millitary Farm	Ferozepur	Ferozpur	Punjab	573	31/12/1999
	Millitary Farm	Jallandhar	Jallandhar	Punjab	500	31/12/1999
	Millitary Farm	Pathankot	Pathankot	Punjab	196	31/12/1999
	Millitary Farm	Agra	Agra	Uttar Pradesh	352	31/12/1999
	Millitary Farm	Allahabad	Allahabad	Uttar Pradesh	234	31/12/1999
	Millitary Farm	Bareilly	Bareilly	Uttar Pradesh	396	31/12/1999
	Millitary Farm	Jhansi	Jhansi	Uttar Pradesh	303	31/12/1999
	Millitary Farm	Kanpur	Kanpur	Uttar Pradesh	120	31/12/1999
	Millitary Farm	Lucknow	Lucknow	Uttar Pradesh	505	31/12/1999
	Millitary Farm	Meerut	Meerut	Uttar Pradesh	172	31/12/1999
	Millitary Farm	Dehradun	Dehradun	Uttaranchal	309	31/12/1999
	Millitary Farm	Pithoragarh	Pithoragarh	Uttaranchal	46	31/12/1999
	State Cattle Breeding Project	Sector-II	Hisar	Haryana	428	31/03/2002
Frieswal	Millitary Farms	Secundrabad	Secundrabad	Andhra Pradesh	662	31/12/1999
	Millitary Farm	Guwahati	Guwahati	Assam	154	31/12/1999

Breed	Name	Location	City	State	No	As on date
	Millitary Farm	Jorhat	Jorhat	Assam	36	31/12/1999
	Millitary Farm	Ambala	Ambala	Haryana	679	31/12/1999
	Millitary Farm	Dalhousie	Dalhousie	Himachal Pradesh	39	31/12/1999
	Millitary Farm	Jammu	Jammu	Jammu & Kashmir	143	31/12/1999
	Millitary Farm	Rajori	Rajori	Jammu & Kashmir	15	31/12/1999
	Millitary Farm	Srinagar	Srinagar	Jammu & Kashmir	74	31/12/1999
	Millitary Farm	Udhampur	Udhampur	Jammu & Kashmir	87	31/12/1999
	Millitary Farm	Bangalore	Bangalore	Karnataka	402	31/12/1999
	Millitary Farm	Belgaum	Belgaum	Karnataka	158	31/12/1999
	Millitary Farm	Gawalior	Gawalior	Madhya Pradesh	18	31/12/1999
	Millitary Farm	Jabalpur	Jabalpur	Madhya Pradesh	482	31/12/1999
	Millitary Farm	Mhow	Mhow	Madhya Pradesh	153	31/12/1999
	Millitary Farm	Ahmednagar	Ahmednagar	Maharashtra	271	31/12/2002
	Millitary Farm	Pimpri	Pimpri	Maharashtra	610	31/12/2002
	Millitary Farm	Ferozepur	Ferozpur	Punjab	226	31/12/1999
	Millitary Farm	Jallandhar	Jallandhar	Punjab	791	31/12/1999
	Millitary Farm	Pathankot	Pathankot	Punjab	176	31/12/1999
	Millitary Farm	Agra	Agra	Uttar Pradesh	444	31/12/1999
	Millitary Farm	Allahabad	Allahabad	Uttar Pradesh	69	31/12/1999
	Millitary Farm	Bareilly	Bareilly	Uttar Pradesh	290	31/12/1999
	Millitary Farm	Jhansi	Jhansi	Uttar Pradesh	149	31/12/1999
	Millitary Farm	Kanpur	Kanpur	Uttar Pradesh	71	31/12/1999
	Millitary Farm	Lucknow	Lucknow	Uttar Pradesh	354	31/12/1999
	Millitary Farm	Meerut	Meerut	Uttar Pradesh	1509	31/12/1999
	Millitary Farm	Dehradun	Dehradun	Uttaranchal	355	31/12/1999
	Millitary Farm	Pithoragarh	Pithoragarh	Uttaranchal	13	31/12/1999

