Compendium

Model Training Course

Small Scale Dairy Development as a means of livelihood Improvement in North Eastern Hill Region

October, 24-31, 2017

Sponsored by
Directorate of Extension
Ministry of Agriculture & Farmers Welfare
Govt. of India

Organized by:

ICAR-NATIONAL RESEARCH CENTRE ON MITHUN
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October, 24-31, 2017

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ICAR- NRC on MITHUN, MEDZIPHEMA-797106 NAGALAND

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Medziphema, Nagaland-797106, India.

Year of publication: 2017

Printing: *Print House, Dimapur-797112 Nagaland*

Edited by: Abhijit Mitra

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Sponsored by

Directorate of Extension Ministry of Agriculture & Farmers Welfare, Govt. of India

Published by

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Foreward

The North-Eastern Region (NER) of India is a land of magnificent beauty, possessing diverse hill ecosystems covering more than two-thirds of the total geographical area and thrilling flora and fauna covering 255.79 lakh hectares, constituting 7.92% of the total land area of the country. Agriculture is the prime source of livelihood for the majority (85%) of the rural population in this region. Livestock rearing forms an integral part and is pre-dominantly the endeavor of smallholders, as almost 90% of the rural household rear livestock of one species or the other. Responding to the burgeoning demand for livestock products in a sustainable manner is a big challenge. Though there is vast potential for growth in this sector, the region has not achieved self-sufficiency level in its production. Milk production is secondary to agricultural operations in the region. The total milk production in this region is not sufficient to meet the demand. But, at the same time with a rise in income, per capita milk consumption is increasing and which may go up to 100%. There are hardly any commercial livestock farms in the rural areas. However, having the favorable climatic conditions for setting up of dairy farms and processing units, cooperatives and private players may play a significant role. As a step towards this, they may need to shape alliances with the local players for procuring milk and selling their branded products.

Our institute is regularly organizing training as well as awareness programmes for the farmers, educated unemployed youths, NGO's, self-help groups (SHGs) for sustainable animal husbandry. In continuation, we are organizing this training programme on "***Small Scale Dairy Development as a means of livelihood Improvement in North Eastern Hill Region***" sponsored by Directorate of Extension Ministry of Agriculture & Farmers Welfare, Govt. of India. The aim of this training is to popularize and small-scale dairy development as a means of livelihood. This training programme will upgrade the knowledge and skills to professionals involved in clinical and extension activities related to dairy animals in North Eastern region. This compendium published by the institute will not only of immense help to all the stakeholders but will also attract the educated youths to adopt small-scale dairy development as a remunerative enterprise.

(Abhijit Mitra)

Preface

India's North-eastern region (NER) is endowed with diverse hill ecosystems covering more than two-third of total geographical area. Livestock production in the North East is pre-dominantly the endeavour of small holders, as almost 90% of the rural household rear livestock of one species or the other. Besides income and employment, small scale dairy farming provides nutritional security to the rural people. Though there is vast potential for growth in this sector, the region has not achieved self sufficiency level in its production. There is no recognized breed of cow and buffalo although these are the two important milk producing animals. Milk production is secondary to agricultural operations. There are hardly any commercial dairy farms in the hilly and backward areas. The crossbreed cows are occupying the significant place in view of increasing demand for milk and milk products. Small and medium enterprises are unorganized, and technological obsolescence is high. Therefore, to improve the conditions and upgrade technology for small industries as well as for small farmers, there is an urgency to improve the infrastructure facilities, a necessity to reduce the transaction costs involved in sourcing from small scale farmers to small and medium farmers. Hence, supportive technical, institutional and policy initiatives for improvement of breeds, feed availability, and disease control are further required to expand production and improve productivity.

Every effort has been made to include various information related to small scale dairy development to comprehend this compendium. All our valuable contributors were encouraged to provide suitable and fundamental information to the trainees for improvement of knowledge, practical implementation of different technologies in their field conditions to enhance the socio-economic status of the livestock owners.

We acknowledge our contributors of this book who are working with the ultimate objective development of dairy sector to maintain sustainable improvement in the North Eastern region. We wish to extend our sincere thanks to Directorate of Extension, Ministry of Agriculture & Farmers Welfare, Govt. of India for the financial support. The organising committee is highly thankful to the Director, ICAR NRC on Mithun, Medziphema Nagaland for his valuable advice and guidance.

Date: 24th October 2017 **Editors**

CONTENTS

Scope and Prospect of Dairy Farming in North Eastern Region of India

S.S. Hanah, Lalchamliani,Jayanta Chamuah and Kezhavito Vipru

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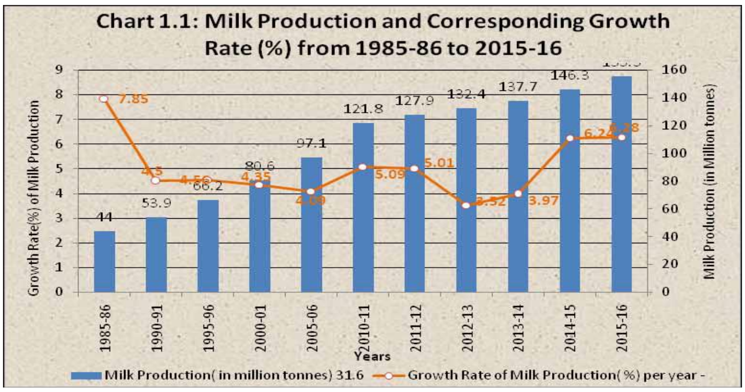
Introduction

India is the highest milk producer in the entire globe and it is also known as the 'Oyster' of the global dairy industry, with opportunities galore for the entrepreneurs globally. It might be dream for any nation in the world to capitalize on the largest and fastest growing milk and milk products' market. The dairy industry in India has been witnessing rapid growth, ranking first in milk production, accounting for 18.5 % of world production, achieving an annual output of 146.3 million tonnes during 2014-15 as compared to 137.69 million tonnes during 2013-14 recording a growth of 6.26 %. Whereas, the Food and Agriculture Organization (FAO) has reported a 3.1 % increase in world milk production from 765 million tonnes in 2013 to 789 million tons in 2014.

Per capita availability of milk in India has increased from 176 grams per day in 1990-91 to 322 grams per day by 2014-15 which is more than the world average of 294 grams per day during 2013. This represents a sustained growth in availability of milk and milk products for the growing population. Dairying has become an important secondary source of income for millions of rural households engaged in agriculture. The success of the dairy industry has resulted from the integrated co-operative system of milk collection, transportation, processing and distribution, conversion of the same to milk powder and products, to minimize seasonal impact on suppliers and buyers, retail distribution of milk and milk products, sharing of profits with the farmer, which are ploughed back to enhance productivity and needs to be emulated by other farm produce/producers.



The dairying has been considered as a potential means of alleviating large scale unemployment especially in rural areas. It played a prominent role not only in household nutrition security but also in strengthening our rural activity. Today more than million rural families are engaged in milk production. Like any other enterprise, the profitability and sustainability of dairy production depends upon its cost structure and a remunerative price, for which a good marketing outlet is crucial. The demand for milk is increasing rapidly in the country. This is primarily due to increasing population and growing incomes accruing from the multitude of central schemes launched for livelihood and employment generation. If we by the emerging trend, the demand for milk is likely to be about 155 million tonnes by the end of 12th five year plan and in the range of 200-210 million tons in 2021-22, there is a need to reach an average of 6 million tons per year over the 12 years to meet the ever increasing demand.

Milk Marketing Channels in India

India has co-existing organized and unorganized sectors for the marketing of milk and milk products. The informal or traditional milk market sector, comprised of the marketing of raw milk and traditional products such as locally manufactured ghee, fresh cheese, and sweets. The organized or formal sector is relatively new in historical terms, and consists of Western-style dairy processing based on pasteurization. In a nutshell, the reviewed studies suggested that while the informal sector scores over the formal sector by virtue of the fact that in many areas it is the only marketing channel open to the rural producer and other factors related to, paying slightly higher prices, offering short term instant cash credit and providing milk collection service at farmer doorstep, the formal sector provides an assured and permanent market as well as an number of other livestock support services.

Dairy animal status in North Eastern Region of India

In general, the situation in North-Eastern Region (NER) of India is still not at par with the other states of the country in terms of various dairy development indices. Livestock rearing in the NER forms an integral part of the age-old crop livestock mixed farming system and assumes additional significance, as the scope of commercial livestock farming options are limited in these areas. There is no recognized breed of cow and buffalo although these are the two important milk producing animals. There are hardly any commercial dairy farms in the hilly and backward areas. According to 19th Livestock Census, there are 132.90 lakhs cattle in NER of India. Among the eight states in the region, Assam being the largest state have maximum (77.56%) of the total cattle, followed by Tripura (7.14%) and Meghalaya (6.74%). Maximum of the cattle population is local cows, crossbred (CB) being only 7 % which is much lower than the national average of 21 %. Sikkim and Tripura has shown a significant increase in crossbred population during the same period. The percentage decline in cattle population is higher in NER (-9%) than the national average level of -4 %.

Population of cattle in NER of India during the year 2013 (in 000')				
State	Crossbred	Local	Total	% share
Arunachal Pradesh	23 (5.01)	441 (94.99)	464	3.49
Assam	396 (3.84)	9912 (96.16)	10307	77.56
Manipur	44 (16.79)	220 (83.21)	264	1.99
Meghalaya	35 (3.93)	861 (96.07)	896	6.74
Mizoram	11 (32.68)	23 (67.32)	35	0.26
Nagaland	129 (54.86)	106 (45.14)	235	1.77
Sikkim	127 (90.07)	14 (9.93)	140	1.06
Tripura	133 (14.03)	816 (85.97)	949	7.14
NER Total	898 (6.76)	12391 (93.24)	13290	100
All India	**39732 (20.81)**	**151172 (79.19)**	**190904**	**-**

Note: Figures in parentheses are percentage to total (Source: BAHS, 2014).

Milk Production and Per Capita Availability of Milk in NER of India

Dairying is an important component of mixed farming systems in NER. About 82% of rural households keep cattle or buffalo. The average milk yield of indigenous cattle, crossbred cattle and buffalo is far below the national average. However, there is an increased trend of milk production from 1021 thousand tonnes in 1999 to 1236 thousand tonnes in 2012-13 which is an increase of 17 % but during the same period milk production of India has increased by 41 %. Milk production has increased in all the NE states except Arunachal Pradesh and Mizoram during the period during the same period. Assam produces the highest milk in the region. In 2012-13, the total milk production of the region is only 0.93 % of the total milk production of the country and per capita availability of milk in the region was only 86 gms/day which was only 29 % of the national average of 299 gms/day and much lower than the Indian Council of Medical Research (ICMR) recommendation level of milk consumption of 220gms/day for a person. The per capita availability of milk has declined during the same period while national average has improved by 27 %. Arunachal Pradesh, Manipur and Mizoram witnessed decline in per capita availability of milk while it has increased in other states.

Dairying in this region is characterized mostly by rural smallholders' producing using indigenous cattle and buffalo, with pockets of specialized dairy production using improved dairy cattle in the peri-urban areas and in certain rural zones having better market access. While the increasing farm-level production and productivity will require more improved animals, improved fodder/feed technology and access to livestock services, smallholders' access to reliable markets to absorb more milk at remunerative prices may remain a critical constraint. Organized marketing of milk remains insignificant, despite efforts in the past to develop and promote collective market mechanisms.

Milk Production (000 Tonnes)				
State	**2008-09**	**2009-10**	**2010-11**	**2011-12**
Arunachal Pradesh	24	26	28	361
Assam	753	756	790	752
Manipur	79	78	78	78
Meghalaya	78	78	79	77
Mizoram	17	11	11	17
Nagaland	53	78	76	45
Sikkim	42	44	43	42
Tripura	96	100	104	91
NER Total	**1,142**	**1,171**	**1,209**	**1,134**
All India	112,182	116,424	121,844	107,934

Source: 1. Agricultural Statistics at a Glance 2011 & 2012, Directorate of Economics and Statistics, Ministry of Agriculture.2. Basic Animal Husbandry & Fisheries Statistics 2013, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture

The demand for fresh milk and milk products is drastically increasing thereby, developing the traditional market will be extremely important for the region dairy sub-sector and a set of interventions that could facilitate improvements in that market could complement the ongoing efforts to develop cooperative organized milk markets. Most of the rural farmers all over NER of the country depend on middlemen for marketing of milk. Consequently, they are exploited by the middlemen. It is reported that about 80 per cent of fresh milk produced in region consumed as non-pasteurized fresh milk in different habitations. If infrastructural facilities such as refrigerated vehicles and new technology of processing exist, milk production and availability will be assured. Such institutional support should aim at safeguarding the interests of producers as well as consumers of milk. We need to recognize the institution that will help the system and place them within pro-poor dairying location so as poor households to take part in the process. A Pro poor inclusive dairy development plan should necessarily address the problems faced by the traditional sector, most of the milk consumed in the region is 'raw' unpasteurized milk supplied by smallholders which also indicates the consumer preference for whole fresh milk.

Scope for Dairy Development in NER

The total milk production in this region is not sufficient to meet the demand of the region at the same time with a rise in income per capita milk consumption may go up to 100%. Increased milk production and consumption can ensure better health and reduce the pressure on other agricultural commodities as well. It is observed that dairy farmers of the region don't utilize properly the scheme provided by the animal husbandry sector, Govt. of India. It is also reported that dairy farmers are no aware of different dairy development scheme and farmers avoid spending any money or inputs on these non-descript cattle. Below tables are the facts and figures of how the concerned department has implemented for dairy livestock improvement.

Artificial Inseminations performed during 2007-08 to 2011-12 in NER (000 Tonnes)					
State	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
Arunachal Pradesh	1	1	1	2	2
Assam	144	134	204	204	271
Manipur	13	12	13	12	-
Meghalaya	24	27	29	29	28
Mizoram	4	5	5	4	4
Nagaland	24	20	50	5	-
Sikkim	7	8	10	10	-
Tripura	86	94	105	120	125
NER Total	**303**	301	**417**	**386**	**430**
All India	**36,205**	**40,745**	**45,851**	**50,077**	**41,165**

Source: Basic Animal Husbandry & Fisheries Statistics 2013, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture

*Note: *- Data Based on 31.03.2011*

State	**Number of Animals Insured Under Livestock Insurance Scheme in NER**					
	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Arunachal Pradesh	72	585	298	142	39	0
Assam	1,138	432	17,470	20,947	30,641	34,696
Manipur	184	210	150	261	114	80
Meghalaya	124	326	396	308	392	209
Mizoram	0	591	173	0	105	43
Nagaland	3,567	4,993	3,140	4,460	1,612	4,833
Sikkim	2,310	2,013	313	1,386	1,446	565
Tripura	2,090	1,731	0	535	2,226	1,796
NER Total	**9,485**	**10,881**	**21,940**	**28,039**	**36,575**	**42,222**

All India	531,226	449,622	397,137	679,662	821,370	813,964

Source: Basic Animal Husbandry & Fisheries Statistics 2013, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture

The above data indicate that dairy farming standard of the region is still far behind the national level. To attend the national standard, the concerned department should not lose sight of long-term goals for short-term gains, they should disseminate different dairy development scheme, subsidy information, technical now how etc. provided by Government of India to rural poor dairy farmers, by conducting dairy development training, awareness camp etc. They should encourage the poor dairy farmers for introducing high yielding breed for higher productivity. The dairy farmers should think globally and not only for the region. the dairy farmers should be encourage to adopt “healthy practices” for healthy dairying and further improving quality, both in terms of input as well as output. There is a strong need to take concrete steps towards educating the farmers for quality milk production through scientific managemental practices such as sanitation, provision of quality drinking water, fodder, health care etc. to achieved healthy milk. Dairy farmers should understand the multiple dimensions of milk. It is as complete nutrition, will play a key role in combating malnutrition and poverty. The sector requires renewed attention and investments from government and agricultural researcher. Both private and Government sector should shoulder together by developing infrastructure and implementing integrated co-operative system of milk collection, transportation, processing and distribution, conversion of the same to milk powder and products, to minimize seasonal impact on suppliers and buyers, retail distribution of milk and milk products, sharing of profits with the farmer.

Conclusion

It can be seen that the growth of dairy sector has been slower in NER than at the national level. However, a significant proportion of landless laborers, small and marginal farmers have access to livestock resources and the acceleration in the growth of livestock sector in NER offers significant opportunities for household income augmentation and employment generation especially to unemployed youth and women society. A well-developed industry in the region will enable millions of farmers to capitalize on the emerging opportunities and make a significant impact in their standard of living. Among various agricultural enterprises, livestock production has more income redistributive effect on households and is very effective in reducing rural income inequality. Dairying infrastructure should be developed in the region and middleman should be wiped out. Attention should also be paid to improve the viability of small farms by improving their accessibility to both input and output markets. In nutshell, a holistic approach is required such as technical support, institutional and policy initiation for improvement of breeds, feed availability, disease control, food safety and private investment are further required to expand production and improve productivity.

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Selection of Dairy Animals for Commercial Dairy Farming in India

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India has achieved the distinction of highest milk producer in the world (146.3 million tones during 2014-15 as per Economic Survey of India). Towards this direction, commercial and small scale dairy farming in India has been playing an important role in the total milk production and economy of our country. Almost all the regions of India are suitable for setting up dairy farming business. Most of the dairy farmers in India are raising animals in small scale traditional methods. Many of them are not aware about the modern farming methods and improved techniques for dairy farming. As a result, some farmers are losing their investment instead of being benefited. Proper business plan, well management and care can ensure maximum production and profit from dairy farming business.

Benefits of Dairy Farming in India

There are many benefits of starting dairy farming business in India. The main importance and benefits of dairy farming in India are -

- Dairy farming business is a traditional business. So, there is no need to worry about marketing the products. Anyone can easily sell their products in almost every place of India. At the same time, dairy product market is active round the year.
- Dairy farming is eco-friendly and it doesn’t pollute the environment.
- Dairy farming business doesn’t require highly skilled labor. Anyone can easily setup small scale dairy farm with the family labor, provided land and small capital is in hand.

Selection of Dairy Animals

Selection of dairy cows is possible by selecting a calf in calf show, or a cow in cattle/buffalo show by judging. A dairy farmer should build up his own herd by breeding his own herd. Following guidelines will be useful for selection of a diary cow -

- Whenever an animal is purchased from a cattle fair, it should be selected based upon its breed characters and milk producing ability
- History sheet or pedigree sheet which are generally maintained in organized farms reveals the complete history of animal
- The maximum yield by dairy animals are noticed during the first five lactations. So generally selection should be carried out during First or Second lactation and that too are month after calving.
- Three successive complete milkings has to be done and an average of it will give a fair idea regarding production by a particular animal
- A cow should allow anybody to milk, and should be docile.

- It is better to purchase the animals during the months of October and November.
- Maximum yield is noticed till 90 days after calving.

Breed characteristics of high yielding dairy animals

- Attractive individuality with feminity, vigour, harmonious blending of all parts, impressive style and carriage
- Animal should have wedge shaped appearance of the body
- It should have bright eyes with lean neck
- The udder should be well attached to the abdomen
- The skin of the udder should have a good network of blood vessels
- All four quarters of the udder should be well demarcated with well placed teats.

Selecting breeds for Commercial Dairy Farm - Suggestions

- Under Indian condition a commercial dairy farm should consist of minimum 20 animals (10 cows, 10 buffaloes) this strength can easily go up to 100 animals in proportion of 50:50 or 40:60. After this however, you need to review your strength and market potential before you chose to go for expansion.
- Middle class health-conscious Indian families prefer low fat milk for consumption as liquid milk. It is always better to go for a commercial farm of mixed type. (Cross breed, cows and buffaloes kept in separate rows under one shed).
- Conduct a thorough study of the immediate market where you are planning to market your milk You can mix milk from both type of animals and sold as per need of the market. Hotels and some general customers (can be around 30%) prefer pure buffalo milk. Hospitals, sanitariums prefer cow's milk.

Selection of cow/buffalo breeds for commercial farm

- Good quality cows are available in the market and it cost around Rs.1200 to Rs.1500 per liter of milk production per day. (e.g. Cost of a cow producing 10 liter of Milk per day will be between Rs.12,000 to Rs.15,000).
- If proper care is given, cows breed regularly giving one calf every 13-14 month interval.

• They are more docile and can be handled easily. Good milk yielding cross breeds (Holstein and Jersey crosses) has well adapted to Indian climate.

• The fat percentage of cow's milk varies from 3-5.5% and is lower then Buffaloes. Buffaloes

• In India, we have good buffalo breeds like Murrah and Mehsana, which are suitable for commercial dairy farm.

• Buffalo milk has more demand for making butter and butter oil (Ghee), as fat percentage in milk is higher then cow. Buffalo milk is also preferred for making tea, a welcoming drink in common Indian household.

• Buffaloes can be maintained on more fibrous crop residues, hence scope for reducing feed cost.

• Buffaloes largely mature late and give birth to calves at 16 to 18 months interval. Male calves fetch little value.

• Buffaloes need cooling facility e.g. wallowing tank or showers / foggers with fan.

Selection of she-buffaloes for milk production : When buffaloes are purchased from the field for milk production, healthy animals should be selected having well developed udder and free from any apparent disease/deformity.

Breeding Records to maintain in a commercial dairy Farm

• Body confirmation
• Body weight
• Ancestors performance
• Reproduction capacity
• Health condition
• Age
• No. of lactations
• Past performance of the animal
• Free of chronic disease
• Cleanliness of teeth Legs and toes free of injuries
• Good eye site
• Whether animal is dry or lactating
• Date of delivery
• Month of pregnancy
• If non-pregnant, how many times it came in to heat
• Animal should follow owners instructions
• The udder should be in good shape and easy to milk

The animal should not have the following complications

• Poor growth
• Late maturity
• Not coming into heat
• Repeat breeder
• Long gap between two lactations
• Uncurable chronic diseases
• Retained placenta
• Low milk production
• Unable to give milk without calf

General Management Practices for Clean Milk Production and detection of abnormal milk.

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Milk is the main source of income from a dairy enterprise produced basically as food for human consumption. A dairy farmer must aim at maximizing on the milk output from his dairy herd by following standard feeding regime, breeding and proper management. At the same time the farmers must ensure that milk is produced in clean and hygienic conditions so that it is fit for human consumption. Milk and milk products are excellent high quality foods providing both nutritional and culinary values. At the same time, milk is a very good media for bacteria and other micro-organisms growth which is one of the great concerns from the

Public health point of view. Cow's milk consists of a variety of nutrients such as fats, proteins, minerals, vitamins, carbohydrates and water and thus it serves as an excellent medium for bacterial growth (Prescott L.M et al-1999).Given the appropriate conditions milk can act as a carrier of disease causing microorganisms transformation from cows to humans (Gunasekera TS-2002). Bacteria can be introduced into milk from a wide variety of sources such as workers, infected cows udder, faeces, dust in barns, milk containers or other equipments.Milk is therefore, can be a disease hazard in public; can be predisposed by infected milk during production, handling and marketing. We can only consider milk to be clean if it comes from a healthy cow. Therefore, every dairy farmer must ensure that the animal is in proper shape of health and provide clean feeds and water in the right quantities and at the right time. The milking equipments must be cleaned and the attendants must be in sound health to avoid transmitting zoonotic diseases that may compromise quality of the milk and safety on the consumers.

Measures for clean milk production

Whem milk leaves the udder, it is relatively free from bacteria. While some contamination with bacteria from the milking environment and the equipments is inevitable, the total bacteria count should be lower than 3 million/ml or otherwise, it will lead to significant degradation of the fat, protein and lactose causing off-flavor and would significantly reduce the flexibility in the processing the milk.

Feeding of milch animals should be done an hour before milking. At the time of milking, for the purpose of keeping cows busy, provide only concentrates which are less dusty. Feed additives and veterinary drugs used in medicated feed should be critically assessed for safety aspects before using. Appropriate milk withdrawal period should be given after administration of any antibiotic to the dairy animals.

Pre-requisites for Good Milking:

Milking is an art requiring experience and skill. Milking should be conducted gently, quietly, quickly, cleanly and completely. Any amount of scientific feeding or possession of high yielding cows will not help if the milking is inefficient. Cows remaining comfortable yield more milk than a roughly handled and excited cow. The act of milking should be finished within 5 to 7 minutes, so that the udder can be emptied completely so long as the effect of oxytocin is available. Complete milking has to be done, residual milk may act an inducer for mastitis causing organisms and the overall yield may also be less.

Preparation for Milking:

The milking barn should be thoroughly washed and scrubbed after each milking so that the barn will be clean and dry, before the subsequent milking is commenced. No dusty feed should be fed during milking. The hind quarters and thighs of cows should be brushed, and washed if lot of filth-is accumulating on them. Just before milking (after suckling by calf, if weaning is not practiced) the udder should be wiped with a cloth dipped and squeezed in some weak antiseptic solution. In winter the cloth may be dipped in warm antiseptic solution.

A part from cleanliness of cows and their udders, the milkers as well as the milking pails should be clean. The milkers should wear clean dress and cover their heads (with suitable caps, loose hairs may fall in milk). Their nails should be well trimmed and their hands wash and disinfected between each milking by washing in antiseptic solution. Milkers obviously ill and having filthy habits like spilling, blowing nose etc. should not be discouraged.

After each milking the milking pails should first be washed with warm water, scrubbed well using suitable dairy sanitizer and then rinsed well with clean cold water. Afterwards, they should be stacked neatly in racks -upside down, until next milking. Milking cans should also be treated similarly. Sanitary milking pails with dome-shaped top should be used instead of open buckets or vessels. A milk strainer should invariably be used before milk of each animal is poured into the milking can.

Pay attention to the routine of milking operations. Milch animals are sensitive animals. They get accustomed to certain routines and any sudden change in the routine will disturb them resulting in reduced yield. Experienced milkers should be put on first calver cows while/novices should first be tried on older cows. An ideal proposition is to rotate milkers among a group of cows so that the cows will get accustomed to all. Also milk cows at the same home every day. Any change in timing of milking or even change in ration should be brought about gradually.

Milking procedure for clean milk production:

In India hand milking of cows is still the most common practice. The milk must be squeezed and not dragged out of teats. The first few strips of milk from each teat should be let on to a strip cup to see clues in milk for possible incidence of mastitis. This also helps in getting rid of bacteria which have gained access and collected in the teat canal.

Stripping and full-hand milking are the two commonly used methods of milking. Stripping consists of firmly seizing the teat at its base between the thumb and forefinger and drawing them down the entire length of the teat pressing it simultaneously to cause the milk to flow down in a stream. The process is repealed in quick succession. Both hands may be used, each holding different teat, stripping alternately.

Full hand milking removes milk quicker than stripping, because of no loss of time in changing the position of the hand, Cows with large teats and she-buffaloes are milked by full-hand method; but stripping has to be adopted for cows with smaller teats for obvious reasons, Full-hand method is superior to stripping as it simulates the natural suckling process by calf. Stripping causes more irritation to teats due to repeated sliding of fingers on teats; and so discomfort to cows. In spite of these drawbacks when all milk that is available is drawn out by full-hand method, stripping should be resorted to with a view to milk the animal completely; the last drawn milk is called stripping and is richer in fat.

In India, milkers are mostly accustomed to hand milking. They moisten their fingeres with milk, water or even saliva, while milking. This should be avoided for the sake of cleanliness. Wet-hand milking makes the teats look harsh and dry chafes, cracks and sores appear which are painful to animal. The hands should be perfectly dry while milking.

When cracks and sores are noticed on teats, some antiseptic ointment or cream should be smeared over them after milking.

Thumb rule practices for clean milk production

- Periodical check for mastitis with a Strip Cup, CMT or any other method.
- Isolate sick animals and milk them last, their milk should not be mixed with good milk.
- Always cut the long hair around the udder
- Before milking, wash udder, teats and flank of the animal with clean water preferably add with disinfectant. Wipe with a clean cloth.
- Discard the fore milk, which is generally contained more micro-organisms.
- Tie the tail of troublesome animals when milking.
- All milk should be collected from the udder, avoid incomplete milking.
- Use a teat dip after milking.

Features of clean milk

1. It is free from debris and sediments
2. It is free from off flavors
3. Low in bacterial numbers
4. It is free from antibiotics and chemical residues (withdrawal is generally - 5 days)
5. It should have normal composition and acidity (pH of fresh milk is 6.5- 6.7)
6. Colostrums is more acidic than regular milk (< 6.5)

Healthy handling practices for clean milk production

1. Milker's Hygiene

- He should be healthy and clean
- Maintain short finger nails and hair cut (ladies can cover their heads when milking as guard to falling hair)
- Avoid smoking during milking time.
- Be quick and efficient
- Milk consistently without interruptions in the process.

2. Milking shed.

- The shed can be permanent or movable.
- Where possible, provide a cement floor for easy and proper cleaning.
- Water should drain easily and away from the shed.
- Provide a clean feeding trough, water trough and protected store.
- There should be a good source of water nearby.
- The shed should be located away from bad smells and odours
- It should be cleaned after every milking.
- Livestock should not have access to the shed during the day.

3. Utensils

a. Types

- Use seamless utensils preferably aluminium or stainless steel.
- Use cans, metal buckets in milking
- Provide a good washing place

b.Washing procedure

- Rinse excess milk with cold and clean water

- Scrub with a brush using hot water mixed with a detergent e.g. soap or detergent
- Rinse with cold water and place the utensils to dry on a rack upside down during the day.
- Utensils should be stored at night in a safe and clean place, which is well ventilated.

3. Milking Preparation

- Do not excite the animals
- Regularize milking intervals/Timing

4. **Storage**

- Store milk in cool and clean place
- The room used to store milk should without other materials such as chemicals and should also be lockable.

5. Marketing or Disposal

- Milk should be delivered to the market as soon as possible
- It is advisable to delivery milk early in the morning and evening to avoid hot periods of the day.

Strip cup test

Visualization of the milk : Stripping the first few squirts of milk from each quarter into a strip cup at the beginning of milking is a preferred method of detecting flakes or clots in the milk. Gross changes in the milk may be observed at the time of milking such as the presence of flakes, clots or seruous milk. This is the most common means of detection of clinical mastitis.

Examples of milk flakes and clots. Right-hand image, taken in a CMT paddle - has a few flakes (red arrows). Left hand image, taken on the lid of a metal strip cup - has many clots and serous milk from a cow with acute mastitis.

microscopic examination or by electronic instruments designed to count somatic cells.

California Mastitis Test

Background

Identification of cows sub-clinically infected with mastitis is an important part of mastitis control programs. Cows with subclinical mastitis infections do not have a swollen udders or abnormal looking milk. However because an infection is present the somatic cell count in the milk will be elevated. The California Mastitis Test (CMT) is a simple, inexpensive way of detecting unseen infections. Unlike other tests that require laboratories to interpret the results, the CMT is a cow side test that gives valuable, rapid results.

***Equipment*s**

Milk collected for CMT should be collected in a hygienic manner. Samples of milk from each quarter should be collected in a clean CMT Paddle free of any milk residue. The CMT paddle has four shallow cups marked A,B,C, and D for easy identification of the individual quarter from which the milk was obtained. The CMT solution should be properly reconstituted according to package instructions.

Procedure

- About ½ teaspoon (2 cc) of milk is taken from each quarter. That is the amount that would be left in the cups when the paddle is held nearly vertical, or in an upright position.
- An equal amount of CMT reagent is added to each cup in the paddle.
- The paddle is then rotated in a circular motion to thoroughly mix the contents. The mixing should not last more than 10 seconds.
- The test must be "read" quickly because the visible reaction tends to disintegrate after about 20 seconds. The reaction is visually scored depending on the amount of gel that forms. The more gel, the higher the score.

Reading a CMT test

Score	Interpretation
N=Negative	There is no evidence of thickening in the mixture.
T= Trace	There is a slight thickening of the mixture. Trace reactions seem to disappear with a continued rotation of the paddle
1=Weak positive	There is a distinct thickening of the mixture, but there is no tendency to form a gel. If the paddle is rotated 20 seconds or more, the thickening may disappear.
2= distinct positive	There is immediate thickening of the mixture with a slight gel formation. As the mixture is swirled, it moves toward the center of the cup, exposing the bottom of the outer edge. If the motion stops, the mixture levels out and covers the bottom of the cup
3 = strong positive.	A gel is formed and the surface of the mixture becomes elevated (like a fried egg). A central peak remains projected even after the paddle rotation is stopped.

Correlation of CMT Scores and SCC

CMT scores are directly related to average somatic cell counts. The following table shows how they are related. As indicated, the somatic cell range can vary from 0 to over 5 million cells per milliliter of milk. Any reaction of trace or above indicates that the quarter has subclinical mastitis.

CMT score	*Somatic Cell Range*	*Interpretation*
N=Negative	0 – 200,000	Healthy Quarter
T= Trace	200,000 – 400,000	Subclinical Mastitis
1=Weak positive	400,000 – 1,200,000	Subclinical Mastitis
2= distinct positive	1,200,000 – 5,000,000	Subclinical Mastitis
3 = strong positive.	Over 5,000,000	Serious Mastitis Infection

Table: Jasper, D.E. 1967. Proc. of National Mastitis Council (adapted)

Somatic cell counts can be run on milk from the **bulk tank** as an indicator of herd mastitis status. Bulk tank SCC indicates the overall level of mammary inflammation in the milking herd at each milking. It is the bulk tank SCC that is used by the milk processor plant to determine milk quality premiums to the producer. A bulk tank somatic cell count exceeding 750,000 cells/ml will result in loss of Grade A milk status (the producer cannot continue selling the milk until the problem is taken care of). A single cow with high SCC probably will not increase the bulk tank SCC by very much, however if the herd has many chronically infected cows (often as in herds with a *Staph. aureus* problem or other contagious mastitis problem), then the bulk tank SCC may increase significantly.

Even if the cow is not infected, the sterile milk coming from the cow will become contaminated by bacteria as it moves from the cow to the bulk tank. These contaminating bacteria will include coliform bacteria and other species that ultimately affect the very perishable milk. The bulk tank will always have a level of contaminating bacteria. Normal ranges should be less than 10,000 per milliliter of milk. Herds should try to keep the bulk tank bacterial counts below 3,000 per milliliter. If the bulk tank contains *Strep. agalactiae* which only survives in the mammary gland, then that means the herd has cows infected with that organism. If the bulk tank has elevated *Staph. aureus*, then that is an indicator that Staph aureus may be a problem in the herd. However, there are always contaminating coliforms and other environmental bacteria in the bulk tank milk, so bulk tank bacterial counts and speciation will not help diagnosis environmental mastitis problems. Most bacteria should be killed upon pasteurization.

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Strategy to enhance production efficiency of dairy animals in hilly areas

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World milk production is almost entirely derived from cattle, buffaloes, sheep, goat and camels. Other less common milch animals are yaks, horses, rain-deers and donkeys. The presence and importance of each species varies significantly among regions and countries. The key elements that determine the dairy species kept are feed, water and climate. Other factors that may influence the presence of a dairy species are market demand, dietary traditions and socioeconomic characteristics of industrial households (e.g. poorer families tend to rely on small ruminants).

Cattle produce 83% of world milk production, followed by buffaloes with 13%, goats with 2% and sheep with 1%; camels provide 0.4%. remaining share is produced by other dairy species such as equines and yaks. However, in India the share of milk production in 2012-13 was highest by buffaloes followed by exotic/crossbred cows, indigenous/non-descript cows and goats with 51, 24, 21 and 4% of total milk production respectively (Islam et al., 2016). In the present endeavor importance will be given how availability and quality of feeds and fodders; and environment affects the dairy production system in hilly areas.

Hilly regions in India mostly confined to agro-climatic zones of North Western and North Eastern Himalayas spread over Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Sikkim, West Bengal, Assam, Arunachal Pradesh, Nagaland, Manipur, Meghalaya, Mizoram and Tripura. It is characterized by large rangelands with cultivated area or occasionally fallow-lands that harbor natural or seeded / planted vegetations.

The hill regions of North Western Himalayas have much diversity. The valleys receive good rainfall and have rich soils, though the temperate zones of Ladakh face climate barriers against agricultural growth. High altitude temperate zone of this region receives rainfall of about 1052 mm in Jammu at an altitude of 330 meters but it decreases to 92 mm in Leh at an altitude of 3505 meters. In high hill temperate zone the climate is humid and sub-temperate and the average annual rainfall is 1300 mm (Alam, 2006a). About 31% of hill temperate zone is under forests and only 40% is available for cultivation. However, only 12% of the net sown area is irrigated (FSI, 2011). The valley temperate zone of North Western Himalayan region has a highest forest cover of nearly 65%. However, large part of this is thin on vegetative cover. Only 12% of the land is cultivated. About 37% of the cultivated area is irrigated (Alam, 2006a).

The North Eastern Himalayan region includes Sikkim, parts of north West Bengal, Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, is a part of Indo-Burma 'hotspot' zone, the second largest next to Mediterranean basin. It is considered as 'hotspot' as 70% or more of its primary vegetation is lost. It is a major cause of concern in terms of identification, preservation and judicious use of these plant resources. The climate varies from tropical in the plains to alpine in the high hills.

Shifting cultivation (locally known as *"jhum";* slashing and burning of primary vegetation) is thought to be one of the major contributing factors for reduced available forest area in this region. With the increased population, the villagers are reducing the fallow period in order to allot *jhum* land. Reduced fallow period of 1-3 years is not enough for regeneration of the land for further use thereby, resulting in degradation and encroachment of steep slopes with forests. The clearing of forest areas at regular and frequent intervals for *jhum* results in loss of primary forests and formation of secondary forests. This causes substantial loss of tree diversity and associate vegetation those are adapted to primary forests. Due to shortening of *jhum* cycle, quite often the secondary forests also do not get adequate time to regenerate. The repeated use of land with short *jhum* cycle finally converts the *jhum* follows into degraded waste lands (Tripathi and Barik, 2003).

There are three sub-agroclimatic zones in the hilly areas of the North Eastern Himalayan region, namely Himalayan Hills (Sikkim and Darjeeling of West Bengal), North-East Hills (Arunachal Pradesh, Nagaland, Meghalaya and Karbi Anglong and Cachar Hills of Assam) and Southern Hills (Manipur, Mizoram and Tripura). Besides this, the region includes plain areas of Lower and Upper Brahmaputra. The rainfall in hilly areas varies between 2052 to 3528 mm in a year (Alam, 2006b).

It is apparent from above mentioned data that from agro-climatic as well as agricultural practices point of view North Western Himalayas are a beat different from North Eastern Himalayan region. Due to heavy rainfall, soil type, variation in temperature ranges in different altitude in North Eastern Himalayan region is endowed with rich biodiversity. However, the natural resources of the Himalaya as a whole have been exploited for centuries in an unplanned manner leading to degradation all along and North Eastern Himalayan region has been declared as ‘hotspot’ zone.

For consideration of augmenting the productivity ruminants in these regions we have to consider first the population trends. Cattle, buffalo and yak has shown a decreasing trend when we consider the livestock census data 2007 and 2012, at a rate of 0.58%, 9.98% and 1.62%, respectively (Table 1 & 2). The mithun, sheep and goat population has shown an increasing trend at a rate of 12.49, 38.41% and 32.15%, respectively in the North Eastern Himalayan region. However, in the North Western Himalayan region cattle, buffalo, sheep and goat and yak was observed to be declined by 12.50, 19.42, 14.21, 3.00 and 9.72%, respectively. Overall, in Himalayan region the rate of decline in the population of cattle, buffalo, sheep and yak was 5.03, 17.77, 10.41 and 7.82%, respectively. However, the mithun and goat population was increased by 12.84 and 16.73%, respectively. It is interesting to note that both mithun and goat are browsing species and they are increasing their number in the Himalayan region where forest cover of the geographical area is about 52.79% (Table 3).

The decline in overall population might have various reasons like replacement of low-producing indigenous population with exotic stock and simultaneously crossbreeding for increasing the productivity, shortage of feeds and fodders and major disease outbreak. In cattle efforts are being made to upgrade the indigenous stock through crossbreeding. However, in the North Eastern Himalayan region crossbred / improved cattle is about 6.8% only, though smaller states like Sikkim and Nagaland has made significant improvement (Table 4). The performance of North Western Himalayan region (41.03%) is better than the

North Eastern side as well as national average (20.8%). If it is judged in terms of milk productivity of crossbred animals it shows a reverse trend, with 6.25 kg/d in North Eastern Himalayan region and 5.69 kg/d in the Eastern side (Table 5) during 2010-11. However, both regions showed improvement in their performance in terms of milk productivity. It is apparent from the above observations that replacement of low-producing indigenous population with exotic stock might not be the sole cause of declining of the population might be compounded with scarcity of feeds and fodders.

