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EDITION

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Skills for Entrepreneurship Development in Buffalo Husbandry

ICAR-Central Institute for Research on Buffaloes (CIRB)Hisar, Haryana-125 001
National Institute of Agricultural Extension Management(MANAGE), Hyderabad

ICAR-CIRB, Hisar & MANAGE, Hyderabad

'Skills for Entrepreneurship Development in Buffalo Husbandry'

Programme Coordination

ICAR- Central Institute for Research on Buffaloes (CIRB) Hisar, Haryana-125 001

Jointly Published By

ICAR-CIRB, Hisar
&
MANAGE, Hyderabad

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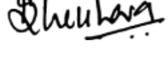
MESSAGE

National Institute of Agricultural Extension Management (MANAGE), Hyderabad is an autonomous organization under the Ministry of Agriculture & Farmers Welfare, Government of India. The policies of liberalization and globalization of the economy and the level of agricultural technology becoming more sophisticated and complex, calls for major initiatives towards reorientation and modernization of the agricultural extension system. Effective ways of managing the extension system needed to be evolved and extension organizations enabled to transform the existing set up through professional guidance and training of critical manpower. MANAGE is the response to this imperative need. Agricultural extension to be effective, demands sound technological knowledge to the extension functionaries and therefore MANAGE has focused on training program on technological aspect in collaboration with ICAR institutions and state agriculture/veterinary universities, having expertise and facilities to organize technical training program for extension functionaries of state department.

Entrepreneurship development appears to be the best substitute to find employment opportunities, income generation, poverty reduction and improvements in nutrition, health and overall food security in the national economy. Buffalo which ranked first in population and milk production was neglected for a long period even in India, due to poor breeding, health care and marketing infrastructure. During recent years, with better awareness about the quality of milk and available technologies to reduce the fat content without changing other qualities, buffalo milk is regaining its popularity. With better awareness and application of modern science and technologies, the productivity of buffalo can be enhanced significantly, while increasing the popularity of its milk. However, there is a wide gap between the available scientific knowledge and the understanding of buffalo owners in India. Hence, need to collect more information about current status of buffalo population, production practices and challenges faced by small farmers in increasing milk production, and to suggest suitable management practices to improve their economy.

It is a pleasure to note that, ICAR- Central Institute for Research on Buffaloes (CIRB) Hisar, Haryana and MANAGE, Hyderabad, Telangana is organizing a collaborative training program on "Skills for Entrepreneurship Development in Buffalo Husbandry" from 24-27 August, 2021 and coming up with a joint publication as e-book on "**Skills for Entrepreneurship Development in Buffalo Husbandry"** as immediate outcome of the training program.

I wish the program be very purposeful and meaningful to the participants and also the e-book will be useful for stakeholders across the country. I extend my best wishes for success of the program and also I wish ICAR- Central Institute for Research on Buffaloes (CIRB) Hisar, Haryana many more glorious years in service of animal husbandry ultimately benefitting the livestock farmers. I would like to compliment the efforts of Dr. Shahaji Phand, Center Head-EAAS, MANAGE and Dr. Avijit Dey, Principal Scientist, ICAR-Central Institute for Research on Buffaloes, Hisar, Haryana for this valuable publication.



Dr. P. Chandra Shekara
Director General, MANAGE

भाकृअनुप - केंद्रीय भैंस अनुसंधान संस्थान
ICAR - Central Institute for Research on Buffaloes

Dr T.K. Datta
Director

FOREWORD

The livestock industry is critical to the socioeconomic growth of rural households. It generates roughly 26% of India's overall GDP from the agriculture sector. The demand-driven growth in livestock production enables millions of poor to escape the poverty trap. Buffalo contributes over 93 million tonnes of milk and the demand for Indian buffalo meat in international market has sparked a sudden increase in the meat exports in recent times. Buffalo meat dominates the exports with a contribution of over 89.08% in total animal products export from India. Also, buffalo contributes high-value hides, bones, and draught power for agricultural activities. Buffaloes are well appreciated for their meat and draught in addition to their milk production. Buffalo milk fetches higher price, as it contains 7-7.5% fat, almost twice that from cows. They are efficient converters of low-quality feeds, coarse fodder and agroindustry byproducts and widely renowned for their ability to thrive on low-quality crop wastes and green forage under harsh climatic conditions.

India has been regarded as an extremely rich gold mine of buffalo germplasm resources as it harbors all the recognized, high producing breeds of this species. Indian dairy industry is undergoing transformational change and buffalo sector has an important contribution in overall milk production as it alone contributes to 49% of total milk in the world. Buffalo farming has become a livelihood and resource generating enterprise for varied strata of our farmers. It is playing a major role in alleviation of poverty and the commercial buffalo enterprises now provide employment to rural communities. Buffalo acts as an important asset of rural farmers' property, possession, and profession since it provides the greatest promise for food security and sustainable development. Considering the key role played by buffalo species in the farming systems from the time immemorial to date, interest in this livestock species is expanding as more methodical planning is being implemented for the growth of country's agrarian economy as well as need for entrepreneurship in buffalo farming system. In his context, I appreciate the effort of ICAR-CIRB and MANAGE to organize this collaborative training on "**Skills for Entrepreneurship Development in Buffalo Husbandry**" to enlighten field functionaries with the modern technologies of buffalo husbandry practices. I further commend the organizers for choosing such an important topic for training, and I am confident that this compilation of resource material from the learned speakers will serve as a source of information and knowledge for stakeholders.

August 24, 2021

TK Datta
Director,
ICAR-Central Institute for Research on Buffaloes

PREFACE

This e-book is an outcome of collaborative online training program on "**Skills for Entrepreneurship Development in Buffalo Husbandry**". This compendium is intended for Faculty and students of Veterinary Universities, veterinary professionals of KVKs, ICAR institutes and state Animal Husbandry departments, who are key players in the livestock sector. The compendium is our attempt to bring together the knowledge regarding modern technologies of buffalo husbandry practices in India and to develop skills on improved technologies of buffalo production systems to field functionaries. The content of proposed training programme has been designed in such a way, so that it can provide updated information towards capacity building in the proposed area. Attempt has been made to cover topics about advances in buffalo nutritional management with special reference to formulation of ration and precision feeding, alternative feed resources, technologies for fodder production, silage production, feed block and supplements for buffaloes. Topics like feeding management of buffaloes during transition period and high yielding buffaloes have also been included as proper feeding can protect the animals from negative energy balance and improve milk production. Topic like reproductive inefficiency and amelioration has also been introduced to describe the main factors affecting the low reproductive efficiency in buffalo and corrective measures to be taken for its improvement. Looking into the demand of quality buffalo semen, topics related to semen freezing and artificial insemination like assisted reproductive technology that has revolutionized animal breeding is also included. Apart from this, management of buffalo calves, rearing of buffalo broilers and economic analysis of buffalo production systems which have a major impact on the economic viability of buffalo operations, are also taken into consideration while preparing the program schedule. The technologies for value addition of buffalo milk and meat, and their quality assessment with reference to present FSSAI rules have been incorporated. The newer dissemination of technologies (mobile app./ web based) of buffalo husbandry and entrepreneurship development for profitable buffalo farming have been incorporated for the benefit of extension officers and rural youth.

The compendium has been developed with the inputs from many scientists across the country specialized in their area of research and development. We sincerely thank all the contributors for their efforts that have allowed us to put together this document. We hope that you find it useful and we would be pleased to receive comments and suggestions for further improvement.

Best of Luck

24th August 2021

Editors

CONTENTS

SNo.	Lecture Topics	Authors	Page No.
1.	Buffalo the Black Gold: Role in Indian Economy	T.K. Datta	1-6
2.	Entrepreneurship Development among Youth for Profitable Livestock Production	V.B. Dixit, Gururaj M. and M.L. Sharma	7-12
3.	Buffalo Calf Management	A. Bharadwaj, Sanjay Kumar and S.K. Khurana	13-18
4.	Reproductive Inefficiency in Buffalo and Ameliorative Measures	R.K. Sharma, S.K. Phulia, A. Jerome and A.K. Balhara	19-26
5.	Feeding Management of Transitional Buffaloes	A. Dey, A. Jerome, Meeti Punetha and P.C. Lailer	27-35
6.	Buffalo Production Systems and Economics of Buffalo Rearing	Inderpreet Kaur and Pranav K. Singh	36-42
7.	ICT Enabled Tool: A New Dimension of Smart Herd Management	U.B. Angadi, Mir Asif Iqueba1 and Dinesh Kumar	43-50
8.	FSSAI Rules with Special Reference to Marketing of Milk and Milk Products	Rajan Sharma and Richa Singh	51-56
9.	Technologies for Buffalo Meat Value Addition	Arun K. Das and Annada Das	57-65
10.	Rearing of Buffalo Broiler	Goutam Mondal and Rashika Srivastava	66-71
11.	Feeding Management of High Yielding Buffaloes under Heat Stress Condition	Nitin Tyagi and Bilal Chamadia	72-77
12.	Management of Breeding Bulls and collection, processing and preservation of semen	Pawan Singh	78-81
13.	Estimation of Farm Profits in Dairying: Methodological Aspects	Smita Sirohi	82-85
14.	Entrepreneurship Opportunities in Value Added Buffalo Milk Products	Ashish Kumar Singh, Heena Sharma and Chander Mohan	86-91
15.	Feeds and Fodder Technology, Silage Production, Feed Block and Supplements	P.C. Lailer, A. Dey and Sarita Yadav	92-100

CHAPTER 1

BUFFALO THE BLACK GOLD: ROLE IN INDIAN ECONOMY

T.K. Datta
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Buffalo production plays a significant role in food security and poverty alleviation in Asian countries. Buffaloes, described as the ''Black Gold'', are favourite multipurpose animals of farmers and are in fact the ''bank on hooves'' with huge potential for social and economic changes for the agrarian community. Buffalo has been an integral part of livestock agriculture in Asia for over 5000 years producing milk, meat, hides and draft power. With more than 90% of global buffalo population present in Asia, 77.9% buffaloes are inhabitant of south Asian countries. India is home for 57% world buffalo population and contributing nearly 50% of total milk production of the country. Data from the 20^{th} livestock census shows that the buffalo population has grown by 1.06 per cent between 2012-2019.

With 20 per cent share of world's bovine population, India is one of the largest producers and exporters of buffalo meat. India has exported 1.086 million tonnes of buffalo meat products to the world for the worth of Rs. 23,460.38 Crores/ 3,171.19 USD Millions during the year of 2020-21. During the last 70 years, buffalo contribution of nearly 50 per cent in milk pool elevated India to the No. 1 pedestal in total milk production, while buffalo meat export earned India another distinction of being the largest buffalo meat exporting country in the world. Buffalo meat also surpassed basmati rice as the largest exported agricultural commodity during the year 2016-17.

Status and contribution of buffalo milk:

Livestock sector is growing faster than any other agricultural sub-sector. While percentage contribution of agriculture and allied sector at constant prices (2011-12) in total gross value added (GVA) decreased from 18.5 to 14.8 per cent from 2011-12 to 2019-20; the share of livestock to total GVA increased from 4.0 to 4.4 per cent. Buffalo is prominent in UP, Rajasthan, Gujarat, MP, Bihar, AP, Maharashtra, Haryana, Telangana and Punjab, where it contributes between 54-85 percent to total milk produced and is important contributor to rural household incomes.

Table 1: Indian buffalo population and annual growth

Year	Numbers (Million)	Year	Annual growth (%)
1992	84.2	-	-
1997	89.9	1992-97	1.30%
2003	97.9	1997-03	1.70%
2007	105.3	2003-07	1.50%

2012	108.7	2007-12	0.60%
2019	109.9	2012-19	1.06%

The total milk production of India was about 165 M tonnes in 2016-17, with buffalo share of over 49%. For the year 2019-20, the total milk production was estimated at 198.4 M tonnes. The productivity of buffalo is highest in Haryana followed by Punjab. Uttar Pradesh, having about 26% of total in-milk female buffaloes, is having per animal productivity of 4.44 litres per day (about 50% of the best producing state). There is scope for further improvement in buffalo productivity through improved germplasm dissemination, nutrient availability and health care.

Table 2: Leading states with buffaloes (Million heads) (20th Livestock census-2019)

States	Buffaloes
Uttar Pradesh	33.016
Rajasthan	13.693
Gujarat	10.543
Madhya Pradesh	10.380
Bihar	7.719
Andhra Pradesh	6.219
Maharashtra	5.603
Haryana	4.368
Telangana	4.226
Punjab	4.015

Table 3: Status of buffalo milk production

Production (MT)				Annual Growth Rates (%)		
2001-02	2010-11	2016-17	2019-20	2001/02 - 2010/11	2010/11-2016/17	2016/17-2019/20
45.40	62.35	80.38	97.21	3.73	4.13	5.23

Buffalo milk is rich in protein, fat, conjugated fatty acids (CLA), and minerals with low cholesterol, sodium and chloride. It has double lactoperoxidase activity, more thermally stable β- lactoglobulin, larger fat globules size (4.16-4.6 μm), higher buffering capacity (25-30% more) and more Vitamin A, E and B_{12} (4 folds more). Buffalo milk is not only sweeter in taste but also more creamier and thicker with more solids, hence preferred for preparation of several traditional sweets.