Breed	Name	Location	City	State	No	As on date
Jersey crosses	Cattle Breeding Farm	Chandkhuri	Raipur	Chhattisgarh	153	31/03/2000
	Cattle Breeding Farm	Pakaria	Bilaspur	Chhattisgarh	104	31/03/2002
	Cattle Breeding Farm	Kopardem	Kopardem	Goa	164	15/03/2001
	Cattle Breeding Farm	Emlikheda	Chindwara	Madhya Pradesh	177	31/03/2002
	Cattle Breeding Farm	Gadhi	Balaghat	Madhya Pradesh	210	31/03/2002
	Cattle Breeding Farm	Bod	Amaravati	Maharashtra	118	31/03/2003
	Cattle Breeding Farm	Jat	Sangali	Maharashtra	228	31/03/2003
	Cattle Breeding Farm	Nagpur	Nagpur	Maharashtra	32	31/03/2003
	Cattle Breeding Farm	Pohra	Amaravati	Maharashtra	79	27/05/2003
	Cattle Breeding Farm	Wadsa	Gadcheroli	Maharashtra	291	31/03/2003
	Cattle Breeding Farm	Yavatmal	Yavatmal	Maharashtra	131	31/03/2003
	Cattle Breeding Farm	Lungpher		Mizoram	20	31/07/2004
	Cattle Breeding Farm	Thenzawl		Mizoram	54	31/07/2004
	Cattle Breeding Farm	Chiplima	Sambalpur	Orissa	152	31/12/2002
	Dairy Demonstration Farm St Mary"s	Kurseong	Darjeeling	West Bengal	2	06/03/2002
	District Cattle Farm	Santaldih	Purulia	West Bengal	13	06/03/2002
	District Livestock Farm	Abishegapatti	Tirunelveli	Tamilnadu	2	31/03/2001
	District Livestock Farm	Chinnasalem	Villupuram	Tamilnadu	35	31/03/2003
	District Livestock Farm	Ooty	Ooty	Tamilnadu	7	31/03/2003
	Exotic Cattle Breeding Farm	Patna	Patna	Bihar	42	31/03/2001
	GDF	Visakhapatnam	Visakhapatnam	Andhra Pradesh	112	31/12/2005
	Govt. Bull Rearing Centre	Nagpur	Nagpur	Maharashtra	21	05/08/2003
	Govt. LIvestock Farm	Dhat—Mollem	Dhat—Mollem	Goa	125	15/03/2001
	Govt.Livestock Farm	Kamand	Mandi	Himachal Pradesh	13	01/05/2003
	Govt.Livestock Farm	Kothipura	Bilaspur	Himachal Pradesh	14	01/05/2003
	Govt.Livestock Farm	Palampur	Kangra	Himachal Pradesh	8	01/05/2003

Breed	Name	Location	City	State	No	As on date
	JCF	Banavasi	Kurnool	Andhra Pradesh	8	31/12/2005
	Liverstock Breeding & Dairy Farm	Bhanjnagar	Ganjam	Orissa	57	31/12/2002
	Liverstock Breeding & Dairy Farm	Boudh	Boudh	Orissa	52	31/12/2002
	Liverstock Breeding & Dairy Farm	Keonjhar	Kheonjhar	Orissa	57	31/12/2002
	Liverstock Breeding & Dairy Farm	Khapuria	Cuttack	Orissa	51	31/12/2002
	Liverstock Breeding & Dairy Farm	Kharmanda	Sundargarh	Orissa	29	31/12/2002
	Liverstock Breeding & Dairy Farm	Ramuna	Balasore	Orissa	50	31/12/2002
	Liverstock Breeding & Dairy Farm	Sundargarh	Sundargarh	Orissa	32	31/12/2002
	Livestock Breeding Farm	Hessarghatta	Bangalore	Karnataka	79	31/03/2000
	State Cattle Breeding Project	Sector-II	Hisar	Haryana	18	31/03/2002
	State Livestock Cum Agriculture Farm	Bharani	Jhansi	Uttar Pradesh	44	31/03/2001
	State Livestock Cum Agriculture Farm	Chakganjaria	Lucknow	Uttar Pradesh	82	31/03/2001
	State Livestock Cum Agriculture Farm	Nilgaon	Sitapur	Uttar Pradesh	5	02/05/2000
	State Livestock Farm	Arajlines	Varanasi	Uttar Pradesh	59	31/03/2001
	State Livestock Farm	Babugarh	Gaziabad	Uttar Pradesh	98	31/03/2001
	State Livestock Farm	Hastinapur	Meerut	Uttar Pradesh	10	31/03/2001
Other crosses	All India Co-ordinated Research Project (AICRP)	Haringhata	Nadia	West Bengal	274	06/03/200
	Bull Mother Farm	SAGP, Bidaj	Kheda	Gujarat	445	31/03/2004
	District Livestock Farm	Abishegapatti	Tirunelveli	Tamilnadu	1	31/03/2004
	District Livestock Farm	Chettinad	Sivagangai	Tamilnadu	256	31/03/2004
	District Livestock Farm	Chinnasalem	Villupuram	Tamilnadu	46	31/03/2004
	District Livestock Farm	Hosur	Dharmapuri	Tamilnadu	442	31/03/2004
	District Livestock Farm	Orathanad	Thanjavur	Tamilnadu	10	31/03/2004
	District Livestock Farm	Pudukottai	Pudukottai	Tamilnadu	503	31/03/2004
	District Livestock Farm	Udhagamandalam		Tamilnadu	46	31/03/2004