Grasslands and forests are the major feed resource in Himalayan region. Grazing in the forest areas and sub-alpine and alpine pastures is the mainstay for the animals. Fodder trees and shrubs also contribute significantly. Though livestock rearing is an important occupation of farmers in that area, the forage cultivation has remained almost neglected. The natural resources of the Himalaya have been exploited for centuries in an unplanned manner leading to degradation all along. Reckless felling of trees, indiscriminate use of grazing areas and absence of rehabilitation programmes has lead to denudation of hill slopes, which has resulted in critically low biomass availability and adverse effects on livestock production. Climate, topography, physiographic factors, altitude and related aspects have influenced the distribution of various grass species, which determine the grassland production both qualitatively and quantitatively (Whyte, 1968).

Present Status of forage production

Though Arunachal Pradesh and Mizoram are surplus in green fodders, overall North Eastern Himalayan region is deficient by 57.76% (Table 6). Similarly, in crop residue production Mizoram is in surplus position with overall deficiency by 51.61% in this region. However, all the states in the North Western Himalayan region are deficient in green fodders as well as crop residues with an overall figure by 49.88 and 57.77% which corresponds to 53.95 and 54.58%, respectively for all the regions of Himalaya.

Pastures

Three types of pastureland are available in this region depending on elevation - Temperate, Sub-alpine and Alpine pasture. Alpine pasture is observed mainly in Arunachal Pradesh, Sikkim, Uttaranchal, Himachal Pradesh and Jammu and Kashmir, is extensively used by transhumance and nomadic grazers. In alpine pasture monocotyledon species such as *Poa angustifolia* show high dominance during the early and late part of growing season where dicot species proliferate mainly during middle part of growing season. Asteraceae, Ranunculaceae, Ericaceae, Primulaceae and Rosaceae are dominant plant families in this area. The below ground plant parts contributed nearly 90% of total plant biomass whereas the above ground biomass contributed about 10%. Such partitioning of biomass helps immediate recovery of vegetation after grazing as well as the start of growing season. Most of the species are highly nutritive and have high mineral contents and animals show a preference for species with low lignin content. Alpine pasturelands are inhabited with *Rhododendron* shrubs. Main types of vegetations are *Kobresia spp., Cortia depressia and Carex – Agrostis – Poa* associations. Common plant species are *Kobresia spp.* and *Agrostis spp.* at Kanchanjungha Researve Biosphere. Total area under alpine in Eastern Himalayan region is 4698 sq km.

Sub-alpine pasturelands are associated with a variety of shrubs; common genera are *Berberis, Caragana, Hippophae, Juniperus, Linicera, Potentilla, Rosa, Spiraea and Rhododendron*; in many areas, *Pipthantus nepalensis* has invaded productive pasturelands once dominated by *Danthonia spp.* The common grasses are *Elynus spp., Festuca spp., Stipa spp., Bromushimalaincus, Crysopogon gryllus, Cymbopogon schoenanthus* and *Koleria cristata. Elymus mutans* is of great importance in pastoral system in higher altitudes.

Temperate pasturelands are associated with oak or mixed broad leaved species such as *Quercus* or blue pine. These pastures are very important but due to heavy grazing for many years less palatable species have become prominent. *Andropogon tristis* has been replaced with less palatable species such as *Arundinella hookeri*. The common forage species are *Arundinella hookeri, Andropogon tristis, Poa spp., Crysopogon gryllus, Dactylis glomerata, Stipa concina, Festuca spp., Cymbopogon spp., Bothrichola spp., Desmodium spp and Agrostis micrantha.*Most of the temperate grasses are suited to high hills and alpine region. However, orchard grass, tall fescue and perennial rye grass also grow well at the mid hills. The yield of these grasses is low but they are rich in nutrients as compared to tropical grasses.

The dry matter yield of native grassland (above ground) is estimated to be 0.8 t/ha in nearby area of Sikkim at the height of 2600 masl. Ground biomass production from alpine pasture varies from 0.4 to 5 t/ha. Due to increase in the cover of unpalatable species the herbage production in Himalayan grassland has decreased by 20 – 50% in terms of quality compared to their potential. The dry matter yield of some indigenous fodder grass with pure stand Andropogon *spp*. 7.4 t/ha, *Arundinella spp*. 7.0 t/ha, *Bothrichola spp*. 9.9 t/ha and *Crosopogon spp*. 5 t/ha. The temperate grasses are suitable for alpine region in pure condition and their productivity on dry matter basis for *Dactylis glomerata* 8.2 t/ha, *Festuca arundinacea* 9.9 t/ha, *Loliun multiflorum* 11.2 t/ha and *L. perene* 5.3 t/ha. Misri (1988) studied the biomass availability of some of the representative pastures of Kashmir Himalaya and found that green herbage availability varied from 4.7 to 29.1 t/ha. In Himachal Pradesh the green herbage availability varied from 1.5 to 1.74 t/ha in temperate pastures and 0.5 to 1.0 t/ha in alpine and sub-alpine pastures (Singh, 1995). Ram and Singh (1994) observed that biomass availability varied from 1.62 to 3.96 t/ha (green herbage) in Himalayan pasture of Uttar Pradesh. Tincheng and Yuangang (1989) reported the stocking capacity of central Himalayan pastures between 0.4 and 13.3 sheep/ha/annum under natural vegetation in alpine steppe, meadows and alpine meadows. In semi-natural grasslands in temperate the stocking capacity varied from 0.6 to 1.9 sheep/ha/annum.

Forage cultivation is restricted to only about one per cent of the cultivated area in the entire Himalayan region. This is basically because of the preponderance of marginal and small land holdings in the area. Besides grazing and fodder trees, the major local forage resource is the crop residue, which again is too inadequate to sustain the livestock.

Perennial Grasses and Forage Legumes

Most of the subtropical and tropical grasses grow well under the humid agro-climatic conditions of this region. Notable tropical grasses are Bajra x Napier hybrid (BN-82048), *Brachiaria ruziensis* (Congo signal), *Erianthus longisetosum*, *E. sikkimensis*, Napier x Bajra hybrid (NB-21), *Panicum maximum* (Makueni), *Paspalum dilatatum* (Dallis grass or Paspalum), *Pennisetum polystachyon* (Thin Napier), *Setaria palmifolia* (Dhotisaro), *Setaria sphacelata* (Golden Timothy grass), *Thysanolaena agrostis* (Broom grass) and *Tripsacum laxum* (Guatemala grass). Their productivity is 222.8, 140.5, 42.1, 47.0, 158.8, 160.9, 64.2, 61.1, 45.4, 105.1, 73.6 and 94.0 tones / ha / year, respectively on fresh basis. Most of these grasses produce forage during April to October. Among these grasses *Tripsacum laxum* and *Thysanolaena agrostis* have extended period of growth during dry winter months, a lean period for green fodder (Singh *et al*., 1996).

Annual forage crops

Among the annual forage crops maize, teosinte, jobstear, dinanath grass, rice bean and soya bean can be successfully grown during per-kharif and kharif season and oat, pea, forage mustard, Japanese rape, Chinese cabbage and turnip can be grown during rabi. They produce on an average 250 – 500 q green forage per ha.

K-1, BC-1, BC-7 and BC-10 are the high yielding varieties of rice bean. Oat can be grown where irrigations are made available. Suitable single cut varieties like JHO 816, JHO 817, JHO 822 and Kent, JHO 851 is a promising multicut variety. Cowpea can be grown in the plains of this region.

Tree fodders

In North Eastern Himalayan region about 300 plant species mostly native and few introduced one constitute the green forage resources. Many native plants are yet to explore for use as fodder. The maximum diversity of fodder tree species is observed below the altitude of 1600 masl which decreases with increase in elevation. At the altitude between 1000 to 2000 masl Nevaro (*Ficus hookerii*) shows maximum frequency as a fodder tree. Approximate yield per tree for different age is presented in the Table 7 (Singh *et al.,* 1996).

Many trees have been identified as fodder trees in North Eastern Himalayan region (Balaraman and Goley, 1991; Singh *et al*., 1996 and Varma *et al*., 1982). Shrubs and browses and leaves of most of these trees are rich in crude protein content. Calcium content of tree leaves is very high (0.6 to 5.8%) in comparison to phosphorus (0.1 to 0.7%). Grasses on the other hand contain low crude protein and calcium. The nutritive value in terms of DCP and TDN contents has been determined in a very few feeds and fodders in the North Eastern Himalayan region. The DCP and TDN content of *Arundinaria hookeriana, Artemesia vulgaris, Brassiopsis mitis*, *Ficus hookerii, Ficus infectoria, Schima wallichii, Setaria palmifolia*, *Thysanolaena agrostis* and mixed jungle grass was determined to be 7.89, 66.29; 11.53, 64.88; 5.84, 53.22; 3.91, 49.58; 7.32, 50.16; 5.70, 54.91; 8.16, 47.63; 6.42, 52.87 and 4.94, 54.20%, respectively. Gradation of tree fodders is essential depending on their nutritive values, as these are quite unconventional and are not used as in other part of the country.

Constraints

Acute shortage of nutritious fodder due to low productivity as well as low quality and insufficient grazing facilities are the major cause of low productivity of the livestock in hilly area (Deb Roy et al., 1989 and Deb Roy, 1993). The Himalayan region of India is presently under heavy stress on account of a large-scale exploitation for fuelwood, timber and fodder, mismanagement of forest resources and frequent fires (Khosla and Toky, 1985). The shortage of fodder supply in the Himalayan region is attributed to some of the following reasons.

Less area under fodder crops:

In Himalaya, all the available cultivated land has come into being after massive deforestation and creation of terraces. The division of the families has further fragmented the land. However, lion share of the livestock population is owned by marginal and small farmers (Table 8) and their land holdings are very small and the farmers are always biased in the choice of the crops. Due to these reasons of agricultural land ratio, it is difficult for the farmers to divert land from food production to cultivated fodder. Thus the area under fodder crops is meager and is not more than one per cent of the total cultivated land. However, the permanent pasture and other grazing land is about 5.41% of the total geographical area of Indian Himalayan region (Table 3).

Uncontrolled grazing:

All the three vertical divisions of the Himalaya are under heavy and indiscriminate grazing. Sub-alpine and alpine pastures of higher Himalaya are grazed from April to October, which is the active period for growth of vegetation; during rest of the year these are covered with snow. The edible species do not get enough time to grow, set seed and proliferate. Obnoxious weeds invade the pastures. Excessive and continuous grazing has severely damaged these lands. The herbage species found in these lands represent the third or fourth stage of degradation. The mid-hill grasslands are protected only for about two to three months during monsoon and are grazed during rest of the year. The outer hills are used for the grazing of local livestock and migratory livestock graze here for about six months (Dev, 2001). In the forest area in mithun-rearing the states like Nagaland and Manipur, it is a general phenomenon during winter season that mithun comes out of the forest and destroys crops. It might be due to scarcity of fodders in the forest during winter season.

Heavy livestock population and poor management practices:

There are many areas in the hilly terrains of Himalayan region are inaccessible. Human as well as animal population is more concentrated in those areas where accessibility is comparatively easier. This makes accessible areas more vulnerable in terms of deforestation as well as degradation of pasture lands. Though stocking density per sq-km of cattle, sheep and goat is lower than the national average but significantly higher in terms of per 1000 human population (Table 9). It clearly indicates accessible forests and pasture lands are being over exploited. Presence of inferior and unproductive grass species, lack of fertilization, absence of legume component, improper cutting and indiscriminate grazing are some of the factors responsible for poor productivity of the grasslands. The management practices play an important role in determining the productivity of grasslands, yet this has been the last priority of the farmers in the Himalayan region. There exists a wealth of indigenous knowledge for the proper utilization and management of the natural resource base but the farmers because of increasing population pressure and declining land productivity are not using it (Dev, 2001).

Fodder tree use:

It is reported that the North Western Himalayan region supports about 84 trees and 40 shrubs of fodder value, yet not more than 20 trees are extensively used by the farmers (Misri, 1997) and in North Eastern Himalayan region 300 plant species mostly native and few introduced one constitute the green forage resources (Singh *et al.*, 1996). Tree leaf fodder is the major feed resource during lean periods, particularly the winters. The tree leaf fodder provides 50-90% of the forage demand during lean periods (Negi, 1977). The over exploitation and unscientific management of fodder trees has depleted this resource at huge environmental cost.

Strategies

a) Agronomic management
   i. Control of bushes and weeds in the pasture
   ii. Establishment of pasture or reestablishment of denuded pastures with introduction of grasses and legumes
   iii. Application of manure in the pasture
   iv. Cutting and grazing management
b) Growing fodder crops and fodder trees
c) Silvi-pastoral system
d) Agri-silvipastoral system
e) Agri-horti-silvipastoral system
f) Horti-pastoral system
g) Forage production in various land use system
h) Forage production on terrace risers
i) Preservation of fodders in the form silage, hay, etc, for scarcity period
j) Determination of carrying capacity of forests and pastures in terms of rearing animals without disturbing the ecological balance
k) Regeneration of forest area and taking advantages of carbon credit system

Future thrust

Forage production must be taken up as a first management goal and 25% of the forest area should be put under trees with regulated accessibility to the farmers.

Growing forage grasses and fodder trees along village roads and panchayat lands

Growing forage grasses and fodder trees on terrace risers/bunds- a non competitive land use system

Conservation of native biodiversity for future improvement

Breeding biotic, abiotic, stress tolerant cultivars of forage species suitable for area not used under arable agriculture

Participatory techniques to be adopted to identify the problems and to carry out the improvement programme

In-depth studies on migratory grazers

Forage based agroforestry systems

Effect of cold climate on animals

Feed intake in cold environment

Due to variation in temperature at different altitude level of intake in animals are affected. Animals subjected to cold increase their feed intake. Cattle kept at -20°C have voluntary intake of feed which are 35% greater than they are at 20-30°C (McDowell et al., 1969); in pigs increases are of same order over a similar range (Versteghen et al., 1978). In poultry Sykes (1977) summarized the results of nine separate experiments to show that over a range of environmental temperature from about 5 to 35°C, the voluntary intake of metabolizable energy per bird increased according to the relationship-

Intake per bird (kg/d) = 1690 – 20.1T_a (where T_a is ambient temperature in °C).

The slope of the relationship between feed intake and environmental temperature is the same as that for the relationship between heat production and environmental temperature. However, Burton and Edholom (1955) pointed out that the superficial explanation of higher feed intake in the cold environment was the consequence of greater environmental demand for heat hardly seems tenable. There is considerable evidence from animal experiments that digestibility and hence metabolizability declines in the cold. NRC (1981) has summarized that the digestibility of the energy supplied by feed falls by about 0.25% for every degree fall in environmental temperature. The mechanism of reduction in part might be due to changes in the rate of passage of digesta (Blaxter, 1989).

Effects of cold environment on fasting heat production and nutrient requirement

Fasting heat production (FHP) was measured in yak at altitudes of 2260, 3250 and 4270 m on the Tibetan plateau both in summer and winter, after a 90 d adaptation period at each experimental site. Increasing altitude at similar ambient temperature (T_a) did not affect ($P>0.10$) FHP in the summer, but decreased ($P<0.05$) at different T_a in the winter. However, the decrease of FHP in the winter was mainly due to the decrease of T_a instead of the increase of altitude. At all altitudes for all groups, the daily FHP was higher ($P<0.05$) in the summer (T_a 6-24 °C) than in the winter (T_a 0 to -30 °C), and the T_a -corrected FHP averaged on 920 kJ/kg body weight(0.52) at T_a 8-14 °C and on 704 kJ/kg body weight (0.52) at T_a -15 °C, respectively. We conclude that in the yak high altitude has no effect on the energy metabolism, whereas the cold ambient temperature has a significant depressing effect. The results confirm that the yak has an excellent adaptation to both high altitude and extremely cold environments (Han et al., 2002). However, Haque et al (1998) reported that fasting heat production determined in thermoneutral zone in fine-fibre bearing Cheghu goats which inhabit in the higher altitude of Himalayan ranges under cold and dry climate was 326 $kJ/kgW^{0.75}/d$ and metabolizable energy requirement for maintenance was similar to goats found in the plains of India. Qiao et al (2013) reported that high altitude of the Tibetan plateau impaired rumen fermentation and elevated the basal metabolism rate of Chinese Holstein cows.

Heat production by animals depends on feed intake, body condition, physiological condition, genotype and sex of the animals. Amongst the multitude of factors encompassing both physical and psychological aspects of the animals surroundings, thermal environment provides a strong influence on farm animals with air temperature having the primary effects but affected by wind, precipitation, humidity and radiation. Ultimately, there is altered energetic efficiency which demands a change in nutrient to energy ratio in the diet. The incremental costs of free existence appear greater in summer than in winter because, animals that are fed supplemental feed are inactive during cold and snowy weather choosing to bed around the premises (Jiang and Hudson 1994). Further, within thermoneutral zone body temperature is controlled by regulation of heat dissipation and when effective ambient temperature decreases below the lower critical temperature (LCT), heat increment from normal body tissue mobilization fails to maintain body temperature and it needs to increase its metabolic rate referred to as cold thermogenesis (CSIRO, 1990). Lower critical temperature estimates for young lambs and calves are usually about 10°C and decrease as animals grow. Typical values for dry, pregnant beef cows during winter are between -10 to -20°C, while for high producing dairy cows feedlot beef cattle, measurement suggest values which are usually between -20 to -40°C. Estimates of lower critical temperature for full fleeced sheep are also low (-20 to -30°C) whereas recently shorn sheep the lower critical temperatures are raised to +20°C or more. The LCT should only be considered as indicators for cold susceptibility for, in realty actual values may vary somewhat depending on the housing conditions, breed, nutrition, thermal adaptation and animal behavior (Clark, 1981).

Amongst animals at cold-temperate zone, yak, the migratory type high altitude animal requires extra for sustaining against cold, high altitude grazing and adverse windy climate. Grazing activity was estimated to increase energy requirements relative to maintenance by 20% on flat and as much as 50% on hilly terrain (CSIRO, 1990). NRC (2001) suggested the following equation for the calculation of extra energy spent in grazing on a hill terrain.

NE for grazing on hill terrain= (0.00045 x BW x D) + (0.0012 x BW) + (0.03 x VD x BW)
(BW, body weight in kg; D, distance travelled in km; VD, vertical distance in km)

The metabolic rates increase by 70% above resting in severely cold stressed animals resulting an increase in maintenance digestible energy (DE) intake by 2.5% for adult horses and 1.3% for growing horses fed for moderate gain per 1^0C decrease in ambient temperature below LCT (-15^0C for adult and 0^0C for growing horses; Cymbaluk, 1994). The protein content in the ratio needs to be proportioned to the increase in food intake so as to maintain the absolute intake. For cattle fed restricted diet in a cold climate, an increase in roughage may at times be advantageous. However, if feed is not restricted in cold conditions substituting roughage for concentrate feeds may limit the total available energy intake and reduce rate of productivity. The energy and protein requirement of cattle/yak heifers and cow reared at high altitude is presented in Table 10 and 11 for some ready reference. There is an increase in maintenance requirement of about 10-30% for grazing animals in hill terrain depending on the vertical distance travelled and total distance covered by the animal. There is also need to supplement energy for environmental temperature below the LCT. In milch animals, as milk yield increases, appetite and the amount of energy spent gathering food would increase. A similar allowance would also be required for migratory population depending on the proximity of pasture land and the distance travelled in hilly terrain in a day.

Strategies for management of animals in cold environment

Proper shelter should be designed for protection from inclined weather

Protection from wind

Additional allowance of feed depending on the weather condition

Fleecing of animals (sheep) in warmer weather

Selection of suitable breed for cold and higher altitude

Regular deworming of animals

Development of organic mode of production system

Besides optimization of forage production and utilization and balancing the of other nutrients along with meeting out of energy requirement, keeping in mind the environmental temperature in the Himalayan for increasing the efficiency ruminants, organic mode of production system should be given due importance. It will help in value addition to all the products and byproducts in the ruminant based production system in the Himalayan region. By default many parts of the Himalayan mountainous range is organic. The states like Arunachal Pradesh and Nagaland are using chemical fertilizer minimal in quantity compared to other states (Table 12) and overall figures for Himalayan region is much lower than that of all India level. One of the parameters to fulfill organic in organic animal production system is that at least 60% of the feed dry matter must be supplied by forage produced on the farm itself. The proportion of concentrates in the diet is restricted to 40% on a daily DM basis. It is worthy to mention here that mithun is traditionally reared in the forest in free range system with almost zero input except supplementation of common salt time to time. Moreover, the states like Sikkim have already been declared as organic one. So an organic mode for livestock production system must be developed to make the venture more remunerative and eco-friendly.

The fatty acid composition of milk is an important factor that has been linked to health issue factors in humans (Weller and Bowling, 2007). Health benefit of milk is associated with n-3series of polyunsaturated fatty acid (PUFA) and conjugated linolic acid (CLA) contents, including the prevention of carcinogenesis, a reduced incidence of heart disease and benefits of immune system. The CLA consists of a group of isomers of linoleic acid to which anti-diabetic, anti-atherogenic effects as well as effects on bone metabolism, body composition have also been attributed. It is found predominantly in milk and meat of ruminants due to action of rumen microorganisms in the formation of CLA and its precursors (Blair, 2011).

Investigations cited by Weller and Bowling (2007) have shown that changing the feed from conserved forages to fresh herbage increases the CLA concentration in milk. Conserving crops as hay or silage result in a reduction in CLA content. Forage maize has a higher CLA content than grass silage. As a result, linoleic acid content of milk from cows fed maize silage is higher than that in milk from cows fed grass silage diets with total PUFA concentrations being similar. The CLA content of milk is also influenced by the breed of cows, with milk from Jersey cows having a lower concentration than milk from either Friesian or Holstein cows.

A switch from a concentrate-based diet to pasture has been shown to increase the CLA content of beef. French et al (2000) reported increasing the CLA contents in the intramuscular fat of steers that were consistent with increasing intakes of grass. Levels of 5.4, 6.6 and 10.8 mg CLA were detected in grazing steers with increasing grass intake compared with 3.7 mg/g in animals fed concentrate. Poulson et al (2004) reported a 6.6 times higher CLA content in the longissimus and semitendinosus muscle from steers raised only on forages compared with steers fed a common high-grain feedlot diet (13.1 versus 2.0 mg/g). The increased CLA content in meat from animals grazing on pasture is attributed to the high PUFA content of grass (especially n-3 18:3 with an n-6:n-3 ratio of approximately 1:3-5). Although not the only determinant, the amount of dietary level determines the generation of trans fatty acids by rumen bacteria.

Breed of animals might also be an important factor. Zembaayashi et al (1995) concluded that Japanese Black cattle have a genetic predisposion for producing carcass lipids containing higher concentration of monounsaturated fatty acids than Holstein, Japanese Brown or Charolais cattle. Dinh et al (2010) reported significantly higher concentrations of saturated fatty acid (26.67 mg/g), monounsaturated fatty acids (26.50 mg/g)) and polyunsaturated fatty acids (2.37 mg/g) in longissimus dorsi muscle from Angus cattle than in Brahman cattle. These findings indicate a genetic variability in fatty acid synthesis and deposition among breeds that influences both marbling and its composition. Mithun is also raised in forests in free range system, consuming mainly tree fodders having four strains- Arunachal, Nagaland, Manipur and Mizoram, must be checked for fatty acid composition.

Natural Organic Standards Board of USA started to consider maintenance of biodiversity as one the points in the check list before certification of organic production system for reaccreditation from 2009 which might also be an obligatory feature for our country in future.

Strategies for transformation of animal production system in Himalayan ranges

Suitable breeds of animals should be selected having more CLA content in meat and milk

Slowly transforming the animal rearing system, feeding feeds and fodders produced under organic mode

Rejuvenation of pasture lands and forests

Certification of the system from competent authority for organic production system

Development of marketing facilities for products and byproducts developed under organic system

Studies on rumen microbes forming CLA and its precursors

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Table 1. Population trend in ruminants in Himalayan region

States	Cattle	Buffalo	Sheep	Goat	Cattle	Buffalo	Sheep	Goat
	2007				2012			
Arunachal Pradesh	503120	3208	19880	292121	463758	5970	13549	305538
Assam	10041269	499912	353799	4319773	10307604	435265	518067	6169193
Manipur	341956	62167	8696	50577	263843	66369	11463	65158
Meghalaya	887243	22627	21041	365483	896000	22059	20096	473070
Mizoram	34929	5832	974	15710	34573	5174	650	22206
Nagaland	469818	35022	3649	178072	234974	32720	3838	99350
Sikkim	134873	243	2536	91995	140467	703	2634	113364
Tripura	954386	14257	3685	633052	948794	10806	3110	610922
NEHR	**13367594**	**643268**	**414260**	**5946783**	**13290013**	**579066**	**573407**	**7858801**
Himacha	2269178	761589	901299	1240836	2149259	716016	804871	1119491

l								
J&K	3443115	1050340	4127149	2068273	2798326	738989	3389485	2017900
Uttaranchal	2235116	1219518	290411	1335306	2006053	987775	368756	1367413
NWHR	**7947409**	**3031447**	**5318859**	**4644415**	**6953638**	**2442780**	**4563112**	**4504804**
India	**199075005**	**105342644**	**71558232**	**140537405**	**190904105**	**108702122**	**65069189**	**135173093**
Share of NER in India, %	6.71	0.61	0.58	4.23	6.96	0.53	0.88	5.81
Share of NWR in India, %	3.99	2.88	7.43	3.30	3.64	2.25	7.01	3.33
Share of Himalayan region in India, %	10.71	3.49	8.01	7.54	10.6	2.78	7.89	9.15

GoI (2007 & 2012)

Table 2. Trend in mithun, yak and pig population in Himalayan region

States	Mithun	Yak	Pig	Mithun	Yak	Pig
	2007			2012		
Arunachal Pradesh	218931	14251	355583	249000	14061	356345
Assam	0	0	2000429	0	0	1636022
Manipur	10024	0	313882	10131	0	277215
Meghalaya	0	0	524357	0	0	543381
Mizoram	1939	0	267361	3287	0	245238
Nagaland	33385	0	697791	34871	0	503688
Sikkim	0	5225	35250	0	4036	29907
Tripura	0	0	263694	0	0	362534
West Bengal	0	26	-	0	1089	-
NEHR	**264279**	**19502**	**4458347**	**297289**	**19186**	**3954330**
Himachal	14	1705	2493	918	2921	5033
J&K	16	61910	904	57	54493	2421
Uttaranchal	0	50	19822	0	62	19907
NWHR	**30**	**63665**	**23219**	**975**	**57476**	**27361**
India	264309	83169	11133566	298264	76662	10293695
Share of NE in India, %	99.99	23.45	40.04	99.67	25.03	38.42
Share of NER in India, %	0.01	76.55	0.21	0.33	74.98	0.27

Share of Himalayan Region in India, %	100	100	40.25	100	100	38.68

GoI (2007 & 2012)

Table 3. Forest cover, pasture and net sown area in Himalayan region

States	Geographical area (sqkm)	Reported area ('000 ha)	Forest cover ('000 ha)	Forest cover (%)	Permanent pasture and other grazing land ('000 ha)	Permanent pasture and other grazing land (%)	Net sown area ('000 ha)	Net sown area (%)
Arunachal Pradesh	83743	5659	5154	91.07	19	0.33	211	3.73
Assam	78438	7850	1853	23.6	160	2.04	2753	35.07
Manipur	22327	1965	1693	86.16	1	0.05	236	12.01
Meghalaya	22429	2227	948	42.57	0	0	284	12.75
Mizoram	21081	2109	1594	75.58	5	0.24	95	4.5
Nagaland	16579	1621	863	53.24	0	0	316	19.49
Sikkim	7096	723	319	44.14	4	0.55	107	14.9
Tripura	10486	1049	606	57.73	0	0	280	26.63
NEHR	**262179**	**23203**	**13030**	**56.16**	**189**	**0.81**	**4282**	**18.45**
Himachal Pradesh	55673	4549	1101	24.21	1496	32.89	541	11.9
J&K	222236	3781	2023	53.5	128	3.39	739	19.55
Uttaranchal	53483	5673	3486	61.45	199	3.51	754	13.29
NWHR	**331392**	**14003**	**6610**	**47.2**	**1823**	**13.02**	**2034**	**14.53**
NEHR + NWHR	**593571**	**37206**	**19640**	**52.79**	**2012**	**5.41**	**6316**	**16.98**
India				**21.05**				

FSI (2011)

Table 4. Adoption of crossbreds / improved breeds in Himalayan region: 2012

States / Species			
	Crossbred / Improved	Crossbred / Improved	Crossbred / Improved Pig%

	Cattle%	Sheep%	
Arunachal Pradesh	5.0	9.7	10.5
Assam	3.8	1.7	37.5
Manipur	16.8	34.3	65.8
Meghalaya	3.9	3.0	24.6
Mizoram	32.7	78.8	86.8
Nagaland	54.9	20.8	75.6
Sikkim	90.1	41.1	91.8
Tripura	14.0	4.3	58.9
NEHR	**6.8**	**3.0**	**45.6**
Himachal	45.8	37.9	38.6
J&K	52.5	68.3	36.3
Uttaranchal	24.8	34.6	36.3
NWHR	**41.03**	**46.93**	**37.07**
India	**20.8**	**5.6**	**23.9**

GoI (2012)

Table 5. Average milk productivity in crossbred cows in Himalayan region

State	Milk (kg/d)	
	2005-06	2010-11
Arunachal Pradesh	6.00	6.59
Assam	3.52	3.70
Manipur	7.49	7.65
Meghalaya	8.93	8.98
Mizoram	8.12	7.46
Nagaland	6.39	5.18
Sikkim	5.00	5.84
Tripura	4.12	4.58
NEHR	**6.20**	**6.25**
Himachal	3.18	4.66
J&K	5.19	5.65
Uttaranchal	6.69	6.75
NWHR	**5.02**	**5.69**
India	6.44	6.63

Basic Animal Husbandry Statistics (2006 & 2012), AHS Series - 10, GoI

Table 6. Requirement and availability fodders in Himalayan region (Dry matter) (estimated in 2008)

States	Availability (million tonnes)		Requirement (million tonnes)		Deficit (million tonnes)		Deficit / Surplus (%)	
	Crop residues	Greens	Crop residues	Greens	Crop residues	Greens	Crop residues	Greens
Arunachal Pradesh	0.47	1.57	1	0.53	0.53	1.04 (Surplus)	53.00	196.23 (Surplus)
Assam	5.82	0.95	12.39	6.61	6.57	5.66	53.03	85.63

Manipur	0.36	0	0.72	0.38	0.36	0.38	50.00	100.00
Meghalaya	0.31	0.4	1.17	0.62	0.86	0.22	73.50	35.48
Mizoram	0.15	0.5	0.06	0.03	0.09 (Surplus)	0.47 (Surplus)	150.00 (Surplus)	1566.67 (Surplus)
Nagaland	0.56	0.3	0.74	0.4	0.18	0.1	24.32	25.00
Sikkim	0.23	0.01	0.25	0.13	0.02	0.12	8.00	92.31
Tripura	0.53	0.19	1.09	0.58	0.56	0.39	51.38	67.24
NEH region	**8.43**	**3.92**	**17.42**	**9.28**	**8.99**	**5.36**	**51.61**	**57.76**
Himachal Pradesh	2.3	1.98	4.6	2.45	2.3	0.47	50.00	19.18
J&K	2.53	0.64	6.79	3.62	4.26	2.98	62.74	82.32
Uttaranchal	2.05	1.73	4.9	2.61	2.85	0.88	58.16	33.72
NWH region	**6.88**	**4.35**	**16.29**	**8.68**	**9.41**	**4.33**	**57.77**	**49.88**
NEH + NWH	**15.31**	**8.27**	**33.71**	**17.96**	**18.4**	**9.69**	**54.58**	**53.95**

(http://www.indiastat.com/table/agriculture/2/fodder19971998to20112012/449338/466304/data.aspx (Lok Sabha Unstarred Question No. 726, dated 24.11.2009)

Table 7. Some of the important fodder tree species, period of fodder availability and approximate yield

Sl No	**Botanical name**	**Common name (Nepali / Sikkimese)**	**Age of first lopping (years)**	**Approximate yield / tree (kg at age in year)**
2000 masl altitude and above				
1	Salix sp	Salix	8	8 – 10 (10)
2	*Populus cilliata*	Shinnka	4	5 – 7 (8)
1400 – 2000 masl altitude				
3	Castanopsis sp	Katuse	7	-
4	*Saurauia napaulensis*	Gogun	4 – 5	30 – 40 (20 – 25)
5	*Celtis australis*	Khari / Phutta	-	150 (5)
6	*Machilus edulis*	Kawala	-	60 – 90 (15)
7	*Prunus ceresoides*	Wild cheri	3 – 5	100 (8 – 10)
8	*Helixanthera ligustrina*	Lisso	15 – 16	400 (15 – 20)
9	*Machilus sp*	phumchi	-	-
10	*Schima wallichii*	Chillowne	-	-
1000 – 2000 masl altitude				
11	Ficus hookerii	Nevaro	5 – 7	20 – 80 (10 – 15)
12	*Ficus nerifolia*	Dudhilo	7 – 10	90 (9)
13	*Ficus semicordata*	Khanyun	4 – 5	270 – 300 (12 – 14)

14	*Brassaiopsis hainla*	Chuletro	4 – 5	50 – 150 (4 – 10)
600 – 2000 masl altitude				
15	Ficus subincisa	Lute Khanyun	4 – 5	160 – 200 (7 – 8)
Below 1600 masl altitude				
16	Ficus bengalensis	Bar	5 – 6	500 – 700 (30)
17	*Ficus infectoria*	Kabra	5 – 10	60 – 80 (15 – 30)
18	*Ficus hirta*	Khasre	5 – 8	-
19	*Ficus glaberrima*	Pakhure	5 – 6	60 – 100 (1 – 12)
20	*Litsea polyantha*	Kutmero	5 – 6	150 (12 – 14)
21	*Erythrina arborescens*	Faledo	-	-
22	*Malotus philippensis*	Sindure	7 – 8	160 (50)
23	*Celtis orientalis*	Khari	7 – 8	160 (50)
24	*Bauhinia variegata*	Koiralo	-	50 – 75 (10 – 12)
25	*Artocarpus lakoocha*	Barhar	-	-
26	*Grewia elastica*	Sialphusre	-	-
27	*Lisea citrata*	Sil timur	-	7 – 8 (9 – 12)
28	*Bauhinia purpurea*	Tanki	-	-
29	*Betula cylindrostachys*	saure	-	-
30	*Ficus elastica*	Rubber tree	7 – 8	-

Deciduous tree species: Sl No 1,2,6,9,17,18,21,23,24,26,27,27,29 Singh et al., (1996)
Evergreen tree species: Sl No 3,4,5,8,10,11,13,14,15,16,19,22,30
Deciduous & Evergreen: Sl No 7,12,20,25

Table 8. Distribution of land and livestock holdings in North Eastern Himalayan region of India: 2003

Item	Landless (0 ha)	Marginal (<1.0 ha)	Small (1-2 ha)	Medium (2-4 ha)	Large (>4 ha)	All
Share in households, %	18.7	61.8	14.6	4.2	0.7	100.0
Share in land, %	0.00	23.8	24.2	28.2	23.9	100.0
Size of holding, ha	0.00	0.38	1.48	2.81	6.58	1.20
Share in livestock, %						
Cattle	0.0	59.0	27.8	11.1	2.0	100.0
Buffalo	0.0	57. 0	33.3	8.9	0.9	100.0
Sheep and goat	1.4	67.7	21.7	7.0	2.3	100.0
Pig	0.9	64.9	22.7	9.7	1.8	100.0
Poultry	3.0	68.7	19.8	6.9	1.6	100.0

Source: NSS Report, Land and Livestock Holdings, 2003

Table 9. Density of livestock in Himalayan region

	Cattle	Buffalo	Sheep	Pig	Goat

States / Species	Per sq.km	Per 1000 people	Per sq.km	Per 1000 people	Per sq.km	Per 1000 people	Per sq.km	Per 1000 people	Per sq.km	Per 1000 people
Arunachal Pradesh	6	335	0.07	4.32	0.16	9.8	4.25	768.4	4	221
Assam	131	331	5.55	14	6.6	16.6	20.86	158.7	79	198
Manipur	12	97	2.97	24	0.51	4.2	12.42	1050.7	3	24
Meghalaya	40	302	0.98	7	0.89	6.8	24.23	606.4	21	160
Mizoram	2	32	0.24	5	0.03	0.6	11.63	7093.3	1	20
Nagaland	14	119	1.97	17	0.23	1.9	30.38	2143.6	6	50
Sikkim	20	231	0.1	1	0.37	4.3	4.21	212.9	16	187
Tripura	90	258	1.03	3	0.3	0.8	34.57	382.1	58	166
NEHR	**51**	**292**	**2.21**	**13**	**2.19**	**12.6**	**15.08**	**297.5**	**30**	**172**
Himachal	39	313	12.86	104	14.46	117.4	0.09	2.3	20	163
J&K	13	223	3.32	59	15.25	270.1	0.01	0.9	9	161
Uttaranchal	38	198	18.47	98	6.89	36.4	0.37	9.9	26	135
NWHR	**21**	**236**	**7.37**	**83**	**13.77**	**154.6**	**0.08**	**3.9**	**14**	**153**
NEHR + NWHR	**34**	**269**	**5.09**	**40**	**8.65**	**68.4**	**6.71**	**53.0**	**21**	**165**
India	58	158	33.07	90	19.8	53.8	3.13	8.5	41	112

Compiled from Livestock Census Report, GoI (2012).

Table 10:Energy and protein requirement of growing heifers reared at high altitude

BW (kg)	Gain (kg)	Nutrient requirement/d					
		Energy		CP	DCP	%Extra requirement	
		ME (Mcal/d)	TDN (kg)	(g/d)	(g/d)	ME/TDN	CP/DCP
100	0	5.64	1.57	140	70	11.29	10.00
	0.1	5.97	1.66	264	145	10.61	11.65
	0.2	6.26	1.74	320	192	10.07	13.18
	0.3	6.61	1.84	372	242	9.49	10.83
	0.4	6.94	1.93	418	293	9.00	10.99
	0.5	7.29	2.02	465	349	8.53	9.61
150	0	7.73	2.15	200	98	12.50	7.80
	0.1	8.21	2.28	295	159	11.69	9.52
	0.2	8.60	2.39	375	221	11.10	10.63
	0.3	9.02	2.51	440	282	10.52	10.63
	0.4	9.49	2.64	492	339	9.95	9.83
	0.5	9.96	2.77	530	392	9.44	10.62
200	0	9.68	2.69	240	115	13.43	10.19

	0.1	10.26	2.85	350	186	12.56	10.30
	0.2	10.77	2.99	440	255	11.90	10.09
	0.3	11.34	3.15	515	324	11.23	9.81
	0.4	11.91	3.31	566	385	10.64	10.64
	0.5	12.49	3.47	602	439	10.09	10.09
250	0	11.52	3.20	280	132	14.20	14.20
	0.1	12.22	3.39	400	208	13.28	13.28
	0.2	12.08	3.55	490	279	12.60	12.60
	0.3	13.42	3.73	575	357	11.94	11.94
	0.4	14.16	3.93	630	422	11.25	11.25
300	0	13.28	3.69	310	143	14.86	14.86
	0.1	14.09	3.91	340	173	13.89	13.89
	0.2	14.77	4.10	560	314	13.16	13.16
	0.3	15.54	4.32	636	388	12.43	12.43
	0.4	16.30	4.53	697	460	11.79	11.79
350	0	16.64	4.62	380	171	15.97	15.97
	0.1	17.59	4.89	500	250	14.97	14.97
	0.2	18.51	5.14	600	330	14.13	14.13
	0.3	19.67	5.46	681	409	13.18	13.18

NRC (1989 & 2001)

Table 11: Nutrient requirements of lactating cattle* at high altitude and exposed to cold (<5^{0}C) stress.