Table 4: Buffalo milk- a source of extra nutrients

Constituents	Buffalo milk	Cow milk
Water (g/L)	820	870
Total solids (g/L)	172	125
Lactose (%)	5-5.5	4.8
Protein (%)	4-5	3-4
Fat (%)	6-9.5	3.6-4
Cholesterol (mg/g)	0.65	3.14
Conj. Linoleic Acid (mg/g fat)	6.1	5.5

Buffalo Meat:

Meat production from buffaloes contributes immensely to Indian economy and plays a pivotal role in sustainable buffalo husbandry through improvement in productivity, remunerative price for the culled/ unproductive stocks, prevention of degradation of soil and water resources and reduction in the greenhouse gas effect. Resultantly, there are no stray buffaloes on the streets. The total meat production ofthe country was 8.6 million tonnes in 2019-20 with a steady increase from 7.4 million tonnes since 2016-

17. Buffalo contribute 22% of total meat production of the country (2019-20) and UP, Maharashtra, AP and Telangana are the largest producers of buffalo meat (2018-19).

Table 5: Meat production (MT) in India

Attributes	2015-16	2019-20
Buffalo meat	1.61	1.545
Beef	0.329	0.326
Mutton	0.485	0.677
Goat meat	0.943	1.097
Poultry meat	3.264	4.06
Pork	0.388	0.404
TOTAL	**7.0**	**8.6**

India is the leader in buffalo meat production with an export of 1.086 million tonnes of buffalo meat (APEDA, 2021; https://agriexchange.apeda.gov.in/indexp/exportstatement.aspx) worth of Rs. 23460.38 crore (2020-21). Presently, there are 68 modern abattoirs with meat processing facilities approved by APEDA for export of buffalo meat from the country.

Table 6: International buffalo meat production (2019)

Country	Production (MT)
India	16,81,372.00
Pakistan	9,67,075.00
China	6,49,357.00
Egypt	3,81,724.00
Nepal	1,86,903.00
Philippines	1,03,259.00
Vietnam	90,155.00
Indonesia	58,262.00
Myanmar	52,481.00
Thailand	26,083.00

(Source: https://www.nationmaster.com/nmx/ranking/buffalo-meat-production)

According to the All India Meat and Livestock Exporters Association (AIMLEA) export abattoirs-cum- meat processing plants in India registered with the export regulatory authority (APEDA) are employing74,000 workforce directly and 1,50,000 indirectly. Slaughter restrictions on utilization of male buffalo calves and other unproductive buffaloes need to be relooked for increasing revenues from buffalo meat.FMD control programme needs to be implemented effectively for control / eradication of this important economic disease, which will enhance the market potential of both milk and meat across the globe for attracting better prices.

Utilization of slaughterhouse by-products and value addition:

When meat animal is slaughtered and processed, only one third is meat and the rest comprises of by-products and waste which are used as variety of meat for human consumption, pet foods, industrial products and organic fertilizers.Value addition of slaughterhouse by-products for pet food viz. sausages, nuggets from blood and rumen pickles/ flakes, earlobe, intestines, dried offals, tendons could be prepared to fill the gap of demand for pet food in the country. Dry/ semi moist pet food from buffalo offals could also be prepared to generate income. Rendering converts highly perishable meat by-products that are unfit for human consumption into useful commodities such as meat meal, bone meal, meat and bone meal, pet food along with additional quantities of fats, tallow and greases used in various feed and industrial sectors. Rumen and intestinal contents as well as remaining unusable wastes are fed into bio-digestors for production of bio-gas and manure.

Table 7: Major buffalo by-products and their uses

Primary by-product	Secondary by-products
Hide / skin	Leather, collagen sheets, Glue
Edible offal - lung, liver, spleen, stomach, etc	Variety meat for human consumption
Inedible /condemned offal	Pet foods , meat meal, tallow
Bones	Bone meal, gelatin
Blood	Blood meal, albumin, haemoglobin, serum, plasma, fibrin
Intestine	Sausage casings, instrument strings, surgical sutures, tennis racket guts
Horns	Keratin, artifacts, buttons
Hoofs	Keratin, hoof meal, neat's foot oil
Intestinal contents	Manure
Pancreas	Insulin
Lung	Heparin
Liver	Liver extract
Fat	Tallow - Soap industry, textile industry

Buffalo slaughter regulations need to be pragmatic and dynamic to the changing situations so that sustainability of the species could be achieved.The existing bans/restrictions on buffalo slaughter in place since 1970s in some states, need to be relooked in view of changes in land utilization pattern, buffalo production scenario, economic pressures, feed and fodder availability, importance of productivity etc., which demand a pragmatic approach for making modification to the existing provisions.

With decreasing role of draught animals for providing farm power, rearing male buffalo calves with backward integration for meat purpose seem to be the appropriate alternative to contribute for the total productivity of buffaloes for sustained production.

Issues for enhancing buffalo economy in India:

- Breeding strategies: It should be based on the resource position of farmers, which is by and large, poor.
- Ensuring clean production system of meat and milk: For promoting exports and also for domestic consumers.
- Enhancing value addition, processing and market linkage: Preventing wastage of products due to contamination, unfair trade practices and elimination of intermediate agencies in marketing will further enhance the profit margins (presently only 30% milk is sold through the organised sector).

- Augmenting buffalo reproduction: Buffalo should calve once in every 12-16 months. For this, she must be pregnant by 65 days after calving and for this, breeding should start at 40 days after parturition. Estrus detection is frustrating problem in buffaloes leading to more incidence of repeat breeding.
- Policies and funding for solving the issues in buffalo reproduction, dissemination of superior germplasm, disease control and marketing need to be looked into.

Conclusion

Buffalo are good grazers; as compared to cattle they graze a wider range of plants. They have a larger rumen, slower rumen movements, rate of outflow from the rumen, and higher bacterial activity capable of utilizing low grade roughages. They are capable of round-the-year breeding with good nutrition and care. The production of fat-corrected milk matches favourably with any high yielding cattle breed. Absence of religious taboo on buffalo slaughter, helps scavenge the value for spent animals as well, making buffalo farming more remunerative. Buffalo will continue to contribute in Indian agricultural economy for livelihood, food and nutritional security. Full potential of buffalo needs to be explored for sustainable gainin Indian economy.

* * * * *

CHAPTER 2

ENTREPRENEURSHIP DEVELOPMENT AMONG YOUTHS FOR PROFITABLELIVESTOCK PRODUCTION

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With growing urbanization, the land for agriculture is reducing continuously. As a result, more and more farmers and their children find themselves out of work. Increasing influence of education has also created a need for jobs amongst the rural masses. The number of jobs in government and organised sector is limited and the opportunity for the same is on the decline. Besides these limitations, educated farm youths are showing some reluctance for going back to farming. Farming does not interest them anymore and they attribute a very low status to it. Keeping in view the changing scenario, there is a strong need to mobilize the farming community to take advantage of emerging opportunities.

Dairy sector in India plays an important role in the national economy and in the socio- economic development of the country. It has a significant role in supplementary family income and generating employment in the rural areas, particularly among the landless, small, marginal farmers and farm women, besides providing cheap and nutritious food to millions of people. More importantly small and marginal farmers account for three-quarters of these households. Income from livestock production accounts for 14-15 per cent of total farmhouse holds income in different states. Thus, an increase in demand for livestock products can be a major factor in raising the income and living standard of rural households. The majority of rural dairy farmers need support for building up their capacity development through entrepreneurial training programmes which may help them to upgrade their knowledge.

What is Entrepreneurship?

Entrepreneurship is the ability and readiness to develop, organize and run a business enterprise, along with any of its uncertainties in order to make a profit. The most prominent example of entrepreneurship is the starting of new businesses. The entrepreneurial vision is defined by discovery and risk-taking and is an indispensable part of a nation's capacity to succeed in an ever-changing and more competitive global marketplace.

Who is an Entrepreneur?

The entrepreneur is defined as someone who has the ability and desire to establish, administer and succeed in a start-up venture along with risk entitled to it and to make profits. The best example of entrepreneurship is the starting of a new business venture. The entrepreneurs are often known as a source of new ideas or innovators, and bring new ideas in the market by replacing old with a new invention.

Characteristics of Entrepreneur:

Not all entrepreneurs are successful; there are definite characteristics that make entrepreneurship successful. A few of them are mentioned below:

- Ability to take a risk: Starting any new venture involves a considerable amount of failure risk. Therefore, an entrepreneur needs to be courageous and able to evaluate and take risks, which is an essential part of being an entrepreneur.
- Innovation- It should be highly innovative to generate new ideas, start a company and earn profits out of it. Change can be the launching of a new product that is new to the market or a process that does the same thing but in a more efficient and economical way.
- Visionary and Leadership quality: To be successful, the entrepreneur should have a clear vision of his new venture. However, to turn the idea into reality, a lot of resources and employees are required. Here, leadership quality is paramount because leaders impart and guide their employees towards the right path of success.
- Flexible- An entrepreneur should be flexible and open to change according to the situation. To be on the top, a businessperson should be equipped to embrace change in a product and service, as and when needed.
- Know your Product: Dairy farmers should know the product offerings and also be aware of the latest trend in the market. It is essential to know if the available product or service meets the demands of the current market, or whether it is time to tweak it a little. Being able to be accountable and then alter as needed is a vital part of entrepreneurship.

Importance of Entrepreneurship:

- Creation of Employment: Entrepreneurship generates employment. It provides an entry-level job, required for gaining experience and training for unskilled workers.
- Innovation: It is the hub of innovations that provides new product ventures, market, technology and quality of goods, etc., and increases the standard of living of people.
- Impact on Society and Community Development: A society becomes vibrant if the employment base islarge and diversified. It brings about changes in society and promotes facilities like higher expenditure on education, better sanitation, fewer slums, a higher level of homeownership.
- Increase Standard of Living: Entrepreneurship helps to improve the standard of living of a person by increasing the income. The standard of living means, increase in the consumption of various goods andservices by a household for a particular period.

Entrepreneurship development through training on improved buffalo husbandry:

The institute organizes on and off-campus at least one training per month. In this regard, CIRB conducted a study on training need assessment of 254 rural youths, farm women and other farmers and accordingly designed training modules to bring in desired knowledge, skills and competence in stakeholders. Accordingly, contents were developed and training schedule was strictly adhered to. It was, therefore, considered imperative to find out impact of trainings at different levels to be able to measure incremental change during the training programme; Bennett (1979) came up with the hierarchy that showed the causal links between steps from inputs to outcomes. Therefore, in order to conduct a comprehensive study, Bennett's hierarchy was used to measure the impact of training on improved buffalo husbandry.

Information about schedule of training was put up on the Institute website and applications of farmers, farm women and youths were invited to participate in the training programmes. In order to see the impact of five trainings organised during 2014-15 were selected randomly. For these five trainings 761 farmers applied and out these finally 395 farmers attended these trainings. However, it can be observed that there was steady increase in the number of farmers in each training. The details are given in the Table 1.

Table 1: Details of farmers' involvement in the training programmes

Training	No. of farmers applied	No. of farmers attended
23-28 June, 14	98	14
4-9 Aug., 14	128	54
10-21 Oct., 14	115	75
3-12 Jan., 15	200	98
7-16 Mar., 15	220	154
Total	761	395

Impact analysis was conducted to find out if there was entrepreneurship development amongst those farmers who attended these trainings. The process of entrepreneurship development was studied through following parameters, which are discussed below.

Practice Change:

Information on change in adoption pattern of some practices as a result of training was collected and results are presented in Table 2. With regard to some of the practices like AI, PD, balanced feeding, adoption of ASMM, colostrum feeding and deworming practices, it was noticed that the number of respondents who started adopting these practices increased by 79.5, 52.3, 56.8, 80.7, 75.0 and 43.2 per cent respectively. With regard to natural service it was found that number of respondents who were using natural service in buffaloes was decreased by 33 per cent. Thus, training influenced the adoption pattern of improved buffalo husbandry practices.

Table 2: Adoption of improved buffalo husbandry practices before and after training programme

Practices	No. of respondents practising = 88		Percentage change
	Pre-training	Post-training	
AI	10	80	79.5
PD	25	71	52.3
Balanced feeding	22	72	56.8
Adoption of ASMM	14	85	80.7
Colostrum feeding in buffaloes	11	77	75.0
Deworming	31	69	43.2
Natural service	70	41	-33.0

The data presented in Table 3 showed that the mean herd size increased in all the units as a result of training. Another significant positive change was that the herd size was increased with increase in the size of the units with maximum change in the large units. As the respondents were able to take advantage of the training, they wished to further increase their herd size subjected to the resource availability especially bank loans, land and labour. Overall t-value of 6.64 indicated positive and significant change in herd size of respondents.

Table 3: Impact of trainings on change in herd size

Herd size	Before Training		After Training		t-value
	Mean	SD	Mean	SD	
Small (1-5)	2.37	0.82	4.47	0.56	13.09**
Medium (6-10)	3.58	1.70	7.66	1.45	10.96**
Upper Medium (11-15)	4	1.93	13.5	1.6	10.71**
Large (>15)	8	5.21	27.83	8.35	4.93**
Overall	3.39	2.17	8.19	6.42	6.64**

****Significant at 1% level of significance**

The increase in herd size also reflected on the milk production as could be observed from the data presented in Table 5. The increase in milk production increased with increase in the herd size as the average monthly milk production ranged from about 456 kg in small herd size to 3120 kg in large size units. The increase in milk production was significant in all the herd sizes as revealed by significant t-values. There was significant increase in average monthly milk production which is apparent from the t- value of 7.36.