Breed	Name	Location	City	State	No	As on date
	Exotic Cattle Breeding Farm	Eachenkottai	Thanjavur	Tamilnadu	47	31/03/2004
	Govt. Cattle Breeding Farm	Dumnaroo	Buxar	Bihar	77	31/03/2001
	Livestock Breeding & Training Centre	Hessarghatta	Bangalore	Karnataka	32	29/07/2004
	Livestock Breeding & Training Centre	Kurikuppi	Bellary	Karnataka	4	31/03/2002
	Livestock Breeding & Training Centre	Munirabad	Raichur	Karnataka	2	31/03/2002
	Livestock Breeding Farm	Dharwad	Dharwad	Karnataka	2	29/07/2004
	Livestock Breeding Farm	Hessarghatta	Bangalore	Karnataka	9	29/07/2004
	Livestock Breeding Farm	Koila	Dakshina Kannad	Karnataka	52	29/07/2004
	Livestock Research Station	Anand	Kheda	Gujarat	257	31/03/2004
	Livestock Research Station	GAU	Anand	Gujarat	215	31/03/2002
	State Cattle Breeding Project	Sector-III	Hisar	Haryana	269	31/03/2002
	State Livestock Farm	Baramullah suri	Birbhum	West Bengal	4	06/03/2002
	State Livestock Farm	Kalyani	Nadia	West Bengal	1025	06/03/2002
	State Livestock Farm	Ranjitpur	Bankura	West Bengal	36	06/03/2002

ANNEXURE - III

List of Farms of Buffalo Breeds

Breed	Name	Location	City	State	No	As on date
Bhadawari	State Livestock Farm	Saidpur	Lalitpur	Uttar Pradesh	28	31/03/2001
Jaffarabadi	Bull Mother Farm	SAGP, Bidaj	Kheda	Gujarat	1	31/03/2002
	Cattle Breeding Farm	GAU	Junagadh	Gujarat	183	31/03/2002
Mehsana	Bull Mother Farm	Ambasan	Mehsana	Gujarat	10	31/03/2002
	Livestock Research Station	Sardar Krushinagar	Banaskantha	Gujarat	150	30/10/2004
Murrah	All India Co-ordinated Research Project (AICRP)	Haringhata	Nadia	West Bengal	14	06/03/2002
	Buffalo Breeding Farm	Kuriottumala	Quilon	Kerala	58	31/12/2002
	Buffalo Breeding Farm	Thenzawl		Mizoram	19	31/07/2004
	Buffalo Breeding Farm	Mattewara	Ludhiana	Punjab	158	31/03/2004
	Bull Mother Farm	SAGP, Bidaj	Kheda	Gujarat	76	31/03/2002
	Calf Rearing Centre	Dag	Jhalawar	Rajasthan	13	31/12/2001
	Calf Rearing Centre	Kumher	Bharatpur	Rajasthan	14	31/03/2003
	Calf Rearing Centre	Nagaur	Nagaur	Rajasthan	13	31/03/2004
	Cattle & Buffalo Breeding Farm	Anjora	Durg	Madhya Pradesh	51	01/04/1994
	Cattle & Buffalo Breeding Farm	Rataina	Sagar	Madhya Pradesh	87	31/03/2002
	Central Buffalo Breeding Farm	Alamadhi (Avadi)	Chennai	Tamilnadu	252	31/03/1994
	Central Institute for Research on Buffalo	Hisar	Hisar	Haryana	756	31/03/2002
	District Livestock Farm	Abishegapatti	Tirunelveli	Tamilnadu	231	31/03/2004