BW (kg)	Milk Yield(kg)	Nutrient requirements/d			Nutritive		% Extra requirements	
		DM(kg)	TDN(kg)	CP(kg)	TDN	CP	ME/TDN	CP
200	2	5.5	3.33	450	60.55	8.18	32.91	21.84
	3	6.0	3.66	550	61.00	9.17	29.45	19.74
	4	6.5	3.98	650	61.23	10.00	26.37	18.33
	5	7.0	4.30	700	61.43	10.00	23.87	9.49
	6	7.5	4.62	800	61.60	10.67	21.79	9.69
250	2	6.2	3.87	500	62.42	8.06	36.05	23.82
	3	6.7	4.19	600	62.54	8.96	32.32	21.50
	4	7.2	4.51	650	62.64	9.03	29.28	11.34
	5	7.7	4.83	780	62.73	10.13	26.75	15.76
	6	8.2	5.15	920	62.80	11.22	24.62	20.45
300	2	7.0	4.33	540	61.86	7.71	36.72	23.68
	3	7.5	4.66	640	62.13	8.53	33.56	21.53
	4	8.0	4.93	750	62.25	9.38	30.68	21.63
	5	8.5	5.30	870	62.35	10.24	28.24	23.12
	6	9.0	5.95	980	66.11	10.89	33.56	23.02
	8	10.0	6.59	1200	65.90	12.00	29.24	22.87
350	3	9.5	5.59	700	58.84	7.37	36.46	18.96
	4	10.0	5.91	800	59.10	8.00	33.76	17.92
	5	10.5	6.23	920	59.33	8.76	31.42	19.73
	6	11.0	6.55	1020	59.55	9.27	29.38	18.82
	8	12.0	7.20	1200	60.00	10.00	26.17	15.56
	10	13.0	7.84	1400	60.31	10.77	23.45	14.90

NRC (1989 & 2001)

Table 12. Consumption of fertilizer during 2011-12

States	Per hectare fertilizer consumption (kg)			
	N	P_2O_5	K_2O	Total
Arunachal Pradesh	1.88	0.8	0.33	3.01
Assam	37.92	12.32	18.96	69.2
Manipur	36.31	5.21	1.86	43.38
Meghalaya	12.26	6.11	1.57	19.94
Nagaland	1.89	1.34	0.57	3.8
Sikkim	8.47	0.76	1	10.23
Tripura	31.66	17.73	11.46	60.85
NEH region	**18.63**	**6.32**	**5.11**	**30.06**
Himachal Pradesh	36.1	12.31	10.36	58.77
J&K	63.37	30.95	10.08	104.4
Uttaranchal	103.74	24.69	8.36	136.79
NWH region	**67.74**	**22.65**	**9.6**	**99.99**
NEH + NWH	**33.36**	**11.22**	**6.46**	**51.04**

Department of Agriculture and Cooperation (2012). Indian fertilizer scenario 2012. Dept. of Fertilizer, Ministry of Chemical and Fertilizer, Govt. of India.

Fertility prediction and selection of quality breeding bulls for dairy farming

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Introduction:

Fertility is defined as the capability to produce offspring. Bull fertility is measured by the number of viable animals that have been sired by a specific bull. It is the ability of the sperm to fertilize and activate the egg and sustain development of the conceptus. Bull fertility is measured by the percentage of cycling females exposed to the bull and impregnated during a specific time period (usually 60–90 days). Actual fertility levels are the result of a combination of genetic potential and environmental factors including nutrition, health, and cow and bull management. It is not feasible to determine true fertility before a bull is used in the herd. Nevertheless, a bull can be evaluated for breeding soundness and this information used to assess his potential fertility. A high fertile bull will impregnate 80% - 90% of the cows he services in the first 21 days of the breeding cycle. The sub-fertile bull will impregnate 60% - 75% in the first 21 days of the breeding cycle. A bull below the sub-fertile line can be as low as 10% conception.

Bull is considered as half the herd. Male infertility has received much lesser attention inspite of its greater contribution in improving any herd. Application of Artificial Insemination provided a platform for extensive use of a single bull. Some bulls are known to have sired 100000 to 200000 cows in their lifetime. Therefore, fertility prediction of bulls is an area of research that has been active for some time.

For a bull to be fully fertile and perform to full potential each of the following components must be considered:

- Libido (sex drive) and physical fitness
- Ability to achieve intromission and deposit semen in the vagina
- Production of sufficient quantities of high quality semen
- Absence of disease that could be transmitted to cows during breeding e.g. Bovine Virus Diarrhoea (BVDV) or Campylobacter etc.

Selection of breeding bulls:

For selection of breeding bulls a basic breeding soundness evaluation (BSE) mainly consists of:

- Physical examination of the animal
- Examination of reproductive organs.
- Measurement of scrotal size.
- Evaluation of semen.

In addition, following routine procedures may also be included in the BSE:

- Mating ability
- Pelvic measurement
- Test for sexually transmitted diseases

Physical Examination

The bull need to be examined physically for any deformities. It should be able to see, eat, smell and move around successfully to be physically fit to breed the females. Recent history of illness and vaccination should be taken into account as semen quality or/and quantity is affected by these factors.

The bull should have a proper vision. Bulls with weak vision are usually dominated by other bulls and his breeding efficiency gets reduced. Proper vision enables bulls to detect females in heat. Therefore, both eyes should be examined carefully, they should be free from any injuries, diseases or cancerous growths. Loss of vision in bulls due to different factors may became a reason to cull bulls many a times.

Most importantly for a breeding bull the feet and legs are to be examined properly. Strong feet and legs enable them to mount and serve a female successfully. Bulls with structural defects of feet and legs should not be selected for breeding. Some of the structural faults are heritable. Such defects should be identified and bulls should be rejected for breeding purpose. Diseases of the foot including foot rot, interdigital corns, and puncture wounds can be treated and such bulls may be selected after recovery.

Examination of reproductive organs

Following physical examination of the bulls, the reproductive organs should be properly examined. The internal organs can be examined by per rectal palpation. The accessory sex glands should be examined for inflammation, adhesion or fibrosis. The spermatic cord, scrotum, testicles and epididymis need to be examined for abscesses, injury, frost bite or tumors. Testicles should be firm, equal in size and adequate to large for the bull's age. Testicular hypoplasia is a highly heritable trait, bulls with such conditions should be rejected.

The penis and sheath should be properly examined for any defects like sores, lacerations, abscesses, scar tissue, hair rings, warts or adhesions. Persistent penile frenulum is occasionally found in young bulls, but it can be corrected. Old lacerations and adhesions may prevent the penis from being fully erect and causes pain during breeding. Bulls with any type of painful lesions lose their desire to breed cow. Warts on penis are seen in young bulls. These may be surgically removed and in severe cases, such bull should be culled.

Measurement of scrotal size

Scrotal circumference correlates with daily semen production. Bulls with bigger testicles usually produce more semen and sires male calves with bigger testicles. Breed have an influence on the scrotal size. Zebu cattlr (*Bos indicus*) or breeds having percentage of Zebu blood tend to have smaller testicles compared to *Bos taurus* breeds. Scrotal circumference is given a score based on the age of the bull, presented in the following table:

Age of the bull	Minimum scrotal circumference

< 15 months	30 cm
15-18 months	31 cm
19-21 months	32 cm
22-24 months	33 cm
>24 months	34 cm

Evaluation of semen

Many a times, a bull found satisfactory in physical and reproductive organ examination may still have low fertility due poor semen quality and quantity. Therefore, semen evaluation is an important parameter in bull selection for breeding purpose. Routinely, the ejaculate should be examined for motility, concentration and morphology. The sperm concentration along with the volume represents the total sperm output of the bull, providing an indicator of the bull's serving capacity.

Individual sperm motility in another important factor determining the fertility of bull. A sperm sample should contain more than 90 per cent vigorous, progressively motile sperm cells. Sperm morphology is another important semen characteristics. Stained sperm slides should be examined under microscope for morphology studies. Sperm cells with droplets, bent or coiled tails, deformed heads or other defects are less likely to fertilize an egg and sustain pregnancy. Abnormal sperm should usually be less than 25 percent of total sperm cells to qualify a bull for breeding.

Mating ability

Libido or sex drive is important to select a bull for breeding purpose. Semen production, scrotal size or hormone levels do not relate satisfactorily with bull's mating performance. Therefore, visual observation of bull serving a cow is a good indicator of bull's fertility. Assessment of libido and mating ability is important to help in detecting physical abnormalities that prevent a bull with good semen quality to fertilize a cow. Libido and semen production do not appear to have any relationship, so it is possible to get good semen from low-libido bulls and vice versa. Libido may be tested by placing a bull in front of a heifer in standing heat.

Pelvic measurement

Pelvic area measurement is another important tool for bull selection. This trait is highly heritable with heritability value of 0.55. Genetic correlation between pelvic size and growth is also positive. Therefore, selecting both bulls and cows for pelvic size, a herd of cows could be developed with larger pelvic area. This may lead to increased growth rate and weaning weight in calves. Selecting bulls on pelvic size will result in increased pelvic size of daughter offspring. Hip height, frame score and scrotal circumference were found to have positive correlation with pelvic size. Table below represents minimum pelvic areas for yearlings and two year old bulls:

Age	**Pelvic Area**
Yearling	150 to 170 cm^2
2 years old	190-200 cm^2

Test for sexually transmitted diseases/Venereal diseases

Bulls before selection for breeding should be screened for sexually transmitted diseases. Bulls failed to pass the screening should not be selected for breeding. Venereal diseases in the bull can influence in two ways —firstly by, failure of conception and secondly by loss of pregnancies through abortion or resorption. By definition, venereal diseases are those diseases that can be spread through natural service. These are usually transmitted by an infected bull mating with susceptible cows. However, an uninfected bull can spread the disease by mating with an infected cow and subsequently breeding a susceptible cow within a short period of time. More unusual cases can occur by the use of infected semen from custom collection of bulls and the failure to test the bull and/or semen for venereal diseases.

Venereal disease in cattle can be caused by bacteria, viruses, and protozoal organisms. *Campylobacter fetus* (Vibrio), *Trichomonas fetus,* Bovine Herpes Virus (a form of IBR), *Hemophilus somnus*, ureaplasma, mycoplasma, and Bovine Viral Diarrhea (BVD) are the most commonly recognized causes of venereal disease in cattle. Vibriosis and Trich are only spread by venereal contact. The viruses and bacteria can be spread through other contact with infected animals such as through aerosol spread through the respiratory tract.

Conclusion

Fertility in bull cannot be accurately predicted by single evaluation. A combination of test or procedures is required to determine the fertility of a bull. Selection of good quality breeding bull is a prerequisite for any dairy enterprise to be profitable. Therefore, thorough evaluations of bulls are important along with screening for venereal diseases. However, with the advancement in research now a day's some genetics and proteomic markers are identified by researchers to identify the fertile bulls.

Suggested Readings:

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Overview of Zoonotic Parasites and their control measures

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The north-eastern region is very rich in natural resources and great cultural diversity exists among different ethnic people of this region. Almost 70% of their livelihood depends upon agricultural activities and livestock rearing. Livestock economy has great influential role over their life to fulfill their economic demands and hunger of animal protein. Moreover, 90% of the people of this region are non vegetarian. Because of cultural and feeding habits of people of this region, they suffer from different zoonotic diseases through consumption of meat and meat products. Among different diseases, parasitic zoonoses is of one of the important causes of loss of productivity in domestic livestock as well as threat to public health. Moreover, occurrence of animal transmitted disease is one of the common phenomenons to the people of this region due to their feeding and socio-cultural habit. Food borne parasitic diseases have a major impact on the health and economy of the people in developing countries particularly in tropics and sub tropics including India. In India, particularly north eastern region are considered to be paradise of parasites due to congenial atmosphere of climate for completion of parasitic life cycle. However, the interactions between parasites, hosts and vectors are influenced by environmental, socio-cultural and livestock production changes that influence the distribution, prevalence and severity of disease. In this context , a systematic study on food-borne diseases more particularly on meat born diseases which includes Hydatid cyst, the water-borne trematodes Schistosoma spp., *Fasciola gigantica*, and other parasitic protozoa *Toxoplasma gondii* and Sarcocystis species are very important from the public health point of view. This aspect needs to be considered when assessing or developing regional control programs for north eastern region of India.

As most of the aforesaid parasitic zoonotic diseases cannot be diagnosed at ante mortem which could be diagnosed only in post mortem cases, it is very essential to develop sero-diagnostic kit so that these diseases can be diagnosed at an early stage in order to reduce the incidence of zoonotic parasites in bovines with allied domestic livestock as well as to enhance the profitability of the livestock farming by reducing the mortality due to this diseases. In this article, we will discuss only few important zoonotic parasites which are important from public health point of view.

Taeniasis

Taeniasis is one of the important zoonetic parasites that affect millions of people around the world. Prevalence is mostly seen in beef eating countries where hygienicity is less maintained. The 75% of the population may harbor the parasites where beef forms a part of the normal diet. The occurrence of disease was mostly seen in African countries. Middle East countries and south Asian countries like Iraq, Iran

Etiological agent: ***Taenia saginata***

Life cycle :

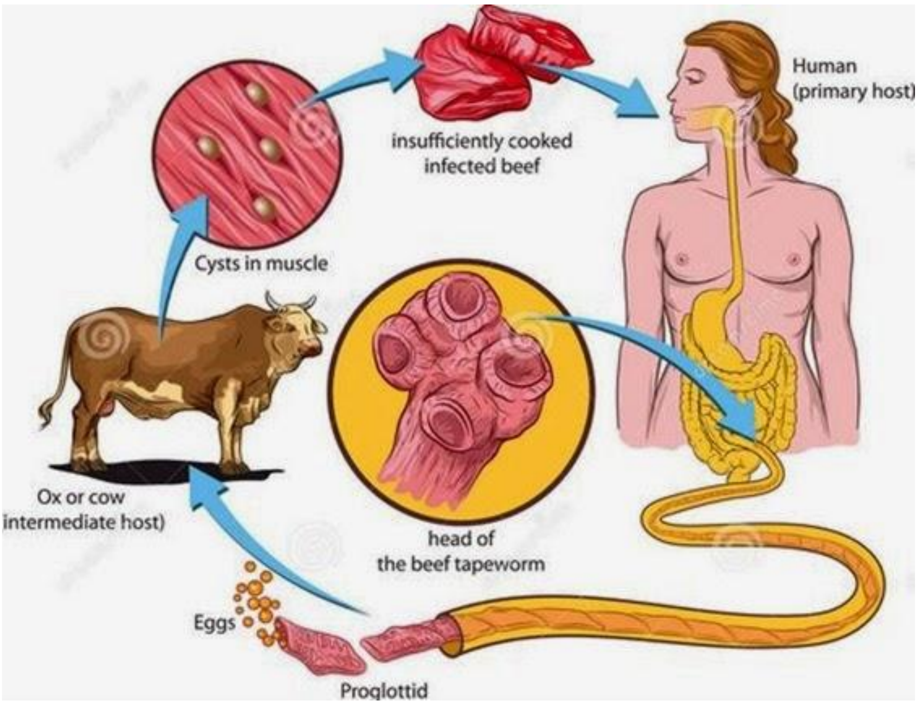

Fig: Shematic diagram of Taenia saginata (Source of figure is internet)

The gravid proglottids are motile and migrate spontaneously from the anus and contaminate the beds or grounds or pasture even through defecation, it contaminates the pasture. Open defecation by the people is great way of transmission and contaminate the pasture. The eggs of Taenia remain viable for several months in slum dwelling area and is a potential source of infection due to lack of hygienicity and overcrowded. The cattle may be infected through several ways like contaminated pasture and eggs hatched in the intestine under the influence of gastric & intestinal juice. The oncosphere hatched and penetrate intestinal mucousa and reach various part of the body through blood circulation. They localize different parts of body like intramuscular connectivity tissues, heart and masseter muscle as well as in subcutaneous fat. Man become infected through eating of raw (measly beef) affected with cysticerci.

The parasites in the man need 8-10 weeks for reaching mature stage and man pass gravid proglottids after 100 days of infection. The cysticerci which one present in the intramuscular connective tissues usually degenerate and may survive up to 9 months. The longevity of the infection depends on age of the infection of the animal, duration of the infection and immune status of the animals.

Clinical symptoms

In human most common symptoms are

1. Discharge of gravid proglottids from anus
2. Irritation and anal itching
3. Abdominal pain
4. Nausea
5. Reduce appetite and
6. Headache

Epidemiology

1. The cysticerci of *T. Saginata* are transmitted to human through the ingestion of raw or inadequately cooked beef.
2. Human can disseminate and contaminate the environment with large number of eggs up to 50,000 eggs/ day. These eggs are resistant to moderate desiccations, disinfectants or even in low temperature.
3. Infected farm workers also play a very important role in contamination of hay fields, silage and other feeds, irrigation water used on field crops
4. Indiscriminate defection by people in open fields is a potential source of contamination.
5. Taenid eggs can survive in sewage even after treatment, which are used as fertilizer in crop fields can contaminate the whole area.
6. Transmission can also mechanically possible by birds, earthworms, beetles which fed raw sewage sludge.
7. By wind also, egg can contaminate the surrounding pasture and environment.

Diagnosis

1. The cysticerci can usually diagnose during meat inspection.
2. However, antemortem diagnosis is only possible through different serological technique, however, is not specific and accurate in diagnosis.
3. Calcified intramuscular cyst can be detected with x-ray.
4. Biopsy of nodules located on the surface of skin or in subcutaneous tissues and muscle.

5. Eggs can be detected in faecal mass or anal swab. It is accurate and confirmatory diagnosis.

Treatment

1. Niclosamide @ 10 mg/kg bw
2. paraziquantel @ 10mg/kg bw

Prevention and control

1. Health education is must and compulsory.
2. Indiscriminate human defecation must be strongly discouraged.
3. Sewage should be treated to kill the eggs.
4. Cysticerci in meat can be killed by freezing at -20^0 C for 12 hours.

Toxoplasmosis

Toxoplasmosis is an intestinal coccidian parasites occurring wide range of warm blooded animals, including human being. The name is derive from (Toxon = arc and Plasma=farm) cresent shape of the tachyzoite. It has worldwide in distribution in definitive host like domestic cat, leopard, lion etc.

Toxoplasma gandii was discovered in two different species of anianmals a rodent (*Ctenodactylus gondii*) in North America and a rabbit in Brazil. As a causative agent of human disease was noticed only when Janaku described the parasite from retinal secrete of in fant who has died of congenital toxoplasmosis in 1923. It is caused by a parasite called *Toxoplasma gondii.* Humans acquire infection by ingestion of tissue cysts present in raw or undercooked beef, lamb or pork and ingestion of oocysts from soil, water, milk or vegetables. Toxoplasmosis is present in every country of the world and seropositivity rates range from less than 10% to over 90%. Worldwide, over 6 billion people have been infected with *T. gondii* (Klaren *et al.,* 2002). Seroprevalence in India is about 22% approximately (Srirupa *et al.,* 2011).Human infection is acquired by ingestion of tissue cysts in raw, poorly cooked meat of lamb and pork or ingestion of sporocysts derived from cat faeces containing soil or inadequately washed vegetables. Majority of congenital infections are caused when the mother acquires infection during pregnancy.

Life cycle:

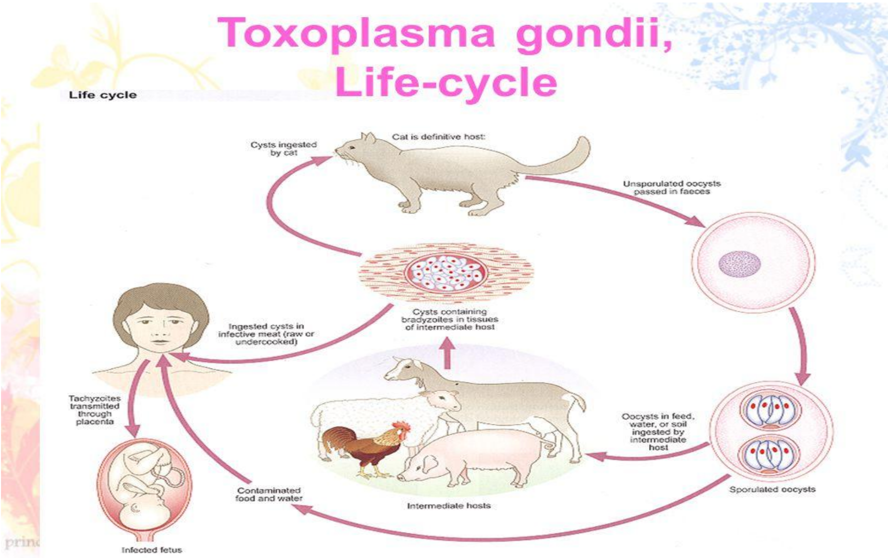

Fig: Life cycle of *T. gondii* (Source of figure is internet)

Life cycle consist of two phases

a. Asexual stage- occur in Intermediate and definitive host
b. Sexual stage- In definitive host only

There are three stages of parasites infactive stage i.e. the tachyzoites (in pseudocyst), bradyzoites (tissue stage) and the sporozoite stage (in oocyst)

The tachyzoites enter the host cell by phagocytosis and multiply asexually by repeated endodyogeny within the host cell. Tachyzoites are not usually infective when ingested as they are destroyed by the acid in the stomach.

Bradyzoites is actually the resting stage of parasites within the host cell, usually spherical contains thousand of crescent-shaped bradyzoites. This cyst may locate in different visceral organs like lung, liver, kidney, brain, eyes, skeletal and cardiac muscles. Infectious are also occur through laboratory accidents, transplacental infection of women and blood transfusion are well documented, However, fatal toxoplasmosis also noted during organ transplant when immune- suppressive therapy given.

Clinical Symptoms

Toxoplasmosis in man may occur as a congenital or an acquired infection or both forms may also noticed in individuals. In congenital cases- Abortion, miscarriage, still birth or birth of baby with manifestation of acute Toxoplasmosis like microcephaly. Two forms of congenital infection are noticed.

1. In generalized form- anaemia, jaundice, hepatospleenomegaly, lymphadenitis and retinochoroiditis are common. In neurological form like hydrocephalus, retinochoroiditis, convulsion and intracranial infection are well documented.

Acquired form

Acquired infection in less severe. Lymphadenopathy accompanied with fever, malaise and rash, It with fever, malaise and rash, It is a common congenital toxoplasmosis where chorioretinal involvement of brain is very common with 70-80% patients with also who are diagnosed as Toxoplasmosis.

During acute toxoplasmosis, symptoms are often influenza like: swollen lymph nodes, or muscle aches and pains that last for a month or more. Young children and immunocompromised people, develop severe toxoplasmosis. This can cause encephalitis or necrotizing retinochoroiditis. Infants infected via placental transmission may be born with either of these problems, or with nasal malformations. Swollen lymph nodes are commonly found in the neck or under the chin, followed by the axillae (armpits) and the groin (Ling *et al.*, 2011). It is usually found at single sites in adults, but in children, multiple sites may be more common. Enlarged lymph nodes will resolve within one to two months in 60% of cases. However, a quarter of those affected take two to four months to return to normal, and 8% take four to six months. A substantial number (6%) do not return to normal until much later (Dubey *et al.,* 2006). Most infants who are infected while in the womb have no symptoms at birth, but may develop symptoms later in life (Foulon *et al.*, 2000). Skin lesions may occur in the acquired form of the disease, including roseola and erythema multiforme-like eruptions, prurigolike nodules, urticaria, and maculopapular lesions. Newborns may have punctate macules, ecchymoses, or “blueberry muffin” lesions (Dubey *et al.*, 2006).

Epidemiology

1. Incidence in animals and man depends on environmental condition, climate, animal fauna, cultural habit and feeding habitat of the people and also varies according to the different geographical area.

2. In majority of the congenital infection in man occur when the mother acquires the infection during pregnancy.

3. Toxoplasmosis also acquired the infection either by ingestion of food contaminated by mature oocyst or by eating undercooked or raw infected meat.

4. Mechanical transmission is also possible cockroaches and flies can spread oocyst mechanically.

5. Infection due to laboratory and autopsy accidents and handlings without proper care.

6. Blood transfusion is also possible.

7. Prenatal transmission is also possible.

Diagnosis:

Laboratory diagnosis includes detection of Toxoplasma specific antibodies which is the primary diagnostic method to determine infection with Toxoplasma. Antibodies are detected by numerous serologic tests and most of the test kits are commercially available to detect *T. gondii* specific IgG, IgM, IgA or IgE antibodies. The IFAT, LAT, DAT and ELISA are used more commonly. If more precise knowledge of the time of infection is necessary, then an IgG positive person should have an IgM test performed by a procedure with minimal nonspecific reactions, such as IgM-capture EIA. A negative IgM test essentially excludes recent infection. New born infants suspected of congenital toxoplasmosis should be tested by both an IgM- and an IgA-capture EIA. Detection of Toxoplasma-specific IgA antibodies is more sensitive than IgM detection in congenitally infected babies **(**Joao *et al.,* 2011). Detection of *T. gondii* in human blood samples, CSF and amniotic fluid may also be achieved by using the polymerase chain reaction (Webster *et al.,* 2010). The other methods of diagnosis are imaging methods and immunohistochemical studies.. Biopsy of enlarged lymph node for histopathology and culture. Whole blood or CSF in acute phase for culture of the parasites.

1. A rapid diagnosis can be made by microscopic examination of impression smears stained with Giemsa technique.

2. Laboratory animal inoculation: Infected tissue samples are ground with physiological saline solution in a pestle and mortar and inject intraperitoneally inoculated into albino mice. When Toxoplasma is present, the animal shows the presence of peritoneal exudates in 7-10 days and easily examined peritoneal fluid under the microscope.

3. In Immunoperoxidase method, tachyzoites react positively with immune serum and can be confirm within a few hours.

4. Numerous serological procedure are also available for confirmation or detection of Ag or Ab in serum e.g Sabin-Feldman dye test, Complement fixation test, Modified agglutination test and ELISA etc.

Treatment

1. Sulphonamides and Pyrimethamine are two drugs used commonly for the treatment of Toxoplasmosis.
2. Trimethoprim and Sulfamethoxazole can also be used as an alternative option.
3. Spiramycin
4. Roxithromycin
5. Monensin
6. Chlorinated Lincomycin analogue.

Prevention and control measure

1. A new live toxoplasmosis vaccine" Toxovax" has been introduced in UK
2. Proper cooking of meat. Heating meat at 66c kill the organism.
3. Sand and soiled represent a common source of infection to children
4. Pregnant mother should be away from pet animals like dog and cat.
5. Routine serological check up of pregnant women.
6. Treatment of infected pregnant mother will be a valuable step in protecting foetus.

7. Preventive measures include avoiding eating raw or undercooked meat, washing fruit and vegetables before cooking and eating, avoiding drinking unpasteurized goats' milk or eating products made from it, avoiding handling or adopting stray cats

8. Routine antenatal screening for toxoplasmosis and treatment of infected mothers would be an effective step in protecting the fetuses from toxoplasmosis. No vaccine is at present available for this disease (Joao *et al.*, 2011).

Hydatid cyst:

Hydatid cyst is a zoonotic disease, one of the growing concern in developing countries like India and as far as India is concerned north eastern region of India is gaining attention in this regard due to socio-economic, cultural and feeding habitat of the people of this region. Among zoonotic parasites, cystic echinococcosis (CE), caused by the metacestode stage of the tapeworm *Echinococcus granulosus*, is a neglected zoonotic disease producing economic losses in animals and high morbidity and mortality rates in humans. The geographical distribution and endemicity of CE differs by country as well as by region and is influenced by different biotic and abiotic factors. Moreover, high environmental egg concentration in specific rural settings constitutes an epidemiologically important issue related to CE transmission.

Life cycle:

The life cycle of *E. granulosus* involves a definitive host (dogs and other canids) for the adult *E. granulosus* that resides in the intestine, and an intermediate host (sheep and other herbivores) for the tissue-invading metacestode (larval) stage. Humans are only incidentally infected; since the completion of the life cycle of *E. granulosus* depends on carnivores feeding on herbivores bearing hydatid cysts with viable protoscoleces, humans represent usually the dead end for the parasite. On ingestion of *E. granulosus* eggs, hydatid cysts are formed mostly in liver and lungs, and occasionally in other organs of human body, which are considered as uncommon sites of localization of hydatid cysts.

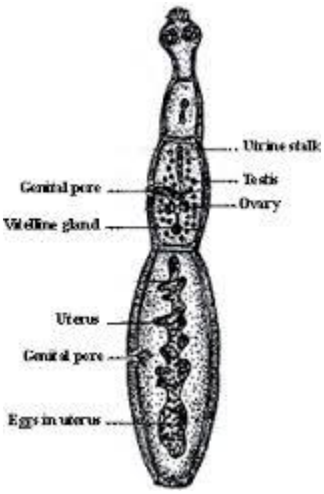

Fig: Adult parasites in the intestine

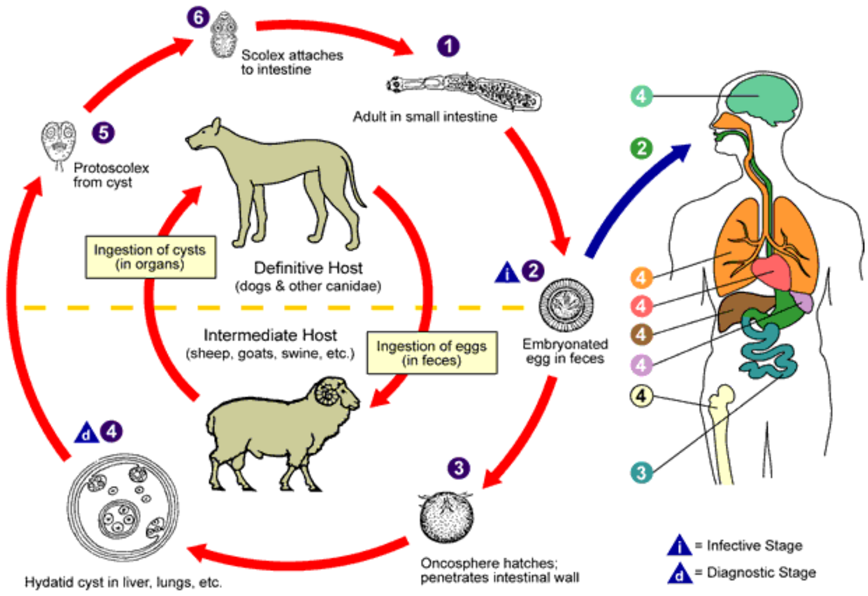

Fig: Life cycle of Hydatid cyst (Source of figure is internet)

Clinical symptoms:

Clinical symptom will be vary according the location of cyst. Sometimes ruptured cyst will cause anaphylaxis in patient.

Diagnosis:

Surveillance for cystic echinococcosis in animals is difficult because the infection is asymptomatic in livestock. Diagnosis and detection of *Echinococcus granulosus (sensu lato)* infection in animals is a prerequisite for epidemiological studies and surveillance of echinococcosis in endemic, re-emergent or emergent transmission zones. It has been known for many years that sheep infected experimentally with *E. granulosus* can mount detectable specific IgG responses within weeks which serve as the basis for the development of serodiagnostic techniques. Serological tests based on crude parasitic extract/ hydatid cyst fluid results in cross reaction with other taenid species rendering it less sensitive. So there is an urgent need to develop a specific as well as sensitive serological assay for generating accurate sero surveillance data. It demands development of recombinant antigen based assays and the proposed project will be aiming to develop the same as reliable data on the prevalence and incidence of echinococcosis in NE regions of India is not available at present.

Robust surveillance data is fundamental in order to show the burden of disease and to evaluate the progress and success of control programmes. However as for other neglected diseases, data is scarce and will need more attention if control programmes need to be implemented and measured.

Treatment

The diagnosis of extrahepatic echinococcal disease is more accurate today because of the availability of new imaging techniques, and the current treatments include surgery and percutaneous drainage, and chemotherapy (albendazole and mebendazole). But, the wild animals that involve in sylvatic cycle may overlap and interact with the domestic sheepdog cycle, and thus complicating the control efforts.

Conclusion

Keeping in view the essence of studies on epidemiology in the distribution of various parasites and use of molecular probes for identification of the parasites affecting our livestock, systematic studies on pathogenic zoonotic parasites are needed in order to address the problem. Also, proper identification of the species based on the molecular characterization of these parasites is required for proper mapping of the zoonotic parasites prevalent in domestic livestock of our country. This will help in formulating future control strategies on these parasites based on epidemiology.

REPRODUCTIVE MANAGEMENT OF DAIRY CATTLE FOR ENHANCING PRODUCTIVITY

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Fertility is a factor which has great effect on the economy of dairy farming. Fertility is, to a large extent, influenced by management. This means, the individual dairy farmer or herd manager plays a very important role in fertility control. In order to achieve the best possible reproduction results, sound management abilities are required. A useful parameter for determining the quality of the reproduction management should contain all important fertility features. The parameter used fertility determination is the calving interval. The calving interval is the period between one calving and the next. Important fertility aspects, such as the pregnancy rate after first insemination, the number of inseminations per conception and the number of days from calving to conception all have their influence on the length of the calving interval. The calving interval itself does not explain which part of the herd reproduction management needs improvement. A further study of how the calving interval is realized needs further discussion before any conclusions can be drawn. Any improvement in herd reproduction management means one step further towards sound and more profitable dairy farming.

ECONOMIC RESULTS

Better reproduction improve the economics of dairy farming in two ways:

- a higher total life-time milk production of the cows;
- a higher number of calves per year.

An additional advantage of a larger number of calves means that the selection opportunities within the breeding herd will increase further and consequently a higher income can be generated by selling calves or heifers. Research has revealed that the best possible average calving interval is about 365 days. This goal is not always achievable under all circumstances. But regardless of the conditions, it is always a challenge to strive for a calving interval of about 365 days.

IMPROVING THE REPRODUCTION

To improve the reproductive performance of the herd, one should consider all possible ways to achieve optimal results. This may involve many different managerial factors, which are all interrelated.

1. HEAT DETECTION

Heat detection has a major influence on the length of the calving interval. An optimal calving interval can be achieved only if the herdsman maintains a healthy, properly fed herd in which each mating is carefully planned. Planning starts months before the contemplated mating and therefore it is very important to have a well-planned and properly executed heat detection programme. There are a number of factors which make heat detection less easy, notably:

- the length of the estrus cycle varies from 18 to 24 days;
- Heat signs often occur over a shorter period only;
- The sexual behavior of cows in heat varies;
- The duration of heat varies from cow to cow, especially in maiden heifers;
- Sexual activity tends to be greatest between 6 pm and 6 am and mainly depends on the ambient temperature.

The intensity of sexual behavior depends on the number of cows in heat in a group. The signs of heat are obviously shown better when more cows are in heat at the same time. Loose housing without slippery floors and enough space is an advantage in detecting heat signs. Heat can be divided into three different stages. The signs of heat that may be shown will be described for each stage.

Early heat period

A sexual mature, non-pregnant cow comes in heat every 18 to 24 days. It starts with the development of an ovum in the ovary. At this stage the cow shows early signs of heat. The length of this period varies from 6 to 24 hours.

Signs of early heat are:

1. Not standing when mounted;
2. Attempts to mount other cows;
3. Sniffing at other cows;
4. Looking for the company of other cows;

5. chin resting; - being restless;
6. Being extra attentive;
7. A wet and slightly swollen vulva;
8. Bellowing.

Standing heat period

Early heat changes into standing heat. The length of this phase of heat ranges from 6 to 18 hours. It is shorter under tropical conditions than under more temperate conditions.

The signs of heat are:

1. Mounting other cows;
2. Chin resting;
3. Frequent bellowing and restlessness;
4. Attentiveness, 'ear play';
5. Bending backbone, loin part downward and sacrum upward;
6. Regular sniffing at reproductive organs of other cows;
7. Red and swollen vulva and clear mucous discharge;
8. Ruffled tailhead due to mounting;
9. Less appetite and generally less milk;
10. Slightly higher body temperature;
11. Glistening mucus on tail and hindquarters.

Late heat period

After the period of standing heat some cows continue to show behavioral signs of heat. This period is called the late heat period and can last for 12 to 24 hours.

Signs of the late heat period are:

1. Not standing when mounted;
2. The cow is sniffed by other cows and is sometimes sniffing other cows;
3. Clear mucous discharge from vulva;
4. Dry mucus on tail.
5. About two days after the end of heat, cows may show a bloody mucous discharge from the vulva. This can be of help in case of unclear or doubtful signs of observed

heat. The next heat period should then occur about 19 days (21 - 2) after the bloody discharge.

Regular observation

Most cows show the signs of heat better during the cooler periods of the day. Good detection results will be obtained when the cows are observed three times a day, preferably:

- in the morning, before and after milking;
- in the afternoon, before and after milking;
- in the evening around 10 o'clock.

Additionally, all other possibilities of detecting cows in heat should be used. The time required for good heat detection depends upon the:

- Experience of the person in charge;
- Number and breed of cows;
- Environment of the cows.

Generally, at least 20 minutes are needed each time to do a good heat check. In larger herds in very hot climates it may be wise to keep the cows also under surveillance at night.

Good recording

One of the most useful aids in heat detection is good record keeping. Good systems for proper fertility recording are, for example: a cow calendar, a herd fertility and health monitor chart and individual cow records. Even an ordinary calendar can be very useful. All data relating to the cow's reproductive status should be recorded, i.e. calving date, ease of calving, date of heat, insemination date, name of sire, fertility disorders and their treatment, etc. They also indicate when cows can be expected to be in heat, which cows need special attention and which cows should be inseminated when in heat. For instance, when a cow is seen in heat, this should be marked on the calendar or chart for a close observation of the cow three weeks later. There are also some computerised herd management and recording systems available. These software programmes assist in the daily herd management, daily action lists, herd performance monitoring and problem analysis, and are often flexible enough to be useful for many types of dairy facilities. However, the success of computer information depends mainly on the daily input of information by the dairy farmer. Complete records are essential to achieve optimal values. Which recording system is best depends on, among others, herd size, the system of management and preference of the dairy farmer. Important questions to be asked when choosing a recording system are:

a. Is the system user-friendly?
b. How much time does the system require?
c. Does the system monitor all cows throughoutlactation?
d. Is it easy to look up individual cow information?
e. Does the system provide action lists for day-to-day use?
f. Can the system provide a continuous and up-to-date feature of herd performance?

It is important to take these questions into consideration before selecting a system, because a system can be successful only if the dairy farmer enjoys working with it.

Additional heat detection methods

There are special features available to assist the dairy farmer with heat detection, such as paint-filled or pressure-sensitive devices glued on the tailhead of the cows, a chin-ball marking device for a teaser bull or a pedometer. A pedometer is strapped around the cow's leg, measuring the activity of the cow. When a cow is in heat, she is more active than usual. These aids cannot take over the dairy farmer's job, but can be used in addition to visual observation. Other indications may be a sudden decrease in milk production or feed consumption. Clear visual observation remains the most reliable indicator, however.

2. INSEMINATING AT THE RIGHT TIME

Inseminating a cow at the end of the standing heat period or at the start of the late heat period ensures the best results. Inseminating when the cow is still in early heat is useless. Where the insemination is done by an AI technician, all cows which were seen in heat in the morning, should be inseminated later that day. Cows that are still in heat the next morning, should be re-inseminated. When heat is first seen in the afternoon or evening, insemination can safely be postponed until the next morning (AM-PM rule).

3. INTERVAL FROM CALVING TO FIRST INSEMINATION

Although advancing the date of first service after calving will also advance the average date of conception, it is not wise to serve the cows as soon as possible after calving because:

- All cows need time to restore body reserves in early lactation;

- First-calf heifers require time to establish themselves in the herd before a new pregnancy is proceeded to;
- The conception rate will be very low; - calving intervals of less than 365 days are not advisable.

To achieve the best pregnancy results, a cow must be in perfect physical condition. This means that a cow must be fed according to her nutritional needs and must not have any health problems.

In order to maintain an average calving interval of one year, the average cow should be pregnant 90 days after calving. Therefore, cows should generally be inseminated for the first time between 50 and 75 days after calving. This usually means the second or third heat after calving. As regards high-yielding cows or cows with fertility problems, such as a retained placenta or endometritis, it may be advisable to postpone the first insemination for a while. Cows which do not show heat within about 60 days after calving should be checked by a veterinarian.