Table 5: Impact of training on average monthly milk production

Herd size	Average monthly milk production (in kg.)		Average monthly increase in milk production (in kg.)	t-value
	Before training	After training		
Small (1-5)	585	1053.16	456.16	6.83**
Medium (6-10)	836.67	1928.33	1092	6.71**
Upper Medium (11-15)	1192.5	3037.5	1845	6.17**
Large (>15)	1730	4850	3120	6.61**
Overall	821.25	1850.45	1029.20	7.36**

****Significant at 1% level of significance**

Out of 395 farmers trained at this institute 88 started their dairy enterprise of different sizes, which lead toentrepreneurship development among farmers as they started new venture.The details are given in table 4. It is obvious from the table that about 43 percent respondents established small dairy units comprising of1 to 5 buffaloes, while 41 percent established dairy units between 6-10 buffaloes. About 9 percent started dairy farm with buffaloes ranging from 11-15 buffaloes. There were only 7 percent respondents who established large dairy units having more than 15 animals.

Table 6: Different sizes of dairy established

Herd Size	No. of respondents = 88	
	Frequency	Percentage
Small (1-5 buffaloes)	38	43.0
Medium (6-10 buffaloes)	36	41.0
Upper medium (11-15 buffaloes)	8	9.0
Large (>15 buffaloes)	6	7.0
Total	88	100.0

It was found through analysis of data pertaining to theses training programs that by establishing dairy units of different sizes, farmers started investing in this enterprise by adopting improved buffalo husbandry practices, which lead to increase in milk production and ultimately also helped in entrepreneurship development. Skills in buffalo rearing, milk production have been handed over from generation to generation. This is a blessed heritage of people of India which however needs to be resurrected through structured training programs, as these were based on the needs of the farmers. It was also found that the management skills of farmers and their knowledge about the improved buffalo husbandry practices are major determinants of future buffalo production which can be honed by training. A systematically arranged training programme helps in bringing desirable changes in the behaviour of people and ultimately entrepreneurship development which can significantly increase the income of farmers.

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CHAPTER 3

BUFFALO CALF MANAGEMENT

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Calves are the future stock of a buffalo dairy industry and its success depends on appropriate calf management. In India buffaloes are reared mainly by small, marginal and landless farmers and most of them do not follow the appropriate management practices. Poor management practices lead to economic losses to the farmers in terms of higher calf mortality, poor growth rate, delayed maturity and poor productivity. Further, not feeding of colostrum to new born calves on within recommended time duration reduces the immunity of calves and makes them susceptible to the diseases which increase the cost of rearing on treatment and farmers faces economical loss by calf mortality. Therefore, it is imperative to follow the scientific management practices of the calf by the buffalo rearer. The main objective of good management of calves is to obtain optimum growth rate commensurate with their genetic potential so that they can attain early maturity. The success of any dairy farm depends upon fast growth of calves to a breedable age with a minimum mortality, so as to have replacement stock. To keep a healthy replacement stock of buffaloes it is important for every farmer to implement best calf management practices.

The buffalo calf may have some innate systematic problems which make it more vulnerable to the physical, nutritional and disease environment. After birth there are some problems which may arise such as: (i) Infection of calf during and just after birth (ii) Catching cold just after birth (iii) Improper maneuvering of navel cord (iv) Too late or insufficient supply of colostrum, (v) Diarrhoea in calf after birth.

Calf mortality is the most important constraint in herd replacement. The highest morbidity and mortality rates generally occur in buffalo calves prior to weaning. A higher calf mortality rate will increase the herd replacement cost as well as the time needed to produce replacements. The major causes of calf mortality reported worldwide are diarrhoea and pneumonia. The highest mortalities are reported during the first 30 days to 3 months of life. Incidences of buffalo calf mortality vary from as low as 2% to as high as 60% with half of the deaths upto one year of age occurring in 1st month of life and majority (60-70%) in rainy and winter seasons, mostly from digestive and respiratory disorders (Sastry and Verma, 1988). The causes of calf mortality can be divided into infectious and non-infectious. Various infectious agents are capable of causing diarrhea and pneumonia in the neonatal calf which includes bacteria (*E. coli*, *Klebsiella* spp., *Salmonella* spp., *Pasteurella multocida*, *Mycoplasma bovis*), Virus (Rotavirus, coronavirus), Protozoa (Cryptosporidium, Coccidia) and Helminthes (*Toxocara vitulorum*, *Moniezia* spp.). The major non-infectious causes are dystocia, improper feeding of colostrum, low birth weight, and poor management practices.

During the 1st few hours of birth the calves should be protected from source of infection since natural immunity at that time is not yet achieved and besides, the calf has to overcome the discomfort and stress due to change in environment and physical surroundings. The new born calf gets infected mainly by germs penetrating into the body through mouth, nasal passage and through navel cord. Therefore, it is essential to wash the vulva and hind quarter of the animal with disinfectant before and during parturition and help out the calf at the time of calving with clean hands or disinfected gloves.

Calves are frequently exposed to disease from the dam at birth; therefore minimum contamination of calving area should be kept. In the calving pens where the birth has to take place, the calves should be placed on the floor and putting sufficient straw on the floor and removing the dam's faeces if any.

Immediately after birth, the mucous or phlegm should be cleared from the nostril and mouth of calf. It becomes necessary to provide artificial respiration, if calf does not start respiring after birth. Allow the mother to lick her calf dry, if necessary the calf should be cleaned and dried with gunny bags or wheat straw. It is most important to disinfect the navel cord soon after birth. The simplest way is to cut the navel cord, if it is longer than 3 inches, by the sterilized scissors and apply tincture iodine on the cord by the cotton swab or the cord itself is dipped in tincture iodine. A better method is to insert the swab of tincture iodine into the vessel and twine is tied below the swab. After 3-4 days the swab along with dead umbilical tissues fall off, leaving the umbilical opening completely healed.

Placenta of the buffaloes effectively separates the blood of the fetus from that of the dam and prevents any transfer of protective immunity while in the uterus, therefore, the antibodies (Immunoglobulins) cannot pass from dam to offspring through placental membranes. As a result, calves are born with no circulating antibodies to combat infection and the calf is born completely dependent on the absorption of maternal antibodies from colostrum after birth. The blood antibodies production is initiated after 10 days of birth and normal level is attained only after about 8 week of age, the requirement of feeding colostrum within an hour or two of the birth of the calf is often necessary to help in resisting infection (Jankiraman, 1987). Calves with inadequate immunoglobulin concentrations have reduced growth rates and feed conversion efficiency, increased risk of disease and death. Therefore, early and adequate consumption of high quality colostrum during the first 24 hours after birth is considered the single most important management factor in determining health and survival of the neonatal calf. Failure of passive transfer of immunity in calves is defined as a blood IgG level of less than 10 mg/mL at 24 hours after birth or serum protein levels less than 5.2 g/dl. This failure of passive transfer may be attributed to colostrum containing inadequate mass of IgG, poor colostrum feeding methods, and poor efficiency of IgG absorption in calves. Feeding of at least one litre of colostrum within 1^{st} three hours is a good start to build up sufficient resistant against all kind of disease. Total amount of 4-5 litres colostrum should be ensured to fed the calves during the first 24 hours of calving.

Colostrum of another animal in the herd should be fed, if colostrum is not available from the calf's mother. High nutritive value and laxative action to remove the meconium (first faeces) are other important function of colostrum feeding. Buffalo calves seem to have some problem with absorption of immunoglobulin. This may one of the reasons for high mortality rates in buffalo calves during early calf hood. There is wide variation in serum immunoglobulin concentration among young calves (Sikka et al., 1995). Immunoglobulin level has been reported as 29.73 mg/ml in the blood of one day old buffalo calves, it increases to 37.66 mg/ml on second day of life. Verma *et al.* (1996) estimated the immunoglobulin concentration in the blood of buffalo calves in the 2^{nd}, 4^{th}, 17^{th} and 30^{th} day of life to be 44.04±2.23, 48.79±2.59, 34.56±1.63 and 29.78±3.47 mg/ml, respectively. Colostrum contains 68.75 mg/ml on the first day, 23.73 mg/ml on the second day and 1.01 mg/ml immunoglobulin level on the fifth day of lactation (Bhargava and Balakrishna, 1978).

At the stage upto 3 months, calves require high plane of nutrition and good quality easily digestible feed. However, to speed up development of rumen and early initiation of microbial fermentation the calves should be offered calf starter and green grass from second week of life. As intake of calf starter and green grass increases milk has to be reduced gradually as per following schedule:

Table 1: Calf starter, Green roughages in correspondence with the whole milk

Age (Days)	Whole milk (Kg)	Calf starter (Kg)	Green roughage (Kg)
1 to 7	2.50	Nil	Nil
8 to 14	2.50	0.05	0.25
15 to 21	3.00	0.10	0.35
22 to 28	3.50	0.20	0.50
29 to 35	3.50	0.40	0.55
36 to 42	3.00	0.60	0.60
43 to 49	3.00	0.70	0.70
50 to 56	2.00	0.80	0.80
57 to 63	1.50	1.00	1.00
64 to 70	1.50	1.20	1.10
71 to 77	1.00	1.30	1.20
78 to 84	0.50	1.40	1.40
85 to 90	Nil	1.70	1.90

Calf starter should contain 22% CP and 70-75% TDN and it should be prepared from good quality feeds i.e. easily digestible low fibre feed and has to be free from any kind of toxins or antimetabolites. After 3 months of age, the calves attain about 60-70 kg body weight under normal feeding condition. In this phase rumen developed substantially and microbial digestion in rumen become functional and beyond 3 months of age suckling is usually not allowed except for very short period to facilitate milk let down. Hence, the major portion of nutrient requirements has to be met from concentrate or roughage source. Generally, at this phase protein and energy level of diet are kept similar to those fed upto 3-month age. However, there is reasonable ability of compensatory feed intake if calves are given low plane of energy and protein. Thus, a palatable diet containing 13-14 % crude protein and 60-62% total digestible nutrient may support 500-600 g average daily growth rate.

Table 2: Some simple and flexible calf starters for buffalo calves may be prepared as:

Ingredient	Percent composition (kg per 100 kg)								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Crushed maize	30	42	38	50	10	–	–	50	49
Crushed barley/oat	10	–	–	–	10	10	–	–	–
Crushed ragi/jowar	10	–	–	–	–	–	20	–	–
Crushed wheat/rice	–	–	–	–	30	40	30	–	–
GN cake/soybean meal	30	28	20	40	20	30	30	27	20
Til cake/linseed meal	–	–	–	–	–	–	8	10	10
Mustard cake	–	–	–	–	10	–	–	–	–
Fish meal	10	8	–	–	–	–	–	–	8
Wheat bran	7	19	26	7	10	10	10	10	10
Molasses	–	–	–	–	7	7	–	–	–
Skimmed milk powder	–	–	13	–	–	–	–	–	–
Mineral mixture	2	2	2	2	2	2	2	2	2
Common salt	1	1	1	1	1	1	1	1	1
10g vitamin supplement (A, B2, D3) should be added in 1 quintal of the mixture if green fodders are not fed.									

The new born calves should be kept preferably in separate pens (20 sq. feet) for the first three months to avoid suckling instinct. Keeping them in cages with bedding is hygienic and reduces the scours and parasitic infestation (Arora, 1988). Initial expenses are high but in long run the practice proves economical. All the calf pens must be cleaned daily with disinfectant. In commercial herds where this system is not practiced and the calves are kept in small groups in large pens, it is necessary to feed them individually. Bharadwaj and Sethi (2000) found that the daily weight gain was slightly higher in individual stall-fed system than under group fed system. The individually fed calves had full access to the feed and fodder, felt more comfortable and consumed full quantity individually.

Deworming should be started from the first week of buffalo calf. A single oral dose of 10 g piperazine adipate is recommended preferably in the first week of life to control neonatal ascariasis in buffalo calves. Deworming should be done every month for first 6 months, thereafter once in three months. Vitamin A @ 10,000 IU should be given to buffalo calf as anti-infective agent once a week and a total dose of 500,000 IU (usually 1 cc) of vitamin A is required early in life. Special care is necessary to prevent tick infestation in buffalo calves. Antibiotics are usually unnecessary in feeding calves above 3 months of age when rumen start functioning and these are liable to interfere with microbial fermentation. Antibiotics help the calf to overcome certain stress conditions and thereby show improved growth performance (Arora, 1988). From the age of 2 months calves will be given free access to feeding green fodder (berseem, maize, oat etc.) and dry roughage. When feeding of milk is stopped the quantity of concentrate should be increased.

Vaccination is the easiest and cheapest way to prevent diseases therefore vaccination of buffalo calf should be done as given in Table 3.

Table 3: Vaccination of Buffalo calf

Name of Disease	Age at first dose	Booster dose	Subsequent dose
Foot and Mouth Disease (FMD)	2- 4 months	6-8 months	Six monthly
Hemorrhagic septicemia (HS)	6 months and above	-	Annually
Black Quarter (BQ)	6 months and above	-	Annually
Brucellosis	4-8 months of age (Only female calves)	-	-
Anthrax	4 months and above		Annually only in endemic areas

The weaning management in buffalo could be useful to promote clean milk production and to get other established benefits of weaning similar to dairy cattle. Weaning management involves separation of young ones from their mother and rearing them under artificial feeding system. The practice of weaning is well established in dairy cattle; however, its feasibility and sustainability is still challenging for dairy buffaloes. If weaning is practiced in buffaloes, the dairy producers will not only be able to estimate the actual milk yield, but it will also support them for scientific rearing of buffaloes. Several factors can influence time of weaning such as body condition of animals, behavioral temperament of dam, feed resources, standards of management and managerial skill of stockpersons (Khan et al, 2007; Gudev et al, 2007; Bharti et al, 2018). Weaned young ones of dairy calves are raised without suckling to their mothers and they can be fed on whole milk or milk replacer or concentrate ration of high nutritive values along with provisions of green fodder, dry fodder, etc. Weaning of buffalo calves may be attempted, keeping in mind the maternal instinct, ease of letdown in dam and acceptability of milk by calves under hand milking system. Weaning can be done at various stages on the basis of the age of calves, as: (1) **Zero-day weaning or weaning at birth** can be done immediately after birth of calves. Calves are fed on colostrum either of dam or other contemporary dams for initial 5 days through bottle or pail feeding method. (2) **Weaning before development of rumen** can be done a few days or months after the birth (at 30, 45, 60, 75 days) before complete development of rumen in calves but this period is very crucial for growth and health of calves. (3) **Weaning at development of rumen** can be done at complete development of rumen which takes place by 3 to 4 months of age. If calves are weaned at this stage, they can survive on concentrate and fodder resources. (4) **Late weaning** under natural conditions of a calf is completed at about 9-11 months of age. In this method of weaning calf is allowed to suckle the dam just for letdown and this practice is being continued till longer period during the lactation.