Breed	Name	Location	City	State	No	As on date
	District Livestock Farm	Orathanad	Thanjavur	Tamilnadu	248	31/03/2004
	Exotic Cattle Breeding Farm	Eachenkottai	Thanjavur	Tamilnadu	15	31/03/2004
	Exotic Cattle Breeding Farm	Salboni	Midnapur (W)	West Bengal	48	06/03/2002
	Govt. Cattle & Buffalo Breeding Farm	Anjora	Durg	Chhattisgarh	75	31/03/2000
	Govt. Livestock Farm	Banavasi	Kurnool	Andhra Pradesh	32	31/12/2005
	Govt. Livestock Farm	Mannor	Warangal	Andhra Pradesh	121	31/12/2005
	Liverstock Breeding & Dairy Farm	Khapuria	Cuttack	Orissa	20	31/12/2002
	Liverstock Breeding & Dairy Farm	Kharmanda	Sundargarh	Orissa	59	31/12/2002
	Livestock Breeding & Training Centre	Koila	Dakshina Kannad	Karnataka	108	31/03/1995
	Livestock Breeding & Training Centre	Munirabad	Raichur	Karnataka	19	29/07/2004
	National Dairy Research Institute	Karnal	Karnal	Haryana	335	03/02/2003
	Progeny Testing Unit	Banavasi	Kurnool	Andhra Pradesh	103	31/12/2005
	State Cattle Breeding Project	Sector-II	Hisar	Haryana	9	31/12/2000
	State Livestock Cum Agriculture Farm	Nilgaon	Sitapur	Uttar Pradesh	51	02/05/2000
	State Livestock Farm	Hastinapur	Meerut	Uttar Pradesh	124	31/03/2001
	State Livestock Farm	Manjhara	Lakhimpur	Uttar Pradesh	192	31/03/2001
	State Livestock Farm	Niblet	Barabanki	Uttar Pradesh	29	31/03/2001
	State Livestock Farm	Kalyani	Nadia	West Bengal	189	06/03/2002
	State Livestock Farm	Ranjitpur	Bankura	West Bengal	6	06/03/2002
Nili Ravi	Buffalo Breeding Farm	Mattewara	Ludhiana	Punjab	14	31/03/2004
	Central Institute for Research on Buffalo	Nabha	Patiala	Punjab	398	31/03/2002
Surti	Buffalo Breeding Farm	Tegur	Dharwad	Karnataka	67	29/07/2004
	Cattle Breeding Farm	Hingoli	Hingoli	Maharashtra	191	31/03/2003
	Central Breeding Farm	Dhamrod	Surat	Gujarat	320	31/03/2002
	Govt. Bull Rearing Centre	Nagpur	Nagpur	Maharashtra	10	05/08/2003

Breed	Name	Location	City	State	No	As on date
	Livestock Breeding & Training Centre	Hessarghatta	Bangalore	Karnataka	31	29/07/2004
	Livestock Breeding Farm	Koila	Dakshina Kannad	Karnataka	15	29/07/2004
	Livestock Research Station	Navsari (GAU)	Valsad	Gujarat	232	31/03/2002

Annexure - IV

Dairy Related Equipment Manufacturers

A.I. Equipments

Bal Krishan Plasikrafts, F-4 DSIDC Industrial Complex, Rohtak Rd, Nangloi, Delhi 110041 Ph 011 25472673, Fax -011-25475191, Email: info@balkrishan.com, Web: www.balkrishan.com

IBP Co. Ltd. Business Group-Cryogenics, Head Office: A-4 MIDC Industrial Area, Ambad, Nashik 422010, Ph: 0253-2382032, 2382132, Fax: 0253-2382362, Email: csrikrishna@ibpoil.com, sandsouza@ibpoil.com, Web: www.ibpoil.com

IMV India Pvt. Ltd. Plot No 747, Phase 5, Udyog Vihar, Gurgaon 122016, Ph: 0124-404430- 32, Fax: 0124-4002172, Email: contact@imvindia.com, Web: www.imv-technologies.com

National Meditek D 4/8 Krishna Nagar, Delhi 110051, Ph:011- 22094246, 22094089, Fax:011-22094089, Email: natomed@sify.com

President Surgical Co. A-5/17 Krishan Nagar, Near Lal Quarter, Delhi 110051, Ph: 011 -22016822