4. REPEAT BREEDERS

Unfortunately not all inseminations result in a successful pregnancy. Sometimes a cow does not conceive at all after several inseminations. It also happens that cows conceive well, but sometimes the embryo or foetus dies after conception. The loss of a conception during the first 42 days of pregnancy is called embryo death, and foetal death between 43 and 151 days of pregnancy. After this period/ it is called abortion. Embryo loss can happen without any clear visible sign. It is very important that heat detection is continued after a cow has been inseminated. Especially when no heat signs have been observed 3 weeks after insemination, one may think that the cow is pregnant. However, at this time this is not certain yet. Therefore, continued observation should take place at intervals of 3 and 6 weeks after insemination. If the cow comes back in heat (repeats), she should be inseminated again to avoid losing time and money. Cows without any signs of heat should be pregnancy-tested by a veterinarian about 6-8 weeks after the last insemination in order to be absolutely certain that the cow is pregnant. This may prevent disappointments.If a cow is not pregnant after several inseminations, one should consider culling the cow. If there are more cows with such problems, it is advisable to contact the veterinarian. He can detect the cause of these problems, which often are of a managerial nature. The choice between giving a cow another chance or culling it because of its reproductive problems should mainly depend on economic considerations, e.g. the milk production and the breeding value of the cow should be taken into account. Problem breeders can be early identified by means of accurate recording and regularly scheduled visits of a veterinarian.

5. QUALITY OF INSEMINATIONS

The person performing the inseminations has a great influence on the pregnancy rate. The best results will be obtained by an experienced AI technician. In hot climates, where cows have a shorter heat period, AI service should be available during the whole day. However, proper training in AI techniques is essential to obtain optimal results. Monitoring the individual results of the technicians performing the inseminations helps to evaluate and improve the pregnancy results. Next to the performance of the AI technician, the quality of the semen also has a major influence on pregnancy rates. There is a considerable difference in quality of semen from different bulls. Furthermore, in order to get good pregnancy results, semen should be stored in a regularly tested storage tank.

6. NUTRITION

Good nutrition means the provision of sufficient energy, proteins, minerals and vitamins. Providing a well-balanced ration does not only result in more milk, but also in better reproductive performance. In early lactation, when the milk production is at its peak, it is very hard to adjust the daily dry matter intake to the nutrient requirements of the cow, especially a high-yielding cow. A cow’s dry matter intake develops slowly during early lactation, and as a consequence an energy deficit per day is common at this time. This deficiency can be made up by mobilising the body reserves, mostly fat and a little protein. Therefore it is important for the cow to have the required level of nutrition during the preceding lactation and dry period. Cows that are (too) fat at calving seem more likely to get problems at calving and to develop insufficient dry matter intake in early lactation compared with cows calving at the right condition. If the diet of the cows does not contain sufficient green roughage or contains a high level of by-product feeds, deficiencies of vitamin A, phosphorus, copper, cobalt, iodine and/or selenium may arise. This may cause problems in high-yielding cows. It is important that cows continuously have access to good quality minerals of the required composition. Feeding rations with sufficient and good quality roughage, and formulated for correct levels of protein, energy, minerals, vitamins and trace elements will normally result in a short period between calving and first heat.

7. HYGIENE

Good hygiene, especially around calving is essential. Cleaning of the cow's vulva, birth-ropes and your hands before the calving process and having a clean, disinfected pen for the cow to calve will normally be sufficient. If these things are neglected, uterine inflammation (endometritis) may occur. It affects the cow's subsequent fertility and it will take longer before the uterus is ready for another pregnancy. Endometritis can be diagnosed by a white mucus discharge from the vulva. It can be treated by a veterinarian, but on the other hand, the uterus may also clean itself naturally when the cow returns into heat.

SUMMARY

For profitable dairy farming it is important to strive for optimal reproductive performance, thereby aiming at a calving interval close to 365 days. In order to achieve these results, the herd reproduction management should be at a high level. Good management is the best guarantee for good results. The basic guidelines for good reproduction management are:

1. Practice frequent heat detection, at least three times a day and at least 20 minutes each time;
2. Record all data relating to the cow's reproductive status, predict heats by making use of these records and observe the cow closely at those dates;
3. Cows that are seen in heat and are eligible for insemination should be inseminated about 10-15 hours later;
4. Most cows should be inseminated for the first time 50-75 days after calving, which is usually the second or the third heat;
5. Cows which have been inseminated should be checked for heat at intervals of 3 and 6 weeks after the last insemination;
6. Pregnancy diagnosis 6-8 weeks after the last insemination by a veterinarian will give absolute certainty about the cow being in calf;
7. Inseminations should be carried out by a trained AI technician;
8. Aim at the right body condition at calving;

9. Especially in early lactation, cows should be fed well-balanced rations of high-quality roughage and concentrates with the required minerals available at all times;
10. Maintain high hygienic conditions at calving.

Infertility in dairy cattle and its ameliorative measures

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Cattle and buffalo are an integral part of the mixed crop-livestock smallholder farming systems in the developing countries. Apart from being a crucial source of high quality food (meat and milk), dairy farming provides employment, sustainable income and social security to millions of smallholder farmers.

Fertility means the ability of the animal to produce live offspring. Infertility is the inability of the animal to produce living offspring due to temporary causes. Whereas sterility is the inability of the animal to produce living offspring at all. Dairy production systems that use cows that have been highly selected for milk production in recent decades have suffered a decline in cow fertility. Fertility is a multi-factorial trait and its deterioration has been caused by a network of genetic, environmental and managerial factors and their complex interactions make it difficult to determine the exact reason for this decline. This chapter focuses on factors that affect fertility and the successful establishment of a viable/sustainable pregnancy within 83 days of calving in 80% of dairy cows.

1. **Genetic and management effects on milk production and fertility**

Understanding genotype by environment interactions is crucial in determining the best health and management practices to achieve high levels of productive and reproductive efficiency. Recent studies have reported higher reproductive performance in high milk producing herds (herd average of >10,000 kg milk production per lactation) than low producing herds and concluded that this was likely due to better nutritional and reproductive management (LeBlanc, 2010). In addition to increases in milk production, increases in herd size, changes in housing conditions and increases in do-it-yourself artificial insemination have all contributed to increased difficulty in managing the high producing dairy cow to achieve high fertility. However, unlike lactating dairy cows, nulliparous dairy heifers with similar genetic merit for milk production have higher conception rates (39% vs 64%, respectively) and this has not decreased during the period of genetic improvement in milk yield (Pryce et al., 2004). Hence, it is reasonable to suggest that demands of high milk production negatively impact a number of physiological pathways to reduce the likelihood of the concomitant establishment of pregnancy and that changes in management practices may go a long way to providing solutions to poor fertility in high producing cows.

2**. Factors in the early post partum period affecting subsequent fertility**

Events in the post partum period are also influenced by pre partum management, most notably nutritional management. Poor nutrition during the pre partum period can lead to a cow at calving that is more susceptible to increased metabolic disorders, body condition score (BCS) loss and a more severe negative energy balance. At the other extreme, high dry matter intake increases the metabolic clearance rate of steroid hormones and this can lead to periods of sub oestrus and decrease oestrus detection efficiency.

2.1. Body condition score loss and negative energy balance

High milk producing dairy cows experience a substantial increase in energy requirements to facilitate the dramatic increases in daily milk yield, which peaks between 4 and 8 weeks postpartum. This requirement is only partially met by increased feed consumption (due to limitations in intake and appetite) with the remainder being met by mobilisation of body reserves resulting in animals entering negative energy balance (NEB). The consequences of severe NEB are an increased risk of metabolic diseases, that largely occur within the first month of lactation, reduced immune function and a reduction in subsequent fertility. Cows in low BCS at calving, or that suffer excess BCS loss early postpartum, are less likely to ovulate, have a reduced submission rate to artificial insemination, conception rate to first service, 6-week in-calf rate and also have an increased likelihood for pregnancy loss and increased calving to conception interval. This can partly be attributed to impaired oocyte competence associated with a low BCS (1.5–2.5; 5- point scale). Fertility in cows that are over conditioned at calving (BCS≥3.5; 5-point scale) is also compromised as they have reduced dry matter intake (DMI) just prior to calving, take longer to increase DMI postpartum, tend to have greater fat mobilisation and therefore a more severe NEB early postpartum than cows with an optimum BCS at calving. Heat stress can further exacerbate the effects of NEB. During periods of heat stress, lactating cows have a reduced appetite and higher BCS loss early postpartum compared to non heat stressed cows. Furthermore, concentrations of glucose, IGF-I and cholesterol are lower, while concentrations of NEFA and urea are higher in blood and follicular fluid of heat stressed animals. These changes, along with a decrease in dominant follicle diameter, and coupled with a more severe NEB in heat stressed cows make achieving high reproductive efficiency in subtropical and tropical climates a greater challenge. Thus, this highlights the importance of monitoring body condition score pre- and postpartum as an aid to nutritional and management decisions in order to ensure a mild, but not severe NEB occurs early postpartum and to minimise its carry-over effects into the remainder of the lactation. In conclusion, minimising BCS loss in the first few weeks post partum is an imperative. It is recommended that cows have a BCS of 2.75–3.0 (scale 0–5) at calving and that they are managed to suffer a BCS loss not more than 0.5 between calving and first service.

2.2. Metabolic disorders

During the period which extends from 2 weeks pre-calving to about 4 weeks post-calving, dairy cows experience the stress of parturition, the commencement of lactation, the increased demand for energy and protein to meet milk production combined with reduced feed intake which is generally inadequate to meet her maintenance and production requirements. Thus cows enter a period of NEB characterised by marked changes in endocrine, metabolic and physiological status. This time period is also associated with increased oxidative stress in the dairy cow and this, coupled with the aforementioned stressors, may play a role in compromising the immune and inflammatory response of the cow to these changes. Immuno-compromised dairy cows are at risk of developing metabolic disorders, which include acidosis, fatty liver disease, retained placenta and displaced abomasums. Metabolic disorders, caused by a mismatch between macro mineral requirements and availability in the diet such as clinical hypocalcaemia (milk fever), hypomagnesaemia and ketosis can further exacerbate the degree of immune-compromisation experienced in early lactation. Cows that suffer from metabolic disorders in the peri parturient period are more likely to have increased incidence of mastitis, lameness and endometritis all of which contribute to reduced reproductive efficiency. Due to NEB, insulin concentrations remain low which prevents an increase in liver growth hormone receptors and IGF-I secretion causing the somatotropic axis to be uncoupled. This negatively impacts reproduction as insulin and IGF-I are unable to synergise with the gonadotrophins on ovarian cells preventing the dominant follicle from ovulating and delaying the resumption of cyclicity. In conclusion, based on the evidence above the implementation of nutritional strategies during the dry period and early postpartum is the principle route to minimising the effects of NEB, reducing BCS loss and thereby avoiding the development of metabolic disorders thus leading to a healthy cow capable of establishing a pregnancy.

2.3. Uterine pathology, udder health and lameness

Uterine contamination at parturition or in the following days is unavoidable and normal with 80–100% of animals having bacteria in the uterine lumen in the first 2 weeks postpartum. The most prevalent uterine pathogenic bacteria in infected animals include Escherichia coli, *Arcanobacterium pyogenes, Fusobacterium necrophorum, Prevotella melaninogenica* and *Proteus species* and these are associated with increased endometrial inflammation and purulent vaginal mucus. Many cows successfully deal with this bacterial contamination; however, at least 20% of cows are unable to resolve the contamination and develop metritis within 21 days postpartum. In approximately 15–20% of the herd, persistence of pathogenic bacteria for 3 weeks or more results in clinical endometritis. The risk of infection is increased in cows with twins, stillbirth, dystocia or retained fetal membranes. However, even cows that are treated successfully for clinical endometritis have conception rates that are approximately 20% lower than in unaffected animals and an extra 3% of animals remain infertile and are culled.

The incidence of mastitis within the first 30 days postpartum is reported to be 23%. A positive genetic correlation between mastitis and milk yield (range 0.15–0.68) has been reported and consequently high yielding cows have an increased risk of developing mastitis. Cows that experienced clinical mastitis (diagnosed when visible abnormalities in milk were observed) in the first 28 days after calving had delayed onset of oestrous behaviour (91 days) compared to their healthy herd mates (84 days). Cows with clinical mastitis required more services per conception compared to their healthy herd mates (2.1 vs. 1.6, respectively) and had longer days empty (140 vs. 80, respectively).

Lameness is associated with increased number of services per conception and consequently lower conception rates to first service. Cows that were lame within 30 days post calving were also 2.63 times more likely to develop ovarian cysts before breeding and were half as likely to become pregnant than cows without history of lameness within the first 150 days of lactation. Firstly, histamine and endotoxins released during the decline of ruminal pH in animals suffering rumen acidosis act indirectly to destroy the microvasculature of the corium causing laminitis. These substances can also potentiate their affects at the neuroendocrine and ovarian level and compromise the LH surge system. Secondly, stress induced hormones may alter the GnRH and/or LH surge system. Finally, the degree of NEB may be greater in lame cows and hence affect the somatotropic axis. In conclusion, high producing dairy cows have reduced immune competence that can lead to increased incidence of lameness, mastitis and endometritis when compared to low producing dairy cows. The main efforts to improve fertility and overall herd health during this time should be aimed at increasing dry matter intake during the transition period, minimising NEB, decreasing BCS loss early postpartum and resolution of uterine infection

2.4. Resumption of cyclicity

A 'normal' post partum dairy cow can be defined as one which has resolved uterine involution, resumed ovarian follicular development, ovulated a healthy dominant follicle early postpartum and continues to have normal oestrous cycles at regular intervals of approximately 21 days, coupled with homeostatic concentrations of insulin, IGF-I and glucose. Up to 50% of modern dairy cows have abnormal oestrous cycles postpartum resulting in increased calving to first insemination intervals and decreased conception rates. Primiparous cows had more days to first ovulation (31.8±8.3 days) than multiparous cows (17.3±6.3 days). Additionally, primiparous cows have energetic demands for growth as well as lactation and may be in greater NEB than multiparous cows. Other risk factors cited for delayed resumption of cyclicity include periparturient disorders, season of calving, management, mastitis, lameness and severe BCS loss. In mastitic and lame cows, a delay in the resumption of cyclicity could add an extra 7 and 17 days, respectively to the calving to conception interval. Compared to their healthy herd mates, cows with clinical endometritis were 4.5 times more likely to have delayed resumption of ovarian cyclicity and 4.4 times more likely to have prolonged postpartum luteal phases. Endometrial epithelial cells respond to uterine infection by altering the secretion and thereby function of prostaglandins from luteolytic (prostaglandin F2) to luteotropic (prostaglandin E2) action. Pulsatile secretion of luteinizing hormone (LH) early postpartum is necessary for pre-ovulatory follicle growth, oestradiol secretion and ovulation of the dominant follicle. However, low BCS coupled with severe NEB during this period suppresses pulsatile LH secretion, reduces ovarian responsiveness to LH stimulation and also reduces the functional competence of the follicle characterised by reduced oestradiol production and ultimately results in delayed ovulation. Heat stressed animals may also have low LH pulse amplitude and frequency, low oestradiol concentrations and smaller dominant follicles which can extend the interval from calving to first ovulation. In conclusion, management factors that stimulate the early resumption of ovulation, leading to a number of oestrous cycles before insemination, will result in more cows getting pregnant than poorly managed cows that have prolonged periods of post partum anoestrus.

3. Factors affecting fertility during the breeding season

In order to obtain a 365-day calving interval the breeding season needs to commence 60 days postpartum and the cow needs to conceive by 83 days postpartum assuming 282 days gestation length. Insults that occurred in the early lactation period need to be overcome so that the dairy cow is in optimum condition to be bred. These include resolution of uterine infection, recovery from NEB and the establishment of normal oestrous cycles. However, there are many reasons that can prevent successful establishment and maintenance of pregnancy.

3.1. Oestrous behaviour

Normal oestrous cycles in cows coupled with overt signs of oestrus are essential so that insemination can occur at the appropriate time relative to ovulation. Coupled with poor expression, an inability to easily detect oestrus further hinders insemination at the correct time. Based on visual observation for standing heat and use of tail paint as an aid to detection an average oestrus detection rate of 70% has been reported with individual herd rates ranging from 25 to 96%. Studies that investigated oestrus detection rates using pedometers reported efficiencies between 80 and 100%. Risk factors for poor expression of oestrus are classified as either cow or environmental factors where cow factors include silent or anovulatory anoestrus, parity, milk production and health, and environmental factors include nutrition, housing, season and number of herd mates in oestrus simultaneously. In tie stall compared to free stall housing, overt signs of oestrus are reduced in cows. Furthermore, compared to free stall housing, cows on pasture exhibited less mounts per hour during oestrus (11.2 vs 5.4 mounts, respectively) and is partly explained because cows spend more time grazing than cows in confined housing.

High producing dairy cows (≥39.5 kg/day) have shorter oestrus (6.2 h vs 10.9 h), less total standing time (21.7 s vs 28.2 s) and lower serum oestradiol concentrations (6.8 pg/ml vs 8.6 pg/ml) compared to lower producing dairy cows (<39.5 kg/day). One hypothesis explaining the reduced oestradiol concentrations in high producing dairy cows is an increased metabolic clearance rate of oestradiol due to the higher dry matter intakes in high producing dairy cows. In support of this, nulliparous heifers have higher circulating concentrations of oestradiol around the time of oestrus and this may account for the longer duration of oestrus (11.3±6.9 h) and longer standing oestruses (16.8±12.8) observed in nulliparous heifers when compared to multiparous cows. Secondly, NEB has been linked to decreased pulsatile LH secretion and IGF-I concentrations. Both LH and IGF-I act synergistically to promote follicular development therefore follicular competence is compromised in these animals which leads to lower oestradiol concentrations resulting in poorer expression of oestrus. Finally, stressors such as lameness and mastitis reduce GnRH and hence LH pulse frequency, leading to short term decreases in follicular oestradiol production as well as delaying and reducing the magnitude of the LH surge. In conclusion, decreased duration and intensity of oestrus is a hallmark of high producing cows and is exacerbated during periods of heat stress. Therefore more attention and new tools to detect oestrus to ensure insemination occurs at the correct time are needed.

3.2. Fertilisation failure

Fertilisation rates in the 1980s in Holstein-Friesian dairy cows were greater than 95%; however, in a recent review of the literature, it was estimated that this figure has declined to 83% (Sartori et al., 2010). In contrast, fertilisation rates in heifers have remained consistently high at and greater than 90%. Heat stress between 50 and 20 days prior to AI has been associated with a reduction in oocyte quality and early embryo development. Similarly, cows exposed to heat stress prior to AI were 31–33% less likely to conceive than those not exposed to heat stress. Similar fertilisation rates between lactating and non-lactating cows have been observed (87.8 and 89.5%, respectively) during the cool season; however, lactating dairy cows had lower fertilisation rates than heifers during high ambient temperatures (55.6 and 100%, respectively). These findings indicate that in addition to heat stress, physiological status (lactating and non-lactating) can significantly compromise fertilisation success. Deficiencies in sperm characteristics such as viability, morphology and functional and molecular traits can impede fertilisation success. This can be through inability to reach the site of fertilisation (technician effect and bull effect), inability to penetrate the oocyte, inability to initiate fertilisation if contact is made with the oocyte, inability to prevent polyspermy and incompetence to maintain fertilisation process or subsequent embryogenesis. In conclusion, oocyte quality is poorly defined and the effects of metabolic disorders and disease in the post partum period on oocyte quality are not well understood. However, management of cows to reduce diseases and disorders (as described above) will likely have the additional beneficial effects of increasing oocyte quality and fertilisation rates.

3.3. Embryo mortality

The ultimate test of the quality of an oocyte is its ability to be fertilised and develop to the blastocyst stage, to establish a pregnancy and to produce a live calf. Embryonic mortality is one of the major causes of reproductive failure. Early embryo mortality occurs between fertilisation and day 24 of gestation, late embryo mortality occurs between days 25 and 45 at which stage embryonic differentiation is completed, while fetal mortality occurs after this and up to parturition. 20 and 45%, estimates for late embryonic/fetal loss ranged between 8 and 17.5% while estimates for late abortion ranged between 1 and 4% (Humblot, 2001).

3.3.1. Very early embryo mortality (days 0–7)

The causes of very early embryo mortality focus on the early embryos inability to develop as a consequence of poor oocyte quality or an inadequate uterine environment. There is general agreement that in vitro embryo development (to day 7) of oocytes from cows with high genetic merit for milk production is inferior compared to oocytes from cows of medium-genetic merit, irrespective of actual milk production. Furthermore, physiological status (lactating or non-lactating) has a significant effect on embryo quality. Embryos recovered at day 7 from non-lactating Holstein-Friesian heifers and beef heifers were of higher quality compared to lactating Holstein-Friesian cows. The very early embryo remains in the oviduct for 4–5 days after ovulation before travelling into the uterus. The oviduct provides nutrients (e.g. ions, amino acids and glucose) and local growth factors (e.g. IGF-I and IGF-II) to the developing zygote that can be modified by maternal nutrition, energy balance and lactation. The uterine environment before day 7 may also be suboptimal in lactating dairy cows for supporting early embryo development. The reproductive tract of the lactating dairy cow provides a less favourable environment for very early embryo development than that of the heifer. Progesterone is the hormone of pregnancy and its role in early pregnancy in cattle has received much attention in recent years. Animals that have an earlier increase in progesterone concentrations between days 4 and 7 after insemination (i.e. greater concentrations during this period) have a greater chance of maintaining a pregnancy than animals with a slower rise. In conclusion, the need to ovulate good quality oocytes needs to be restated, and the development of very early embryos in a uterus that had experienced a minimum of metabolic disorders and disease is desirable. An adequate increase in circulating progesterone concentrations before day 7 also substantially benefits later embryo development.

3.3.2. Early embryo mortality (days 7–24)

The embryo descends into the uterus between days 5 and 7 after insemination. During this time up to day 15 the embryo forms a blastocyst which develops into an elongated filamentous conceptus and occupies the uterine horn. The microenvironment of the uterus plays a leading role in determining embryo quality. Low concentrations of progesterone and IGFs can create a suboptimal uterine microenvironment that is unable to support early embryonic development. Uterine function is also compromised by the presence of pathogenic bacteria which can cause embryonic death and abortion. As previously mentioned, an early rise in progesterone concentration is associated with enhanced conceptus development and size around the time of maternal recognition of pregnancy. The challenge of the elongating conceptus is to produce adequate concentrations of interferon tau to signal maternal recognition of pregnancy and inhibit the release of luteolytic prostaglandin F2 from the uterus. This is more easily achieved by a larger than a smaller embryo. Early embryo loss due to the failure of maternal recognition of pregnancy is thought to account for up to 25% of failures of conception in dairy cows. It should also be noted that approximately 5% of embryos die because of gross chromosomal abnormalities preventing development. In conclusion, prior uterine infection and the development of small embryos (because of inadequate uterine environment caused low progesterone concentrations) significantly increase the chances of embryo mortality and decrease the likelihood of maternal recognition and the establishment of pregnancy.

3.3.3. Late embryo and early fetal mortality (days 24–285)

Late embryo and early fetal loss has been defined as the death of the embryo between days 25 and 45 of gestation and days 46 until parturition, respectively. Factors causing late embryo and early fetal loss are categorised as genetic, physiological, endocrinological and environmental. In addition, infection with pathogenic agents can cause embryo and fetal loss in cattle. Many bacterial, viral, fungal and protozoal pathogens have been associated with infertility and abortion in cattle and the subject has been comprehensively reviewed. Although the extent of late embryo and early fetal mortality is relatively low compared to losses observed within 24 days post insemination, it nonetheless presents financial losses and management difficulties to the dairy producer especially those operating a seasonal calving herd. Therefore, it is important to minimise exposure to environmental stressors and pathogens during mid to late gestation to avoid abortion and stillbirths.

4. Hormonal Causes of Infertility

Cystic ovarian disease

In cows with cystic ovarian disease there may be behavioural changes, with some cows showing nymphomania (bulling at short, less than ten days, intervals) or oestrus not observed. Rectal palpation reveals one or more large ovaries. Ultrasound scanning will reveal one or more structures that are greater than 25 mm. They may sometimes have a thickened wall greater than 2 mm. This structure usually persists within the ovary for more than ten days. The exact definition of an ovarian cyst is: a cystic (fluid-filled) structure within the ovary which is greater than 19 mm (normal ovulatory follicles never exceed 19 mm) that persists for longer than six days (longer than follicular phase of cycle).

Pathogenesis

The pathogenesis of cystic ovarian disease is much debated, but in simplified terms the follicle fails to ovulate, continues to grow and becomes cystic (Fig. 11). This failure of ovulation has many possible causes and these include problems with:

● Release of GnRH

● Oestrogen production

● No LH surge

● Other ovarian factors causing inhibition of ovulation.

These factors are poorly understood but may include problems such as adhesions preventing normal ovulation. In some cases the cyst has a thin wall of luteal tissue, forming a luteal cyst which produces progesterone.

NB: Large CLs with central lacuna may be misdiagnosed as luteal cysts. These are generally physiologically normal CLs and may be up to 30 mm. Many early CLs have these fluid-filled centres, which usually disappear as the CL ages, so it is uncommon to find lacunae in CLs of pregnancy.

Cysts are commonly found on the ovaries of cows calved less than 30 days; these usually spontaneously resolve with no treatment. Cysts may also occur on ovaries with CLs indicating cyclical activity; these may be benign structures compared to functional cysts.

Treatment

The different aetiologies of cysts may explain why some treatments are more effective on different farms. Treatments may be used alone or in combination with one another.

Follicular cysts

● LH is used in the treatment of follicular cysts.

This includes treatments that induce its release (GnRH), have LH-like action, such as human chorionic gonadotrophin (hCG) or LH itself may be used. (LH and hCG may stimulate immune reaction due to their large molecular size, but this is very unlikely with GnRH.) Treatment brings about an LH surge, with either induction of ovulation or luteinisation of the cysts. Where luteinisation occurs this is usually followed by luteolysis 16-18 days later. Earlier luteolysis may be achieved using PGF2a. Treatment with GnRH is usually either double the standard dose, or the standard dose followed seven days later by PGF2a

● Progestagens can be used to re-establish hypothalamic function and normal cyclical activity. Used alone, exogenous progestagen treatment for 12 days is required to reset the hypothalamus. This treatment causes atresia of oestrogen-active cysts.

Luteal cysts

● Progestagens: may have little effect on oestrogeninactive or luteal cysts

● PGF2a: where luteal tissue is present, PGF2a causes luteolysis and resumption of cyclical activity.

5. Infectious Causes of Infertility

Infectious agents can be responsible for reduced ovulation rates, fertilization rates, embryonic survival rates, fetal survival rates, or perinatal survival rates. Reduction of any of these may result in observed infertility. Reproductive pathogens include *Leptospira, Campylobacter, Hemophilus*, *Brucella, bovine herpesvirus-1, bovine viral diarrhea virus*, *Tritrichomonas foetus,* and *Neospora caninum*. Infectious infertility can be prevented or controlled with appropriate surveillance, biosecurity, and/or vaccination.

Bacterial causes

1. Leptospira

2. Brucella abortus

3. Listeria

4. Campylobacter

5. Hemophilus

6. Ureaplasma epizootic bovine abortion

7. Mycoplasma

8. Chlamydia

9. Anaplasma

10. Salmonella

Viral causes

1. IBR (Bovine herpes)

2. BVD

3. Bluetongue

4. Vesiviruses

5. Cache Valley virus

Protozoal causes

1. Tritrichomonas

2. Neospora spp.

3. Sarcocystis neuroni

Fungal causes

1. Aspergillus fumigatus

2. Mucor spp.

3. Mortierella wolfii

6. Conclusions

The first consideration is of NEB that leads to many negative outcomes and is a major factor contributing to the pathogenesis of infertility. In addition recovery from uterine inflammation and infection after parturition are critical for the uterus to provide a favourable environment for establishment and maintenance of pregnancy. Therefore, future strategies to improve fertility focusing on the early postpartum period should be based upon minimising the duration and degree of NEB and resolving uterine infection. On day 0 of the cycle (and pregnancy) detection of oestrus and insemination at the correct time relative to ovulation is paramount. A holistic approach is now needed and future efforts to improve fertility in dairy cow's needs to focus on genetic and management solutions to improve the physiological events associated with the establishment of pregnancy

Epidemiology and Control measure of gastrointestinal parasites of bovines

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Introduction

The epidemiology of parasitic diseases is determined by several factors governed by the environment and host-parasite interactions. This north-eastern region of India is known to be the "heaven of parasites" as its climate is congenial for growth and propagation of parasitic population. In order to sustain economic growth in livestock industry and considering the livelihood importance of livestock in the lives of ethnic people of the region, veterinarian has the prime duty to control parasitic burden.

Nematodiasis

The genera of parasites that have been found to cause parasitic gastroenteritis are *Haemonchus contortus, Oesophagostomum, Trichostrongylus* sp. *Mecistocirrus, Cooperia* and *Trichuris* sp. The *Toxocara vitulorum, Strongyloides papillosus, Bunostmum phlebotomum* and *Haemonchus contortus* are the parasites that have been found to be the major causes of anaemia and mortality in calves .

In general, the development, survival and transmission of eggs and infective larvae are influenced by climatic and environmental factors like temperature, humidity and precipitation. These factors often lead to seasonal fluctuations in the availability of infective larvae and this subsequently affects the prevalence of infections and worm burdens in the host. Habitually grazing animals harbor a variable but significant number of worms and active development of parasites occur during the rainy season. In the areas with a distinct rainy and dry season, the majority of third stage larvae (L3) undergo arrested development towards the end of the rainy season. Subsequently faecal egg counts decline and remain consistently low during the dry season. Subsequently, at the onset of the rainy season the pasture larval challenge as well as intake of infective larvae becomes high and as a result there is a sharp increase in the parasitic egg output.

The larvae of some genera of nematodes are able to delay the maturation to adult stages and this phenomenon is known as hypobiosis. Subsequent resumption of parasitic development usually coincides with the onset of rainy season that is the most favorable period for larval development and transmission. This may occur as a manifestation of acquired immunity of parasites or as a result of prior exposure to adverse climatic conditions during the stages as free-living larvae. While the onset of arrested development in parasite has been linked to decline in environmental temperature in some temperate zones, the stimulus in tropical areas is distinctly different. Towards the end of the rainy season, the arrested larvae accumulate in the abomasal and intestinal mucosa of the animal, remain in this form throughout the dry season and then resume and complete its development at the beginning of the next rainy season.

The phenomenon of periparturient rise in faecal egg count has been extensively reported in other ruminants as it plays a major role in the epidemiology of gastrointestinal nematodes in ruminants. This phenomenon is mainly due to prolactin hormone level which causes temporary relaxation of immunity in pregnant animals.

Pathologically, *H. contortus* is number one killer both adult and young animals. They cause severe anaemia and death of the animals. Likewise, Ostertagiosis cause morocco leather appearance of abomasums. However, other strongyle group of parasite cause digestive disturbance, anorexia and stunted growth according the level of infection in animals.

Filarial worm

Among filarial worms, most commonly occurred in cattle and buffalo are *Setaria digitata* and *S. labiatopapillosa*, which are non pathogenic. However, in immature stage, they cause lumbar paralysis particularly in sheep and goat. In Assam, particularly eastern region of India, Hump sore is very common cause by *Stephanofilaria assamensis* causing cutaneous infection in skin region. Another species, *S. zaheeri* cause infection in ear region. Life cycle is indirect and culicine mosquito acts an intermediate host. The occurrence of parasites in animals is not influenced by gender of host animals. According to a report, microfilaria found in the blood smear of bovines is sheathed and are prevalent during monsoon season. The same study reported a higher prevalence in older animals. However, systematic study is needed for its species identification and epidemiological feature in future course of infection. The drug of choice for treating the infection is the Ivermectin @ 1ml/50 kg body weight subcuateneously.

Trematodes

The infestation of flukes is regarded as the major cause of clinical manifestation in ruminants. Among the flukes, fascioliosis and amphistomiasis has been found to play pivotal role leading to mortality in ruminants. In mithun infestation with adult amphistomum like *Paramphistomum, Gastrothylax crumenifer, Cotylophoron cotylophorum, and Fischoderius elongatus* has been found to cause subclinical manifestation and acute infestation. In contrast, there have been reports of mortality in calves due to heavy infection with immature amphistomiasis.

Fascioliasis:

The causative agent for fasciolosis in bovines has been identified as *Fasciola gigantica* and *F. hepatica* The geographical distribution of trematode species in ruminants depends on the presence of suitable aquatic *Lymnaid* snail that serves as an intermediate host for the parasite. However, the existence and propagation of any fluke infection in any area depends not only on the presence of snail but also on favourable climatic and ecological conditions that may be appropriate for the parasite as well as the intermediate host. In most of the tropical developing countries the temperature is generally favourable for the development of both the fluke and their intermediate host, but due to the variations in the precipitation and humidity there are fluctuations in the development of snail and free-living stages of parasites.

Life cycle:

The water snail *Lymnaea auricularia* and *L. truncatula* act as a intermediate host of Fasciola for completion of their life cycle. There is a marked increase in the reproduction of snails in the rainy season that leads to a peak in snail population towards the end of the season. This trend slows down or completely ceases during the dry or cold periods resulting in less snail population in the dry season. This is accompanied by considerable fluctuation of herbage infestation and survivability of metacercariae. The infective stage may survive up to 10 months in the humid tropics and the longevity of metacercariae have been reported to vary from a few weeks to 3-4 months in relatively hot and dry climate . The ultimate determinant of epidemiology of parasitic disease is the rate of egg production by the adult flukes which subsequently influences the degree of pasture contamination. In addition, the grazing habits and management of the animals may significantly influence the epidemiology of liver fluke infection.

Pathology:

Presence of worm in biliary duct cause inflammations, thickening of biliary walls cause fibrosis, hepatomegaly and liver cirrhosis. Obstruction of biliary duct can occur in months or years leading to obstruction jaundice. Abdominal pain due to penetration of intestinal wall. Peritonitis is also occurs by penetration of intestinal wall and the presence of metacercariae in the peritoneal cavity.The immature worms cause necrosis, fibrosis, hepatitis, and hepatomegaly.Allergy and eosinophilia are also common. The most predominant clinical sign is bottle jaw in dependant parts of the body.

Treatment:

1-Triclabendazole (Fasinex): drug of choice. It is acting on immature and adult worms @900mg/100kg body weight.

2-Hexanide @1g/100kg body weight.

Amphistomiasis:

This group of the parasites are are commonly called as Amphistome fluke or rumen fluke, commonly associated with mortality of animals in low lying area. The species important for pathogenic point of view are as follows-*Paramphistomum cervi, Explanatum explanatum, Cotylophoron cotylophorum, Gastrothylax crumenifer, Fischoderius elongatus* and *Carmyerius spatiosus.*

Life cycle: The different species of snail act as an intermediate host.

Clinical symptoms:

The most common symptoms of acute immature Amphistomiasis are oedema, anorexia and diarrhea. Oedema start as small, flabby swelling in the dependant parts of body which may extend up to check and sternum. Within a week of the appearance of oedema, the animal develops diarrhoea in chronic cases, rectal haemorrhage may occur due to persistent straining which results in the presence of blood clot in the faeces.

Treatment and prevention:

1. Oxyclozanide @1g/100 kg body weight
2. Bithionol@ 15mg/kg body weight orally

3. Destruction of snail from the surrounding by mechanical, chemical and biological means is the right solution for the prevention of Amphistomiasis.

Schistomiasis:

Schistosomiasis is a snail borne trematodal diseases affecting millions of cattle and buffalo resulting increase morbidity followed by less mortality of animals. The different species of Schistosoma are as follows as *Schistosoma nasale*, *Schistosoma indicum* and *Schistosoma spindale* etc.

Life cycle: The different species of water snail being act as a intermediate host of different species of Schistosoma species.

Pathology and clinical symptoms:

The different species mainly responsible for hepato-intestinal syndrome and nasal schistosomiasis. In hepato-intestinal syndrome, clinical manifestation are profuse diarrhea, dehydration and anorexia in acute infection. Anaemia, hypoproteinaemia, decrease body weight are the common symptom. There is also marked eosinophilia

In nasal schistosomiasis, animals show rhinitis, mucopurelent discharge, sneezing and dyspnoea and prominent snoring sound.

Treatment and prevention:

1. Drug of choice is the Anthiomaline @10-15ml deep I/M

2. Destruction of snail habitat.

Ascariosis

Adult *Toxocara vitulorum* are the largest worms that infect cattle. They can be up to 40 cm long and 7 mm thick, and translucent in appearance. The eggs are almost spherical, about 70x80 micrometers., have a thick and pitted membrane and contain a single cell.

Life cycle of *Toxocara vitulorum*

Toxocara vitulorum has a direct life cycle, i.e. there are no intermediate hosts involved. Adult females lay eggs in the small intestine of the host that are shed with the feces. These species is one of the most prolific worms: an infected calf can shed up to 8 million eggs daily! Once in the environment L2-larvae develop inside the eggs in about 7 to 15 days at 27°C to 30°C, the ideal temperature. Development stops below 12°C but can resume when temperature rises again. These eggs are infective and contaminate the pastures. They can survive for months and possibly years, but are sensitive to sunlight.

Adult livestock becomes infected after ingesting embryonated eggs. Larvae emerge from the eggs in the gut, penetrate the gut's wall and migrate through the blood stream either to the liver, lungs, trachea, mouth, esophagus and back to the small intestine where they complete development to adult worms and begin producing eggs; or they migrate to other tissues, including the mammary glands and the placenta of pregnant cows from where they can be transmitted to the calves or to unborn embryos, respectively. Larvae can survive on tissues for up to 5 months. Larvae that reach the mammary glands remain dormant until about 3 weeks before parturition when they are re-activated and passed to the sucklings with the milk during the first 3 weeks after parturition (lactogenic transmission). Transmission through the milk seems to be the most frequent infection way in calves.

In infected calves, larvae that reach the intestine do not migrate but develop directly to adult worms in about three weeks after birth or after being ingested with the milk. Maximum egg output occurs in calves up to 3 months old, and ends quickly after.

The prepatent period is 3 to 4 weeks in calves. In adult cows it is longer, depends on the migration and dormancy periods. However, it seems that most larvae do not complete development and lay eggs in adult cows but are perinatally transmitted to the offspring.

Harm caused by *Toxocara vitulorum*, symptoms and diagnosis

Toxocara vitulorum is usually not pathogenic for adult cattle. But it can be very harmful to calves in tropical and subtropical regions, where they are the number one killer in buffalo calves at the age of 16-45 days of age. Migrating larvae can seriously damage numerous organs in adult cattle, particularly the lungs, where they can cause infections with secondary bacteria and subsequent pneumonia. In calves, the adult worms in the small intestine compete for nutrients with the host, and can cause diarrhea (often putrid), colic, enteritis, loss of appetite and weight. Due to the large size of the worms massive infections can obstruct the gut and even perforate it.

Diagnosis is based on detection of typical eggs in the feces. However, pregnant cows without any detectable eggs in their feces may be infected with dormant larvae in the tissues that will be passed to their offspring. In some countries immunoassay (e.g. ELISA) are available for serological diagnosis. A typical sign of *Toxocara vitulorum*infections in calves is a characteristic butyric acid or acetone odor on breath and/or urine that may even stick to meat and cause rejection at slaughter.

Cestode

The cestode infestation is one of the most common problems encountered in animals of this region. It has been reported that parasitic infection with *Moniezia expansa* and *M. benedeni* not only impairs the digestive function but also reduces the productivity of the animals . The presence of suitable intermediate host for cestode and favorable climatic condition, both determines the epidemiology and prevalence of parasites in animals. The cysticercoid is the infective stage of tapeworm in oribatid mite that initiates the infection after ingestion by the animals during grazing. The incidences of hydatidosis is also very common in bovines due to sharing of sylvatic and non sylvatic life cycle. Arecholine hydrobromide@ 1-2mg/kg body weight, Praziquantel@ 5mg/kg body weight are very effective for the treatment of common tapeworms occurs in bovines.