There are several future aspects of weaning in dairy buffaloes such as (1) It can be practiced to improve reproductive efficiency (2) It makes the calf rearing system independent from mother (3) It promotes the scientific calf rearing based on nutritional requirement (4) It avoids underfeeding and overfeeding in calves (5) Individual care to calf as well as dam may be possible for better health (6) It reduces service period and thereby calving interval (7) It improves the margin of profit and returns at farm (8) Allows a rest period to dam before giving birth to next calf.

All surplus calves must be disposed off as far as possible after birth, since it is very expensive to raise calves on milk even upto 12 weeks. Male calves may have to be disposed off at an early age unless they can be used for breeding or draft. Male buffalo calves are usually disposed off but they can be reared for meat purpose. Buffalo calf meat can combat the issue of nutritional security and on other side can also enhance the export potential of the country. The rearing of buffalo calves for meat purpose can further reduce the farmers' burden and simultaneously improve the socio-economic status of the farmers. The good quality meat from male buffalo calves is available after about 10-12 months of restricted suckling period (Pathak *et al.,*1976). The dressing percentage of buffalo carcass of 130 to 500 kg body weight has been found to range between 50 and 55% (Tilakaratne *et al.,* 1976). 450g/day body weight gain could be provided in male buffalo calves supplemented with limited amounts of concentrate at 0.75% of their body weight from 128 to 250 kg and higher daily gain, 0.72 kg, can attained by increasing the concentrate amount at 1.5% of body weight (Kumagai et al, 2012). Other studies indicated that average daily gain of buffalo calf ranged between 0.433 and 0.780 kg (El-Feel *et al*., 1993, Gigli *et al*., 1993, Omar *et al*., 1993).

The growth potential of buffalo calf is best upto 2.5 years of age. This growth has to be exploited by appropriate feeding. Unfortunately calves at weaning after 10-12 months of age are most neglected on farms due to shifting to far off sheds without proper arrangement for their care. The thermoregulatory system of buffalo is very poor and they are much vulnerable to extreme climatic conditions particularly in summers. The growth rate of buffalo calf/ heifers declines during extreme hot and cold months of the year. Physical protection from cold and heat stress is equally important feature in raising the growth rate of the animal. The most important cause of decline in growth rate of buffalo calves in summer is negative nutrient balance due to scarcity of good quality greens, diversion of better feed to producing buffalos at the cost of growth stock, adverse effect of hot climate causing reduced intake, overcrowding and unsuitable housing. The growing heifers face three summers up to first conception. Therefore, care of heifers during summer is of great importance in the tropics as animals grow poorly or even lose weight during this period largely due to fall in the status of feeding. However, if legume hay is fed during such period higher growth rate can still be obtained.

The heifers should be protected from thermal stress by showering or splashing cold water on animal two or three times during the hottest part of the day, provision of cold water for drinking and protecting under shade during day and keeping in the open at night. The experimental findings have indicated that adequate nutrition and provision of thermal amelioration including proper housing are effective to overcome summer slumps in growth of buffalo heifers. In severe winter, it is essential to protect calves from cold stress, especially for 5 days after birth, by providing straw bedding, changing the moist bedding, tying gunny bags round the chest and grooming etc. Electric heater may also be provided, but closed room with adequate ventilation body cover is enough. The winter slump in growth can effectively checked by housing calves in open paddock during day and shifting them indoors at night with slightly higher dry matter in the ration for overcoming adverse effect of cold. Provision of comfort and warmth during extreme winters through straw bedding, jacketing gunny bag or curtains in sheds proves beneficial in terms of body weight gain. The sick calves should be kept in isolation so they do not come in contact with healthy calves.

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CHAPTER 4

REPRODUCTIVE INEFFICIENCY IN BUFFALO AND AMELIORATIVE MEASURES

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Buffalo is considered as black gold of India, owing to its major contribution in Indian dairy industry. The animal is often compared with cow and blamed for having poor reproduction ability and high calf mortality. Moreover, India ranks 1st in production of buffalo meat with share of 42.60% and exports buffalo meat to more than 70 countries across the globe. Surprisingly, the population of cattle decreased from 204.5 million to 192.49 million between year 1992 to 2019 and despite so many odds, population of buffalo increased from 84.2 miliion to 109.85 million during the same period. These data make us to believe that buffalo is not a poor breeder as compared to cow.

Resumption of Ovarian cyclicity:

Post-calving early resumption of ovarian cyclicity is important for early breeding. At CIRB herd buffalo (n=102) were screened every 10 days starting from day 30 post-calving using ultrasound for appearance of first corpus luteum. Buffaloes were having a wet average of 8-9 kg during the period and provided balanced diet as per standard practices. It has been observed that nearly 40% buffaloes resume their first estrus by day 30, 25% buffalo resume first estrus between day 31-60 and 15% resume first estrus between day 61-90 post-calving. Despite providing balanced diet, nearly 20% buffaloes do not resume cyclicity by day 90 and even additional nutrient supplementation in the form of bypass protein and bypass fat do not improve the reproduction but production.

First breeding after delivery:

In order to get ready for the next pregnancy, uterus returns to its normal non-pregnant state by day 35-40 after calving in buffaloes. By this time, nearly 40-50% buffaloes already have their first overt or covert estrus. The first heat cycle may be short (7-10 days) in a few animals. First breeding of buffaloes should not be carried out before 40 days of calving. If the discharge in first heat is turbid or flakes are there then this heat can be missed/ treated for breeding in the next heat. Uterine environment get better in subsequent heat as the animal clears infection in each heat. First heat after calving is sometimes delayed (>90 days) in a few buffaloes either due to silent estrus or anoestrus and must be examined by a veterinarian by this date. For early breeding post-partum, buffalo should be provided balanced diet and comfortable housing, observed carefully for estrus signs and inseminated with fertile semen at right time and technique.

First breeding in buffalo heifers:

Usually buffalo heifers express their first heat when they attain a body weight around 300 to 350 kg. This body weight is attained at an age of around 24-30 months if proper nutrition is provided. However, a few heifers do not come into heat even after attaining this weight and requires veterinary intervention. On the other hand, if body weight is less than 300 kg and heifer is > 3 years age, a balanced diet along with quality mineral mixture should be given. To accelerate puberty attainment at an early age, balance diet, mineral mixture supplementation, feeding of green fodder, regular deworming and reducing heat stress during summer season is required.

Management of yearly calving:

Calving interval is a very useful marker of fertility and it is the interval between two successive calving's. The ideal calving interval is 365 days for cows and buffaloes. However, a calving interval of < 400 days is considered as good in cows and <420 days in buffaloes due to nearly 1 additional month of pregnancy. This means that the buffalo must conceive by day 100 postpartum. If buffalo conceived by 200 days it will have next calving in 500 days and if conceive by 300 days it will have next calving in 600 days. By controlling this interval only we can achieve the goal of calf a year. This calving to conception interval is influenced by three factors: how soon after calving buffaloes come in heat, how accurately heat is identified and how readily they become pregnant following breeding. Early treatment of uterine infection, balanced diet, accurate estrus detection, comfortable housing and managemental factors are important to be taken care of.

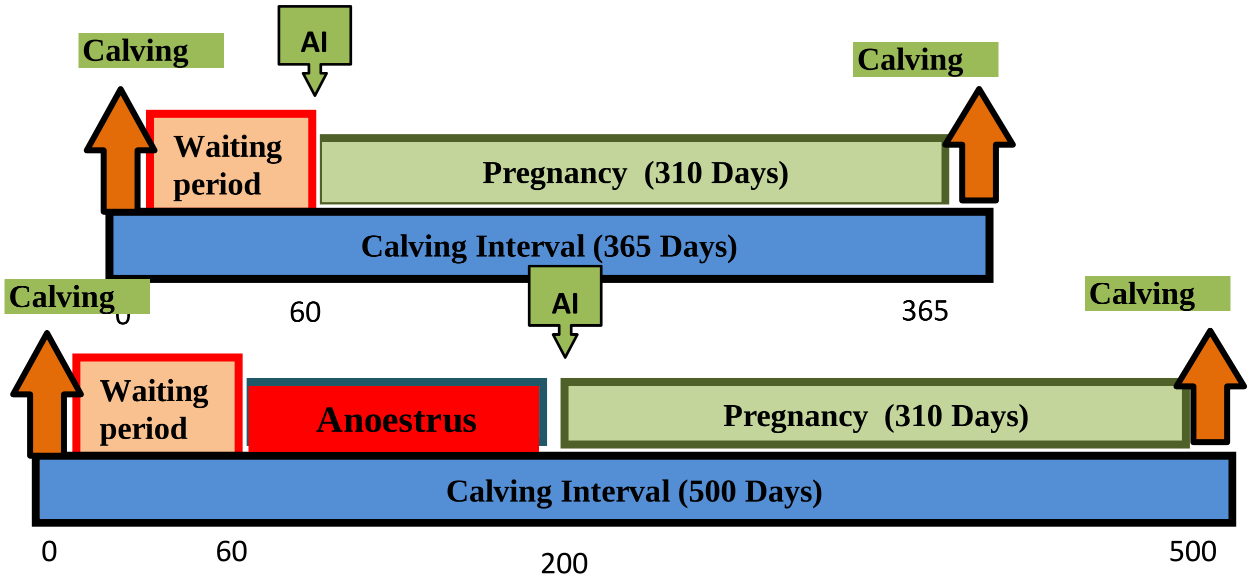


Fig 1: Schematic representation of yearly calving interval (365 days) and long calving interval (500 days) in problematic buffaloes

Buffalo and estrus signs:

Estrus is the period of sexual receptivity and willingness of female to stand for mounting and mating by the male bull. Great individual variations are observed in the occurrence and the intensity of heat signs in buffaloes within same and different parities. Inherently buffalo have poor estrus expression. As a result, many reproductive problems in buffalo are associated with poor oestrus detection by the owner. In buffaloes, heat signs are not as expressive as in cows. The oestrus signs are not detected either due to less intensity of heat, due to short duration of heat, occurrence of heat during night hours or ignorance of signs as farmers often compare them with cow. Important heat signs in buffaloes are: Frequent bellowing, micturition, clear mucous discharge hanging from vagina during rest, tail raising, swollen vulva, mounting on other animals, chin resting and rubbing, restlessness, sniffing behaviour, decreased milk production, off feed and temporary engorgement of teat about 3 days prior to impending estrus in buffaloes. It is important to note that neither all buffalo express all these signs nor signs expressed earlier will remain same on subsequent estrus. Farmer should always suspect for signs of heat if any one sign appear and get them confirmed by a veterinarian. Two to three visual observations per day are necessary for increasing the chances of identifying animals in heat.

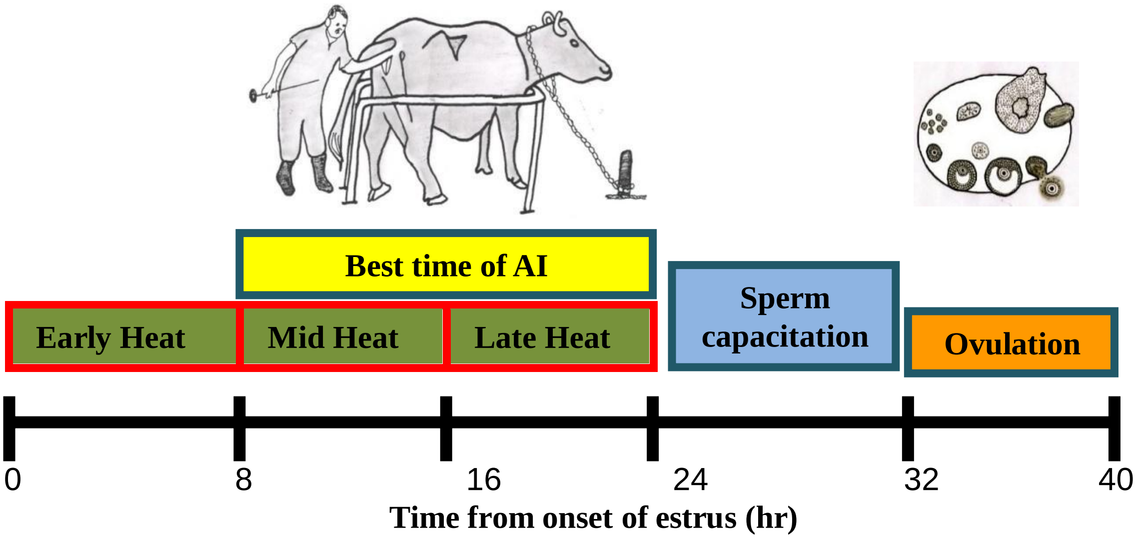


Fig 2: Schematic representation of best time of AI with respect to onset of heat and ovulation time

Early pregnancy diagnosis:

Early pregnancy diagnosis is very important for reducing intercalving interval so that non-pregnant animals can be detected at the earliest and rebred as early as possible. Ultrasound scanning is the most suitable method for early pregnancy diagnosis. The most practically suitable early date for reliable pregnancy diagnosis by ultrasound under field conditions is Day 30-post breeding. On day 30, animals found non-pregnant can be given prostaglandin injection to induce the estrus and subsequent rebreeding.