SSN Exports B-18 Sindhu Society, Near Anand Cinema, Thane (East) 400603, Ph: 022- 25320887, Fax: 022- 25320887, Email: v-nevatia@vsnl.com

SVI Biomedical Pvt Ltd. Metos House, D-213 Vivek Vihar-1, Delhi 110095, Ph: 011- 22155942,221156138, Fax:011-2155987, Email:drgoel@vsnl.com, Web: www.goelgroup.com

Shakti Enterprises 87/B-1 East Azad Nagar, Delhi 110051, Ph: 011- 22016828

Spectra Cryogenic Systems Pvt Ltd E-132(A1), Rd No5, IPIA, Kota 324005, Ph 0744- 2428742, Email: spectracryo@yahoo.com

Liquid Nitrogen Plants

BOC India Ltd. Oxygen House, P-43 Taratala Rd, Kolkata 700088, Ph: 033-24014708, 24015172, Fax: 033-24014974, Web: www.boc-india.com

Bharat Heavy Plates & Vessels Ltd. BHPV Post, Visakhapatnam 530012, Ph: 0891-2517381, 2517621, Fax: 0891-2517626, 2511997, Email: bhpv-cryocomml@sancharnet.in, Web: www.bhpvl.com

IBP CO Ltd. Business Group-Cryogenics, Head Office: A-4 MIDC Industrial Area, Ambad, Nashik 422010, Ph: 0253-2382032, 2382132, Fax: 0253-

2382362 Email: csrikrishna@ibpoil.com, sadsouza@ibpoil.com, Web: ibpoil.com.

PSA Nitrogen Ltd. D-9/6 Okhla Industrial Area, Phase 1, New Delhi 110020, Ph: 011-26815336, 26815337, 26816251, Fax: 011-26815337, Email: pnmpsa@del2.vsnl.net.in

Pennwalt Ltd. Plot No D-221, MIDC Area, Trans Thane Creek, Thane - Belapur Rd, Near London Pilsner, Nerul, Navi Mumai 400706, Ph: 022-27632503, 27632520, 27632528, Fax: 022-27632560, Email: Pennwalt@vsnl.in, info@pennwalt.com, Web: www.Pennwalt.com

Cryogenic Containers

BOC India Ltd. Oxygen House, P-43 Taratala Road, Kolkata 700088, Ph: 033-24014708, 24015172, Fax: 033-24014974, Web: www boc-india.com

Bharat Heavy Plates & Vessels Ltd. BHPV Post, Visakhapatnam 530012, Ph: 0891- 2517381, 2517621, Fax: 0891-2517626, 2511997, Email: bhpv-cryocomml@sancharnet.in, Web: www.bhpvl.com

IBP CO Ltd. Business Group-Cryogenics, Head Office: A-4 MIDC Industrial Area, Ambad, Nashik 422010, Ph: 0253-2382032, 2382132, Fax: 0253-2382362 Email: csrikrishna@ibpoil.com, sadsouza@ibpoil.com, Web: ibpoil.com.

Gujrat Perfect Engineering Ltd. Nizami Compound, Makapura Road, Near AIR Station, Vadodara 390009, Ph: 0265- 2642140, 2646711, 2651834, Fax: 0265-2651834, Email: gperfect@icenet.net

Inox India Ltd. ABS Tower, 4th Floor, Old Padra Road, Baroda 390007, Ph: 0265- 2343125, Fax: 0265-2333398, 2341449, Email: mktg@inoxindia.com, Web: www.inoxindia.com

Cattle Identification Tags

Mass Transfer Products industries, B-14 Pravasi Industeial Estate, Off Aarey Road, Goregaon(E), Mumbai 400063, Ph:022- 28752379, Fax: 022-28780252, Email: mpti@vsnl.com, Web: www.amienterprise.com

Milking Machines/ Systems

Chadha Sales Pvt Ltd. 137-139 Rajindra Market, Tis Hazari, Delhi110054, Ph:011-23961416, 23944840, Fax: 011-23914211, Email:info@chadhasales.com, Web: www.chadhasales.com, www.dairyequipmentonline.com

De Laval Pvt limited. A-3Abhimanshree Society, Dr Homi Bhaba(pashan) Road, Pune 411008, Ph:020- 25675881-82, 25675886, Fax: 020-25675916, 25675917, Email:marketing.india@delaval.com, Web: www.delaval.com