Tissue Protozoal infection

The most prevalent protozoal species reported in mithuns from north-east India are *Eimeria bovis, E. zuernii, E. ovoidalis, E. bukidonensis E. auburnensis, E. ellipsoidalis, E.subspherica* and *E. albamensis* . The prevalence of Eimerian species is generally highest in premoonsoon than that of other season. Infestation with Eimeria species has been reported to be in all age groups of animals. Comparatively, the pathogenicity has been observed to be always higher in young mithun. The severity of eimeriasis in ruminants may be correlated with different managemental factors. The use of sulfadimidine and amprolium was found to be effective for treatment of Coccidiosis in mithun calves. Few other tissue protozoa like *Balantidium coli and Cryptospordium bovis* have also been found to be common. Cryptospordiosis is a tissue protozoon that mostly affects the younger ones. It has been identified as one of the major causes of calf diarrhoea and mortality.

Toxoplasmosis is another tissue protozoa that affects most of the warm blooded animals. The prevalence of *Toxoplasma gondii* infection in mithun has been found to increase with the increase age of the animal. Animals like wild fox and jungle cat play a significant role in epidemiology and transmission of toxoplasmosis as they act as a mediator in maintaining the sylvatic transmission cycle of toxoplasmosis.

Ectoparasite infestation

Ticks and leech are the most important ectoparasites of animals which is reared in pastoral herds in semi-wild conditions in the states of north eastern region. Very little has been studied regarding the epidemiology of ticks and leech species populations. In India, almost all the livestock species suffer from tick infestations which results in tremendous production loss . Besides its effect on growth and production, tick infestations pose significant threat to the availability of good quality of hides and skin for leather industry which has been facing tremendous shortfall of good quality hides and skin to meet the demand. Ticks are responsible for tick injury, ticks pyaemia, ticks paralysis besides transmitting various microorganism including bacteria, virus, helminth and protozoal parasites to the host animals. Besides ticks, lice and fly are responsible for irritation, annoyance and decrease production loss of animals.

Leeches are segmented worms, which can suck blood of her host as many as nineteen times of body weight. Leeches as pathogenic parasites cause complications such as pain, itching, inflammation, severe anemia, short-term bleeding, hypersensitivity, and anaphylactic reactions on their host . The parasite in the respiratory tract has been reported in animals. Some reports have mentioned that hirudiniasis may cause severe anemia with hemoglobin lesser than 5g/dl . Nowadays, hirudiniasis is categorized as emerging and reemerging diseases. The leech attaches to the body surface, nasal cavity as well as reproductive organs of the animals. It causing death of animals through asphyxia of respiratory system and it also invited secondary bacterial infection in the wounded area cause by leech.

Strategy for parasitic control in mithun

Anthelmintics

There are a broad range of commercial anthelmintic formulations available in the market under different brand names. However, a limited numbers of effective anthelmintics are available to treat worm infestation. The fact is that there are different chemicals within a group having similar mode of action. One has to be aware of the possibilities of side effects and resistance within anthelmintics with similar mode-of-action. Hence, to avoid the occurrence of anthelmintic resistance one must know the mode of action of a particular anthelmintic before using it. The important factors to be considered before administering an anthelmintic are health condition of the animal, type of parasitic infestation, dose and route of drug administration. The different drugs which are commonly used in are shown in the table 1.

Table 1. Synthetic anthelmintics for ruminants

Sr. No.	Anthelmintic	Used against	Dose (mg or ml / kg body wt.)	Route
1	Tetramisole	Round worm	7.5mg	S/C ly
2	Levamisole	Round worm	7.5 mg	S/C ly
3	Pyrantel	Tapeworm	10mg	Orally
4	Morantel	Broad spectrum	10-20 mg	Orally
5	Benzimidazole group	Broad spectrum	7-15 mg	Orally
6	Niclosamide	Fluke infestation	90 mg	S/C ly
7	Oxyclozanide	Fasciola, Amphistomum	10mg	Orally
8	Triclabendazole	Fasciola	9 mg	Orally
9	Ivermectin	Broad spectrum	0.02mg	S/C ly
10	Doramectin	Broad spectrum	0.02 mg	S/C ly

Biological control

Biological control of animal parasites could become a strong arm for Integrated Parasite Control in the very near future. The philosophy behind biological control is to utilise one or more of the natural enemies of the nematodes, making it possible to reduce the infection on pasture to a level where grazing animals can avoid both clinical and subclinical effects of the parasitic nematodes. The important requirement is the presence of the fungi in the faecal pats where the development of the pre-parasitic larvae takes place. Therefore, to be effective, the fungi should pass through the gastrointestinal tract of the host without loss of viability. The fungi, *Duddingtonia flagrans* and *Verticillium chlamydosporium*,which can be isolated from organic environment of India produces thick walled chlamydospores, the stage responsible for their survival during passage through the gut of ruminants following oral administration. The results had indicated survival of the fungus during gastrointestinal transit in grazing animals and successful reduction of numbers of parasitic nematode larvae on pasture. The dose of fungal spores to be given to an animal and the time of administration for effective parasite control has been standardized.

Grazing Management based on epidemiological knowledge

In worm control program, the role of grazing management based on epidemiological knowledge is to provide clean pasture on which animals may graze safely.

1. Alteration of host species: The basic principle of this strategy is that two or more host species in any given environment don't share common parasite species to some extent and hence alteration between species can be successful means of enhancing worm control. As mithun and sheep do not share common species of parasites letting mithun to graze along with sheep may be a good strategy.
2. Rotational grazing: This comprises the withdrawal of the susceptible host from the pasture/forest until the free living parasitic stages have died due to aging and environmental exposure. Then the animals are again introduced in the grazing area. It is impractical under intensive farming condition and in temperate climate since the long survival time of the infective larvae on pasture requires longer period of resting. Nevertheless, this may be practical method for parasitic control in tropical countries where extensive farming is practiced and grazing fields are abundant.
3. Clean pasture approach: Under this practice collection and removal of deposits from pasture is done by pasture sweeping or vacuum cleaning twice in a week. This is a costly but effective measure that is practiced in some animal farms in USA. However, similar type of practice is not feasible for mithuns and other animals reared under Indian condition.
4. Forecasting: On the basis of data on environmental factors like number of rainy days, amount of rainfall, temperature and prevalence of helminth infection in a year, it is possible to estimate rate of parasitic infection in pasture and predict risk of future worm infection. Adoption of such forecasting system may assist farmers to implement timely and appropriate measures against specific parasitic infestation.

Conclusion

The strategies for controlling gastrointestinal helminth parasites in bovines have to be followed depending on the variations in the epidemiology of helminth parasites. One cannot solely rely on chemical control, but should also follow other managemental strategies and control measures based on grazing management, biological control and different immunological approaches. Looking into the present scenario as well as the future possibility in the organic meat production market, the biological control may be considered as one of the most preferable parasitic control strategies for mithun. Moreover, in a situation where the incidences of anthelmintics resistance are increasing so rapidly, the herbal drug therapy may be considered as another promising option instead of synthetic or chemical anthelmintics. Therefore, for concrete and rigid control of worm burden in bovines including mithun, measures should be undertaken that may assist in enhancing socio-economic growth of this region.

Calf Survival: A challenge to Dairy Industry

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Introduction:

Survival of neonatal calves is imperative for livestock propagation, as the future of the dairy herd solely depends upon the successful raising of young calves especially heifers as replacement stock, however, a large number of calves die during the first 3 months of life causing heavy drain on the economics of livestock production. Calf morbidity and mortality represent an irrefutable, irrecoverable financial and genetic loss to the dairy industry. Therefore, identifying the cause specific factors such as individual risk factors, cause specific factors, herd level risk factors, managemental factors, meteorological factors etc. that cause high morbidity and mortality need immediate attention for accurate planning and successful execution of breeding plans and livestock improvement programmes. This will not only ensure in getting regular and time bound replacement of heifers, but, will also help in maintaining a constant ratio of milch to dry females in a herd i.e. 70:30.

A dynamic and good dairy herd should have regular annual female replacement up to 20%, as the average herd life of productive animal is expected to be 6-8 years. The poor management practices adopted by most of the dairy farmers, in turn, are dictated in poor calf survivability as well as increased neonatal susceptibility to various diseases like diarrhea and Pneumonia. Digestive problems followed by respiratory disorders together accounted for 70-80% of the total deaths (Prasad *et al.,* 2004). Mortality in neonatal calves has mostly been attributed to infectious agents, i.e., rotavirus, coronavirus, enteropathogenic ***Escherichia coli,*** *Salmonella* species and cryptosporidium enteric flora of ruminants.

Economic impact:

Among all animals present on a dairy farm, the highest morbidity and mortality rates generally occur in young calves prior to weaning. Neonatal calf mortality varies from 8.7 to 64 per cent throughout world (Afzal *et al.,* 1983), India accounting 12.5 to 30 percent (Verma *et al.,* 1988). It is roughly estimated that a calf mortality of 20% can reduce net profit by 40% (Blood and Radostits 1989). Furthermore, 25% average early calf mortality hardly provides any chance for regular replacement of low production animals. A minimum mortality rate of

5% is usually acceptable to dairy farm having standard managemental conditions. The rearing cost of pneumonia calves in a herd is £43 (Andrews, 2000). The estimated average loss per calf at risk in a herd with an outbreak of enteritis accounting for loss in calf value, expenses for extra work, veterinary treatment and extra feed to compensate the retarded growth due to outbreak of enteritis to be approximately £33 and due to pneumonia was £21 (Gunn and Stott, 1997).

In Michigan, dairy producers estimated that respiratory diseases in calves cost around £14.17 per calf/year (Kaneene and Hurd, 1990). Producers in California estimated that calf hood respiratory diseases cost them $9 per calf/year (Sischo *et al.*, 1990). Bicknell and Noon (1993) reported that neonatal calf diarrhea is a costly disease, with losses estimated to be over $250 million annually and death loss of up to 25% of U.S. calf crop. Defra (2003) estimated calf mortality in UK (which died before 6 months of age) and reported an economic loss of about £ 60 million per annum.

The National Animal Health Monitoring System (NAHMS) estimated preweaning mortality of U.S. dairy calves to be 10.8%. The National Dairy Heifer Evaluation Project, sponsored by NAHMS, reported retrospective data on 1,811 dairy farms and prospective surveillance data on 921 U.S. dairy farms (anonymous, 1994). Pre-weaning calf mortality was 8.4% and 6.8% for the prospective and retrospective data, respectively. Diarrhea accounted for 52.2% of mortality, followed by respiratory problems (21.3%), trauma (2.4%), joint and navel problems (2.2%), and other or unknown causes (21.9%). Morbidity during the first 3 weeks of life was attributed to pneumonia (25%), diarrhea (29%), and umbilical disease (29%) in data obtained from 410 dairy calves born in 1990 on 18 commercial dairy herds located in New York (Virtala et al., 1996).

Most common infectious agent in relation to Ages of Calves

Causative agent	**< 5 days**	**5-15 days**	**15-30 days**	**> 30 days**
E. coli	Yes	No	No	No
Rotavirus	No	Yes	No	No
Coronavirus	No	Yes	No	No
Cryptosporidia	No	Yes	Yes	No
C. perfringens B,C	No	Yes	Yes	No
Coccidia	No	No	Yes	Yes
Salmonella	No	No	Yes	Yes
BVD	No	No	No	Yes
C. perfringens D	No	No	No	yes

Incidence of calf mortality at different weeks of age.

Reference	**Country**	**Incidence**	**Age (weeks)**	**Buffalo / Cow**

		(%)		calves
Freese and Gravert (1982)	Germany	50	Soon after birth	Cow
Fink (1980)	Germany	30.8	1	Cow
Jenny et al. (1981)	USA	19.1	1 4	Cow
Gusbi and Hird (1983)	Libya	12.5-26	4	Cow
Verma et al. (1988)	India	12.5	4	Buffalo
Peters (1986)	UK	3.96	5	Cow
Braun and Tennant (1983)	USA	18.9	5	Cow
Buhullar and Tiwana (1995)	India	34	12	Buffalo
Umoh (1986)	Nigeria	8.7	12	Cow
Gusbi and Hird (1983)	Libya	18.8	13	Cow
Afzal et al. (1983)	Pakistan	39.8	Before 1 Year	Buffalo
Zrelli et al. (1988)	Tunisia	18.8	-	Cow
McGuire et al. (1989)	USA	64	-	Cow

Risk Factors

Simple exposure to infectious agents is not sufficient cause for the development of diseases in calves. In calf rearing, the difference between health and disease is very often just a slight tip of a delicate balance that weighs calf and environmental factors with the bacterial, viral, or parasitic agents to which the calf will be exposed. The infectious agents that are capable of causing scours, pneumonia, or septicemia in young calves are ubiquitous. Calves will inevitably be exposed and several may become infected, but only a few should get a disease if the relevant risk factors are minimized and the sources of infection are diluted or bypassed.

Even though the immune system of a calf is functional at birth, it is less responsive than that of adult animals and is naive and easily overwhelmed by the bacteria, viruses, or parasites in the environment. Prolonged exposure or an increased level of exposure occurs when susceptible dairy calves remain in the calving area and have continued contact with adult cattle or in contact with affected calves or are housed in facilities that are under-bedded, warm, damp, humid, or poorly ventilated. Noxious gases, dusts, and molds in the air put calves at significant risk for developing pneumonia. Cold housing can reduce the risk of infection, provided calves can be dry and draft-free. Calf-to-calf contact, crowding, or continuous use of facilities prolongs the survival rate and increases the numbers of pathogens in the environment of the calf, even with cold housing.

Infection Source

Persistence of the agents that cause diarrhea, pneumonia, and septicemia in the environment is the major reason for outbreaks of calf problems on the dairy. Usually the source of infection is feces (diarrhea and septicemia)—from normal adult cows into shared housing and calves that are non-immune shedders—or aerosol (respiratory disease pathogens). Occasionally, water, feeding utensils, rodents, birds, pets, or people can be the source of infection for calves. Depending on the time of onset of disease, the most likely source of infection can be identified. Problems that occur within 5 days of birth usually have their source as the dam or the calving environment. After 7 days of age, problems develop from a source in the calf environment. If the source of infection can be identified, it can be diluted or bypassed through scientific managemental system.

The three most important disease problems in the young calf are septicemia, diarrhea, and pneumonia.

Diarrhea

Diarrhea is the most common cause of death in young calves and is almost entirely avoidable by good management. The highest risk period for diarrhea is from birth until about 1 month of age. Bacteria, viruses, and or parasites cause diarrhea in calves. Usually, the calf is infected with more than one agent. Knowing the potential pathogen provides insight into the infection source as well as the relevant factors that may have triggered the outbreak. The agents commonly incriminated in calf diarrhea outbreaks are listed below. *E. coli, Salmonella species,Clostridium perfringens* type C, *Campylobacter* spp., *Rotavirus*, *Coronavirus, Bovine Diarrhea Virus (BVDV), Cryptosporidium parvum, Eimeria spp. (coccidiosis), Giardia spp.etc.* Despite the fact that the agents differ, the resulting enteritis is remarkably consistent in terms of the presenting clinical picture. Calves with diarrhea consistently have some degree of dehydration. Dehydration is always a life threatening and can be assessed by observation of typical clinical signs.

In most cases of fatal diarrhea, the calf dies of dehydration and loss of electrolytes. Electrolyte abnormalities involving potassium, bicarbonate, and sodium are frequently found, but these resolve rapidly when fluids are given to correct the dehydration and calves have access to water. For this reason, treatment of calves with diarrhea is primarily supportive. The most important aspects are early recognition and aggressive fluid therapy. Prompt treatment with oral fluids and electrolytes is necessary for successful treatment of diarrhea.

Septicemia

When a calf has septicemia, it has disease-producing organisms or their toxins in its blood. Septicemia in calves is usually the result of a bacterial infection that occurs while the calf is in the uterus or during or immediately after birth. The route of infection can be the blood of a sick dam, an infected placenta, the calf's umbilical stump, mouth, nose (inhalation), or wound. Septicemia is the most severe medical problem that a calf can develop because the blood-borne infection disseminates and damages many different organs. The bacteria that cause septicemia in calves, many of which are characterized as gram-negative bacteria like *E. coli* and *Salmonella*, are difficult and expensive to treat, and survival rate is low. Early signs of septicemia may be subtle but affected calves are usually depressed, weak, reluctant to stand, and suckle poorly within 5 days of birth. Swollen joints, diarrhea, pneumonia, meningitis, cloudy eyes and tender navel may develop. Fever is not a consistent finding in septicemic calves; many have normal or subnormal temperatures. Most septicemic calves have a history of inadequate colostrum intake.

Pneumonia

Pneumonia is an inflammation of the lungs. Clinical signs of pneumonia include nasal discharge, dry cough, body temperature of >41°C, respiratory distress, and decreased appetite. Calves that develop pneumonia prior to weaning frequently share the same risk factors as those that develop diarrhea, failure or incomplete transfer of immunity from colostrum, prolonged exposure to adult cattle, and or poor ventilation of calving pen or calves pen. As with diarrhea, frequently more than one agent is identified in an outbreak. Herds often experience outbreaks of pneumonia occurring in a number of calves at the same time. Early identification of risk factors and treatment are imperative, Calves that develop chronic pneumonia seldom recover completely and should be culled. The causative agents are usually one or a combination of the following: *Pasteurella haemolytica*, *Pasteurella multocida*,*Mycoplasma dispar*, *Mycoplasma bovis*, *Hemophilus somnus*, *Actinomyces pyogenes*, BVDV, BRSV, IBR/PI3 and *Salmonella Dublin*. The first three agents listed are the most important in the young dairy calf. Frequently pneumonia is first recognized right after weaning when calves are grouped for the first time.

Care and management for better survivability:

Feeding

The early nutritional status of calves has a marked influence on their later productivity. Feeding a calf is always a full time as well as challenging job. Feeding twice a day is satisfactory, with half the required amount being fed at each feeding. The milk should be heated to body temperature before providing to the calf and constant temperature need to be maintained throughout the feeding programme. Care must be taken not to overfeed or underfeed the calves, especially during the first 3 weeks of life, as both the case contribute digestive problem.

Colostrum feeding

Colostrum is the milk produced by the dam prior to and during the first few days after calving. It is thick and yellowish in colour. It contains less lactose (sugar) but 4 to 5 times more protein and 10 to 15 times more vitamin-A than normal milk. Protein portion of colostrum contains much higher proportion of globulins which acts as defence mechanism in the calf for many infections. It is also rich in minerals like Cu, Fe, Mg and Mn and contains several other vitamins like Riboflavin, Cholin, Thiamine, Pantothenic acid etc., which are essential for normal growth of calf. Colostrum also contains transferrin and lactoferrin which bind iron and restrict bacterial growth. Therefore the farmer's first target should be to get their calf sufficient colostrum within the two hours of calving from the mother or from artificial source because the ability of the calf's intestine to absorb immunoglobulin declines within few hours after birth. Getting enough colostrum is not only important for calf survival from infectious agents of their environment, but also for future health and growth as well. Calves that have high antibody levels in their blood stream by 24 hours after birth are less susceptible to get scours and grow faster than calves without colostrum. It is reported that early consumption of colostrum lead to heat production in calves particularly if calves are born into cold environments.

Artificial colostrum:

If the dam died after calving and the calf didn't received first milk from the mother, the herdsman should prepare artificial colostrum or should get the colostrum from other dam which has calved recently. The artificial colostrum can be easily prepare by adding 600 ml whole milk, 300 ml water, ½ teaspoon of castor oil, 1 egg and 1 tablespoon of glucose powder this colostrum substitute should be fed three times a day and continue for first three days of life.

Milk feeding schedule:

The farmer's can follow the given scientific feeding schedule for better survivability.

0-3 days	Colostrum (1/10th of body weight)
4-28 days	Whole milk Colostrum (1/10th of body weight)
29-42 days	Whole milk Colostrum (1/15th of body weight)
43-56 days	Whole milk Colostrum (1/25th of body weight)
57-65 days	Whole milk Colostrum (1/25th of body weight)

Water:

Feeding of milk does not provide enough water. Therefore, fresh, cool and clean water should be available at all times which will help to keep calves healthy. Calves will begin to drink water when they are about a week old.

Milk replacer:

Milk replacers are used instead of fresh whole milk and are available at any merchandise stores. It should be reconstituted and fed as directed by the manufacturers. Whether feeding once, twice or thrice a day, it is important that milk temperature does not vary from feeding to feeding. Optimal temperature is either 15-20ºC (cool) or 36ºC (warm). Feeding milk replacer at the wrong temperature can lead to fat breakdown and reduced protein quality, finally lead to diarrhea

Calf starter/solid feed:

Milk is a highly digestible energy source with the correct balance of protein, vitamins, and minerals required for the first weeks of life. To ensure continued normal growth, this balance must be maintained during weaning from milk and the transition to solid feed. The calf start nibbling the solid food by second week of life, therefore, the owner should make access to hay/green grass and concentrates from second week onwards to stimulate the rumen activity. The rumen starts functioning well by 10–12 weeks of age. Concentrates can be introduced by placing a small amount in the milking bucket after the milk is fed and or as the calf finishes drinking, rub a little concentrate on its muzzle to encourage the calf to taste it. Changing of feed should be done very gradually so as to avoid digestive problem.

Keep calves healthy:

The most critical time in neonate's life is from birth to weaning. After leaving the warmth and safety of the dam's uterus, the newborn is exposed to the "hostile world" of bacteria, viruses, fungi, and parasites the stresses begin to multiply. Therefore, proper care during the first 24 hours is very important for calf survival.

Care of naval cord:

The navel or umbilical cord of the newborn calf offers a route into the bloodstream for bacteria that can cause severe or fatal septicemia, joint illness, meningitis and arthritic problems. Therefore, it is always safe to tie and cut 2 inch away from the body dip or swabs the navel of the newborn with a 2%tincture of iodine or other similar topical disinfectant and observes the navel at regular intervals over several days to ensure it dries and heals without infection.

The Environment has a substantial effect on calves morbidity and mortality. Calves will become cold-stressed at approximately <10°C, requiring additional energy for maintenance and growth. Therefore, calf's environment should allow for thermal comfort, physical comfort, disease control, and behavioral satisfaction. The controlling of calf mortality is one of the most important factors for increasing profits from dairy farming. Many research workers conducted their research studies on calf mortality in different regions of the world. Knowing the risks and understanding common causes of mortality in dams and calves can help producers to implement good management practices to reduce these losses. An effective herd-health and production management program would typically include biosecurity practices to prevent the spread of disease agents, nutrition and preventive health programs to improve disease resistance of buffaloes and calves and optimize reproductive success, and reproductive management practices, to enable timely assistance for dams and calves during calving season. The early death of cow calves affects not only the milk and meat production but also result in reduction of genetic progress, and disruption of breeding programs due to early mortality of male and female calves

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The Physiology of Milk Ejection and its Role in Dairy Production

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Introduction: The physiology of lactation is intimately intertwined with the physiology of reproductive processes. Milk secretion involves both intracellular synthesis of milk and subsequent passage of milk from the cytoplasm of the epithelial cells into the alveolar lumen. Milk removal includes passive withdrawal from the cisterns and active ejection from the alveolar lumina or milk ejection usually is the only way in which milk in the alveolar lumen can be expressed from the gland. In 1949 Richardson clearly identified these myoepithelial cells, so confirming McFarlane's communication. Linzel, later published a paper re-affirming the conclusion postulated by Richardson regarding the identity, contractibility, and participation of these myoepithelial cells in the milk ejection reflex. Thus four important links in the chain of events leading to milk ejection have been established. Briefly summarized these are:

- Posterior pituitary extracts are capable of eliciting a milk ejection response in both the normal and perfuse gland. Moreover, the posterior lobe of the pituitary appears essential if milk ejection is to be stimulated.
- The blood of a cow stimulated to let-down contains a substance capable of evoking milk ejection in a perfuse udder.
- The complete denervation of the mammary gland prevents the milk ejection response from being initiated.
- The mammary gland contains myoepithelial cells so placed that their contraction would cause the ejection of milk from the alveoli. Posterior pituitary extracts actually cause a contraction of these muscular myoepithelial elements.

The physiological mechanism of milk production in dairy animals can be readily split into four major dependent processes. Briefly stated these are:

- The successful anatomical development of the mammary gland.
- The maintenance of the milk secretory tissue within the gland itself.
- The maintenance of an adequate flow of milk precursors to those secretory cells.
- The successful removal of milk once formed.

Development of the mammary gland: The gross anatomy of the mammary gland differs a lot among different species. The development of the mammary gland starts early in the fetal life. The developments of milk ducts and the milk secreting tissue take place between puberty and parturition. The udder continues to increase in cell size and cell numbers throughout the first five lactations and the milk producing capacity increases correspondingly. This is not always fully utilized, since the productive life time of many cows today is as short as 2.5 - 3 lactations. The udder is a very big organ weighing, around 50 kg (including milk and blood). However, high yielding animal's weights up to 100 kg have been reported. Therefore, the udder has to be very well attached to the skeleton and muscles.

The mammary gland consists of secreting tissue and connective tissue. The amount of secreting tissue or the number of secreting cells is the limiting factor for the milk producing capacity of the udder. It is a common belief that a big udder is related to a high milk production capacity. This is, however, not true in general, since a big udder might include a lot of connective and adipose tissue. The milk is synthesized in the secretory cells, which are arranged as a single layer on a basal membrane in a spherical structure called alveoli. The diameter of each alveoli is about 50-250 mm. Several alveoli together form a lobule. The milk which is continuously synthesized in the alveolar area, is stored in the alveoli, milk ducts, udder and teat cistern between milking. Around 60-80% of the milk is stored in the alveoli and small milk ducts, while the cistern only contains 20-40%. However, there are relatively big differences between dairy cows when it comes to the cistern capacity.

The teat consists of a teat cistern and a teat canal. Where the teat cistern and teat canal meet, 6-10 longitudinal folds form the so called Fürstenberg' s rosette, which is involved in the local defense against mastitis. The mammary gland is densely innervated especially in the teat. The udder is also provided with nerves connected to the smooth muscles in the circulatory system and the smooth muscles in the milk ducts. However, there is no innervation directly controlling the milk producing tissue. The mammary gland is very well supported with blood vessels, arteries and veins. Right and left udder halves generally have their own arterial supply. The primary function of the arterial system is to provide a continuous supply of nutrients to the milk synthesizing cells.

Mammary development after conception: Most mammary growth occurs during pregnancy. The rate of growth remains exponential throughout gestation. Depending on the species, between 48 and 94 percent of total mammary growth occurs during gestation. In dairy cattle, growth of mammary parenchyma increases exponentially throughout gestation; the rate of increase is approximately 25 percent per month. Most of the increase in total mammary cell numbers during pregnancy are associated with the proliferation of parenchyma, not stroma (adipocytes). After 3 to 4 months of gestation in cows, mammary ducts elongate further, and alveoli form and begin to replace stroma in the supra-mammary fat pad. As mammary ducts elongate further and development reaches its peak, parenchymal tissues gradually replace stroma, resulting in an extensive development of the lobulo-alveolar system by the end of the six month in cows.

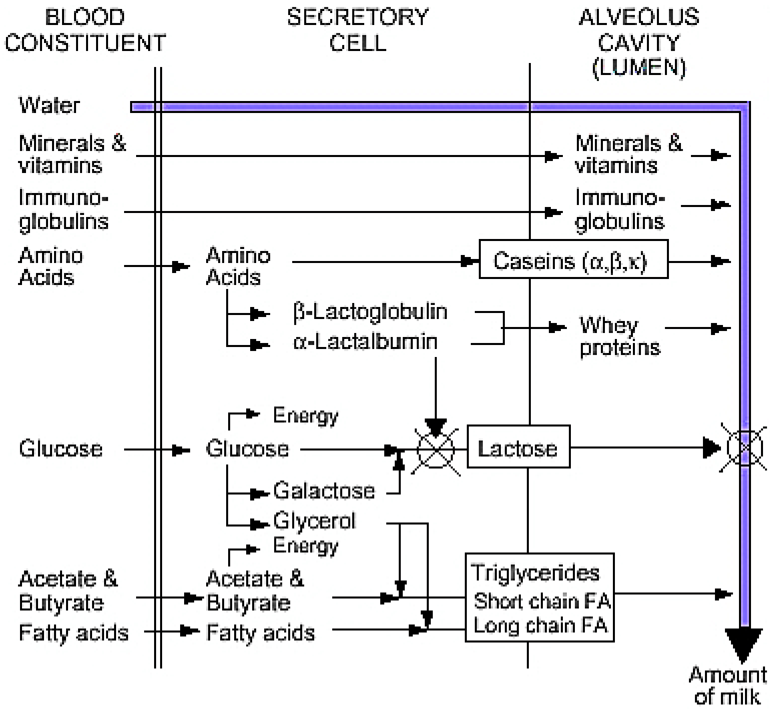
Accelerated mammary growth during pregnancy is most likely due to increased and synchronous secretion of estrogen and progesterone. Achievement of growth in response to estrogen and progesterone requires coincidental secretion of prolactin and perhaps somatotropin. Placental lactogen secretion increases during pregnancy and probably stimulates substantial mammary growth (synergistic with estrogen and progesterone) in species in which the hormone enters the maternal circulation. To produce 1 liter of milk 500 ltr. of blood have to pass through the udder. When the cow is producing 60 liters of milk per day, 30,000 liters of blood will be circulating through the mammary gland. Thus, if there is anatomical developmental defect in the mammary gland they yield of the animal might be very less though the size of the udder may be big. For proper development of mammary gland it is always possible to influence by proper feeding during their early growth phase, as the development of the mammary gland starts early in the fetal life and development continues up to the sixth month of gestation.

Maintenance of the milk secretory cells: The udder is known as an exocrine gland because milk is synthesized in specialized cells grouped in alveoli, and then is excreted outside the body through a duct system that functions like the tributaries of a river. The udder is made up of four mammary glands or “quarters.” Each quarter is a functioning entity of its own which operates independently and delivers the milk through its own teat. Generally, the rear quarters are slightly more developed and produce more milk (60%) than the front quarters (40%). Genetically superior cows are thought to contain large quantities of secretory tissue, even though the synthetic activity per secretory cell is not known. The secretory tissue which is responsible for producing of milk during lactation is made up of epithelial cells. After calving, the metabolic activity of secretory cells is dependent on:

- Neuro-endocrine stimuli which are partly linked to suckling or milking.
- Availability in arterial blood of nutrients that are used for milk synthesis
- Regular and complete evacuation of alveolar milk, to decrease intra-mammary pressure and to remove inhibitors that are secreted into the milk.

The decrease in milk yield after lactation peak (that determines milk persistency) results primarily from a decrease in the number of secreting cells. There is little knowledge on the possibility of manipulating the number of secretory cells during lactation. During extended lactation in the mouse, a stronger milking stimulus caused by new younger pups was able to increase the longevity of secretory cells, thus maintaining the number of cells at peak values and milk yield at two-thirds of peak values, suggesting that better milk persistency was due to cell number maintenance. During concurrent pregnancy and lactation, there is a sharp decrease in milk yield during late pregnancy (after about 5 months in the cow) primarily due to increased oestrogen secretion that inhibits milk synthesis (and to some extent to competition for nutrients by the foetus), at the same time a large proliferation of new secretory cells takes place, that will produce more milk during the following lactation. This proliferative phase is probably stimulated by drying-off the animals before the next lactation. Milk persistency between lactation peak and late pregnancy is also reported to sustaining the metabolic activity of secretory cells. Moreover, adequacy in feeding and management such as milking or suckling in good conditions and proper management of dry period etc, will enhance the potentiality of expression of mammary secretory cell.

Flow of milk to secretory cells: Milk secretion by the secretory cells is a continuous process that involves many intricate biochemical reactions. During milking, the rate of milk secretion is somewhat depressed, but it never stops completely. Between milkings, the accumulation of milk increases the pressure in the alveoli and slows down the rate of milk synthesis. As a result, it is recommended that high-producing cows be milked as close as possible to 12 hour intervals (the highest milkers should be milked first in the morning and last in the evening). More frequent ejection of milk reduces the pressure build-up in the udder, and for this reason milking three times a day can increase milk yield by 10 to 15%.



Overview of milk secretion in the secretory cells (crossed circles are key regulatory steps).

Milk Secretion Rate: Milk secretion rate is important in the dairy industry. It influences the required frequency for milking of cows and the acceptable intervals between milkings. In part, milk secretion rate depends on the pressure that accumulates within the mammary gland. When milk accumulates within the mammary gland for a long enough period of time, pressure is built up to a sufficient level to inhibit secretion and milk is resorbed by the blood. A marked increase in pressure occurs after 1 hour of milking. Residual milk or complementary milk moves from the alveoli into the teat and gland cisterns. Thereafter, a gradual increase in the pressure occurs owing to the movement of milk from the alveoli to the teat and gland cisterns. The rate of milk secretion is linear for about 10 to 12 hours after the last milking, after which it decreases slightly. It continues to decrease until it finally reaches zero about 35 hours after the last milking. Part of the early increase in intramammary pressure is due to residual milk that is left in the udder after normal milking. The amount of residual milk can be as great as 15 to 30 percent and this percentage is higher in low-producing cows than high-producing cows.

Regulation of milk volume: The amount of milk produced is controlled primarily by the amount of lactose synthesized by the udder. Lactose secretion into the cavity of an alveolus increases the concentration of dissolved substances (osmotic pressure) relative to the other side of the secretory cells where the blood flows. As a result, the concentration of dissolved substances on each side of the secretory cells is balanced by drawing water from the blood and mixing with the other milk components found in the cavity of the alveolus. For normal milk, a balance is reached when there is 4.5 to 5% lactose in the milk. Thus lactose production acts as a “valve” that regulates the amount of water drawn into the alveoli and therefore the volume of milk produced.

Milk Ejection Reflex: The milk ejection reflex is a neuroendocrine reflex. The reflex has an afferent pathway (neural) and an efferent pathway (hormonal, blood-borne).

Afferent Pathway: The greatest amount of innervation in the mammary gland is in the teats, where there are pressure sensitive receptors in the dermis. Mechanical stimulation of the teats activates pressure sensitive receptors in the dermis where the pressure is transformed into nerve impulses that travel via the spinothalamic nerve tract to the brain. These nerves synapse in the paraventricular nucleus and in the supraoptic nucleus in the hypothalamus. When the cell bodies of the oxytocin-containing neurons are stimulated by these impulses originating in the teat, an action potential moves down the oxytocin-containing neurons from the cell body in the hypothalamus down the axon to the neuron ending in the posterior pituitary. This causes release of oxytocin and neurophysin into the blood. *The efferent pathway starts at this point.*

Efferent Pathway: The efferent pathway begins with the release of oxytocin into the blood. The oxytocin then travels to the mammary gland via the blood, binds to oxytocin receptors on the myoepithelial cells, causing the myoepithelial cells to contract, and resulting in increased intra-lumenal (intramammary) pressure and ejection of milk from the alveolar lumen.

Optimizing milk removal: Milk removal involves several mechanisms that impact milk production, including removal of local inhibitory components, regulation of local blood flow, and even physical factors in the alveolus. The effects of frequency of milk removal are tied closely with the local regulation of milk secretion. The mechanism by which the alveoli physically express milk from the lumen during milk removal is called milk ejection. Stimulation of the mammary gland, particularly the teats or nipples, results in secretion of the hormone oxytocin from the posterior pituitary. Oxytocin travels via the blood to the mammary gland and causes contraction of the myoepithelial cells surrounding the alveolus. This results in expulsion of the luminal milk from the alveolus into the ducts and out of the gland, resulting in the physical removal of milk from the alveoli.

Under normal conditions, 15 to 30 percent of the milk produced by the udder can be left in the udder after milking. Moreover, there appears to be a negative feedback system wherein the milk remaining in the udder can influence further secretion rates. For continuation of optimum production the milk must be effectively extracted from the udder. Without frequent emptying of the mammary gland (milk removal), milk synthesis will not persist in spite of adequate hormonal status. If milk ejection can be optimized to reduce this residual milk, then milk yields can be increased significantly. Conversely, maintenance of intense suckling or milking stimulus will not maintain lactation indefinitely. Nevertheless, suckling or actual removal of milk from the gland is required to maintain lactation.

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Ensuring clean milk production: a farm to table approach for hygienic milk production

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Livestock products Technology

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Milk that is "wholesome and free from foreign matter" is known as 'clean milk' and is generally defined as milk drawn from the udder of healthy animals, which is collected in clean dry milking pails and free from extraneous matters like dust, dirt, flies, hay, manure, contaminated water, drug residues and contains no harmful bacteria which are pathogenic to humans. Milk is a complete food as it containsprotein, fat, carbohydrates, and all essential vitamins, minerals for sustaining life and for maintaining good health.Producing good quality milk is essential for maintaining good taste and flavour, pathogens free milk, enhancing the shelf life, reducing wastage of milk due to early spoilage and for development of good quality dairy products. Safe and wholesome quality milk should have:

Appearance: Free from foreign matter, off taste and smell

Normal composition– especially fat, solid and protein contents, normal acidity

Hygienic characteristics – handled in hygienic conditions, cleanliness and quality

No adulteration – with water, preservatives, added solids

Free from drug, chemical residues, Low in bacterial counts

Contamination of milk occurs at different levels: at farm level, during collection and storage, and at processing centres. A number of factors should be taken care of and must be observed right from the farm, processing and thereafter to the retailers and then to consumers in order to enable milk to reach the processor and ultimately the consumer.

Quality control and assessment for milk and milk products:

1. **At the farm:**The following aspect has to be kept in view

a. Clean and healthy animals: Supervision of veterinarian, preventive treatments such as vaccination, regular inspection, identification, and treatment of ailments, protection from diseases,

b. Proper management and housing:Clean and dry stall, flies, rodents and other vermins must be controlled. Hygienic practices at the time of milking, assessment of microbial load at various stages of manufacture or processing which will result in longer shelf life.

c. Good hygiene: Milkers'is in good health, hands and clothes are clean and milking equipment are kept clean and dry and adequate supply of clean and potable water

2.While transporting milk: Milk containsome micro-organisms when it is drawn from the udder, and it multiplies during handling which deteriorates the quality of milk producing off flavour, acidity etc. So, in order to reduce this deterioration of milk quality milk should be promptly cooled to 5°C after freshly drawn until processed.

3. Processing plant: It is of prime importance to check the quality of raw milk to assess its suitability for processing. The quality of milk and its products depends upon the quality of raw milk used for manufacturing, processing and handling conditions. Thereby platform test is of utmost importance to check the quality of the incoming milk which is received. So different test needs to be undertaken for judging the milk quality for acceptance and rejection and care should be taken so as to ensure the whole bulk samples are mixed properly before taking the sample.

Table: Platform test for milk quality

Test	Purpose	Interpretation
Visual and organoleptic test:	To check any objectionable flavour, colour, odour.	Reject milk with abnormal colour, odour or flavour
Sediment test	To check the cleanliness of the milk received	Rejecting milk with abnormal sediment
Clot on boiling test (COB)	To check whether the milk is suitable for further processing	formation of flakes after boiling the milk indicates positive and to be rejected
Alcohol test	This test is done to determine the heat stability of milk	Formation of flakes: positive test. Should not be used for manufacture of concentrated or sterilized or dried milk
pH	Normal pH 6.6-6.8	High pH probably infected(mastitis) udder and lower pH developed acidity
Acidity test	To determine the acceptance/rejection of milk	Normal acidity of the milk is 0.12-.16 (Average 0.14%). Above normal sour milk and should be rejected

Bacteriological quality control of milk

Change in flavour and appearance of the milk are due to microorganism as milk provide a suitable medium for their growth as it contains all the nutrients required. The following is a guide for grading raw milk in our country.