Therapeutic interventions for anestrus condition in buffaloes:

For improving the reproductive efficiency in buffaloes theoretically there are three strategies with respect to time period: Improving genetics of animals- a long term strategy, improving nutritional status- a medium term strategy and hormonal intervention- a short term strategy. In the present paper we will discuss about the short-term strategy. While treating any animal for anestrus condition generally we come across two types of animals: silent estrus and anoestrus (also referred as anovular, acyclic or true anestrus) animals. For making rational treatment for silent estrus or anestrus animals, an accurate diagnosis of such status is required. For this ultrasound examination of animal is highly useful as it makes a correct and immediate diagnosis.

As a short-term strategies hormonal treatment are preferred to induce heat within a narrow window of 3-10 days. These hormonal preparations are advocated only in animals that has body condition score ≥3.0 and are on a good plane of nutrition. Some of the commonly available hormonal preparations are as follows.

Table 1: Hormones and their commercially available preparations

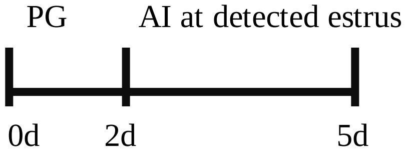
Hormones	Ingredient	Commercial Product	Packing
GnRH	Buserelin 4mcg/ml	Receptal, MSD	2.5 ml, 10 ml
		Gynarich, Intas	2.5 ml, 5 ml
		Pregulate, Virbac	5 ml
hCG	Chorionic gonadotrophin	Chorulon, MSD	1500 IU Vial
PMSG	Pregnant mare serum gonadotrophin	Folligon, MSD	1000 IU vial
Prostaglandin	Dinoprost tromethamine 5 mg/ml	Lutalyse, Pfizer	5 ml, 10 ml
	Cloprostenol 250 mcg /ml	Estrumate, MSD	2 ml
		Vetmate, Vetcare	2 ml, 20 ml
		Pragma, Intas	2 ml
		Pregova, Virbac	2 ml
Progesterone	Vaginal Progesterone implant	CIDR, Zoetis	Pack of 10
		TRIU-B, Virbac	Pack of 10
	3.3 mg Norgestomet ear implant and 3 mg orgestomet + 2 mg oestradiol injection	Crestar, MSD	Pack of 5
Estrogen	Oestradiol valerate 10 mg/ ml	Progynon depot, German Remedies	1 ml Ampoule
	Oestradiol benzoate 1mg/ml	Pregheat, Virbac	2 ml, 5 ml

These hormonal preparations are used either alone or in combinations known as protocols for bringing silent estrus and anoestrus buffaloes into heat. These hormonal protocols are to be given with very caution and the strict supervision of a veterinarian. In our country, they are mainly used as a treatment strategy rather than estrus synchronization protocol owing to high cost of hormonal therapy. Following protocols may be used for estrus induction in buffaloes depending upon their cyclic status.

Prostaglandin injection in silent oestrus/ cyclic buffaloes:

The silent estrus buffaloes are identified by presence of CL where estrus signs are not manifested or observed. Buffaloes detected with a mature CL in the ovary, can be administered with single or double injections of $PGF_{2\alpha}$, 11-14 days apart. This is followed by insemination at observed estrus, usually occurring within 2-5 days post-injection. Majority of estrus occur 72h after prostaglandin injection. This injection is ineffective in those animals that do not have a mature CL (CL between 1-7 days) or those animals that are anovular viz prepubertal heifers and postpartum acyclic females. Prostaglandin injection is very effective management tool where estrus detection system is poor or frequency of silent estrus condition is high like buffaloes. There are three alternatives for estrus induction using PG injection.

Animals having a mature CL of 7-18 days of estrous cycle are given an injection of PG and observed for estrus after 2-5 days of injection. Animals are inseminated on observed estrus.



As an alternative, prostaglandin injection is given to all cyclic animals and insemination is carried out at observed estrus between day 2-5. Those animals not reported in heat are given one more PG injection between 11-14 days apart and insemination is made at observed estrus.

Another alternative is to administer two injections of PG at 11-14 days interval to all cyclic animals. Animals reported in heat on first PG, are not inseminated and insemination is made when animals are found in heat following 2nd PG injection.

Estrus induction in anovular buffaloes:

In order to induce ovulatory and fertile estrus, anovular buffaloes essentially require progesterone priming. Exogenous progesterone implants (CIDR, TRIU-B, CRESTAR) can be used for inducing heat in such animals. Studied carried out in anovular buffaloes revealed that oestrus induction rates as well as conception rate were highest with progesterone implants as compared to GnRH based protocols following fixed time insemination. Progesterone implants are available as Controlled Internal Drug Release (CIDR) device that is kept intravaginally for 7-9 days. By continuously releasing progesterone hormone, they mimic the function of corpus luteum until removed 7-9 days later. Animals are reported in heat and fixed time insemination (FTAI) is done at 48 and 60 hr after implant removal. It is suggested that vagina should be squeezed after CIDR removal so as to clear it from any purulent discharge which is a common feature in vaginal implants insertion. Otherwise, purulent vaginal discharge may appear while insemination and may give an impression of metritis. In anovular buffaloes, an injection of 400 IU PMSG at implant removal is also required for better response and development of an ovulatory follicle. However, this injection is not required in cows. Furthermore, prostaglandin is not required in anovular buffaloes but required in cyclic animals.

Progesterone Implant for confirmed acyclic buffaloes

Estrus induction in buffaloes when cyclic status not confirmed:

Sometimes CL in buffalo remains embedded in the ovary and on palpation per-rectum ovary is felt as smooth and ultrasound facilities are not there to immediately confirm the diagnosis. In such situation, a combined treatment of silent estrus as well as anoestrus condition is required with following protocol. This treatment is more suitable when we are giving it as blind treatment or during non-breeding/ summer season. Animals are reported in heat and fixed time insemination (FTAI) is done at 48 and 60 hr after implant removal.

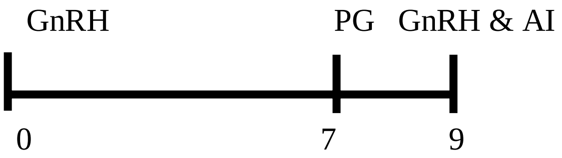
Progesterone Implant for unknown cyclic status buffaloes

Another alternative protocol is to inject prostaglandin injection 72 h prior to CIDR insertion. Buffaloes reported in heat at 72h or earlier are inseminated and remaining non-inseminated buffaloes are inserted CIDR protocol on Day 3. Animals are reported in heat and fixed time insemination (FTAI) is done at 48 and 60 hr after implant removal. This protocol is more cost-effective during breeding season.

Progesterone Implant for unknown cyclic status buffaloes

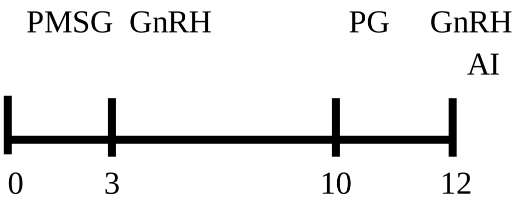
Estrus and Ovulation synchronization using GnRH based protocols:

Using GnRH and prostaglandin injection, a protocol popularly known as Ovsynch protocol has been developed to synchronize estrus and ovulation particularly in cyclic animals. This protocol is not very effective in anovular buffaloes. The concept is that first injection of GnRH (day 0 of treatment) causes ovulation/ luteinization of the largest dominant follicle and starts a new of follicular wave. Prostaglandin injection when given 7 days later, lyse the CL and a second GnRH injection on day 9 facilitate ovulation. Animal is inseminated at fixed time 16 h after second GnRH injection. Owing to not so good conception rate in the protocol, several variations have evolved in the quest for higher conception rate, better ovulation synchronization and scheduling resynchronization program. The protocol variations are- Selectsynch, Hybridsynch, Heatsynch, Cosynch, Ovsynch Plus, Doublesynch, Estradoublesynch, Double Ovsynch, Presynch, Resynch, Resynch 7, CIDR Synch and many more. Since reproduction is govern not only by reproductive hormones, but metabolic hormone and other external cues also influence the overall function of follicular development by very complex and intricate mechanism, additional hormone supplementation did not result in significantly improved conception rate as compared to normal AI or natural breeding.



Ovsynch Protocol

Using GnRH based protocol, it has been found that only those anovular buffalo conceive which develop CL in response to both GnRH injections, separately. If animal dose not responds by CL formation to either first GnRH or second GnRH, it will not result in a pregnancy. An additional injection of PMSG (400 IU), 72 hr prior to Ovsynch protocol has been found to increase the ovulatory response in anovular buffaloes.



Ovsynch Plus Protocol

Treatment choice:

Treatment choice depends on reproductive status of animal, diagnostic facilities, availability of hormones, cost and managemental considerations. The best choice in silent estrus animal is PG injection and insemination at observed oestrus. If animal is not observed in heat within 2-5 days, one more injection of PG 11-14 days later may be injected and insemination should be carried out at observed estrus. Buffaloes those are anovular, progesterone implant for 7-9 days and a small dose of PMSG (400 IU) on the day of implant removal is better choice. In buffaloes where, reproductive status of cyclicity (Silent estrus or anovular) is not confirmed, progesterone implant protocol used in anovular buffaloes along with an injection of prostaglandin on day 7 is best choice. Using prostaglandin injection in silent estrus animals and progesterone implant in anovular buffaloes, the pregnancy rate on induced estrus is similar to what obtained on normal breeding (40-60%). However, if implant is not available then GnRH based protocol like Ovsynch Plus protocol is the second choice that can be used in cyclic as well as anovular buffaloes. While instituting any hormonal treatment it should be the goal of a veterinarian to properly evaluate it for non-pregnancy, only be used in well fed animals and use minimum hormone. Any protocol that a veterinarian feels is working good in their hand must be employed.

Buffalo requires extra care during summer:

Skin of buffalo becomes very hot during summer due to its black color. Greater thickness of skin and presence of only a few sweat glands further reduce faster heat dissipation. The quantity and quality of green fodder is declined during summer and feed intake is also reduced. This results in reduced functioning of reproductive system. Buffaloes that calved at the start of summer season take long time for breeding either due to delayed resumption of ovarian cyclicity or silent breeding. However, buffaloes conceived/ calved during summer season are more profitable as compared to those during favourable breeding season as milk prices during lean period are at peak. As a managemental strategy such buffaloes can be treated with hormones to bred them during summer season. For better productive and reproductive performance, comfortable housing is essential. The shed should be constructed in such a way that it protects the buffalo from direct sun rays and well ventilated. Electric appliances viz ceiling fan, exhaust fan or cooler should be fixed in the shed to improve ventilation and decrease shed temperature. Avoid overcrowding. Buffalo should be kept indoor during day time or under a tree while during night hours it should be allowed to rest in open paddocks. A wallowing tank is very useful as buffalo enjoy wallowing in the pond. Two to three times sprinkling of cold water is very helpful in lowering body temperature. Fresh drinking water should be available to animal in the shed. Feeding times should be arranged in such a way that buffalo consume fodder when environment temperature is low i.e. late evening and early morning.

Set Target:

To attain improved reproductive performance, certain targets have to be fixed and one should try hard to achieve these targets. They are as follows:

Table 2: Improving Reproductive Performance

S.No.	Parameters	Targets
1	Age at First heat	24-30 Months
2	Minimum body weight at first breeding	300-350 kg
3	Age at First Calving	<42 Months
4	Calving Interval	<14 Months
5	Voluntary Waiting Period	45-60 days
6	Calving to Conception Interval (Service period)	<100 Days
7	AI per conception	<2
8	First Service Conception Rate	>50%
9	Minimum Dry Period	60 days
10	Failure to Conceive Culling Rate	<8 %

By taking all these precautions we can improve the reproductive inefficiencies in buffaloes.

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CHAPTER 5

FEEDING MANAGEMENT OF TRANSITIONAL BUFFALOES

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Buffalo husbandry plays a significant role in rural livelihoods and food security in the economic development of the crop-livestock farming system of Asian countries. With more than 97% of world buffalo concentrated in Asian countries, India is the leader of buffalo production with about 57% of global buffalo population and contribution of 97.21 million tonnes of milk (2019-20), which is nearly half of the total milk production of the country. During the last few decades, buffalo contribution over 50 per cent in milk pool elevated India to 1st position in total milk production of the world. For increasing milk production in India, the contribution of buffalo desired to be increased considerably. Achievement of higher milk production from buffalo requires proper nutritional management in each stage of life. Feeding management during transition period is extremely important to achieve not only maximum milk but also reproduction during the subsequent lactation.

Transition period:

It is the most important stage of life during which there is transformation from one state to another. In buffalo, the transition period is often considered to occur from 3 weeks pre-partum to 3 weeks post-partum where buffalo transit from non-lactating state to lactating state. During this period many essential processes undergo within the body of dairy animals preparing for the next lactation. The late dry period should be considered a critical period in which the quality of all inputs will directly impact the productive performances in the next lactation as well as the incidence of disease associated with calving and buffalo health.