GSR Technologies Pvt Ltd. 302 Chetak Complex, Pocket B & E, Commercial Complex, Dilshad Garden, Delhi 110095, Ph: 011- 22131801, Fax: 011-22131802, Email: sandeepgsr@satyam.net.in

Ksheera Enterprises, Pallathadka Vill & PO Murulya 574328, Sullia Tq , D K Dist, Karnataka, Ph: 08257- 275020, Mob: 9448725520

Krishna Industries, Shop No 9, 25/A Chandawadi , 138, C P Tank, Mumbai 400004, Ph:022-23803891,23803892-93, Fax: 022-23803890, Email: sales@dairyequipments.com, Web: www.dairyequipments.com

Westfalia Separator (India) Pvt Ltd. 201 Competent House, 7 Nangal Raya Business Centre, New Delhi, 100046 Ph: 011- 28520538, 28522407, Fax: 011-28521769, 28522083, Email: administrator@westfalia-india.com, Web: www.westflia-separator.com

Milk Testing Electronic Equipments

Advance Instruments &Chemicals, 69 Sohan Lal St, Near Hanuman Mandir Chopla, PB No 38, Ghaziabad 201001, Ph: 0120- 2730582, 2803507, Fax: 0120-2851825, Email : advance12@sancharnet.in

Benny Implex Pvt Ltd. B-209 Naraina Industrial area, Phase-1, New Delhi110028, Ph: 011- 25894800, 25795773, 30524800, Fax: 011-25893115, Email: benny@bol.net.in

Everest Instruments Pvt Ltd. Near Chandan Park , Station Road, Visanagar 384315(North Gujarat), Telefax: 02765-325855, 223044, Email : info@everestinstruments.in, Web: www.everestinstruments.in

Foss Electric India, Central Camera Building, 195, D N Road, Mumbai 400001, Ph: 022- 22610682, Fax: 022-2610724, Email: ccc3@vsnl.com, Web: www.foss.dk

L & D Electronics Industries, D-42 Janpath, Shyam Nagar Jaipur 302019, Ph: 0141-2292996, 2293057, Fax: 0141-2293057, Email: ldeijpr@yahoo.co.in

L & D Electrotech, C-69 Valmiki Marg, Hanuman Nagar, Jaipur 302021, Ph: 0141-2247606, 2245567, Fax: 0141-2245567, Email: ldetechemt@datainfosys.net, Web: www.dairymilkester.com

Milko-Tech Equipment Pvt Ltd. Shed No 4-5-6, MG Marbal Industrial Estate, Opposite Shreenath Marble, Near Gota Railway Crossing Ahmedabad 382481, Ph: 079-26565981-83, Fax: 079-26407958, Mail: sales@milkofat.com, Web: www.milkofat.com

New Dairy Engg & Traiding Co Pvt Ltd. Dairy Division, B-8/5 Badli Industrial Area , Phase-1, Delhi 110042, Ph: 011- 27855765, 27857105, Fax: 011-27855030, Email: netco@milkanalyser.com, Web: milkanalyser.com.

P.M.S. Engineering (International) Services, A-15/29 Vasant Vihar , Post Box No 8847, New Delhi 110057, Ph: 011- 26143742, 26145536, Fax: 011-26145526, Email: pmsengg@airtelbroadband.in, info@pms-engineering.com, Web: www.pms-engeneering.com

Prolate Prompt Equipments Pvt Ltd. 3-B Vardan, Near Stadium Petrol Pump, Near Vimal House, PO Navjivan, Ahemdabad 380014, Ph: 079- 26565981, Fax: 079-26407958, Emal: info@promptscale.com, Web: www.promptscale.com, www. fatomatic.com

Rajasthan Electronics & Instruments 2-Kanakpura Industrial Area, Sirsi Road, Jaipur 302012, Ph: 0141- 2470062, 2470363, 2470784, 2470981, Gram: Reil, Fax: 0141-202701, 2470926, Email: reiljp@sancharnet.in, Web: www.reiljp.com

S S T Engineers Shop no 2, Plot No 45, Kauser Baug, Kondhwa-Khurd , Pune 411048, Ph & Fax: 020-56001162, 56001876, Email: sales@sstindia.com, Web: www.stindia.com

Vaibhav Electronics **Basement, Krishna Kirtan Flat, Behind Sanjivani Hospital, Anand 388001, Ph: 02692- 577192, Fax: 02692-240419.**

❐

Index

9 788171 640669