Table: Bacteriological standards of raw milk (IS-1479 Part III-1997):

Grade	SPC/ml in lakhs	DMC/ml in lakhs	MBRT (hours)	One hour Resuzurin disc No.	Presumptive coliform test(in 0.01 ml) i.e 1 in 100
Very good	<2	NS	>5	NS	Absent
Good	2-10	<5	3-4	4 or higher	Absent
Fair	10-50	5-40	1-2	3.5-1.0	Absent
Poor	>50	40-200	<1/2	0.5-0	Present
Very poor	NS	>200	NS	NS	NS

N.S: Not specified

Pasteurization:

Pasteurization, refers to the process of heating every particle of milk to at least 63°C (145°F) for 30 min. or 72°C (161°F) for 15 sec. or to any other appropriate time temperature combination. After pasteurization, the milk is immediately cooled to 5°C (41°F) or below.At room temperature milk can be stored only for 3 hours immediately after milking. The shelf life of milk can be extended to 24 hours by cooling to 5°C. Its shelf life is further extended to 4 to 7 days by pasteurization making the milk safe for human consumption, destroy the pathogenic microorganisms and improving the keeping quality of milk. Besides good quality raw milk, the usefulness of these processes is dependent on the efficient prevention of post-pasteurization contamination of milk by UHT treatments the shelf life is extended to few months. Some methods of pasteurization methods are:

1. Batch pasteurization / low temperature long time pasteurization (LTLT): Milk is heated to 63°C/145°F for 30 minutes and promptly cooled to 5°C or below.
2. High temperature short time pasteurization (HTST): Milk is heated to 72°C/161°F for 15 seconds and promptly cooled to 5°C or below.
3. Ultra high temperature treatment (UHT):Milk is heated to 135-150°C/275-302°F for about 7 seconds and promptly cooled as usual.

Post pasteurization contamination. Spoilage of milk even after pasteurization may be probably due to post pasteurization contamination or inefficient pasteurization where microorganismsre-entered or multiply into the milk or of the finished product when there is contact with the contaminated equipment or workers or if the packet used for packing the product is contaminated.

Standards for pasteurised milk (15-6397-1971)

Name of test	Standards
Standard plate count	Maximum 30000 cfu/ml
Coliform count	absent in 1:10 dilution
MBRT	more than 4 hours

Alkaline phosphatase test	Negative

Packaging of dairy products:

Packaging is the scientific method of containing food products against physical damage, chemical changes, and further microbial contamination and to display the product in the most attractive manner for consumer preference. Packaging can be described as a coordinated system of preparing goods for transport, warehousing, logistics, sale, and end use. Packaging contains, protects, preserves, transports, informs, and sells. In many countries it is fully integrated into government, business, and institutional, industrial, and personal use.

Packaging of Fluid Milk:

Characteristics:

1. The glycerides of lower fatty acids (butyric, caproic, capric, caprylic and myristic) are mainly responsible for the characteristic flavor of the milk, & the deterioration of these fats causes most off flavor problems.
2. Oxidation of fat produces tallow flavor probably from the formation of hydroperoxides. This reaction is accelerated by heat, acid and metal catalysts-particularly copper.
3. The distinct oxidized flavor is caused by phospholipids oxidation. Another fleshy flavor results from hydrolysis of lecithin to produce trimethylamine.
4. Vitamin content of milk is affected by heat, light, oxygen. Ascorbic acid is deteriorated by heat and oxygen. Thiamine is destroyed by heat.
5. Since milk is an animal product and an excellent growing medium for bacteria, it is an extremely important that it be produced under sanitary conditions.

Packaging Materials:

1.Glass- Until 1950, almost all milk was packaged in glass bottles. The increase in supermarket shopping and decrease in home delivered milk have served to lessen the usage of glass milk bottles. Glass milk bottles originally were round, tapering to a rather wide mouth with a thick flange. Quarts, pints and half-pints were once the standard sizes, however, there is now an increasing trend toward half gallons and gallons.Bottle closures are formed from Al foil, HDPE, Polypropylene and paper -board. Most closures are applied by automatic machinery at high speeds and printing applied prior to use.

2. Paper board- The introduction of wax coated paperboard captured the milk market in late 1940s. Although the consumers were attracted to the concept of disposable milk container, some problems existed. Wax particles were found in milk and the outer surface had a cloudy

unattractive appearance. PE coated paper board solved nearly all the problems inherent in milk packaging. It was found to be disposable, clean looking, functional.

3. Plastics- An all plastic bottle is light weight and tougher than its two competitors. In addition, it creates high impulse appeal and allows the milk to be seen. The basic material in general use for an all plastic milk bottle is polyethylene, although several polystyrene bottles are also available. Disadvantages include difficult in printing, labeling& decoration.

Cleaning and sanitation of dairy plant

The prerequisite for production of a high quality product is the cleaning and sanitization of the milk and milk product contact surfaces, which contributes 60% of total contamination. The following factors influence the dairy plant hygiene:

1. Building. Floor should be impervious and sloped for efficient drainage of water. Wall tiles up to 2 m height help in efficient cleaning. Doors and windows should be of self-closing type. A distance of 3 m between walls and the equipment and a minimum of 42 cm to 52 cm between the bottom of equipment and floor is necessary for proper cleaning. Proper ventilation is essential to remove odour, heat, moisture and to minimize condensation on cooled surface.

2. Equipment - Materials and Design. Stainless steel and aluminium alloys, should be non-toxic, noncorrosive and non-taintable.

3. Personnel. Persons working in dairy plant should be educated on hygienic handling of milk and milk products. They should wear washable clean white clothes and caps.

1) Routine health checks of persons engaged in handling foods

2) Factory premises should be provided with clean running water and good washrooms.

3) Workers should wear clean protective clothing and working gear (e.g. gum boots, coats, overalls and caps).

4. Water supply. Uninterrupted, uncontaminated, nonchlorinated, potable, soft water with hardness not exceeding 112 mg/litre is essential.

5. Air Quality. Contamination of air in the plant can be controlled by spraying sanitizers at a level of 0.048 mg/litre which inactivates lactic bacteriophage. Irradiations are used to sanitize the air in culture transfer room and packaging materials. Common sanitizers used in dairy industry are hot water, steam, chlorine (200 mg/litre), iodophor (25 mg/litre) and quaternary ammonium compounds (200mg/litre).

Hygienic control of milk handling equipment's:

Cleaning of dairy equipment refers to removal of soil which includes milk residues, water deposits, detergent and sanitizer residues, dust, sediments or any other foreign matter. Improper cleaning and sanitization of dairy equipment's will lead to food poisoning due to contamination by micro-organisms like coliforms, Bacillus etc. Cleaning and sanitization are complementary to each other, which includes the following steps:

1. Pre-draining. Draining should be carried out thoroughly to minimize product loss, reduce the load on the sewage and helps in cleaning.

2. Pre-rinsing with water. Pre-rinsing helps for flushing of milk residues, prevents drying and sticking of milk to the surface. Lukewarm water should be used for pre-rinsing and temperature should not exceed 60°C in order to avoid coagulation of proteins.

3. Cleaning with detergent. Blended detergents at an optimum temperature and mechanical scrubbing helps in removal of soil from the surface. Common alkaline detergents used in dairy are sodium carbonate, caustic soda, sodium bicarbonate, sodium sulphate at a concentration of 0.2 2.0% while sodium silicate used as a protective agent for aluminium. Acid detergents widely used include nitric acid at 0.5% and phosphoric acid at 2.0%. Acid detergents helps to remove the milk stones and water scale.

4. Hot water rinsing (post - rinsing). Post rinsing with lukewarm water removes all traces of detergent, displaced dirt and prevent deposition of lime scale.

5.Sanitizing. It involves effective bactericidal treatment with chemical /thermal agents to reduce the bacterial count including pathogens to a safe level on the utensils and equipments. Sanitizing solution used are hypochlorites, organic solution of chlorine with 100-200 mg/L of available chlorine, mixed halogens - 25 mg/L ofavailable Iodine.

6. Post - draining and drying. This is to prevent contamination of milk with the residual sanitizer.

Cleaning in Place (CIP).

Manual cleaning is usually practised for easily accessible utensils and equipment. CIP is practised in bigger dairies where it is difficult to dismantle and reassemble. The CIP system is time saving, labour saving, cost effective and minimizes the damage to the equipment. In this method detergent and sanitizers are circulated for specific period of time at a specific speed and in a specific sequence. The efficiency of cleaning can be evaluated by visual inspection (by light, feel and odour) or staining procedure. Microbiological efficiency of sanitization can be assessed by swab test, rinse method, membrane filter technique and direct epifluorescent filter technique.

Hazard analysis and critical control points (HACCP).

The dairy industry throughout the world has recognized the importance of HACCP system in controlling hazards in dairy products thereby not only increasing the safety of consumers, but also winning their confidence. HACCP system which is scientific and systematic identifies a specific hazard throughout the food chain, i.e. from primary production of milk till it reaches the consumer.

COMMON REPRODUCTIVE DISEASES OF DAIRY CATTLE, ITS PREVENTION AND TREATMENT

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A variety of situations can cause problems with the reproductive system in cattle like anestrus, cystic ovaries, reproductive tract infections (metritis), retained placenta, and repeat breeding.

Anestrus

True anestrus means no ovarian activity; however, it is often suspected when a cow fails to show signs of estrus (heat). In 90 percent of the cases in which anestrus is suspected, the animal is actually cycling but just not manifesting any signs of estrus or not being detected in estrus. Keeping reproductive records on each animal's estrous dates, examination dates and findings, unusual events such as difficult calving or retained placenta, and any treatments will help identify problem animals early and provide information that can help determine a possible cause. True anestrus can be caused by anemia, phosphorus deficiencies, being underweight, hormone levels that are excessively low due to a prolonged diet of only stored feed, cystic ovaries, and pyometra (pus in the uterus). Each of these causes of anestrus will be discussed below along with their treatment.

A. Anemia - Anemia (low red blood cell numbers) can be detected with a blood sample. It is caused by anaplasmosis, internal or external parasites, or deficiencies of protein, iron, copper, cobalt or selenium. Treat anemia by eliminating the cause; i.e. check for internal and external parasites and treat for them if present, or supplement the animal's diet if element deficiencies are revealed in the blood test.

B. Phosphorus deficiency - Have feed analyzed regularly to determine an appropriate nutritional level for normal reproductive function. The calcium and phosphorus ratio should be between 1.5 to 1 and 2 to 1 in the diet.

C. Underweight - Cattle should ideally be at a body condition score of about 6-7 right before the breeding season. Prepare cattle by placing them on a weight-gaining diet prior to breeding season.
D. Low hormone levels due to a stored-food diet - To overcome this problem, provide access to fresh forage for at least 4 weeks per year.
E. Cystic ovaries - Breeding stock should be examined for uterine infections and cystic ovaries on a regular basis; intensively managed herds should be palpated between 15 and 45 days after calving.
F. Pyometra (infection or pus in the uterus) - It is important to identify the source of the infection and then utilize prostaglandins (PGF2□ □ , antibiotics, or uterine lavage to help resolve the problem.

Additionally, cows that are thought to be not cycling (anestrus), are often animals that are cycling normally, but have been missed during the estrus detection process. These animals do not fit in the true anestrus category, and efforts should be made to improve estrus detection. Careful observation will help identify whether an animal's cycle is merely undetected or whether it is absent. Two-thirds of cattle show signs of estrus between 6 p.m. and 6 a.m. Those that have a shorter estrus may be missed unless they are checked more than the usual twice-per-day schedule. Observation should last at least 20 minutes and be at a time when the cow is not distracted with activities such as eating or being milked. Providing a non-slip surface for estrus detection also makes it easier for an animal to exhibit signs.

Cystic Ovaries (Ovarian cysts)

Cysts on the ovaries are usually structures greater than one inch (25 mm) in diameter that persist for more than 10 days. The cysts affect the cow's hormone levels. This influences uterine tone, can cause failure to release an egg during estrus, and inhibits fertility. These cysts can appear on one or both ovaries and are usually thin-walled, fluid-filled structures. They are the result of follicles that fail to ovulate. This condition is common in dairy animals, but rare in beef cattle.

Causative Agents: Too much calcium or a large discrepancy in the calcium to phosphorus ratio, high estrogen intake, genetic predisposition, and stressful conditions or other health problems during the birthing process or postpartum interval may cause cysts to develop on the ovaries.

Diagnosis: The most obvious signs that a producer may notice relate to the cow's estrous cycles. Cows with cystic ovaries will often have constant or frequent estrus. Other animals may be completely anestrus. Palpation of the ovaries by a veterinarian can often help in determining the presence of ovarian cysts. Follicles and a developing corpus luteum can often be mistaken for a cyst.

Treatment: Many animals may spontaneously recover from a cystic ovary problem; however, if treatment is required, the most common drug given is gonadotropin-releasing hormone (GnRH). Some producers give a dose of prostaglandin (PGF2, □ □ 9 days after the GnRH dose to help reduce the time it takes the cow to return to estrus. In some cases, human chorionic gonadotropin (hCG) can be administered instead of GnRH.

Prevention: To prevent the development of cystic ovaries, start by evaluating the animal's feed. Analyze the animal's entire diet for the proper calcium to phosphorus ratio. It should be between 1.5:1 and 2:1 in the total diet. If the cow is getting greater than two parts of calcium to one part phosphorus, per day, there may be an increased incidence of cysts. Do not use moldy feed. Toxins found in moldy feed can be high in estrogen. Because injectable estrogen products can cause cysts, their use should be monitored by a veterinarian. Genetic predisposition to ovarian cysts is possible; therefore, cull any cows and bulls known to produce cystic daughters.

Uterus Infection (Endometritis, Metritis, and Pyometra)

Endometritis (inflammation of the lining of the uterus), metritis (inflammation of the uterus), and pyometra (infection or pus in the uterus) can be common problems in cows after they calve. If not resolved, these problems will lead to estrus abnormalities, failure to conceive, and an increase in days open.

Causative Agents: Most problems in the uterus are caused by injury or infection that occur during or soon after the calving process. One of the most common causes of a uterus infection is a retained placenta. Injury or contamination of the reproductive tract is also a common cause of uterus infection and can be the result of a difficult birth where manipulations have been made and/or medications have been given in the uterus. Selenium or vitamin E deficiencies and over-conditioning are also possible causes. The over-conditioning predisposes the cow to retained placentas, metritis, and other problems.

Clinical Signs: Most of the time a cow with a uterus infection can be identified simply by the discharge and odor coming out of the vulva. A red, brown or even white discharge following calving is normal in cows for about 2 weeks. However, if the discharge becomes foul-smelling or persists longer than 2 weeks, metritis is likely to be present. An infected uterus can also cause the cow to go off feed (anorexia), have a fever, be lethargic, not cycle, and suffer a drop in milk production. A culture of the discharge can confirm an infection and help identify what organism(s) is causing the infection and what treatment would be appropriate.

Treatment: The most common treatment for cows that have a uterus infection is the administration of prostaglandin (PGF2α) when the problem is diagnosed. Products such as gonadotropin-releasing hormone (GnRH) can also be given instead of the prostaglandin.
Some veterinarians recommend that the uterus be lavaged or infused with some type of antiseptic solution. There are many different combinations of solutions that have been used. One of the most common is diluted povidone-iodine, mixed 20 parts saline to 1 part of 10% iodine solution. Other solutions infused into the uterus include penicillin and tetracycline. It is important to note that ALL antiseptic solutions infused into the uterus will cause some degree of irritation and inflammation to the lining of the uterus. This will delay healing and will often increase the days open. Because of this reason, many producers choose not to administer products into the uterus if it is at all possible.
For cows that are sick and have signs of toxemia (fever, not eating, weakness), it is important to administer systemic antibiotics. Injections of ceftiofur, penicillin, or tetracycline are often given. Severely sick animals should also receive fluids and anti-inflammatory agents (flunixinmeglumine) when necessary.

Prevention:

A. Sanitation: Keep things clean during examinations, insemination procedures, and calving. Using a protected sheath or double-rod technique for insemination has been effective in chronically infected herds. Do not use natural service if there is any indication of infection of the reproductive tract in either the cow or bull. When the time comes for calving, use clean paddocks or pastures in good weather, or sanitize and re-bed pens after each calving. Long-stem bedding is better than sawdust. If metritis is widespread, rest calving sites for 1-2 months and calve in a new, clean site. Keep other animals out of maternity pens.

Ensure any instruments needed to assist the birthing process are sterilized, as well as the arms and hands of anyone assisting with the birth. A non-irritating lubricant used on one's arms will also help prevent injury to the reproductive tract. Wash the cow's vulva and surrounding area with a mild disinfectant and tie the tail to a front leg. Be gentle, working with the contraction of the cow. Make sure the position of the calf is normal before it is pulled. Call a veterinarian if problems arise that cannot be resolved.

B. Diet and Conditioning: Give selenium or vitamin E supplements if the herd is in a selenium deficient area. Injectable selenium-vitamin E supplements should be given at least 21 days prior to calving. Avoid over-conditioning during late gestation.

C. Examinations and Treatment: Examine all cows between 2 and 6 weeks after calving for signs of infection. Avoid routine medication of the uterus unless a cow is known to be infected. Follow recommendations for retained placenta if that is considered the source of anymetritis.

Retained Placenta

Causative Agents: A cow is said to have a retained placenta if she fails to expel the placenta within 12 hours of calving. There are many things that can cause a cow to retain a placenta. They are often associated with cows that give birth prematurely, have an excessively large fetus, or must have a cesarean section to have the calf. Abortions and still births are also common problems that can lead to a retained placenta. Problems such as uterine torsions, dystocia, hypocalcemia (milk fever), and possibly metritis can lead to a retained placenta. Infections with organisms such as brucellosis, IBR, BVD, leptospirosis, neosporosis, and salmonellosis can all cause premature death of the fetus and result in a retained placenta. Nutritional problems such as selenium and/or vitamin A or E deficiency, carotene deficiency, calcium and phosphorus deficiency or excess, and too much vitamin D can also lead to problems. Feeding a high hay ration, too much grain, a poor quality forage, or a lack of fresh forage have all been associated with retained placentas.

Clinical Signs/Diagnosis: A cow may normally take up to 12 hours to dispel the placenta. If the placenta is still attached after 12 hours, there is a problem and the placenta is considered retained. A cow that has retained the placenta will often have some of the placenta hanging out of the vagina. This can vary in length from a few inches to more than a foot or two. In some cases, there may not be any of the retained placenta that can be viewed from the outside. In these instances, the entire placenta is still contained within the uterus and vagina. When infection is present, cattle with a retained placenta will sometimes have a fever, act sick, and not want to eat. As the placenta itself decomposes and infection sets in, a very foul odor can be noticed and a dark, blood-tinged fluid may come out of the vagina.

Most cases of retained placenta can be diagnosed by observing the cow. Others may require that a rectal palpation be performed to actually feel the placenta and abnormal fluids in the uterus.

Treatment: In all cases, it is important to not try and pull the placenta out of the cow. If some of the placenta can be seen hanging from the vagina, gently give it a small tug. If the placenta comes out easily, then remove all that comes with the gentle tug. If it is still attached to the uterus and does not come with a simple tug, leave the placenta in place. *Pulling or forcing a retained placenta from the uterus will only cause injury to the cow, delay healing, increase the days the cow remains open, and increase the chances for severe infections.*

The preferred treatment for most retained placentas is the administration of prostaglandin (PGF2α) when the problem is diagnosed. Products such as oxytocin can also be given instead of the prostaglandin. Some veterinarians recommend that the uterus be lavaged or infused with some type of antiseptic solution. There are many different combinations of solutions that have been used. (See the information previously given under "uterus infections" for details.)

Prevention: To help prevent this problem, minimize stressful conditions during the pre-calving period and at calving. Prevent diseases and problems such as dystocia, abortions, and milk fever. Vaccinate all animals for potential reproductive diseases. Evaluate all rations to make sure cows receive proper nutrition. Give supplements if rations are deficient in calcium, phosphorus, magnesium, selenium, vitamins A and E, or carotene.

- Most dry cows need 135,000-160,000 IU of vitamin A and 800-3,000 IU of vitamin E per head per day. Milk cows need 150,000 units of vitamin A and 1,000 to 1,500 units of vitamin E per head per day.
- Make sure the calcium/phosphorus ratio is 1.5:1 to 2:1.

- Selenium levels should be at 0.3 parts per million in total ration dry matter. If dietary supplementation is not incorporated into the animal's care, administer 30-50 mg of selenium and 680 units of vitamin E as an injection about 3 weeks before calving.
- Provide fresh pasture or green-chop for at least 4 to 6 weeks each year.
- Do not feed more than 0.5% of body weight in grain to cows.
- Keep corn silage intake to less than 50% of forage dry matter.
- Test for brucellosis, neosporosis, IBR, BVD, leptospirosis and non-specific infections.
- Do not allow animals to become over-conditioned.

CRYOPRESERVATION OF SEMEN: PRICIPLES AND APPLICATION

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Spermatozoa were the first mammalian cells to be cryopreserved successfully (Polge et al., 1949). This success was due to the serendipitous discovery by Polge and co-workers of the cryoprotective effect of glycerol. Since then, many methods have been developed for various types of cells, tissues and organs. Much progress in the field has come from empirical work as well as from fundamental cryobiology. Increased understanding of the causes of cryo-injury has continually helped to improve cryopreservation methods. Research into fundamental cryobiology has provided the basis for new cryopreservation methods such as vitrification. The two most commonly used cryopreservation methods for animal germplasm are slow-freezing and vitrification. These are quite different methods, but relate to the same physico-chemical relationships. The differences between the two can be explained by first describing what happens during slow freezing.

Slow freezing

In slow-freezing, cells in a medium are cooled to below freezing point. At some stage, ice masses containing pure crystalline water will form. What remains between the growing ice masses is the so-called unfrozen fraction, in which all cells and all solutes are confined (see Figure 7). The concentrations of sugars, salts and cryoprotectant (e.g. glycerol) increase, while the volume of the unfrozen fraction decreases. The increase in osmotic strength causes an efflux of water from the cells. Slow cooling is needed in order to allow sufficient efflux of water to minimize the chance of intracellular ice formation. As cooling continues, the viscosity of the unfrozen fraction ultimately becomes too high for any further crystallization. The remaining unfrozen fraction turns into an amorphous solid that contains no ice crystals.

Chilling injury and cold shock

The first challenge in cryopreserving cells from homeotherm (warm-blooded) animals is in cooling the cells below body temperature. Cells may be damaged by very rapid cooling (cold shock) or be damaged by low temperature per se (chilling injury). Behaviour and function of membrane lipids and proteins may be affected by temperature. For example, membrane lipids that are normally in a liquid crystalline state may solidify at non-physiological temperatures, which can change their function and begin processes such as cryocapacitation of the production of reactive oxygen species that increase damage to membranes. Decreasing the temperature may cause an imbalance in cellular processes because the rate of one process may be affected more strongly than that of another. One example is the disintegration of the metaphase spindle of oocytes caused by a change in the dynamic equilibrium of the association/dissociation of the tubulin filaments.

Supercooling

In slow-freezing methods cells are brought into a suitable freezing medium and cooling is continued below the freezing point of the medium. Ice formation does not necessarily start at the freezing point. Small ice crystals have a lower melting/freezing point than "bulk" ice, due to their large surface tension. Spontaneous ice nucleation will in most cases occur after the solution is supercooled to a temperature between -5 and -15 °C. Thereafter, ice will grow rapidly in all directions, and the release of the latent heat of fusion will cause the sample to warm up abruptly until the freezing/melting temperature of the solution (i.e. of the remaining unfrozen fraction) is reached. At this point, the ice formation will stop, or will proceed at a rate governed by the rate at which the heat of fusion is transported from the sample. Finally, the sample can "catch up" again with the lower temperature in the freezing apparatus. From a practical perspective, this means that the cells undergoing cryopreservation in a typical semen straw have to withstand a series of large and abrupt temperature changes.

Conditions in the unfrozen fraction

Cells are faced with very high concentrations of solutes in the unfrozen fraction. Dehydration and high salt concentration may result in loss of stability in the membranes or denaturation of proteins (Tanford, 1980; Crowe and Crowe, 1984; Hvidt and Westh, 1992; Lovelock, 1953). Moreover, high salt concentrations may cause extracellular salts to enter the cells, a process known as "solute loading" (Daw et al., 1973; Griffiths et al., 1979). FIGURE 7 Frog erythrocytes in the "unfrozen fraction", which is enclosed by growing masses of ice Source: Rapatz and Luyet (1960). Basic principles of cryopreservation 87 The fast efflux of water causes a rapid decrease in the volume of the cells to approximately 50 percent of their original volume. This leads to structural deformation of the cells. Further mechanical stress may be caused by cells being confined in very narrow channels of unfrozen solution and squeezed between growing masses of ice (Rapatz and Luyet, 1960).

The influence of cryoprotectants

At all practical cooling rates, the total solute concentration (which is measured in moles per kg water) is determined only by the subzero temperature (Figure 8). When the initial freezing medium contains only salts (electrolytes), salt concentrations in the unfrozen fraction will reach extremely high levels as the temperature decreases. In contrast, in a medium that contains a large proportion of non-electrolytes, the total solute concentration at each subzero temperature will be the same as that found at the equivalent temperature in a medium containing only salts; however, the salt concentration will be much lower. Sugars can be used as non-electrolyte solutes, but they will only affect the extracellular salt concentration. Moreover, high concentrations of impermeable solutes impose osmotic stress on the cells already before freezing. This is much less the case when a membrane permeable solute, such as glycerol, is used rather than a non-permeable solute. When cells are brought into a hypertonic glycerol medium, water will leave the cells because of the osmotic pressure difference. However, at the same time, glycerol will enter the cells. After a short period of equilibration, the cells will have regained their original volume. The osmotic stress imposed by a hypertonic glycerol solution is therefore much smaller than that imposed by a hypertonic sugar solution. Hence, glycerol can be used at greater concentrations than sugars without damaging the cells. A substantial initial glycerol concentration in the medium means that part of the extracellular and intracellular water is replaced by the glycerol. Hence, the amount of ice formed is lower, the unfrozen fraction remains larger, the degree of shrinkage of the cells is limited, and the electrolyte concentration in the unfrozen solution and in the cells will be relatively small (see Figure 8). The mechanisms through which other membrane permeable substances, such as ethylene glycol and dimethyl-sulfoxide (DMSO), provide cryoprotection are similar to those involving glycerol. There are additional mechanisms through which polyols, such as like glycerol and several sugars, provide cryoprotection. These substances can stabilize lipid membranes by hydrogen bonding with the polar head groups of membrane lipids (Crowe and Crowe 1984; Crowe et al., 1985), which is especially important under severely dehydrated conditions. In addition, these substances may affect the mechanical properties of the unfrozen fraction, especially its viscosity and glass-forming tendency. The degree to which cells shrink and re-swell after addition of a membrane-permeable cryoprotectant depends on the concentration of the cryoprotectant and the relative permeability of the membrane to water and to the cryoprotectant (Kleinhans, 1998). For instance, bull sperm shrink very little when brought into a freezing medium with glycerol (Chaveiro et al., 2006), whereas bovine embryos react much more strongly. Upon thawing, removal of the cryoprotectant has the opposite effect on cells: they first swell and then they shrink again. This may lead to damage if the cells expand too much. Damage due to over-swelling of cells can be prevented by stepwise removal of the cryoprotectant.

Cryoconservation of animal genetic resources

The influence of cooling rate A general observation in the cryopreservation of cells and other biological systems is that each system has a specific optimal cooling rate, with decreased survival at cooling rates that are too low (slow-cooling damage) or too high (fast-cooling damage) (Mazur et al., 1972). Ice growth is a rapid process, but transport of water through the cell membrane is relatively slow, because the membrane acts as a resistance barrier. Therefore, as cooling and extracellular ice growth continue, the liquid water of the unfrozen fraction remains very close to equilibrium with the ice, but the intracellular water lags behind. This means that the water concentration (i.e. the chemical potential of water) is too high for thermodynamic equilibrium, and there may be a risk of intracellular ice formation. The optimal cooling rate falls in a range that is neither too fast nor too slow. When cells are cooled very slowly, the intracellular water lags behind only a little, and the risk of intracellular ice formation is minimal. However, it also means that the dehydration of the cells is maximal, which is not desired. At higher cooling rates, intracellular dehydration, intracellular solute concentration and shrinkage of the cells is less excessive. Moreover, the cells are exposed to the unfavourable conditions for a shorter period of time. However, when cooling rates are increased too much, the dehydration may not be fast enough to prevent intracellular ice nucleation (Mazur, 1963, 1985; Mazur et al., 1972). Fast-cooling damage can also be caused by other factors. For instance, it has been proposed that rapid water flow through membrane pores could lead to an uneven distribution of pressure on the membrane (Muldrew and McGann, 1993, 1994). Fast-cooling damage could also result from the very sudden changes in size, shape and ultrastructure, caused by the rapid efflux of water (Woelders et al., 1997). Different cells or other biological materials (embryos, tissue pieces) may have different optimal cooling rates. The optimal cooling rate of cells is largely determined by their volume FIGURE 8 Effect of subzero temperature on salt concentration in the presence and absence of glycerol Note: The total solute concentration (salts plus non-electrolytes) is a function of subzero temperature. Thus, the presence of non-electrolytes, such as glycerol, results in a lower salt concentration in the unfrozen fraction and inside the cells (Mazur and Rigopoulos 1983). 0 2 4 6 8 10 0 -10 -20 Subzero temperature (°C) Salt concentration (moles ions/kg water) Salt medium Plus glycerol Basic principles of cryopreservation 89 and their membrane surface area (volume to surface area ratio), and by the permeability of the membrane to water and to cryoprotectant.

Interactions of cooling rate with thawing rate and cryoprotectant concentration

The optimal cooling rate may depend on various other factors, such as the cryoprotectant concentration and the thawing rate. It has been observed in semen from a number of species that the combination of fast cooling and slow thawing is particularly damaging to the cells. (Rodriguez et al., 1975; Fiser, 1991; Henry et al., 1993; Woelders and Malva 1998). If intracellular ice nucleation occurs at a low temperature and cooling proceeds rapidly, it may be that the cytoplasm turns into glass before the intracellular ice crystals grow to a significant size, thus causing only sublethal, or no, damage. During slow thawing, the small crystals can grow and subsequently damage the cells (Rall et al.,1984). In addition, cells may be damaged by extracellular restructuring of ice masses, a process known as "recrystallization" (Bank, 1973).

Programmable and non-programmable freezers

Biological material can either be frozen using quite simple, non-programmable, freezers or using more sophisticated, programmable, freezers (see Figure 10). Although programmable freezers are more expensive, they do not necessarily yield more satisfactory results, especially for experienced technicians and cryobiologists. Therefore, the choice between FIGURE 9 Effect of cooling rate on survival of different kinds of cells Note: Cells may have a specific optimal cooling rate, i.e. they have a lower survival rate at cooling rates that are too low (slow-cooling damage) and at a cooling rates that are too high (fast-cooling damage) (Mazur, 1985). 0 20 40 60 80 100 0.1 1 10 100 1 000 10 000 Survival (%) Cooling rate (°C/minute) Ova Lymphocytes Red blood cells 90 Cryoconservation of animal genetic resources programmable and non-programmable systems will depend on the financial resources available and the experience of the technicians. In some cases, even the most experienced technicians prefer the operating simplicity of programmable models. In most programmable freezers, the straws or vials are cooled by cold nitrogen vapour. The temperature inside the cooling chamber can be accurately controlled and the time course of the temperature can be programmed. However, the time course of temperature inside the straws may be different due to the generation of heat of fusion (Figure 11). In non-programmable freezers, the straws may be cooled by being exposed to vapour (or a cold surface) at a constant low temperature. An example of a simple system is the freezing of straws placed on a rack in a Styrofoam box partially filled with liquid nitrogen without ventilation. The height of the straws above the liquid nitrogen determines the rate of heat exchange. Alternatively, straws can be placed on a piece of Styrofoam that floats on the liquid nitrogen (e.g. Dong et al., 2009). The thickness of the Styrofoam piece determines the rate of heat exchange. Generally in such systems, the rate of heat exchange is governed by the temperature difference between the inside and the outside of the straw, and by the extent of heat conduction. The latter depends strongly on the volume to surface ratio of the straw or vial and the rate of (forced) ventilation. Therefore, it is difficult to compare one type of non-programmable freezer with another, or to know the actual freezing rate obtained with any given non-programmable apparatus. Optimal conditions have to be determined by experimentation. FIGURE 10 Example of a programmable freezer Note: the freezer is about 1 metre in height. Photo credit: IMV Technologies, l'Aigle, France Basic principles of cryopreservation 91 Non-programmable systems do, however, have an advantage. The cooling curve (the time course of cooling and freezing) is, by default, of the form theoretically predicted to be optimal for slow freezing (Woelders and Chaveiro, 2004), with relatively low cooling rates directly after ice formation begins and higher cooling rates later. The bulk of the ice formation happens in the temperature range between the freezing point and -10 °C, and consequently most of the water efflux from the cells must also take place in this temperature range. Thus, the heat of fusion liberated during ice formation slows the cooling exactly at the point when cells need extra time to export intracellular water. The overall steepness of the freezing curve can be adjusted in non-programmable systems by choosing the height of the straws above the liquid nitrogen, which is proportional to the temperature of the vapour around the straws (Figure 11). In more sophisticated systems with forced ventilation and adjustable preset vapour temperatures, the rate of heat exchange can be adjusted by choosing the preset vapour temperature.

Vitrification

The term "vitrification" refers to any process resulting in "glass formation", the transformation from a liquid to a solid in the absence of crystallization. According to this definition, cells that are properly slow frozen become "vitrified". FIGURE 11 Examples of freezing curves in programmable and non-programmable freezers Left panel: A typical freezing programme in a programmable freezer (dotted line) and the corresponding freezing curve measured inside the straw. Note that the temperature inside the straw doesn't necessarily follow the programmed chamber temperature and that in parts of the curve the cooling rate may be higher than anticipated. Right panel: In a non-programmable freezer (Styrofoam box), the constant temperature outside the straw results in sigmoidal freezing curves. The overall steepness of the freezing curve can be changed by choosing a different vapour temperature, for example, by changing the height of the straws above the liquid nitrogen (Woelders and Zuidberg, personal communication). -60 -50 -40 -30 -20 -10 0 10 3.5 4 4.5 5 5.5 Temperature (°C) -60 -50 -40 -30 -20 -10 0 10 Temperature (°C) Time (minutes) Chamber Inside straw Time (minutes) Programmable 0 0.5 1 1.5 2 2.5 Non-programmable Low High 92 Cryoconservation of animal genetic resources If, in slow-cooling methods, cells ultimately become vitrified, how do so-called vitrification methods differ? Vitrification methods involve the use of a medium that has a very high solute concentration to begin with. Thus, ice cannot form in any part of the sample. As no ice forms, cooling does not have to be slow. In fact, it may be beneficial to cool very rapidly. The vitrified state and the associated physico-chemical conditions obtained using vitrification methods, are to some extent similar to those obtained by slow cooling, but the way of reaching this point is quite different.

Chilling injury and cold shock

As in the case of slow-freezing methods, vitrification methods can damage cells or tissues through cold shock and chilling injury. Depending on the material and the protocol used, however, cells or tissues may be rapidly cooled from a temperature at which chilling injury and cold shock play no role (e.g. room temperature). Extremely high rates of cooling from such a temperature to the vitrified state seem to be able to "outrun" cold shock and chilling injury. For example, rapid cooling seems to prevent disintegration of the metaphase spindle of oocytes.

Cryoprotective agents

In vitrification methods, cells or tissues are brought into a medium that has a very high concentration of cryoprotective agents, also known as cryoprotectants. If the concentration of solutes is high enough, vitrification solutions will solidify to a glass without any risk of intracellular or extracellular ice formation during cooling or warming, independently of the cooling and warming rates used. However, the very high concentrations of cryoprotective agent needed for vitrification may cause damage due to abrupt osmotic changes, extremely low water potential or chemical toxicity. According to the description provided by Rall

(1987), the embryos are first equilibrated with 25 percent vitrification solution at room temperature. Then the embryos are cooled to 4 °C and transferred to 50 percent vitrification solution and then to 100 percent vitrification solution. They are then rapidly packed and transferred into liquid nitrogen. The stepwise increase of cryoprotective agent concentration reduces osmotic effects, while the low temperature and rapid transfer help prevent damage by chemical toxicity. In addition, chemical toxicity may be reduced by using mixtures of various permeant CPAs, or addition of non-permeant CPAs (60 g/litre polyethylene glycol) (Rall, 1987) or 60 g/litre bovine serum albumin (BSA) (van Wagtendonk-de Leeuw et al., 1997).

Reduction of cryoprotective agent concentration at high cooling rates

Solutions that have a solute concentration lower than that of classical vitrification solutions have freezing points below which there is a significant tendency to form ice crystals. But when the solution is cooled very rapidly, there is simply no time for ice formation. Below a certain temperature, the solution becomes so viscous and stiff that ice formation becomes impossible, and the solution turns into “metastable” glass. The solute concentration needed for metastable vitrification decreases as a function of increasing cooling rate. The most recent vitrification procedures, therefore, make use of high cooling rates in order to reduce the concentration of CPAs and thereby decrease the damage caused by osmotic stress and chemical toxicity. Basic principles of cryopreservation 93 The cooling rate can be increased in several ways. One is to reduce the volume of the sample to be vitrified. An early example of this approach is the open pulled straw method (often abbreviated OPS) (Vajta et al., 1998, 2000a,b). Even smaller sample volumes have been used on electron microscope grids, so-called hemi-straws, nylon loops (cryoloops) or polypropylene strips (Cryotop® – Kitazato Supply Co., Fujinomiya, Japan) (Kuwayama, 2007). The Cryotop system allows a volume of 0.1 μl to be vitrified. In addition to reducing the sample volume, a faster cooling rate can be achieved by heat transfer to a liquid that does not boil. Liquid nitrogen at its boiling point (-196 °C) will generate nitrogen gas when it absorbs heat. This will create a film of gas that insulates the sample from the liquid nitrogen. Liquid nitrogen at its freezing point (also known as “nitrogen slush”) doesn’t have this disadvantage. It can be produced with an apparatus called Vit Master® (IMT Ltd, Ness Ziona, Israel) (Arav et al., 2002). In metastable vitrification procedures, it is also essential that the warming (i.e. thawing) of the sample is very rapid. If warming is slow, ice crystals can form while the temperature is between the vitrification temperature and the freezing point of the vitrification solution. Most recent vitrification protocols make use of these ultra-rapid approaches in order to reduce cryoprotective agent concentrations and prevent cold shock and chilling injury. Current vitrification solutions (Liu et al., 2008; Morató et al., 2008) have much lower solute concentrations than those used in classical vitrification solutions (e.g. VS3, Rall 1987). As described in Section 4, very good results are currently obtained when using these approaches for vitrification of oocytes and embryos. Recent studies with pig and cattle oocytes have indicated that the Cryotop system gives better results than the open pulled straw system (Liu et al., 2008; Morató et al., 2008).

Freeze drying

Storage of freeze-dried biological material is extremely cost efficient, as no expensive and bulky liquid nitrogen containers are necessary. Furthermore, it is safe. The material may be stored at ambient temperature and, unlike cryogenic storage, there is no risk of equipment malfunction or of personal injury from liquid nitrogen. On the negative side, however, freeze drying generally reduces cell viability. Therefore, standard insemination procedures generally cannot be used for freeze-dried sperm. However, freeze-dried sperm have been successfully used to produce live offspring using ICSI in mice and rabbits (Wakayama and Yanagimachi 1998; Liu et al., 2004). In addition, freeze-dried somatic cells have been successfully used to produce apparently healthy embryos using SCNT (Loi et al., 2008a, 2008b). However, there have so far been no reports of cloned offspring produced by SCNT using freeze-dried somatic cells. Thus, while freeze drying is potentially useful for gene banking of genetic resources with the objective of regenerating live animals and recovering lost breeds, this would require further development and optimization of procedures. Conversely, freeze-dried gametes and somatic cells can already be used for conservation of germplasm intended for use in (genetic) research. The key to freeze-drying is to bring the material to a vitrified glass state in which the glass transition temperature is higher than ambient temperature. The first step is to bring the biological material to a vitrified state. The next step is to apply a vacuum to the material, which results in sublimation of any ice that may be present and further decreases the water content of the vitrified material. This increases the glass transition temperature, which ultimately reaches a level higher than the ambient temperature. Thus, at the end of the process the material can be stored at ambient temperature while remaining in the stable glass state. Obviously, the initial freezing/vitrification procedure, and the medium used, should be optimized so as to ensure the survival of the germplasm throughout this phase. In addition, the medium composition must be optimized so as to prevent the cells from being damaged by the effects of the further dehydration of the material.