Metabolic adaptations during transition period:

Various physiological, metabolic and hormonal changes occur during the transition period for metabolic adaptations required for the growth of the foetus and onset of lactation.

Lowered feed Intake

The most important physiological changes are the reduction in dry matter intake (about 1.7- 2.0% of BW) around parturition and increase in nutrient requirements for the rapidly growing foetus and milk production. However, the reduction in DMI varies with the breed of the animals, quality of ration, stage of lactation, parity, body condition score (BCS) of animals and the environmental temperature. Study indicated that the DMI declines during the last 3 weeks of gestation can be up to 30–35%, especially in subtropical area, where the summer temperatures usually reach 35°C during the day time. Our studies with Murrah buffaloes also demonstrated reduction in DMI, which ultimately recovered after few days of parturition. These changes occurring in the transition buffaloes further modify her metabolism drastically. During the last trimester of pregnancy, the growing foetus occupies larger part of abdominal cavity which reduces the volume of rumen leading to decrease in dry matter intake. So, proper nutritional management during this period regulates both milk productions in the proceeding lactation as well as the reproductive efficiency of the animals. The concentration of plasma insulin continually declines in the transition period until calving, while somatotropin increases rapidly between the end of gestation and the initiation of lactation. Concentration of plasma progesterone, which is high in gestation, rapidly falls at calving. In addition, there is a transitory elevation in estrogens and glucocorticoids in the periparturient period. These hormonal changes further contribute to decrease in dry matter intake.

Reduced body condition score (BCS)

Most of dairy animals at the onset of lactation experience negative energy balance (NEB) due to the reduction in dry matter intake and increased milk production. So, excessive mobilization of body lipid stores take place to support synthesis of milk and milk fat and increased amounts of non- esterified fatty acid (NEFA) are released into the circulation, the level of which increases gradually in the transition prepartum period, resulting reduced BCS, rumen fermentation and milk production. In dairy cows, it is demonstrated that the over conditioned (BCS>4.0) animals, have a much greater reduction in their feed intake immediately pre-calving, compared with cows with a lower BCS. Several benefits to health and reproduction were reported by many researchers, when cows have a lower BCS at drying off and at calving, without any perceptible effect on milk yield. Data on these aspects in buffaloes are limited, inviting research needs.

Greater nutrient requirements

Extraordinary shift in nutrient requirements happen in transition animals. Parturition leads to an increased (2.7, 4.5 and 2.0 times more glucose, fatty acids and amino acids, respectively) demand of nutrient requirements by mammary gland especially for synthesis of milk lactose, fat and protein, which were lesser need at prepartum for foetus. Therefore, there are challenges to the animal to meet these requirements. Immediately after calving, the demand of glucose for lactose synthesis increases to match the rapidly increasing milk production. In Holstein cows, the mammary requirement for energy was reported to increase three times at 4^{th} day of lactation than that of the gravid uterus. The transition dairy animals suffer a negative energy balance (NEB) postpartum due to rapid increase in milk production which reaches its peak at 5-6 weeks, however feed intake continues to lower up to 12-14 weeks. The propionic acid produced in the rumen during the fermentation of dietary carbohydrates is the major precursor of glucose in the liver. In a study with Holstein cows, it was demonstrated that in the last weeks of foetal development, the foetus uses 46% of maternal glucose taken up by the uterus. Glucose demand in Holstein cows has been estimated at 1000–1100 g/day during the last 21 days of gestation, but it increases sharply after calving to approximately 2500 g/day at 21-day postpartum. Therefore, the shortfall of glucose requirement is covered from gluconeogenesis from body fat mobilization, muscle protein, amino acids, lactate and glycerol, subjecting the liver for a great challenge. The muscle protein mobilization increases threefold during the first week after calving compared with prepartum values; fat mobilization is 300 per cent. Other body tissues also adapted to the reduced availability of energy. Glucose is also an important energy source for the ovary, and its reduced availability in the beginning of lactation can negatively impact the reestablishment of ovarian activity after calving, which affects the subsequent production.

National Research Council (2001) indicated that about 900 g metabolizable protein (MP) is required per day during late pregnancy in Holstein cow and heifer. It is reported that about 120 g MP/day is required for an increased synthesis of mammary tissue, resulting in an overall predicted requirement of between 1000 and 1100 g MP/day. Therefore, supplementation of dietary proteins especially rumen undegradable protein (UDP) is required to meet out these requirements. However, feeding of high protein with more degradability (RDP) could be detrimental to animals, decreased milk yields and delays in both follicular development and luteal function in cows. Feeding of excessive RDP results in elevated blood urea nitrogen (BUN) level, and elevated milk urea nitrogen (MUN); affecting the uterine pH in heifers, which has been associated with reduced fertility. The excess ammonia and elevated pH levels in the rumen causes Ca2+ and Mg2+ to form insoluble complexes with phosphorus making them unavailable for absorption encouraging both hypocalcaemia and hypomagnesaemia, which causes parturient paresis immediately after parturition in cows. There is complete lack of information regarding nutrient requirement for mammary development at different stages of pregnancy as well as pregnant buffaloes in general. Existing feeding standards recommend additional allowance 20 and 10% of maintenance requirement, respectively for immature buffaloes in first and second lactation for maternal growth (Paul and Lal, 2010).

Micronutrients viz. minerals and vitamins are essential for mammary gland development, growth of the developing foetus, and support of the antioxidative and immune functions. The mammary requirement for calcium to produce colostrum on the day of parturition is more than double than that for foetal growth in late gestation. The onset of lactation places such a large demand on mechanisms of calcium homeostasis that most cows develop some degree of hypocalcaemia at calving. In some cases, concentrations of plasma calcium become too low to support nerve and muscle function, resulting in parturient paresis or milk fever. Adaptations to increase the blood supply of calcium very soon after calving include increased intestinal active transport, increased resorption of bone stores and decreased urinary excretion of calcium.

Health disorders coupled to transition period

The changes during transition period favour the occurrence of health problems. The main disorders occurring during the transition period are fatty liver, ketosis, sub-acute and acute ruminal acidosis (disorders related to energy metabolism); milk fever, sub-clinical hypocalcaemia, udder oedema (disorders related to mineral metabolism), abomasal displacement, metritis, and poor fertility which leads to major complicating factors for subsequent reproductive performance, resulting additional economic loss. Poor transitions also result in milk income losses through lowered peak yield. Moreover, the diet of most dairy animals' changes sharply at calving from being mainly forage-based to concentrate-rich diets with high level of fermentable carbohydrates, the amount of VFA produced exceeds the capacity of the rumen to absorb them, leading to decreased pH in the rumen environment. This situation leads to the phenomenon known as rumen acidosis and contributes to reduced DMI and feed digestibility in the early postpartum period.

The increased level of NEFA (> 0.3 meq/l) in the circulation due to negative energy balance during the transition period can be oxidized either completely to carbon dioxide to provide energy to the liver or incompletely, resulting in the formation of ketone bodies (>1200 µmol/l , BHBA concentration) causing a metabolic disorder, ketosis. The liver also re-esterifies NEFA into triacylglycerol (TAG). To release TAG from the liver, it is packaged into very low-density lipoproteins (VLDL). Fatty liver develops when the liver uptake of lipids exceeds the oxidation and secretion of lipids by the liver. Excess lipids are stored as TAG in the liver and are associated with decreased metabolic functions of the liver. Raised blood ketones are associated with a 3–8 times increased risk of a displaced abomasum, double the risk of retained placenta, three times risk of metritis and six times increase in the risk of developing cystic ovaries. Subclinical ketosis causes reduction in milk yield, lowered fertility and longer to return to oestrus. The sudden start of milk synthesis in the udder results in a tremendous demand for calcium. As a result, blood calcium concentrations can drop precipitously at calving, leading to milk fever. Smaller decreases in blood calcium, called subclinical hypocalcaemia, are believed to be contributing factors in disorders, such as displaced abomasum and ketosis, by decreasing smooth muscle function, which is critical for normal function of the digestive tract. Hypocalcaemia also leads to increased secretion of cortisol, which is believed to be a factor in increased incidence of retained placenta after parturition.

It is, therefore, pertinent to elaborate nutritional strategies to facilitate the passage of the buffalo through this transition phase; while minimizing health problems and optimizing productivity/ profitability for the remainder of the ensuing lactation.

Feeding management during transition period:

Suitable feeding strategies are to be taken up to minimise the stress of transition period and to improve production and reproduction performance of the animals.

Improvement of voluntary intake

Maintenance of feed intake in transition buffaloes, especially just after parturition is very important to minimise chance of health disorders and improvement in lactation performance. The feed additives viz. yeast extracts and flavouring agents could be used to improve feed intake in ruminants. Recently, phytogenic substances such as essential oils, herbs, spices etc are being used to improve intake and milk production in cattle and buffaloes. Feeding of composite feed additive to lactating Murrah buffalo during 30 days of lactation was reported to improve feed intake.

Dietary energy-protein management

Energy and protein are required for the maintenance, growth, development, and reproduction and production performance of animals. It is demonstrated that high fibre diet during the dry period decreases the size of the rumen papillae, which are responsible for the absorption of end products of digestion in the rumen. On the introduction of high-energy diet after calving, the size of rumen papillae increases, resulting in higher and faster absorption of nutrients. But, if a diet rich in soluble carbohydrates and low in fibre is offered few days prior to calving, the desired papillae size can be achieved immediately after calving. The diet of such cows must provide the required 10 MJ ME/kg DMI with 16% CP. Paul and Lal (2010) reported daily requirement of ME (Mcal) of 29.76 and CP (g) of 1460 for buffalo having 500 kg BW with 10 litre (7% fat) of milk production. However, care should be taken to check excessive intake of high-energy diet in dry period, especially during last 3 weeks of gestation, to avoid peri parturient complications. Higher plane of nutrition during transition period was reported to improve body weight, parturition and expulsion of placenta with heavier birth weight of calf. Occurrence of 1^{st} post-partum oestrous and conception were also reported better in crossbred cows fed higher plane of nutrition.

Increasing energy density of diet by introduction of grains in the diet of transition cows and heifers at least 3-5 weeks prior to calving may stimulate rumen papillae growth and increase VFA absorption from the rumen, adapt the microbial population to higher starch diets and increase feed intake. It was demonstrated that when energy density of the diet increased from 1.3 to 1.54 Mcal NE_L/kg DM and CP increased from 13 to 16% at about 3 weeks prior to calving, feed intake was increased by 30%. It is reported that increasing the energy and protein density up to 1.6 Mcal of NE_L/kg and 16% CP in diets during the last month before parturition improves nutrient balance of cattle prepartum and decreases hepatic triglyceride content at parturition. Generally, the roughage to concentrate ratio recommended for high yielder is 50:50. But as the DMI is the major constraint, the alternative is either to increase the energy density (by feeding additional grains or adding oil seeds or protected fat) or by reducing roughage to concentrate (R: C) ratio. Formulation of any ration with density beyond 13 MJ ME/kg DM is quite impossible. The total starch contents in the diet of high yielder should be between 20–25%. Molasses is an easily fermentable source of energy and included to increase the palatability as well as level of soluble sugars in the diet. The energy density of a ration can also be increased by dietary supplementation of oils and improve milk yield, fat per cent as well as birth weight of Murrah buffalo. But, addition of oils beyond 4% of total diet may adversely affect the feed intake and fibre digestion.

Generally, buffaloes should be fed to support 750-900g average daily weight gain during last 2 month of pregnancy and about 700g average daily weight gain during the last 3 months of pregnancy. In pregnancy of adult buffaloes, CP requirement increases by 3, 8.4, 16, 26, 43 and 64% of maintenance requirement on 5^{th}, 6^{th}, 7^{th}, 8^{th}, 9^{th} and 10^{th} month of pregnancy, respectively. The corresponding increases in TDN requirements are 4.3, 7.2, 18.8, 22.2, 39.0 and 67.4 % of maintenance requirement, respectively. Pregnant dry buffaloes (at > 5 month of pregnancy) should be fed with 30 kg green fodder and 2 kg concentrate mixture (20% CP & 70% TDN) and ad libitum wheat straw. With decrease in availability of green fodder 1 kg concentrate mixture should be additionally fed to replace every 10 kg green fodder. This ration will meet protein requirement for entire pregnancy and energy requirement up to 9.5 month of pregnancy but will fall short of energy requirement on the last 2 weeks of pregnancy when additionally, 1-1.5 kg grain has to be fed. For pregnant immature buffaloes, in additional 1 kg grain or 5.5 kg cereal fodder or 7.5 kg legume fodder should be fed to support 300-350 g average daily maternal growth. Similarly, buffaloes in their 2^{nd} pregnancy should be fed additional 0.5 kg grain or 2.7 kg cereal fodder or 3.7 kg legume fodder to support 120-200 g average daily maternal growth. Feeding of buffaloes with good quality fodder and concentrate mixture during last three weeks of pregnancy helps in priming the rumen for increased concentrate feeding in early lactation and build up body reserve for lactation.

Dietary protein content and quality in terms of rumen degradability and amino acid composition is very important to meet the requirement of transition buffaloes. After parturition, along with energy high quality protein are required for high yielding buffalo for increasing milk production. Dietary protein should contain both degradable protein (RDP) for providing sufficient ammonia for production of microbial protein in rumen as well as undegradable protein (UDP) for utilization of quality amino acids (AA) in abomasum and lower digestive tract. Natural protein supplement with high UDP content viz. corn gluten meal, cotton seed cake, coconut meal can be supplemented. Supplementation of condensed tannins (CT) through leaves of Artocarpus heterophyllus, Ficus infectoria, Ficus bengalensis and Ficus glomerata at 1.5- 2.0% levels was observed to reduce the rumen degradability of groundnut cake to 60-75% from the normal value of 92%, demonstrating improvement of its utilization at lower digestive tract. Efficient utilization of protein supplements would not only improve the productivity and reproduction of the animal but may also help in reducing the global warming by decreasing the enteric methane production especially from animals fed low quality roughages. The efficiency of rumen fermentation depends upon the amount of microbial biomass synthesized, which in turn depends on the synchronization of protein and carbohydrate breakdown.

Bypass fat supplementation

In India and other developing countries, the high-yielding buffaloes and crossbred cows remain in negative energy balance during late gestation and early lactation due to energy deficiency. Under field conditions crossbred cows and buffaloes often lose 80–100 kg BW after calving. Ovarian cycle ceases when buffalo loose 15-24% of BW. Such animals do not come in heat, unless the loss of BW is at least partially recovered. Fat plays an important role in the performance of lactating animals. Usually the extra energy required by the high yielding dairy buffaloes cannot be fulfilled by conventional ration. So, to increase the energy density of the ration, fats can be added. As fats get degraded in the rumen, which may adversely affect the rumen microbes and feed intake it should be given in rumen protected form. The level of total dietary fat in ration should not exceed 6-7% of diet. Mixture of cereal grain and forages usually contain about 3 % fat, so up to 3 or 4 % of dietary DM can come from supplemented fat. It has been reported that the bypass fat could be incorporated up to 13% in the diet with continual increase in milk production in dairy Holstein cows. In buffaloes, about 100-150 g bypass fat per day could be supplemented to increase milk production performances. Several studies have indicated that dietary supplementation of bypass fat in crossbred cows and Murrah buffaloes during the transition phase/early lactation improved the milk yield and fat content.

In a study with multiparous crossbred cows from −40 days through +90 days of parturition to assess the effect of supplementing bypass fat at 2.5% of DMI reported an increase in birth weights of the calves, while time taken for expulsion of foetal membranes, involution of uterus, onset of cyclicity, the service period and number of inseminations per conception were reduced in supplemented group. Increase in milk fat and yield was also reported in buffalo while supplementation of 15g bypass fat per kg milk yield, however, there was no effect on cyclicity and pregnancy rate.

Rumen-protected amino acids supplementation

Methionine (Met) and Lysine (Lys) are considered to be the two most limiting amino acids for milk production. Dietary supplementation of Met and Lys (1:3) can therefore be an effective approach to improve amino acid balance for milk production. Methionine also has an important role in the formation of very low-density lipoproteins which are necessary for the export of stored fat in the liver and helps in preventing fatty liver. Met and Lys easily gets degraded in rumen. A source of ruminally-protected methionine (RPM) and lysine (RPL) are available commercially. Incorporation of 10g methionine and 30g lysine in the ration has positive effects on milk production and milk composition of lactating buffaloes.

Choline, a component of phospholipid and methyl donor, plays an essential role in very low-density lipoprotein synthesis and thereby contributes to fat export from the liver. Choline is also required for biosynthesis and secretion of milk. Fat metabolism can be improved with the help of choline for better energy production. This also helps in improving milk production. As dietary choline gets degraded rapidly in the rumen, it must be supplemented in rumen protected (RPC) form. Supplementation of 54g of rumen protected choline 40 days before and 120 days after calving increased milk yield and milk composition in dairy cows. The combined effect of supplementing ration with RPM, RPL and RPC on the performance of preparturient crossbred cows revealed improved BCS on the day of parturition, duodenal supply of Met and Lys, plasma TG, VLDL and phosphatidyl choline levels on the day of parturition in cows. Recent study at CIRB, Hisar on transition Murrah buffaloes, where the animals were fed basal diet (G1) with either 7g RPM + 15g RPL (G2), 50 g RPC (G3) or 7g RPM + 15g RPL+50 g RPC (G4) for a period from -3 months to + 3 months post partum and demonstrated that although feed intake and BCS remained comparable among the buffaloes, however, milk fat per cent and 6% FCM yield were increased in all supplemented animals.

Vitamins supplementation

Niacin is a common feed additive in transition diets for its role in the prevention of ketosis through reduced body fat mobilization. Dietary 14g/d niacin supplementation was reported to increase milk production in early lactation of dairy cows. However, a meta-analysis of 27 feeding studies involving niacin supplementation to dairy rations showed no improvement in lactation performance when niacin was given at 6–12 g/day. Supplementation of niacin at high doses to the transition dairy cows has given inconsistent results.

Biotin has a proven ability to stimulate glucose synthesis in the liver, which is the main energy source for milk production. The feeding of high concentrate diet during early lactation reduces rumen pH, which in turn decrease the biotin synthesis, leading to laminitis, which adversely affects milk production. The biotin supplementation demonstrated reduced claw lesions and improved milk production and reproductive performance.

Buffers supplementation

Buffers combat acid production in the rumen and help to reduce digestive upsets or to maintain milk fat percentage when high grain diets are given to the lactating dairy animals to meet out energy deficiency. A mixture of sodium bicarbonate and magnesium oxide (3:1) gives a better response than either fed alone. Buffers should be fed at the rate of 0.6 to 0.8 %

of DMI or 1.2 to 1.6 % of concentrate mixture. Sodium or potassium buffers should not be fed during dry periods, because it elevates dietary cation-anion balance (DCAD) which predisposes the dairy buffaloes to milk fever.

Feeding of rumen modifiers

Rumen modifiers act directly on rumen microbes, altering the balance between the different microbial populations and the proportions of the volatile fatty acids (VFAs) they produce. As such, they play a part in adapting the rumen. Ionophore rumen modifiers include sodium monensin and lasalocid. Antibiotic rumen modifiers include virginiamycin and tylosin. The effects of sodium monensin are primarily increased ruminal propionate balance, reflecting an increase in propionate producing bacteria compared to those producing formate, acetate, lactate and butyrate. The increase in both milk yield and milk production efficiency with decreased risk of ketosis, displaced abomasum, retained placenta and metritis was reported on supplementation of monensin to transition cows. Recently, various plant secondary metabolites are used to modify rumen environment to increase propionate production and reducing methanogenesis in the rumen. Dey et al. (2021) reported an increase in milk production with sustained feed intake when early lactating buffalo were fed a phytogenic composite feed additive at 30 days post-partum.

Minerals supplementation and Dietary Cation-Anion Difference (DCAD)

Buffalo milk is rich in calcium, phosphorus, potassium and magnesium. Most of the B-complex vitamins are present in milk. A marginal deficiency of the vitamins and minerals may not have significant impact on milk quantity and quality. However, calcium is one of the crucial elements in the ration to be considered more carefully in transition buffaloes. At the beginning of lactation, the sudden demand of calcium for milk production increases dramatically, leading to fall in blood calcium levels and the condition is called hypocalcaemia. This stimulates the secretion of parathyroid hormone (PTH), which stimulates the bone resorption. It takes 2–3 days for the PTH cycle to become fully functional. It also activates vitamin D3, which increases absorption of Ca from intestine and mobilized bone Ca. But this process requires 24–48 h and cannot prevent animals from milk fever/parturient paresis as more than 60% of cases of milk fever occur within 24 h of parturition. To avoid incidences of milk fever, the best feeding management practice is to provide low Ca (<50 g/day) diet during last 2–3 weeks of gestation, which should be increased to about 100 g/d at least two days before parturition. The diet, after parturition, should have enough Mg, an essential activator of vitamin D3 in liver.

Paul and Lal (2010) reported a requirement of Ca and P by 0.53% and 0.34%, respectively in the total dry matter intake in buffaloes. Buffalo milk contains about 1.8-2.0 g Ca and 1.1-1.2 g P per kg milk. For per kg milk production daily requirement of Ca is at around 5.2-5.8 g and of P is 2.1-2.3 g. Good quality mineral mixture should be supplemented (50- 60 g / d) to buffaloes for proper foetal growth and milk production.

DCAD refers to the numerical difference between the sum of certain dietary cations (positively charged minerals) and certain dietary anions. Primarily, the cations to consider are sodium (Na) and potassium (K) while the anions are chloride (Cl) and sulphur (S). Reducing DCAD in the prepartum transition period dramatically reduces the risk for milk fever and subclinical hypocalcaemia by improving calcium dynamics for the buffaloes. A diet having

330 mEq/kg DM DCAD has promoted feed consumption, water intake and resulted in greater milk yield and milk fat in early lactating buffaloes and occurrence of hypocalcaemia was reduced by feeding diet containing -110 DCAD level, for last four to six weeks before parturition. Recent study at CIRB, Hisar reported that feeding of 90g anion salt (-749 mEq) from -21 days up to calving and 125g cation salt (Sodi bicarb., +1473 mEq) up to 21 days post-calving improved milk yield and fat per cent in Murrah buffaloes with concomitant improvement in reproductive health of animals. Provision of adequate quantity and quality nutrients as required by buffaloes during the transition period generates positive effects on health, milk production and reproductive performance.

Conclusion:

Feeding management of transitional buffaloes play a central role in improving reproduction and production performances not only in the current lactation but also in the ensuing lactation. Reduced dry matter intake during transition period is the main factor for depressed performance of buffaloes. Quality feeding throughout the life especially during transition period should be advocated to fulfil nutrient requirements for sustaining production and reproduction performance of buffaloes.

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CHAPTER 6

BUFFALO PRODUCTION SYSTEMS AND ECONOMICS OF BUFFALO REARING

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Livestock sector is an integral part of mixed farming systems that characterize Indian agriculture and it plays a significant role in the rural economy. Contribution of livestock sector is evident from the facts that during 2018-19 it contributed 26 percent to the total agricultural GDP of the country and continuously improving over the time (Anon, 2019). In value terms, milk is the number one agricultural commodity contributes ₹5607.70 billion to the national GDP which is higher than the combined value of output of two major agricultural crops i.e., rice and wheat (₹3740.18 billion) together. With annual milk production 198.4 million tons in 2019-20, India is World's largest milk producer and contributing 21 percent of world milk production. Out of the total milk production in India, 49 percent comes from buffaloes. Buffalo is also known as the *'Black gold'* of India used as a major source of draft power, milk, meat, skin and hides etc. Indigenous buffaloes are three times heavier than cattle and produce two times more milk than cattle. The distribution of buffalo is conspicuous in the areas where animal husbandry is poorly developed and badly organized. However, the great adaptability of this species in areas where hardly enough subsistence to survive for stubble fields or marshy lands with sludge, reeds water weeds and grasses, mostly refused by cattle, the buffalo is capable of maintaining itself in good condition. The buffalo not only maintains itself but can also work and supply milk with poor diets. The farmers maintain buffaloes not for ignorance but they find that in the prevailing agricultural situation no other domestic animal will thrive like buffalo and will be so useful and economical.

Current status of Buffalo Population and production in India:

Bovine population in India is approx. 302 million. (Cattle-192 million, buffalo-110 million). At national level population of total milch animals has increased by 36 percent while the total cattle population has declined by 4 per cent over the same period. There is decline in indigenous cows by 40 million (2019). Since 1987, buffalo population in the country has increased by 45 percent in spite of the fact that government policies are more favorable and tilted towards crossbreeding. During the period 1950-51 to 2019-20, milk production in the country has increased more than 11-fold i.e. from 17 million tons to 198.4 million tons. World's largest dairy development program the 'Operation Flood' played significant role not only in making self-sufficient in terms of milk production but also pushed it to number one position at global level. It was launched and implemented in different phases and each phase of operation flood was focused towards different aspects of dairying in India.

A kaleidoscopic view of different dairy development programs and their implications on milk production is presented in Fig. 1.