Technology of dairy development and its products

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Livestock products Technology

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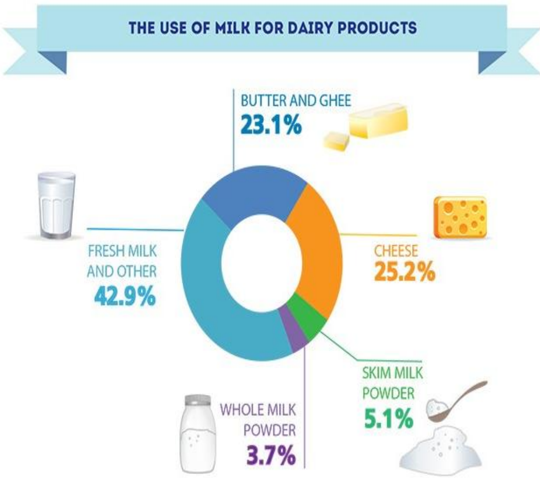
India is the highest producer of milk in the world with 18% of the global milk production producing155.5 million tonnesregistering a growth rate of 6.28% during 2014-16 which is three times more than the world average growth of 2.2%.Milk and dairy products not only provide a vital source of nutrition, they also serve as the main source of livelihoods opportunities for farmers, entrepreneurs, shopkeepers and other stakeholders in the dairy value chain. “Milk Products” means the products obtained from milk such as cream, malai, curd, skimmed milk curd, chhanna, skimmed milk chhanna, cheese, unsweetened, condensed skimmed milk-sweetened and unsweetened, milk powder, skimmed milk powder, partly skimmed milk powder, khoa, infant milk food, table butter and desi butter.

Milk products are of various types:

1. Desiccated milk based products: Khoa/Mawa, Gulab jamun, milk cake,kalakand,barfi, basundi, kulfi and frozen desserts
2. Heat acid coagulated products: Paneer, chhana,rosogulla,rasmalai,rajbhog,cham cham,Sandesh
3. Cultured/fermented products: Dahi and yoghurt, Misti dahi,Lassi, Dahi vada, Raita
4. Fat rich products: Ghee, Makkhan
5. Milk based pudding/desserts: Kheer etc



Source: Infographic milk facts, 2013

Marketing of traditional milk products

The production of traditional milk products presents unique opportunity to the organised dairy sector in India as they have a huge mass appeal and the market for these products far exceeds that of western style dairy products. The consumption of traditional dairy products is growing at an annual growth rate of more than 20%, but for the western dairy products the growth rates are relatively much lower (5-10%) (Patil, 2009). While the western dairy products (with the exception of malted milk and milk chocolates) add about 50% value to milk, the traditional Indian dairy products add about 200% value to milk (Aneja, 2007). Further, the raw material costs of certain Indian traditional dairy products viz. shrikhand, rasogolla, gulabjamun, khoa-based sweets (peda, burfi, kalakand), sandesh and paneer is 29, 33, 34, 35 and 65% of the selling price, respectively. For the western dairy products, comparative costs are relatively higher varying from 70-80% (Patil, 2009).

The market size of ethnic milk products (Table 1) in India alone is estimated at more than 1000 billion INR with an annual growth estimated at 50 billion INR (Aggarwal, 2007).

Table1: Market size of traditional dairy products

Type of products	End products	Estimated market size (Rs. in billion)
Chhana- based sweets	*Rasogolla, sandesh, pantooa, rasomalai, cham-cham, chhana murki, rajbhog, chhana podo*, etc.	520
Khoa-based sweets	*Kulfi, rabri, basundi, burfi, peda, gulabjamun, kalakand, khurchan, dharwad peda, kunda*, etc.	
Paneer (Indian cottage cheese)		20
Fat-rich products	*Ghee* and *makkhan*	310
Fermented dairy products	*Dahi, misti dahi, lassi, chhach/mattha, shrikhand*, etc.	180

Source: Gupta (2007)

Cream

According to FSSAI (2011), cream excluding sterilized cream is the product of cow or buffalo milk or a combination thereof, which contains not less than 25% milk fat. The milk fat in cream may vary from 18-85%. SNF constituents occur in lower proportions than in milk. Various types of cream are

a) Table, light and coffee cream : containing 20-25% fat

b) Heavy /whipping cream: containing 30-40% fat

c) Plastic cream: 65-85% fat

Cream Separation: Cream separation is the process of removing fat from the milk. Milk as discussed earlier contains fat and solids not fat (SNF) in it. The density of fat and SNF is different in milk, this difference facilitates the separation of fat from SNF portion of milk. Density of milk fat is 0.93 kg/l and it is lighter than SNF (1.036 kg/l) of milk. When the milk is kept undisturbed in a vessel, the fat globules being lighter tend to move upwards and collect at the surface in the form of a layer of a cream due to difference in their density, phenomenon known as creaming. Cream is separated mainly by centrifugal separators. When milk enters the rapidly revolving bowl of the cream separator, it is immediately subjected to a tremendous centrifugal force. Under the influence of centrifugal force the fat globules (cream), which are less dense than the skim milk, move inwards through the separation channels toward the axis of rotation. The skim milk will move outwards and leaves through a separate outlet. The velocity by which fat globules move under centrifugal force is based on Stoke's Law. The particle sedimentation velocity increases with:

- increasing diameter
- increasing difference in density between the two phases
- decreasing viscosity of the continuous phase

Raw milk in a rotating container also has centrifugal forces acting on it. This allows rapid separation of milk fat from the skim milk portion and removal of solid impurities from the milk.

Fig: Cream separation

Butter

According to FSSAI (2011), table (creamery) butter is the product obtained from cow or buffalo milk or a combination thereof, or from cream or curd obtained from cow or buffalo milk or a combination thereof, with or without the addition of common salt, annatto, carotene as coloring matter. It must contain not less than 80% by weight of milk fat and not more than 1.5% by weight of curd and note more than 3% by weight of common salt. Diacetyl may be added as flavouring agent and total diacetyl content must not exceed 4 ppm. Calcium hydroxide, sodium bicarbonate etc must not exceed the weight of butter as a whole by more than 0.2%.

Production of butter is a very old way of preserving milk fat, which is an essential part of the nutritional value of milk. Butter can be made from milk of different animal species, for example, sheep, goats, camels, buffaloes, and cattle, but the dominant source for production of butter today is bovine milk. Butter means the fatty product derived exclusively from milk of cow and/buffalo or its products principally in the form of an emulsion of the type water-in-oil. The product may be with or with added common salt and starter cultures of harmless lactic acid and/or flavour producing bacteria.

Butter is a water-in-oil emulsion in which fat globules, fat crystals, water droplets, and air bubbles are dispersed. There are normally two fat phases in butter, a continuous fat phase, which has been squeezed out from the fat globules during churning and working, and a globular fat phase consisting of more or less intact fat globules originating from the cream. The globular fat phase will normally be about one-third of the total fat content of butter, but the balance between the two phases depends on the intensity of the working of the butter, as a very strong mechanical processing, especially at high temperature, will result in an almost homogeneous structure with a highly diminished globular fat phase. Butter remains solid when refrigerated, but softens to a spreadable consistency at room temperature, and melts to a thin liquid consistency at 32–35 °C (90–95 °F). The density of butter is 911 g/L (0.950 lbs per US pint).

It shall conform to the following requirements:

Product	Moisture	Milk fat	Milk SNF	Common salt
Table butter	Not more than 16% moisture m/m	Not less than 80% m/m		
Desi	-	Not less than 76% m/m	-	-
Cooking butter	-			

Manufacturing of butter

The basic principle of the churning method is that air is mixed into cream where it forms foam. Simultaneously some of the fat globule membranes are disrupted, and liquid fat is squeezed out from the damaged fat globules and spread at the interface of the foam making fat globules stick to the lamella of the foam. By further agitation the foam collapses, and the fat globules are forced so closely together that they coalesce into small lumps, which are further pressed into small butter granules. Churning can be accomplished in either continuous or batch processes after a certain pretreatment of the cream.

The traditional way of fermenting cream for production of cultured butter is to use a starter culture containing the lactic acid-producing bacteria *Lactococcus lactis* subsp. *Lactis* and *Lactococcus lactis* subsp. *cremoris,* and citric acid fermenting strains of *Lc. lactis* subsp. *lactis* and *Leuconostocmesenteroides* subsp. *cremoris.* This fermentation method has three disadvantages: first, it results in cultured buttermilk of which there is limited utilization; second, the cooling procedure of the cream for regulation of the consistency is restricted by the culturing process; and third, the method is not suitable for large-scale production.

Procedure for preparation of creamery butter (with culture):

A. Cream

B. Pasteurization of cream

C. Cooling of cream

D. Addition of culture

E. Preparing for incubation

F. Incubation of Cream

G. Churning of cream

H. Butter

Steps in the manufacturing of butter

Ghee

According to FSSAI (2011), ghee is the pure clarified butter fat prepared chiefly from milk or cream and/or desi butter (makkhan) to which no coloring matter is added. It is characterized by its pleasant, cooked and rich flavor. The preferred texture is of uniform size grains having non-greasy consistency. Ghee is preserved by a combination of heat, which destroys enzymes and contaminating micro-organisms, and by removing water from the oil to prevent microorganisms growing during storage. It has a long shelf life if it is stored in a cool place, using airtight, lightproof and moisture-proof containers to slow down the development of rancidity.

Chemical composition of ghee:

Characteristics	Cow	Buffalo
Milk fat	99-99.5%	
Moisture	<0.5%	
Unsaponiable matter		
1. Carotene (µg/g)	3.2-7.4	-
2. Vitamin A (IU/g)	19-34	17-38
3. Tocopherol (µg/g)	26-48	18-37
FFA (% oleic acid)	2.8% maxm.	

Source: De, 1991

Different methods of ghee production

1. **Pre-stratification method:**

Principle: In this, ghee is produced by specially designed equipment (ghee kettle or boiler) in which molten butter is kept undisturbed at a temperature of 80-85°C for 30 min. Here, in ghee kettle, stratification of mass takes place, product stratifies into 3 distinct layers. Denatured protein particles (curd particles) and impurities are collected in top layer and floats on surface. Middle layer consists of clear fat and bottom layer consists of buttermilk serum carrying 80% of moisture and 70% of SNF contained in the butter. The bottom layer is then carefully removed without disturbing the both top and middle layers. Middle layer, largely consists of fat is heated to 114± 2°C along with top later of floating curd particles and denatured protein. This step is necessary to develop characteristic ghee aroma. Milder flavor ghee can be produced, since most of the curd content is removed before final clarification temperature of ghee.

Advantages: 1. Economy in fuel consumption 2. Production of ghee with lower acidity and 3. longer shelf life

2. Creamery butter Method:

Butter is an oil in water emulsion and has around 16% moisture. Therefore there is need to remove this moisture by heat treatment to prepare ghee. The SNF content of butter is less than the cream, therefore the fat absorption by SNF is less thus minimal loss of fat occurs in the ghee residue.

Heating the butter to 120°C

Filtration (ghee residue collection)

Ghee production (Creamery butter method)

Kulfi

Kulfi is a product made from mix which may or may not have higher total solids than ice cream but the concentration is achieved by severe heating of mix made of milk/ cream/ SMP, sugar, nuts etc. This mix is frozen with almost no overrun which provides kulfi its characteristic body and texture.

Procedure:

Milk (Cow milk)

↓ ← Sugar @ 6-7% milk; Stabilizer at 0.2%

Concentrating the milk to 2:1

↓

Chilling to 40°C

↓

Addition of flavour

↓

Freezing (Chilled running water @ -12°C)

A. Condensing the milk

B. Cooling the milk

C. Flavouring agents

D. Pouring in the mould

E. Freezing the mix in chilled water

F. Kulfi

Steps in the preparation of Kulfi

Ice cream

It is a frozen dairy product made by suitable blending and processing of cream and other milk products, together with sugar and flavour, with or without stabilizer or colour, and with the incorporation of air during the freezing process. The broad term frozen desserts refers to ice cream and related products. It comprises a mixture of air, water, milk fat and solid not fat, sweeteners, stabilizers, emulsifiers, flavours and colours. All the ingredients are mixed and processed to form ice cream mix and this mix is then frozen as fast as possible with incorporation of air. This process forms ice cream in semi frozen state which is then hardened to freeze it further.

According to Food Safety and Standards Regulation (2011), Ice Cream, is a frozen product obtained from cow or buffalo milk or combination thereof, or from cream or other milk products with or without the addition of cane sugar, eggs, fruits, fruit juices, preserved fruits, nuts, edible flavour and permitted food colours. It may contain permitted emulsifiers and stabilizers not exceeding 0.5% by weight. The product should contain not less than 10% of fat, 3.5% protein and 36% total solids.

Table1: FSSAI standards for Ice cream

Requirement	Ice Cream	Medium Fat Ice Cream	Low Fat Ice Cream
Total Solid	Not less than 36.0 percent	Not less than 30.0 percent	Not less than 26.0 percent
Wt/Vol (gms/l)	Not less than 525	Not less than 475	Not less than 475
Milk Fat	Not less than 10.0 percent	More than 2.5 percent but less than 10.0 percent	Not more than 2.5percent
Milk Protein (Nx6.38)	Not less than 3.5 percent	Not less than 3.5 percent	Not less than 3 percent

Method of manufacture of ice cream

The method of ice cream making can be divided into two phases viz. ice cream mix preparation and freezing of ice cream mix. For mix preparation, firstly all the ingredients are selected based on the composition, type and quality of ice cream desired. The selected ingredients are then proportioned, blended together, pasteurized, homogenized, cooled and then kept for ageing. Properly aged mix is then frozen in ice cream freezers, packaged in containers of desired size and kept for hardening.

Steps in the manufacturing of ice-cream:

1. **Selection of ingredients:**Dairy ingredients are the sources of fat and milk solid not fat required for imparting a characteristic richness and flavour to ice cream. Various sources of milk fat and SNF are milk, cream, unsalted butter, skim milk powder, sweetened condensed milk etc. Non-dairy ingredients include sweeteners, stabilizers, emulsifiers, eggs and egg product, flavours and colours etc.
2. **Formulation of ice cream mix** For making good quality ice cream and also to conform to legal standards, composition of ice cream mix is decided and according to the desired composition, quantity of different dairy and non-dairy ingredients is calculated.There are various methods followed for calculating amount of ingredients viz. Algebraic method, Pearson square method, Computer developed formulations and Formula tables/graphics method.
3. **Blending of mix:** All the liquid ingredients are first placed in the vat and agitation and heating is started. The dry ingredients like skim milk powder, stabilizer, sugar etc. are added to the vat before the temperature reaches 50°C.

4. **Pasteurization of mix**: It is usually done at 85°C.

Procedure:

Selection of ingredients

↓

Formulation of ice cream mix

↓

Blending

↓

Pasteurization (85°C/2-3 min)

↓

Homogenisation (First stage: 2500 psi, Second stage: 500 psi)

↓

Cooling (4°C)

↓

Ageing (6 h)

↓

Freezing the mix (-4 to -5°C)

↓

Packaging

↓

Hardening (-24 to -36°C)

↓

Storage

Fig: Flow diagram for ice cream processing

Paneer

According to FSSAI (2011), paneer or chhana means the product obtained from the cow or buffalo milk or a combination thereof by precipitation with sour milk, lactic acid, or citric acid. It shall not contain more than 70% moisture and milk fat content shall not be less than 50% of the dry matter. Milk solids may also be used in the preparation of these products.

Paneer, the indigenous variety of soft cheese, is obtained by the acid coagulation of heated milk. Paneer is generally sold as blocks or slices, it is also referred as Indian fresh cheese.Paneer has granular structure consisting of protein particles having a core and lining ultrastructure irrespective of the type of milk used. To coagulate the milk while still hot, a suitable coagulant (lime/citric acid/alum) is added, with a slow stirring. Irrespective of the type, milk should be standardized to a fat and SNF ratio of 1:1.65 so that the final product conforms to PFA requirements.

Paneer form cow milk and Buffalo

Paneer prepared from buffalo milk is a superior product as it contains higher level of casein and minerals particularly calcium and phosphorous which produces rubbery body texture, however cow milk yields soft, weak and fragile textured body. Buffalo milk paneer retains higher fat, protein and ash content and lactose as compared to cow milk paneer. To make paneer exclusively from cow milk, certain modifications in the conventional procedure have to be made. Addition of 0.25% calcium chloride to milk helps in getting a compact and closely knit texture since firmness of the paneer is related to calcium content of milk. Generally, yield of paneer ranges from 20-22% from buffalo milk and 16-18% from cow milk.

Methods of paneer manufacturing:

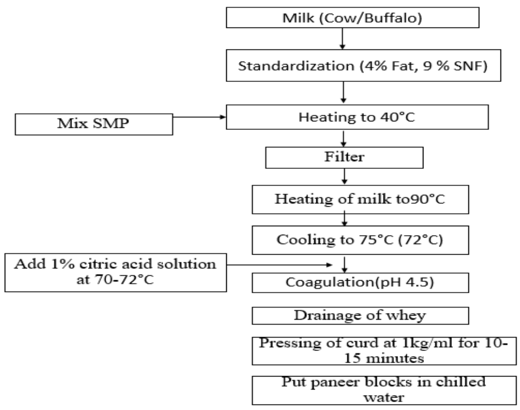
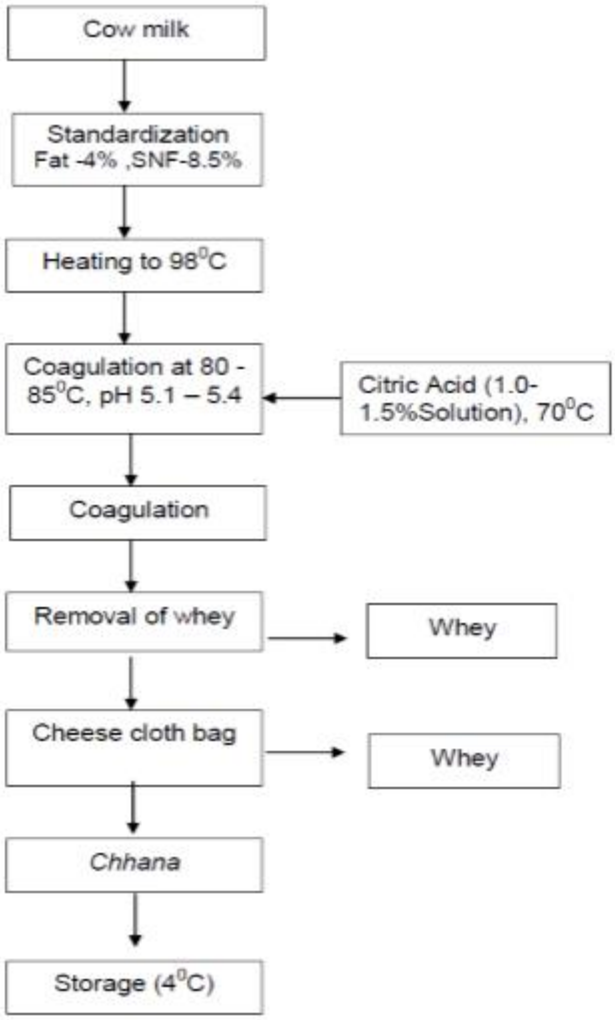


Fig. Flow diagram for the manufacture of paneer

Channa

It refers to the milk solids obtained by the acid coagulation of boiled hot milk and subsequent drainage of whey. The acids commonly used are citric or lactic acid in both natural or chemical forms. A minimum fat level of 4% in cow milk and 5% in buffalo milk is necessary for producing a desirable body and texture in channa for sweet making(De, 1991).

Preparation of chhana from buffalo milk



Kheer and Basundi

Kheer is a South Asian rice pudding made by boiling rice or broken wheat with milk and sugar. It is a partially dessicated, sweetened, concentrated milk-rice confection with added cereals, sugar, nuts and dry-fruits. Preparation of Kheer involves immersion of pre-soaked rice in simmering milk followed by sugar addition and dessicating the mixture till the rice softens. Buffalo milk is preferred for kheer preparation.

It is an Indian desert prepared by the partial dehydration of whole milk in a karahi over the direct fire together with sugar and usually rice. It contains 67.02% moisture, 7.83% fat, 6.34% protein and 8.45% lactose, 1.41% ash and 8.95% added sugar (De, 1991). Average shelf life of kheer is 2-3 days at 37°C and 10-15 days at refrigeration temperature (4°C)

Conclusion: The success of the dairy industry has resulted from the integrated co-operative system of milk collection, transportation, processing and distribution, conversion of the same to milk powder and products, to minimize seasonal impact on suppliers and buyers, retail distribution of milk and milk products, sharing of profits with the farmer, which are ploughed back to enhance productivity and needs by other farm produce/producers.To achieve this, consumers, entrepreneurs and all other stakeholders need to be updated on how milk and dairy products can be utilized and how it contribute to human nutrition and in what way dairying and dairy-industry development can best contribute to increasing food security and alleviating poverty.

Nutritional Management and Feeding Principles for Dairy Cattle

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Living organisms require permanent food intake in order to perform normal functioning of the life process. After ingestion the food get digested, absorbed, metabolized and utilized for various physiological functions in the body system. The quality and quantity of food ingredients for a particular individual primarily depends on their digestive system.

The food of farm animals consists mainly of plant and plants byproducts. The two major components of plants are water and dry matter. The bulk of dry matter can be broadly grouped into organic compounds and inorganic compounds. Organic compounds includes the basic nutrients i.e. carbohydrates, fat and proteins where as minerals and vitamins come under inorganic compounds.

On the basis of digestibility feed stuffs can be broadly categorized into two groups i.e. Roughage and Concentrates. The roughage are bulky feeds containing relatively large amount of less digestible material i.e. crude fibre more than 18% on dry matter basis. Concentrate feeds which contains relatively smaller amount (less than 18%) of fibre and have comparatively higher digestibility. Roughages are subdivided into two major groups i.e. dry and succulent, based upon the moisture content. Succulent feeds usually contain moisture from 60-90 % whereas dry roughage contains only 10-15% moisture. For the sake of convenience succulent feeds are again classified upon various types such as pasture, cultivated fodder crops (Legume: rice bean, cowpea, berseem, lucerne, pea, *etc*.; Non-legumes: maize, oat, jowar, bajra, grasses of guinea, napier, sudan grass, *etc*.), tree leaves, silages, *etc*. Dry fodder comprise of hay (Legume: lucern, berseem, *etc*.; Non-legume: oat, jowar, bajra, *etc*.) and straw (rice, wheat, barley, *etc*.) Concentrates are also broadly categorized into two groups first Energy Supplements (grains and seeds: maize, barley, sorgum, *etc*.; mill by products: wheat bran, rice bran, spent malt *etc*.; Roots: tapioca roots, squash roots, turnip, *etc*.) and second Protein supplements (oilcakes: mustard cake, groundnut cake, till cake, *etc*.; animal by-products: fish meal, meat meal, *etc*.).

General principles for feeding of animals:

1. One should keep in mind that there are six major nutrients i.e. carbohydrates, proteins, fat, minerals, vitamins and water. All these nutrients are important and should be incorporated in the diet in specified level.

2. Feeding strategy for a type of animal depends on their digestive system.
3. Level of incorporation of different ingredients in the ration depends on the type of digestive system of the animal.
4. Sudden change in the ration of the animals should be avoided. However, ingredients of the ration should be changed gradually.
5. Animal should be fed both dry and green fodders in specific ratio.
6. Grains should be crushed before incorporation in the diet.
7. It is better to soak crushed grains overnight with water before feeding animals.
8. Rotten feed ingredients should not be incorporated in the ration.
9. The daily ration should incorporate mineral mixture and common salt.
10. Water should be offered *ad libitum*.
11. Diet of an animal depends on its body weight, type of work, level of production, type and breed of animal.

While considering the feeding schedule of an animal proper consideration should first be made for the purpose for which the animal has to be fed. Hence, to ascertain suitable rations and level of feeding of an animal, these points should be kept in mind

1. There are two types of ration for animals Maintenance ration and Production ration. Maintenance ration is the ration which is offered to the animals to maintain essential body processes at their optimum rate without any gain or loss in body weight or change in the body. Production ration is the additional allowance offered to animals over and above the maintenance ration to fulfill the requirements for production purpose (milk yield or for growth). It means the requirement of a productive animal (milch cow) is more than an unproductive animal (dry cow).
2. Before formulation of a ration for an animal its live weight, age, type of work, level of production, feeding habit and breed are taken into account.
3. The next point considered is about the nutrient content of available feed ingredient.

There are two methods for computation of rations for cattle - Thumb Rule Method and Conventional Method. In Thumb Rule Method, it is easier to explain how to compute rations for cattle, to common farmers in village level. It is followed when individual attention for each animal seems impractical. However, in Conventional Method rations are computed considering body weight of individual animals. It is better to follow this method when individual feeding of animal is possible

A) Feeding of Cattle by Thumb Rule Method

While considering the feeding schedule of adult dairy cattle proper considerations first are made for the purpose for which the animal has to be fed. There are maintenance ration, growth ration, gestation ration and production ration.

Concentrate mixture

A concentrate mixture contains grains, grain by products, mill feeds, oil cakes and supplements of minerals and vitamins. Quantity of each ingredient is calculated based on its chemical composition mainly energy and protein considering presence of other major nutrients as well as requirement of the livestock. A concentrate mixture with 20% crude protein and 75% total digestible nutrient (TDN) may be prepared with 50% crushed maize, 30% deoiled mustard cake, 17% wheat bran, 2% mineral mixture and 1% common salt. More number of feed ingredients might be incorporated to increase palatability and balanced with minerals and vitamins. Many energy and protein rich feed ingredients contain some anti-nutritional factors that limit its utilization.

Maintenance ration

This is the minimum amount of feed required to maintain the essential body processes at their optimum rate without gain or loss of body weight or change of body composition. Dry cow should be offered maintenance ration. There is no need to offer concentrate mixture to dry cows if green fodder are available. If only dry fodders / straws are offered then 0.5 - 1.0 kg of concentrate mixture Type – 1 / 2 / 3 or 4 kg of concentrate mixture Type – 4 might be used (Table 1).

Gestation ration

During first 6 months of pregnancy the cow may be fed as that of dry cows. However, during last 3 months of pregnancy 2.0-2.5 kg concentrate should be added in the rations mentioned in Table - 2. The concentrate mixture Type 4 (Table 1) might also be offered @ 10 kg per day in a non-leguminous fodder based diet.

Production ration

Feeding of milch cow

Feed intake is the key factor in maintaining high milk production. Cows should be encouraged to maximize their intake during early lactation. Milch cow often loses body weight because milk production increases rapidly and reaches peak 6-8 wk after calving. But the maximum DM intake by cow does not reach until 12 to 15 wk after calving. Hence, cow make up the difference in the need & supply by mobilizing body stores. Milch cow should be offered 1 kg concentrate mixture Type 1 (Table1), 5 kg dry fodder and 15 kg leguminous green fodder for maintenance. In addition 1 kg concentrate mixture Type- 1 should also be incorporated in the ration for each 3 kg of milk production. Instead of concentrate mixture Type - 1 concentrate mixture Type - 2 or concentrate mixture Type - 3 (Table 1) might be used at the same rate. However, non-leguminous fodder will be suitable in this case. Concentrate mixture Type – 4 might also be used but its rate should be 4 times of the concentrate mixture Types - 2 or 3 i.e. 4 kg for maintenance plus 4 kg per 3 kg milk and non-leguminous green fodder up to 30 – 40 kg. Concentrate mixture should contain mineral mixture and common salt @ 2% and 1%, respectively.

Feeding of bull

Breeder bulls should be offered 2-3 kg concentrate mixture Type 1, 2 or 3 (Table 1) along with 1-2 kg dry roughage for per 100 kg body weight. If a bull is weighing 450 kg it should be offered 10 kg dry fodder and 2-3 kg concentrate mixture. However, 1 kg dry fodder may be replaced with 5 kg of green fodder. Concentrate mixture Type - 4 (Table 1) may also be used but its quantity should be 4 times to that of other concentrate mixtures.

Feeding of heifer

Growing heifers use available nutrients in an irreversible order: First for daily maintenance second growth and third for ovulation and conception. Besides fodders, 0.5 - 1.5 kg of concentrate mixture should be made available to heifers (Table 2). However, a non-leguminous fodder based diet using concentrate mixture Type - 4 (Table 1) may also be fed. The quantity of concentrate mixture Type - 4 should be 4 times to that of concentrate mixture Type - 2 or concentrate mixture Type - 3 as mentioned in Table 1.

Feeding of calves

The milk secreted from the udder of the cow just after parturition is called colostrum. Feeding of colostrum is must to the calves. Colostrum is secreted up to 4-5 days after parturition. It helps to protect the calves from different types of diseases. At the initial stage the calves should be fed milk 1/10 of its live weight. About one week old calves should be offered a high protein high energy and low fibre starter ration. After one month green fodder should be offered to calves and chaffed dry fodders in the subsequent months along with green fodders. After 3-4 months there is no need to feed milk to calves. However, incorporation of mineral mixture in the diet of calves is very much essential. It helps for proper growth of calves. The composition of calf starter and feeding schedule of calves has been presented in Table 3 and 4, respectively.

Table 1. Preparation of concentrate mixture for dairy cattle (Dairy mixture)

Particulars	Type - 1	Type - 2	Type - 3	Type - 4
	(%)	(%)	(%)	(%)
1. Cereal grains				
(a) Maize / Wheat	20	15	62	-
(b) Jowar / Bajra /Millet	21	19	-	-
2. Oil cakes				
(a) Mustard / Linseed	13	10	35	12
(b) Groundnut / Til / Soybean	13	23	-	-
3. By-products				
(a) Wheat bran / Broken rice	30	30	-	-
(b) Spent malt (wet)	-	-	-	87
4. Minerals				
(a) Mineral mixture	2	2	2	0.6
(b) Common salt	1	1	1	0.4
Dry matter %	90	90	90	25
Digestible Crude Protein	13	16	16	4.75
Total Digestible Nutrient	70	70	72	21.6
To be fed with	Legume	Non-legume	Non-legume	Non-legume

Table 2. Feeding management of heifers

Age	Leguminous fodder based diet			Non-leguminous fodder based diet	
	Leguminous fodder (kg)	Paddy straw / wheat bhoosa (kg)	Concentrate Mixture Type – 1 (kg)	Non-leguminous fodder (kg)	Concentrate Mixture Type – 2 / Type – 3 (kg)
4-5 months	7 - 8	0.5	1.5	6 - 7	1.5
6-12 months	10 - 20	1.0	1.0	10 - 15	1.5
13-18 months	20 - 30	1.5	0.5	15 - 20	1
19-30 months	30 - 35	2.0	.5	25 - 30	1
Pregnant (From 3 months before parturition)	35 - 40	3.0	2.0	35 - 40	2.5

Table 3. Composition of calf starter

Ingredients	%
Crushed maize / crushed wheat	35
Groundnut cake / soybean cake	30
Jowar / millet / bajra	10
Fish meal / meat meal / powdered milk	7
Wheat bran / broken rice	15
Mineral mixture	2

Salt	1

Table 4. Feeding schedule for calves

Age	Milk (litres)	Calf starter (kg)	Green fodder (legumes) (kg)
1-3 days	3.0	-	-
4-5 days	3.0	-	-
16-30 days	3.5	*Ad lib*	*Ad lib*
1-2 months	2.5	0.25	*Ad lib*
2-3 months	2.0	0.5	2-3
3-4 months	1.0	0.75	5-7

B) Conventional Method of Computation of Ration

Voluntary intake of dry matter

The requirement of dry matter feeds and fodders depends on the body weight of the animal and also with the nature of its production. Cattle will generally eat @ 2.0 to 3.0 kg dry matter to every 100 kg of live weight (desi cattle @2% of body weight, crossbred cattle @2.5% of body weight and high yielding purebred cattle @3% of body weight). This means that the animal in question would consume according to its capacity only. Therefore all the requirements for carbohydrate, protein, fat, mineral or vitamins should come from the total dry matter that has to be allotted. Commonly two-third of total dry matter allowance is provided through roughages and one-third through concentrates. The entire nutrient required by the animal has to be supplemented within this quantity of dry matter.

For a crossbred cow weighing 400 kg the ration can be formulated as follows:

Dry matter intake capacity (kg)	= (400 x 0.025)	= 10 kg
Dry matter as concentrates (kg)	= 10 x 1/3	= 3.33 or say 3.5
Dry matter as roughages	= 10 x 2/3	= 6.66 or say 6.5

Requirement of protein and energy (crude protein and total digestible nutrient)

While calculating the total requirement of CP and TDN one has to consider the physiological needs or say purpose for which the animal has to be fed, i.e., whether the animal is just to maintain itself or in addition to carry out advanced stage of pregnancy or whether the animal is under production. In later case it is also necessary to consider the quantity and quality of milk. The requirement of CP and TDN for all these purposes separately might be obtained from Tables 5 or 6.

Computing ration as per requirement

The average crude protein (CP) and total digestible nutrient (TDN) contents of varieties of feeds and fodders are already calculated by various scientists and average values are taken for calculation. From these feeds, one has to select suitable concentrates and roughages as available in the locality.

Illustration II: Computing a ration for a cow weighing 400 kg, giving 10 litres of milk having 4.5% fat. Locally available feedstuffs are as follows: Maize stover, Nevaro (*Ficus hookerii*) leaves and twigs, crushed maize, mustard cake and wheat bran.

Step I: Finding out of DM, CP and TDN requirement

DM requirement (kg) = 10 (Roughages 6.5 kg + Concentrate 3.5 kg), shown in illustration I

Particulars	CP (kg)	TDN (kg)
For maintenance (from Table 6)	0.445	3.30
For 10 litres of milk having 4.5% fat (from Table 6)	1.120	3.48
Total requirements	1.565	6.78

Step II: Finding out the amount of CP and TDN that are to be consumed through roughages:

Ingredients	Nutrients		Amount of DM to be given (kg)	Amount of CP and TDN given through dry matter (kg)		Actual amount of ingredients on fresh* basis (kg)
	CP	TDN		CP	TDN	
Maize stover (DM content 25%)	6.1%	65.0%	3.5	0.2135	2.275	14.0
Nevaro (DM content 28.0%)	18.17%	64.50%	3.0	0.5451	1.935	10.7
Total			6.5	0.7586	4.21	

*The dry matter content of maize stover and Nevaro leaves and twigs has been taken as 25 and 28.04%, respectively

Amount CP and TDN given through roughage is 0.7586 and 4.21 kg, respectively. This amount has to be subtracted from the total requirement. The balance, i.e., (1.565 – 0.7586) = 0.8064 kg CP and (6.78 – 4.21) = 2.57 kg of TDN to be given through concentrates. The quantity of concentrate mixture to be given is 3.5 kg as dry matter.

Step III: Distribution of 3.5 kg dry matter among the various ingredients of the concentrate group in such a proportion that the balance 0.8064 kg CP and 2.57 kg TDN are supplied. To reach the closest figure, for balancing the CP and TDN requirements several trials might have been run. It is tiresome but little practice makes it easier.

Ingredient	% Nutrient contents		Amount of dry matter to be allotted (kg)	Amount of CP and TDN given through dry matter (kg)		Actual amount on fresh* basis (kg)
	CP	TDN		CP	TDN	
Crushed maize	10.18	84.9	1.5	0.1527	1.2735	1.67
Mustard cake	38.00	68.0	1.5	0.57	1.02	1.67
Wheat bran	13.76	67.5	0.5	0.069	0.3375	0.56
Total			3.5	0.7917	2.631	3.9
Required				0.8064	2.57	

*Dry matter of crushed maize, mustard cake and wheat bran is considered to be 90%.

Concentrate ingredients might be added with mineral mixture and common salt @ 2 and 1%, respectively and properly mixed.

Summery of calculations:

For a cow weighing 400 kg, yielding 10 litres of milk with 4.5% fat, the following ingredients might be supplied to meet the nutrient requirements as follows:

Maize stover – 14 kg, Nevaro leaves and twigs – 10.7 kg, crushed maize – 1.67 kg, mustard cake – 1.67 kg and wheat bran – 0.56 kg

Table 5. Daily nutrient requirement of growing cattle

B. Wt (kg)	ADG (g)	DM (kg)	TDN (kg)	ME (Mcal)	DCP (g)	CP (g)			
						Digestibility (%) of dietary CP			
						55	60	64	70
70	000	1.95	1.17	4.25	144	262	241	222	206
	200	2.22	1.35	4.88	186	338	310	286	266
	300	2.36	1.45	5.22	207	376	345	318	296
	400	2.49	1.54	5.57	228	415	378	349	326
	500	2.63	1.63	5.90	248	451	413	382	354
100	000	2.54	1.53	5.55	189	344	315	291	270
	200	2.82	1.71	6.18	231	420	385	355	330
	300	2.95	1.80	6.51	251	456	418	386	359
	400	3.09	1.89	6.84	272	495	453	418	389
	500	3.23	1.98	7.17	293	533	488	458	419
	600	3.36	2.08	7.52	314	571	523	483	449
150	000	3.66	1.83	6.62	171	311	284	262	244

	200	3.82	2.09	7.56	213	387	355	328	304
	300	3.91	2.22	8.03	282	513	470	434	403
	400	3.99	2.35	8.50	318	578	530	489	454
	500	4.07	2.49	9.01	356	647	593	548	509
	600	4.16	2.61	9.45	392	713	653	603	560
200	000	4.65	1.98	7.17	200	364	334	308	286
	200	4.76	2.32	8.39	278	505	463	428	397
	300	4.82	2.50	9.05	317	576	528	488	453
	400	4.87	2.67	9.66	356	647	593	548	509
	500	4.93	2.84	10.28	395	718	658	608	564
	600	4.99	3.01	10.89	434	789	723	668	620
	700	5.04	3.18	11.49	473	860	788	728	676
250	000	4.91	2.52	9.12	233	424	388	358	333
	200	5.26	2.68	9.69	272	495	453	418	389
	300	5.43	2.98	10.78	350	636	533	538	500
	400	5.60	3.14	11.37	389	707	648	598	556
	500	5.77	3.29	11.90	428	778	713	658	612
	600	5.95	3.45	12.49	467	849	778	718	667
	700	6.12	3.61	13.05	506	920	843	778	722
	800	6.29	3.77	13.63	545	991	908	838	779
	900	6.46	3.93	14.21	584	1062	973	898	834
	1000	6.64	4.09	14.79	623	1133	1038	958	890
300	000	5.18	2.80	10.14	259	471	432	398	370
	200	5.85	3.26	11.78	341	620	568	525	487
	300	6.19	3.50	12.67	382	695	637	588	546
	400	6.52	3.74	13.54	423	769	705	651	604
	500	6.86	3.97	14.37	464	844	773	714	663
	600	7.20	4.20	15.20	505	919	842	777	721
	700	7.54	4.44	16.05	546	994	911	840	779
	800	7.87	4.68	16.92	587	1069	980	903	837
	900	8.22	4.92	17.79	628	1144	1049	966	895
350	000	5.81	3.15	11.40	291	529	485	448	416
	200	6.48	3.38	12.22	332	604	553	511	474
	300	6.82	3.85	13.94	414	753	690	637	591
	400	7.16	4.08	14.77	455	827	758	700	650
	500	7.50	4.31	15.60	496	902	827	763	709
	600	7.84	4.54	16.43	537	976	895	826	767

(Mandal *et al*., 2003)

Table 6. Daily nutrient requirement of lactating cattle

B. Wt (kg)	TDN (kg)	ME (Mcal)	DCP (g)	CP (g)			
				Digestibility (%) of dietary CP			
				55	60	64	70
200	1.96	7.09	146	265	243	225	209
250	2.32	8.38	172	313	287	265	246
300	2.66	9.62	198	360	330	305	283
350	2.98	10.79	222	404	370	342	317

400	3.30	11.93	245	445	408	377	350
450	3.60	13.01	268	487	447	412	383
500	3.90	14.09	290	527	483	446	414
550	4.19	15.14	311	565	518	478	444
600	4.47	16.16	332	604	553	511	474
650	4.75	17.18	353	642	588	543	504
700	5.01	18.14	373	678	622	574	533
	Milk production (Nutrient required per kg of milk of different fat %)						
Fat%							
3.0	0.275	0.994	48.54	88	81	75	69
3.5	0.300	1.08	52.83	96	88	81	75
4.0	0.324	1.17	57.11	104	95	88	82
4.5	0.348	1.26	61.39	112	102	94	88
5.0	0.372	1.35	65.68	119	109	101	94
5.5	0.397	1.43	69.96	127	117	108	100
	Body weight gain (Nutrient required per g gain)						
	2.74	9.91	0.41	0.75	0.68	0.63	0.53

(Mandal *et al*., 2003)

Reference

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Feeding Management of Dairy Cattle

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Introduction

Farmers raise dairy cows to produce milk and to make a profit.

Feeding is the biggest cost in milk production.

Improving feeding should focus on:

- Maximise the of potential milk production of cow
- Decrease the cost of production

TWO basic principles are:

1. The more a cow can eat, the more milk she can produce
    - Always try to increase the feed intake of your cows
2. Forages are cheap, concentrates are expensive
    - A dairy cow should eat as much good quality forages as possible:

        The more nutrition we can provide inside the forages, the less concentrate we need to add, the cheaper the diet
    - The cow is the one to produce the milk. So we should give the cow what she needs.
    - This sound obvious, however, in reality many farmers give the feed that is convenient for them, but is not what the cow really needs.

Some rules of the good feeding management

Rule 1: Water is always available

- Cows need a lot of water.
- It should be available at all time, clean, tasty and fresh

Rule 2: Feed forages *ad libitum*

- Forages should always be available in the feeding trough
- If there is no feed, dry matter intake is low and they produce less milk

Rule 3: Provide concentrate in small amounts

- Too much concentrate at one time is not healthy for a cow
- Concentrate should be provided at least 3 times per day

- It is best way to mix forages and concentrate

Rule 4: Always provide a mineral block

- Cows know when they need more minerals
- A mineral block guarantees that cows take up sufficient minerals

Rule 5: Increase forage intake as much as possible

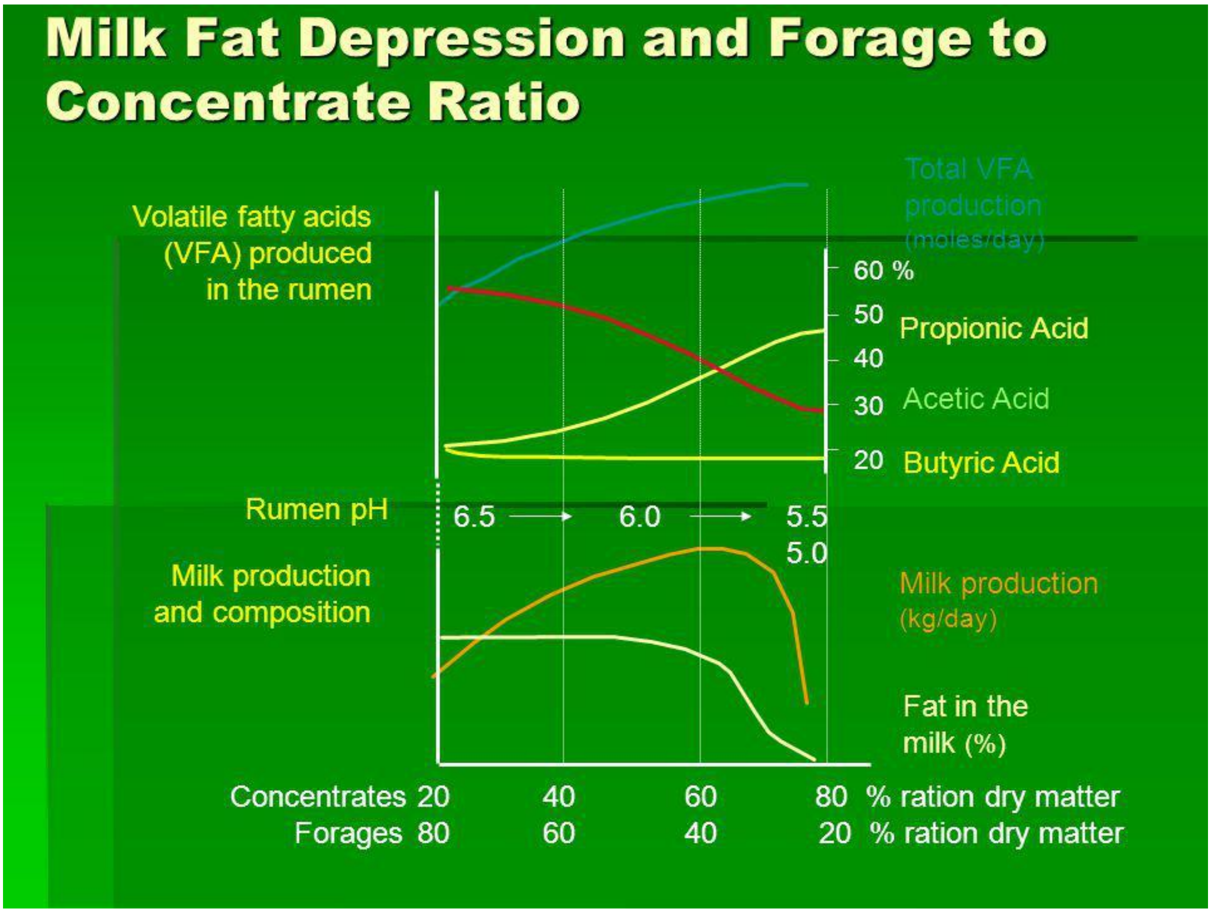
- The more they eat, the more they produce
- Forage are cheap, concentrates expensive
- WHAT you give and HOW you give it will largely determine the feed intake

Rule 6: New feedstuff or ration should always be introduced gradually

- The rumen bacteria change according to the diet
- New feeds need to be introduced step by step, a little bit more every day for 7 to 10 days

The balance between forage and concentrate

- The diet should always have a good forage/concentrate ratio
- The figure below shows the effect of too much concentrate



Phases during a lactation cycle

A dairy cow produces milk for about 305 days, followed by a dry period of about 60days.

During such cycle of 365 days, several aspect of the cow depends largely on the stage of lactation:

The milk production:

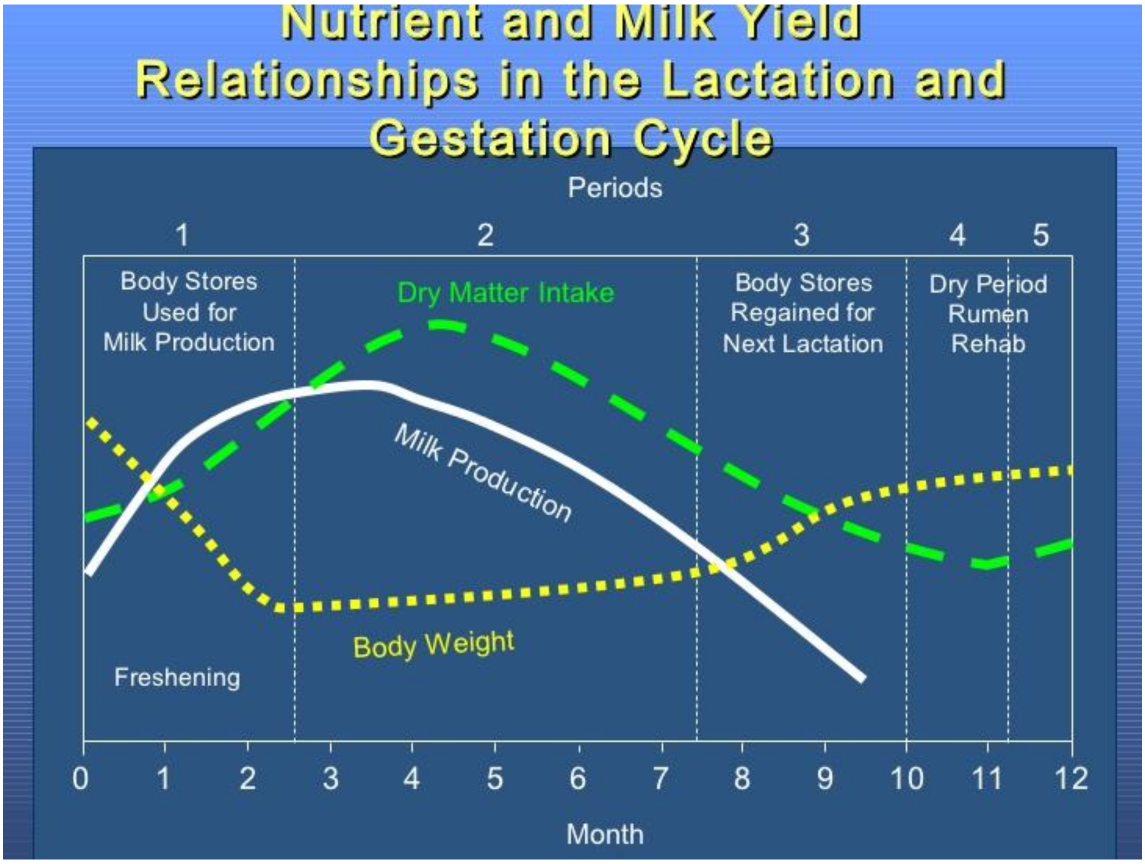
- Peaks 5-6 weeks into the lactation and gradually decreases until the end of the lactation.

The body weight:

- It is lowest during first 10 to 14 weeks of lactation and increase gradually increases until next calving

The DM intake:

- Peaks 16 to 24 weeks into the lactation and decrease gradually until next calving



Nutritional requirements vary with the stage of lactation. For feeding practices, it is define in 5 distinct phases during 365-day period

1- Phase 1: Early lactation: 0 to 70 DIM (Days In Milk) (peak milk production)

2- Phase 2: Mid lactation: 70 to 200 DIM (peak DM feed intake)

3- Phase 3: Late lactation: 200 to 305 DIM (restoration phase)

4- Phase 4: Dry period: 60 to 14 days before the next lactation

5- Phase 5: Transition or close-up period: 14 days before to calving

Phase	Milking			Dry	
	1	2	3	4	5
	Early (0 – 70 days of milk, DIM)	Mid (70 – 200 DIM)	Late (200 – 305 DIM)	Dry (60 days before calving)	Prefresh (14 days before calving)
CP,% of DM	17.5 – 19.5	15 -17	14 -15	12	14.5 - 15
Ration forage min, %	40-45	45-50	50-55	60	55
ADF min, % of DM	17-21	19-22	21-25	30-35	25-29

Phase – 1: Early lactation (0-70 DIM)

Excellent feeding regime during this period is important to obtain maximum production

Characteristics

- Milk production increases rapidly, peaking at 6 to 8 weeks after calving.
- Feed intake does not meet the energy requirements cow uses reserves stored in its body cow looses body weight.

Requirements:

CP: 17.5 -19.5% of DM

- Forage ration level in the total ration > 45%

Feeding: Aim at reaching the highest milk production peak

- Feed top quality forage such as Guinea grass, berseem, lucern, etc. Allow constant access to feed
- Increasing concentrate 0.5 kg per day from day 10 up to day 20. Do not give more than 60% of DM as concentrate because it will make the rumen too acid (= acidosis)
- Make sure the diet contains adequate amounts of CP (17.5-19.5%)
- Make sure the diet contains adequate % of forage: more than 45%
- Consider adding fat from 0.1 to 0.3 kg/cow/day to diets.
- Minimize stress conditions.

- Provide a mineral block

Things to remember:

- A lower peak production translates into a lower total production during this lactation
- A loss of 1 kg in peak milk production equates to a 220 kg loss for the lactation

Phase 2: Mid lactation (70-200 DIM)

If the cow is not inseminated yet, it should happen at the beginning of this period, preferably before 85 DIM, but certainly before 140 DIM. Good feeding management in this period will result in successful insemination, prolonged high milk production and increasing body weight.

Characteristics

- Milk production has passed its peak and starts to decrease.
- Feed intake reaches its peak
- Body weight starts to increase again

Requirements:

- CP: 15 - 17% of DM
- Forage ration level in the total ration > 50%

Feeding: Aim at increasing feed intake

- Feed the highest quality feeds available (high quality forages).
- Feed forages and concentrate several times a day.
- Make sure the diet contains adequate CP% and forage%
- Supplement minerals and provide a mineral block.
- Continue to minimize stress conditions.

Phase 3: Late lactation (200 to 305 DIM)

This phase will be the easiest to manage. It is important to make sure the cows are in good condition to be dried off.

Characteristics

- Milk production is declining (8-10% drop per month)
- The cow is pregnant, and nutrient intake will easily meet or exceed requirements.
- The body weight increases. Avoid making the cows to fat.

Requirements:

- CP: 14 - 15% of DM
- Forage ration level in the total ration > 55%

Feeding: Aim at having the cows in good condition for the dry period

- Feed a mixture of forages and make sure the cow eats at least 55% of DM as forage.
- Higher concentrate amounts will not result in higher milk output but will increase the cost and make your cows too fat!
- Feed an adequate amount of concentrate in several times a day.
- Make sure the diet contains adequate CP%
- Provide a mineral block.
- Continue to minimize stress conditions.

Phase 4: Dry period—60 to 14 days before parturition.

The dry period is a critical phase of the lactation cycle. A good dry cow program can increase milk yield during the following lactation and minimize metabolic problems.

Characteristics

- No milk production
- Body weight increasing
- Feed intake decreasing

Requirements:

- CP: 12% of DM
- Forage ration level in the total ration > 60%
- Ca: 60-80g/day
- P: 30-40g/day

Feeding: Aim at adjusting feeding to have a correct body score for calving

- Separate from lactating cows
- Observe body condition of dry cows and adjust energy feeding as necessary
- Make sure the cows don't become too fat: this will increase the change for problems after calving Increase forage to restore rumen.
- Forage level in the ration at least 60%
- Forage can include some lower quality forages such as corn stover, Napier or rice straw

- Provide correct amounts of Ca and P. Avoid excess calcium and phosphorus intakes. This will increase problems of milk fever.
- Provide adequate amounts of vitamin A, D, and E in rations to improve calf survival and lower retained placenta and milk fever problems.
- Limit salt to 28g and limit other sodium-based minerals in the dry cow ration to reduce udder edema problems.
- Change to a transition ration starting 2 weeks before calving
- Never supplement Mineral Lick Block in this period

Phase 5: Transition period—14 days before calving

The transition or close-up dry cow feeding program is critical to adjusting dry cows and springing heifers to the lactation ration and preventing metabolic problems.

Characteristics

- No milk production
- Body weight increasing
- Feed intake decreasing

Requirements:

- CP: 14.5 to 15% of DM
- Forage ration level in the total ration > 55%
- Ca: 60-80g/day
- P: 30-40g/day

Feeding: Aim at preparing the rumen for the lactating period

- Continue with same forages as in previous stage (dry cow)
- Increase concentrate gradually to 2.5 to 3 kg to adapt rumen bacteria
- Remove salt from the ration if edema is a problem.
- If niacin (to control ketosis) and/or anionic salts (to help prevent milk fever) are going to be used, they should be included in the ration during this period.

Ration formulation for lactating cows

Objective of ration formulation

- Provide a balanced nutrition (forage/concentrate ratio)
- Provide a diet that meets the requirement at the different period of the lactation

- Provide a diet that allows the cows to reach high peak production and maintain a high production for a long period
- Provide the nutrients in the cheapest way possible
- Provide a diet that will result in a high feed intake

Dry Matter intake

- Ratio calculation uses dry matter intake (DMI).
- Remember that DMI of forage depends on a number of factors:

Ration moisture:

- DM of the ration increase DMI increase
- Optimum DM of the ration: 45-55%

Ration palatability

- High palatable DMI increase
- High in fiber (NDF>25%) DMI decrease
- Increase concentrate in the diet up to 60% of DM increased DMI.

Weather

- Hot climate (high temperature and humidity) decrease DMI

Feeding methods

- Feeding frequency increase DMI
- Chopping increase DMI
- Sundry fresh forages increase DMI
- Mix forages and concentrate optimum DMI

Feed intake ≠ feed offer

- All the ration calculation gives you feed intake data.
- For concentrates: Feed offered and feed intake is the same because cow eats 100% of whatever is provided.
- For forages: There is a considerable difference between feed offer and feed intake depending on the quality of the forage.

Important rules of thumb for ratio calculation for lactating Cows

1. Dry Matter Intake (DMI) should be known.
2. Forage DMI should always be minimum 1.5% of body weight or 40% of total DMI

3. Concentrate DMI should never be more than 2 % of body weight or 60% of total DMI
4. Minimum ADF is 18% of DM.
5. Salt should be 1% of the concentrate DM
6. Calcium/Phosphorus balance should be 2/1. Together it should be 1-2% in concentrate DM

The most important pieces of advice

Adapt your feeding to what your cows tell you:

Measure and interpret her total DMI and forage DMI

- Make sure your cow eat sufficient forage
- If she doesn't, change the way you feed her (feed content and feeding method)

Determine her body score and react on it

- Cow is too fat: give less concentrate
- Cow is too skinny: give more concentrate.

Application of Genetic Interventions to Improve Reproductive Efficiency in Dairy Animals

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Genetic improvement of livestock depends on access to genetic variation and effective methods for exploiting this variation. Genetic diversity constitutes a buffer against changes in the environment and is a key in selection and breeding for adaptability and production on a range of environments.

In developed countries, breeding programmes are based upon performance recording and this has led to substantial improvements in animal production. Developing countries have distinct disadvantages for setting up successful breeding programmes: infrastructure needed for performance testing is normally lacking because herd sizes are normally small and variability between farms, farming systems and seasons are large; reproductive efficiency is low, due mainly to poor nutrition, especially in cattle; and communal grazing precludes implementation of systematic breeding and animal health programmes.

A number of scientific interventions have been developed over the years for improving reproductive efficiency and genetic improvement in dairy animals. These are summarized below:

Multiple ovulation embryo transfer and open nucleus breeding system

Multiple ovulation embryo transfer (MOET) is a composite technology which includes superovulation, fertilisation, embryo recovery, short-term *in vitro* culture of embryos, embryo freezing and embryo transfer. Benefits from MOET include increasing the number of offspring produced by valuable females, increasing the population base of rare or endangered breeds or species, *ex situ* preservation of endangered populations, progeny testing of females and increasing rates of genetic improvement in breeding programmes.

Genetic improvement of ruminants in developed countries has made much progress in the last 50 years through the use of large-scale progeny testing of males. As has been pointed out, the general failure of extensive use of AI in developing countries has implied that progeny testing schemes cannot be operated with much success. In any case the generally small herds/flocks and uncontrolled breeding in communal grazing situations preclude implementation of progeny testing. Smith (1988) suggested that the Open Nucleus Breeding System (ONBS) may be especially valuable for developing countries where the use of AI has been a failure due to these reasons.

The ONBS concept is based on a scheme with a nucleus herd/flock established under controlled conditions to facilitate selection. The nucleus is established from the "best" animals obtained by screening the base (farmers') population for outstanding females. These are then recorded individually and the best individuals chosen to form the elite herd/flock of the nucleus. If ET is possible, the elite female herd is used through MOET with superior sires to produce embryos which are carried by recipient females from the base population. The resulting offspring are reared and recorded and the males among them are evaluated using, as appropriate, the performance of their sibs and paternal half sibs and their own performance. From these, an elite group of males with high breeding values for the specific trait is selected and used in the base population for genetic improvement through natural service or AI. It should be noted that, while MOET improves the rate of progress substantially, it is possible to operate an ONBS without ET technology, especially in species, such as small ruminants, with high reproductive rates. Such schemes are being tried for sheep in West Asia by FAO (Jasiorowski 1990) and in Africa (Yapi et al 1994). However, availability of AI and ET, in addition to increasing rates of genetic gain, enhance the flexibility of the system. For example, germplasm from other populations can be introduced easily through semen and/or embryos. One of the advantages of a nucleus herd is that it provides opportunity to record information on more traits than is possible in a decentralised progeny testing scheme.

The ONBS can be used for the improvement of an indigenous or exotic breed. It can also be used to improve a stabilised crossbred population. The level of the genetic response depends on the size of the scheme (that is, number of participating herds/flocks and total number of animals) and the selection intensity.

An ONBS can initially be developed to form a focus for national sire breeding and selection activities. In time, and with experience, the capacity can be expanded and ET introduced to increase the rate of genetic progress.

Indicator traits

Indicator traits are characteristics which are genetically correlated to traits of economic importance and are easier to measure than the latter. Such traits are usually not the target of genetic improvements but provide an indirect means of improving a targeted trait. Blair et al

(1990) reviewed some physiological and/or metabolic characteristics which might be considered as potential indicator traits. Traits such as testicular size in rams or bulls or FSH in ewe lambs (Bodin et al 1986) have potential as indirect predictors of fertility. Indicator traits can improve genetic response by increasing accuracy of selection and reducing generation interval. The value of an indicator trait will depend largely on the magnitude of co-heritability (square-root of the product of heritability of the indicator and of the target trait) and the genetic correlation between the two traits (Woolliams and Smith 1988). Woolliams and Smith (1988) concluded that, with high co-heritability, selection for the indicator trait alone can result in greater rates of response than is possible with progeny testing, especially when breeding values are not accurately measured by progeny testing.

Packed cell volume (PCV), an indication of the extent of anaemia, is widely used as an indicator trait for pathological conditions associated with anaemia. For example, PCV is currently used at ILRAD and ILCA (International Livestock Centre for Africa) as an indicator of the effect of trypanosomiasis and hence of trypanotolerance, and at ILCA as an indicator of effect of the endoparasite *Haemonchus contortus* and hence as an indicator of resistance to the parasite.

Genetic markers and marker-assisted selection

A genetic marker for a trait is a DNA segment which is associated with, and hence segregates in a predictable pattern as, the trait. Genetic markers facilitate the "tagging" of individual genes or small chromosome segments containing genes which influence the trait of interest. Availability of large numbers of such markers has enhanced the likelihood of detection of major genes influencing quantitative traits.

The method involves screening the genome for genes with a large effect on traits of economic importance through a procedure known as linkage analysis (Paterson et al 1988). The chances of major genes existing for most traits of interest, and of finding them are considered to be high (Mackinnon 1992).

The process of selection for a particular trait using genetic markers is called marker assisted selection (MAS). MAS can accelerate the rate of genetic progress by increasing accuracy-of selection and by reducing the generation interval (Smith and Simpson 1986). However, the benefit of MAS is greatest for traits with low heritability and when the marker explains a larger proportion of the genetic variance than does the economic trait. Lande and Thompson (1990) suggest that about 50% additional genetic gain can be obtained if the marker explains

20% of the additive genetic variance and the economic trait has a heritability of 0.2. MAS also facilitates increased rate of genetic gain by allowing measurement in young stock thereby reducing generation interval.

Marker-assisted selection involves establishing a link between inheriting a desirable trait, such as milk yield, and segregating specific genetic markers that are coupled to that trait. Marker-assisted selection is important in animal breeding and selection strategies for studying complex traits governed by many genes (Georges, 2001). The use of this method is expected to increase exponentially as genome-sequencing projects identify greater numbers of useful, segregated markers for economically important traits.

Initially animals will be screened for genes that control simple traits that may be undesirable, such as horns in cattle or metabolic stress syndrome in pigs. In time, easily identifiable markers that accompany multiple genes controlling more complex traits, such as meat tenderness and taste, growth, offspring size, and disease resistance, will become available to improve animal health and production traits (Dekkers and Hospital, 2002).

Two notable examples can be found in sheep. One is the Booroola gene in which a single-nucleotide base change is responsible for the callipyge muscle hypertrophy phenotype—the only known example of polar over-dominance in a mammal (Freking et al., 2002). Another is introgression of the Booroola gene into the Awassi and the Assaf dairy breeds (Gootwine, 2001).

Sequencing genomes of animals that are important to agriculture will identify genes that influence reproductive efficiency. For example, a growth-hormonereceptor variant on bovine chromosome 20 affects the yield and composition of milk, and is expected to increase milk production by 200 kg per lactation and decrease milk fat from 4.4 percent to 3.4 percent (Fletcher, 2003).

Transgenic animals

A transgenic animal is an animal whose hereditary DNA has been augmented by addition of DNA from a source other than parental germplasm through recombinant DNA techniques. Transfer of genes or gene constructs allows for the manipulation of individual genes rather than entire genomes. There has been dramatic advances in gene transfer technology in the last two decades since the first successful transfer was carried out in mice in 1980 (Palmiter et al 1982; Jaenisch 1988). The technique has now become routine in the mouse and resulting transgenic mice are able to transmit their transgenes to their offspring thereby allowing a large number of transgenic animals to be produced. Successful production of transgenic livestock has been reported for pigs, sheep, rabbits, cattle and goat. The majority of gene transfer studies in livestock have, however, been carried out in the pig. Although transgenic cattle and sheep have been successfully produced, the procedure is still inefficient in these species (Niemann et al 1994).

The first reports of the production of transgenic animals created a lot of excitement among biological scientists. In the field of animal breeding, there were diverse opinions on how the technology might affect livestock genetic improvement programmes. Some (Ward et al 1982) believed that it would result in total reorganisation of conventional animal breeding theory while others (Schuman and Shoffner 1982) considered the technology as an extension of current animal breeding procedures which, by broadening the gene pool, would make new and novel genotypes available for selection. Application of the technology in animal improvement is still far from being achieved. However, consideration needs to be given to its potential role in this field. Smith et al (1987) presented a comprehensive evaluation of strategies for developing, testing, breeding and disseminating transgenic livestock in the context of quantitative improvement of economic traits.

An important contribution of transgenic technology is in the area of basic research to study the role of genes in the control of physiological processes. The understanding of the molecular control of life processes has important implications for both medicine and agriculture. For example, the generation (through mutation of an endogenous gene) of an organism which lacks a specific gene is a powerful tool to investigate the function of the gene product. This type of genetic analysis has been facilitated by the availability of in vitro cultures of embryonic stem cells from mice (Bradley 1994).

Recent advances in *in vitro* technology (*in vitro* fertilisation and maturation) will increase the number of zygotes available for gene transfer purposes. This, plus the utilisation of embryonic stem cell (Stice et al 1994) and primodial germ cell (Stokes et al 1994) technologies should enhance the efficiency of gene transfer in cattle and sheep considerably.

Conclusion

The genetic improvement of dairy animals depends on animal breeding technologies. In most of the developing countries including India the animal breeding technologies are neither advanced nor widely adopted because of considerable geographical variation in environment, fragmented farming mostly at a subsistence level, substantial livestock genetic diversity, lack of awareness of rural households and many other problems directly and indirectly associated with the genetic improvement of animals. As a result, in spite of some important genetic resources available in the country, the productivity of dairy animal in general is very low in India in comparison to the dairy animals of developed countries. Thus, the reasoning for genetic improvement of dairy cattle and buffaloes would be critically differentiated in institutional / organised herds and field condition in our situation.

Dairy cow fertility has declined over the past decades. Together with the continuing drive to reduce cost of milk production this sparks questions about the part genetic selection can play in improving fertility. In this regards, various genetic interventions as discussed above are key to addressing genetic variation in fertility related traits, the latter’s association with milk yield, and the availability of management interventions to improve fertility. Breeding strategies have evolved from conventional ones, selection based on breeding values estimated with statistical models from large datasets collected on farm, to innovative strategies that incorporate genomic information. These scientific interventions are quite effective and have been validated world-wide for applying genetics to combat poor fertility in dairy cows and outline contemporary selection strategies.

Prospects of Milk Production Enhancement in NE States: Scope of Application of West Bengal Experience

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Irrespective of the spectacular developments accomplished in dairying at national perspective, the fruits of success did not percolate down across regions and states. In general, the situation in North- Eastern (N.E) states of India is still not at par with the other states of the country in terms of various dairy development indices. However, despite the poor performance of dairy sector in the N.E region, the demand for milk and milk products has been increasing due to increase in per capita income and changes in lifestyle (Feroze *et al.* 2010). Although livestock is an important component of mixed farming system and plays an important role in the economy of N.E region, the production of milk and milk products in this region is least comparing to other regions of the country. This region is the reservoir of 6.2% of total cattle population of India with maximum population in Assam and minimum in Mizoram. Except Tripura and Manipur, all states of NE registered an increase in the population of crossbreds, whereas except Assam, Meghalaya and Mizoram, all states of NE have exhibited decrease in the population of indigenous breeds of cattle. Overall, there was an increase of 24.03% in the population of crossbreds and decrease of 2.71% in the population of Indigenous cattle. This has attributed to a large extent in increase in milk production in the region. However, productivity of cattle in the region is below the all India average. Except Manipur, all the states of NE India have registered an enhancement of milk production, however, availability of milk (gms/day) have decreased in Assam, Manipur and Nagaland. This is mainly because of the fact that most of the cattle are indigenous to this region. Dairy buffalo is almost non-existent. However, Brahmputra valley is rich in Swamp buffalo both in quality and number. The milk yield of crossbred cows in the region is low in comparison to the national average of milk yield with respect to crossbred cows. However, there is simultaneous increase in fodder production in the state like Nagaland and the farmers are gradually coming under organized marketing setup.

West Bengal Experience

West Bengal, an eastern state of India, is traditionally a low milk producer and thus, the whole dairy scenario of this state is rather not very encouraging when given a close look. It constitutes only 4 percent of country's total milk output and the per capita availability of milk (125 gm per day) is much less than that of the minimum nutritional requirement of 250 gm per day. Many statistics also indicate an insignificant change in milk production sector in this state in comparison to that of other states. Milk is mainly produced from the indigenous non-descript cows with very poor productivity (0.374 gm per day) as this state possesses no recognized breed of cattle and buffalo though their population is very impressing. Concentration of buffalo is very less. Buffaloes under urban and peri-urban system are exclusively of Murrah breed. Landrace population is poor milk producer but possesses excellent draught ability. Crossbred cattle constitute only 11 percent of the total population. Indigenous cattle contribute 62 percent of the total milk produced mostly using natural resources and thus at cheaper cost. Though the total cattle population grows exponentially, yet number of cattle per 1000 human declines steadily over the years. Indigenous cattle have undergone long evolutionary history and natural selection. Their adaptability in a given ecological niche is high. They have multipurpose utility to the farmers, *viz.,* dairy, draft, manure, rituals and social security. They are easily manageable under traditional production system as available with majority farmers.

West Bengal represents four distinct agro-ecozones of India, which differ considerably in terms of resource endowments, farming situations as well as various other bio-physical factors that influence dairy production systems in this state. The pressure on land is very high by virtue of high human population concentration and cropping intensity. The dairy production systems are rather complex and generally based on traditional and socioeconomic considerations, mainly guided by available feed resources and traditional consumption habits. However it is a biologically efficient system that converts large quantities of roughages (mostly crop residues and agro-industrial by-products) and other non-food vegetative biomass into milk.

Milk Production Systems of West Bengl

Classically two distinct systems of milk production can be identified *viz.,* rural based small farm system (RBSFS) and production system of urban and peri-urban areas (PSUPA). The formers are more numerous and in totality produces much higher quantity though per unit production is less. RBSFS is constrained by limited market outlet and system rigidity, whereas environmental issue does not encourage PSUPA. RBSFS are tailored into family activity mostly as a component of composite livestock farming for landless or as a minor component of mixed of crop farmers. They are a quite sustainable system and functional since time immemorial. PSUPAs are specialized but are highly flexible and volatile too. RBSFSs are small units and characterized by heavy reliance on natural resources without caring about its degradation, nil or negligible day-to-day cash expenditure in a fanatic effort to keep the cost of production minimum and to avoid risk. Producers are refractory to any change in the system due to suspicion of losing sustainability and satisfaction. Among different production objectives *viz.,* milk, draught, replacement (milk and draught), manure, fuels, wealth and rituals, the first one is often ranked low as milk is neither felt to be dietary essential by farm family nor considered as a dependable source of income. PSUPAs are solely demand driven and consequently have the risk of non-sustainability. Since last twenty-five years or so dairy cooperatives are able to bring a good number of dairy farmers under organized sector with stronger economic efficiency. RBSFS is essentially an endeavour of small and marginal farmers and landless poor having low socio-economic and educational profile with virtually little or no capital and training. However, distribution of benefits (products and services) among themselves and among local consumers is almost equitable. Though in most occasions, the resources available to the farmers were not being utilized efficiently yet RBSFS plays a significant role in alleviating poverty and uplifting the living standard of rural people indicating their social sustainability. There also exists ample scope of improving profitability, resource-use efficiency, ecological soundness, social acceptability and thus sustainability through consistent application of region-specific system-based strategies with provision of adequate infrastructure and input supply, output marketing, training and policy supports to the farmers in a holistic manner.

Production enhancement

Since long various efforts were made for increasing milk production from the native stocks mainly targeting to their genetic improvement. Crossbreeding between exotic and native nondescript stock received maximum efforts. Unfortunately the approach failed to produce desirable impact mainly due to huge unmanaged base population. Maintenance of crossbred population with desired level of exotic inheritance with high heterosis was found to be difficult. Besides, there were problems in conducting field progeny testing, female culling, availability of quality sire of desired genetic make up and huge shortage of management inputs. Breeding objective was not often relevant to the production system, economically viable and was not seen by the average farmers to be most significant to them. Primary objective of any animal production system cannot simply be maximum productive output per animal. An animal must survive to be productive and must reproduce to maintain the system. Improving animal production therefore means giving specific attention to bring improvement both in productive and adaptive traits. Exotic breeds require intensive management with high inputs not available with majority farmers. Being specialized dairy breed they are unable to fulfill multifarious need of the farmers. They are irrelevant to prevailing production system mainly due to poor adaptability. Most critically, there is no reason to assume that imported breeds are superior to indigenous breeds specially when production conditions and market forces are static.

Use of Indigenous Breed

There is little doubt that India harbours the significant share of the world's dairy animal genetic resources and that the country’s dependency on its own dairy animal genetic resources is now increasing. According to World Watch List of FAO there are 61 breeds of cattle and 19 breeds of buffaloes. However, till date National Bureau of Animal Genetic Resources has registered 41 breeds of cattle and 13 breeds of buffaloes. Thus, India is a repository of a large segment of bio-diversity in dairy animals. It has been estimated that one-ninth of the total cattle breeds and almost all the established breeds of water buffaloes of the world have their home-tract in India. They may be important assets for future for having the valuable adaptive traits that they have developed commonly over long periods of time, such as:

1. Tolerance/resistance to diseases, including to often seriously harmful entero- and ecto-parasites.
2. Tolerance to large fluctuations in availability and quality of feed resources and water supply.

3. Tolerance to extreme temperatures, humidity and other climatic factors.
4. Adaptation to low capacity management conditions.
5. Ability to survive, regularly reproduce and produce for long period of time, meaning farmers do not need to maintain a large portion of their herd or flock as young animals which are consuming scarce inputs but not producing.

Among different milch breeds of India Gir and Sahiwal occupy most prized position. Gir has probably originated from Gir forests of South Kathiawar in Saurashtra. It is found more or less in pure from all over Saurashtra and the adjoining areas of Maharastra and Rajasthan. Gir cows are good milk yielders, maximum yield being 3,000 kg in a lactation of 300 days. The bullocks are heavy, powerful animals but medium paced in movement. They are extensively used as draught animals. Sahiwal is now bred throughout Punjab and in other States. They produce above 3,000 kg milk in 300 days lactation and certain cows normally produce as high as 4,535 kg of milk. These genetic resources could be used for ‘grading-up’ local breeds of cattle of West Bengal. Grading-up which exploits additive genetic variation is an economical system to acquire superior animals without spending large sums initially. Genetically it is much simpler to raise and maintain a grade-up population than a crossbred population (Table-1). After four to five generations of crossing, the graded progeny will have 93.8 to 96.9 percent respectively of the genes of the pure breed.

Comprehensive recommendation for milk production enhancement in the State is as under.

- CATTLE AND BUFFALO BREEDING POLICY ARE TO BE REPLACED BY CATTLE AND BUFFALO PRODUCTION POLICY.
- PRODUCTION POLICY (INCLUDING BREEDING POLICY) WILL BE ACCORDING TO FARMERS RESOURCE BASE, NEED AND RELEVANT ECONOMIC AND SOCIAL SCENARIO.
- OFTEN INDIGENOUS BREEDS PROVE TO BE MUCH STURDIER AS THEY ARE WELL ADAPTED TO LOCAL CLIMATE AND GEOGRAPHIC CONDITIONS. COMPARED TO CROSSBREDS, THESE VARIETIES CAN CONTINUE TO REMAIN PRODUCTIVE EVEN WITH LIMITED INPUTS OF FODDER, FEED AND HEALTHCARE.
- LOCAL NON-DESCRIPT BREED WHEN UPGRADED WITH INDIGENOUS RECOGNIZED BREEDS CAN PRODUCE GOOD AMOUNT MILK AT VIRTUALLY NO COST. THE EMPHASIS WILL BE ON PROMOTING INDIGENOUS BREEDS WITH LOW AND MEDIUM INPUTS.
- EXOTIC AND CROSSBREEDS MAY BE PROMOTED ONLY IN WELL-EQUIPPED AREAS WHERE RESOURCES LIKE FODDER, HEALTH CARE FACILITIES, MARKETING, TRANSPORTATION AND STORAGE ARE AVAILABLE.
- DRAUGHT POWER IS AN IMPORTANT INPUT TO CROP FARMING AND A DEPENDABLE MODE OF RURAL TRANSPORT. INDIGENOUS MALES WITH HUMP HAVE ADDED ADVANTAGE OVER CROSSBRED MALES.

Table 1: Advantages of Grade-up (with Indigenous) cattle over crossbreeds (with exotic) cattle.

	Grade-up (Indigenous) cattle		Crossbred (exotic) cattle
1.	Adapted to local feed sources. Performs well on poor quality roughages, agricultural residues. More efficient at converting roughage to body weight than exotic.	1.	Requires quality fodder and concentrates for economically viable performance. Uneconomical if fed on agricultural residues and roughage alone.
2.	Resistant to prevailing diseases. Unaffected by weather extremes. Well adapted to move in rugged terrain for grazing, negotiating the narrow paths.	2.	Susceptible to prevailing diseases, needs veterinary support services. Vulnerable to weather extremes. Unadapted to move in rugged terrain, demands labour intensive stall feeding, unable to walk long distances for grazing in commons.
3.	Multipurpose. Caters to diverse needs of mountain farmers, e.g. milk, draft power, pack animal (in higher altitude), etc.	3.	Single purpose, e.g. milk production. Poor utilisation in other diverse agricultural activities.
4.	Low input at low cost	4.	High input at high cost
5.	Resources (inputs, services) available within the system suffice. Reliance on purchased inputs and services minimal.	5.	High input from outside the system required. Feed, supplements, services, need to be purchased (fodder can be grown at farm but demands extra land and availability of irrigation).
6	Exploits additive effect of gene.	6	Exploits heterotic effect of gene.
7	Simple to run the programme and maintain a grade-up population under field condition.	7	Complicated to run the programme and maintain a crossbred population under field condition.

Conclusion

Thus, dairy scenario of West Bengal presents an identical picture. Experience of which may be applied selectively in different regions of NE states with careful consideration of the resource base, marketing facility and farmers' objectives and motivations. Lalrinsangpuii and Malhotra (2016) in their study on resource use efficiency in dairy production in Mizoram fund that concentrates and miscellaneous expenses (veterinary charge, electricity, drinking water and packaging Material) had positive and significant influence on milk production from both milking local and crossbred cows. For crossbred cows dry fodder and veterinary expenses were underutilised whereas for local cows green fodder was underutilised in the study area. Therefore, they suggested that dairy farmers in Mizoram should put more efforts for efficient utilisation of these inputs to increase the milk production. The extension agencies should also take more initiative for giving technical guidance to the farmers about scientific dairy farming in general and better feeding management of milch animals with quality feeds and fodder in particular, in the area. For sustainable dairy development in NE Region, emphasis should be given to equip the dairy farmers with adequate and appropriate knowledge and skill related operation like dairy cattle rearing to marketing (Venkatasubramanian, *et al*., 2012) . Efforts is to be made for organizing the farmers into groups and federating them for common resource management and marketing the milk under a brand name. Among other things, the establishment of grass root level infrastructural facilities related to breeding and health care is very important institutional support required in this region. To sustain the production system at farmer's level, it is essential to equip the farmers with suitable production technologies related the breeding, feeding and health care management by facilitating closer interaction with Scientists, KVKs, SIRDs, etc. Encouraging the pluralistic extension effort, to cater the location specific needs and challenges is a must. Wider use of mass media, ICT based extension and mobile units are some of the means to a achieve the capacity building processes. Establishment of adequate milk processing capacity along with marketing infrastructure certainly will help to achieve a sustainable dairy development

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