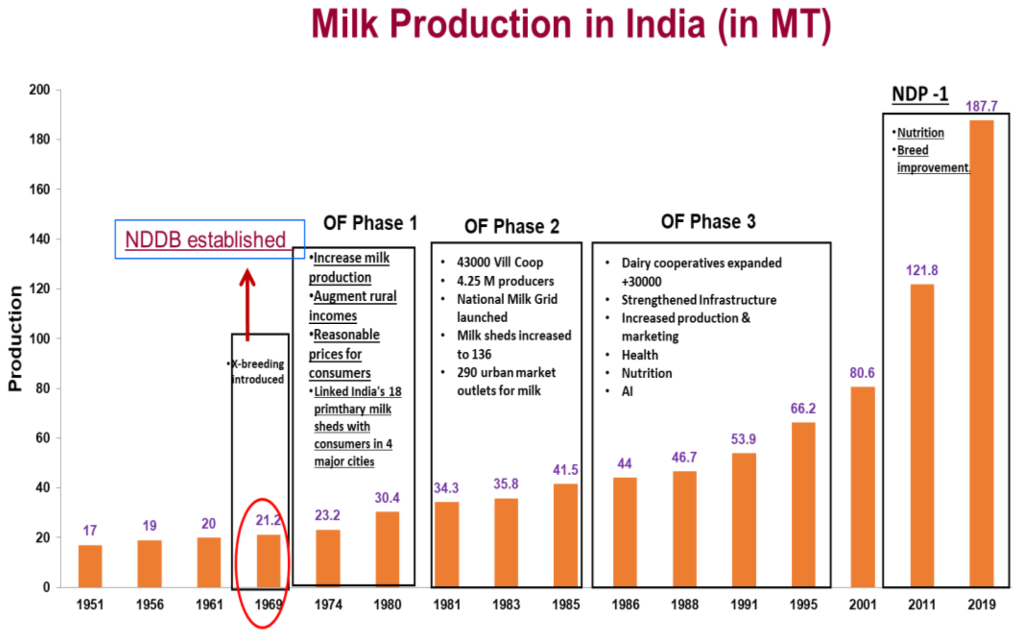

Fig. 1: Growth story of Milk production, 1951 to 2019 (Source: Various Issues of BAHS)

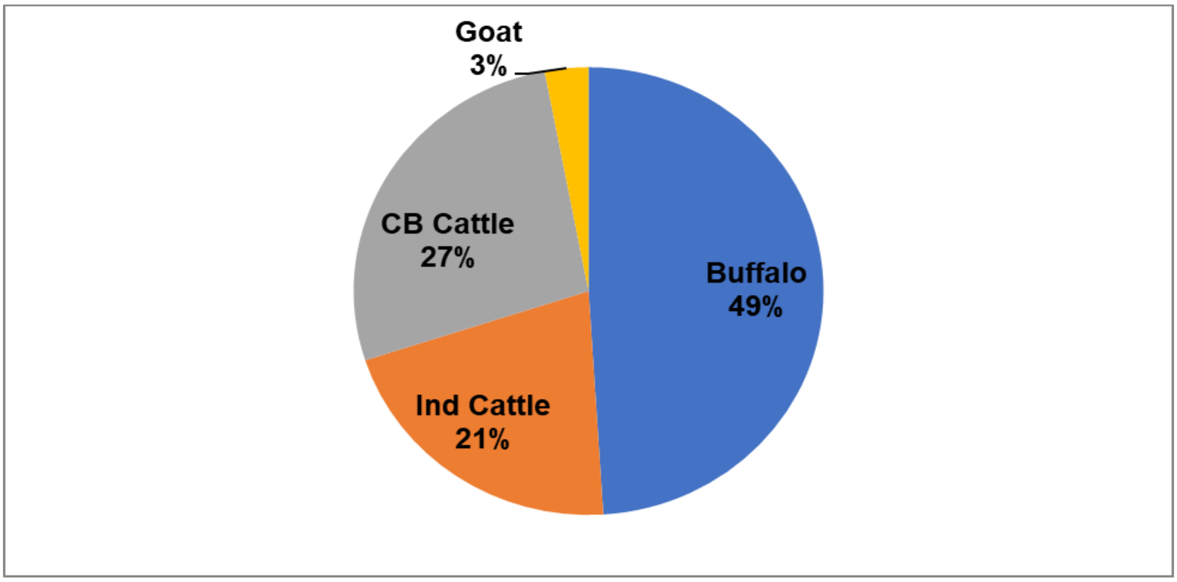

Fig. 2: Species wise milk production in India (2019) (Source: BAHS, 2019)

Though India is number one in milk production but in terms of per animal milk productivity it is ranked at 93rd position which is way behind not only to the developed countries but also to many developing countries. At national level average milk yield of buffalo in India is 5.62kg/day while, with 9.11 kg/day Haryana stands at number one position among states closely which is followed by Punjab (8.44 kg/day). Punjab and Haryana are basically the breeder states for buffaloes and having different production systems as compare to rest of the country. A glimpse of species wise milk production in India is presented in Fig. (2).

Dairy Production System: A case study of Punjab:

Livestock has remained the integral part of mixed farming systems in Punjab and plays a significant role in the rural economy. Integrating crops with livestock on the same farm help farmers to diversify the sources of their income and also contribute in augmenting the employment generation. Crop and livestock complement each other through mutual benefits. While crop residues and by-products are used as feed for livestock, in return dung and urines from livestock contributes as fertilizer for crop production. Cattle and buffalo are available across all regions / districts in the State and account for around 93% of state's total livestock population. These are mainly raised for milk production under semi-intensive/ intensive system. Although, dairying has been integral part of the farming system since ages, the structure of dairy production has changed from semi-intensive to intensive production system over the years. With the change of breeding policy, crossbreeding received higher focus and over the years augmented the crossbred population in the state. However, buffalo was and still continue to be the dominant player of dairy production system in the state. The prevailing dairy farm structure in Punjab has been discussed in Table 1. Large part of the milk production, around 70%, comes from small and medium dairy farms with herd size of 2-10 animals, another 25% from large/commercial herds and the rest from domestic (1%) and peri-urban dairies (4%), which are concentrated around big cities.

Table 1: Dairy Farm structure in Punjab

Type of Dairy Farm Structure	Characteristics	Estimated Number of Bovines in each farm structure (In Lakhs)	Estimated milk production in each farm structure (MT)
Landless/Domestic farmers	These farmers have low yielding crossbred cattle (average size is 1 to 2) and these animals mostly sold by large farmers to small/medium and ultimately, they remain with landless farmers.	3.26	0.13
Small and Medium Rural Dairy Farms	Farm is of mixed type (Both buffalo and cows on farm). They mainly have less than 10 dairy animals and have low to medium yielding animals. Mostly, they grow their own green fodder.	44.11	8.81
Large/Commercial Dairy Farms	Commercial dairy farms are typically one-species enterprises (crossbred cattle). Commercial buffalo farms are very rare. These farms varying in size from 10 to 500 high-yielding breeds of cows. Indigenous breed commercial farms also do exist in system.	15.0	3.15

Peri Urban Dairy Farms	Peri urban dairy farms are located on the periphery of a city/ big town (between approximately 5 and 10 km away from town). They mainly have 20- 100 animals and are mainly held by large landholders. They are in mixed farming (60 per cent crossbred and 30 per cent buffaloes) and they don't keep animal beyond third lactation.	2.50	0.50

Source: GADVASU study (2009 to2015).

Buffalo Population and Production Trends in Punjab:

The total bovine population of Punjab is 65.47 lakhs; out of this, the percent share of buffalo population is 61.33 percent i.e. 40.15 lakhs. Out of the total buffalo population, the female buffalo population is 38.38 lakhs (95.60 percent) and male population is 1.77 lakhs (4.40 percent). Buffalo population of Punjab has decreased tremendously from 60.08 lakhs to 40.15 lakhs during the time period of 1992 - 2019. As compared to previous census of 2012, a negative growth rate of - 3.16 percent in total buffalo population was recorded in latest census data of 2019. Punjab is one of the leading milk producing state; with 13.34 million tons of annual milk production it contributes 6.7 percent to the national milk pool. Change in buffalo milk production in Punjab over the period 1980-81 to 2019-20 is presented in Fig. 3. It is evident from the Fig. 3 that between 1970-71 and 2019-20 the buffalo milk production in the state has grown tremendously from 2.55 million tons to 9.43 million tons. Buffalo contributes 70.53 % of the total milk production in the state. Though in terms of buffalo productivity with 9.7 kg/day Punjab is just behind Haryana however, it is way above to the National average of 5.62 kg/day. This speaks about the quality of our buffalos' breeds, which can find use in National breed improvement programs. In breed improvement programs for evaluation and selection of Murrah and Nili- Ravi buffaloes, priority should be given to increase yield levels to 11kg (2800-3000kg/lactation) in buffaloes**.**

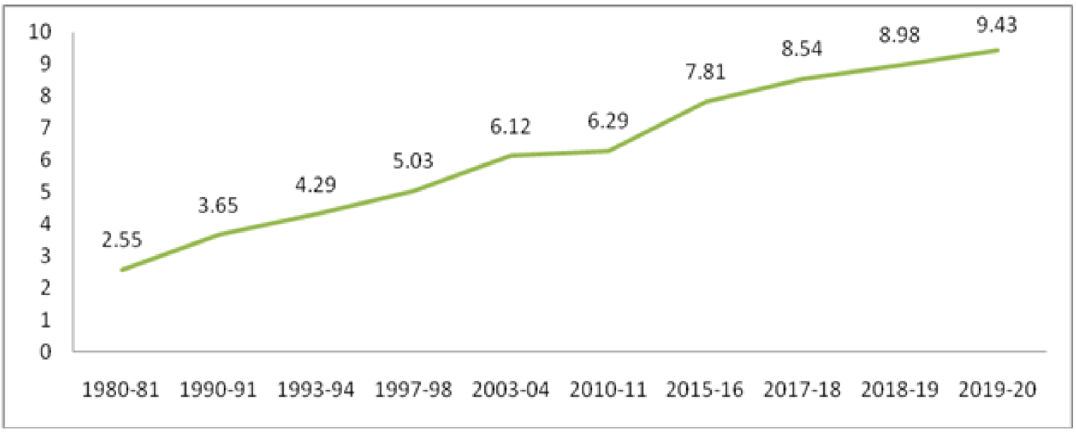

Fig. 3: Growth in Buffalo Milk Production from 1980-81 to 2019-20 (In MT)

Buffaloes therefore continue to maintain their share in milk production in spite of large increase in number of crossbreds. Buffalo milk has higher fat content (7.4%) and total solids (15.5%) than milk from crossbred cows (Table 2). 4000 kg of milk from crossbreds with 4% fat is equivalent to 2500 kg of buffalo milk with 7% fat. An obvious question arises that why to waste more energy to produce water and sugar in milk from cross bred. Further, buffalo has higher longevity, better ability to use coarse roughages and less demanding on health expenditure as compared to crossbreds. State therefore should reconsider its breeding policy and support buffaloes as primary dairy animal not only because of inherent superiority over crossbred but also because of its use as a meat animal at the end of productive life. Buffalo milk should preferably be used for preparing value added products such as ghee, mozzarella cheese, khoa, paneer, dried milk powder etc. for improved economics.

Table 2: Buffalo vs. Cow (CB)

Attributes	Buffalo	CB Cow
Milk		
Milk Fat (%)	7.4	4.1
Casein (%)	3.5	2.6
Lactose (%)	4.5	4.4
Total solids (%)	15.5	12.5
Price /kg (In Rs.)	60.8	40.7
A1 and A2 B casein	A2	A1 and A2
Animal		
Number of Calves Born	4-5	2.3-2.8
entative Expenditure on health (Rs. /year)	700	2000
alue at end of Life (Rs)	20,000	-

Table 3: Suggested model of Product mix for the Processing of 100 kg Cow & Buffalo milk

Particulars	Quantity (in Kg)	Total amount (In ₹) Cow milk	Total amount (In ₹) Buffalo milk
ilk Supply to Dairy Cooperatives	100	2600	3700
Product Mix for Milk Processing			
Liquid milk	50	1750	2250
Flavoured milk	10	750	750
Paneer	30	1069.50	1680
Dahi	5	750	750
Lassi	5	600	600
Ghee	0.60	-	240
Total return/ day		4919.50	6270
Net Return/ day		**4669.50**	**6020**
et return (extra) over supplying liquid milk to cooperative		2069.50	2320

Net return (extra) over sale of entire quantity as liquid milk by self-marketing	1169.50	1520

Assumptions: Cow milk: 3.5% fat and 8.3% SNF @₹26/kg Buffalo milk: 6.0% fat and 9.0% SNF @₹37/kg.

Economics of Dairy Production System in Punjab:

For better understanding and appreciation of dairy production system, it is especially important to study its economics. Profitability of dairy farming depends upon the milk yield, price of milk and cost of milk production. Findings of the study on economics of milk production in Punjab conducted by GADVASU during 2009 - 2015 indicates that milk yield levels lower than 11 kg in crossbreds and 8 kg in buffaloes were not profitable under intensive production system. Crossbreds with 7-9 kg milk in small (five animals) and domestic (two animals) category only recovered cost for family labour. Average cost of production per litre of milk was Rs 22.3 for crossbreds and Rs 29.7 for buffaloes. Small dairy units with less than seven animals were not economical. Feed and labour costs was around 80 % of the input cost of milk production and these have substantially gone up over the years. It is important to mention that 70% of domestic and small farmers own 45% of crossbreds and buffaloes and that it would be difficult for them to continue with dairy farming with the rising feed costs. These domestic and small dairy farmers presently are an integral part of small holder agriculture production system and are continuing because of no alternative options for them.

Table 4: Economics of Milk production, 2015-16

Particulars	**Domestic (2)**	**Small (5)**	**Medium (12)**	**Large (22)**	**Overall**
CATTLE					
Milk yield (Litre)	7.20	9.00	11.94	15.36	10.48
Cost of milk production, Rs/litre/day/farm	25.60	23.80	21.60	19.91	22.32
Dairy Enterprise Profit, (Rs/litre)	-3.12	-1.48	2.92	4.92	1.02
Dairy Enterprise Profit, (Rs/litre) (Excluding labour)	0.47	1.12	4.10	6.10	3.88
BUFFALO					
Milk yield (Litre)	5.95	7.73	8.62	9.66	7.71
Cost of milk production, Rs/litre/day/farm	35.01	33.22	29.91	27.91	29.72
Dairy Enterprise Profit, (Rs/litre)	-4.37	-2.12	3.98	5.99	2.65
Dairy Enterprise Profit,	-0.02	1.32	5.52	7.32	4.62

(Rs/litre) (Excluding labour)					

Unfortunately, no analysis of how these domestic and small dairy farmers are surviving has ever been made. While in agriculture production system, there are well laid schemes to work out the cost of production that decide the procurement price, hardly any scheme is in operation to work out the cost of milk production in the State or at national level.

Buffalo Production System and Reproduction Efficiency:

The other major concerns influencing economics of dairy farming identified were age at first calving and inter calving period. For the buffaloes, the age at first calving was observed to be 3.8 years with lactation milk production recorded as 2158 litres. Inter calving period was observed to be 471 days out of which 284 were wet days and 187 dry days. There is a need and scope to reduce age at first caving in buffaloes. Inter calving period for buffaloes in field was close to values in best organized dairy farms managed by professionals.

Future of Buffalo Production system:

Buffalo is the future diary animal of India. There is no problem of stray animals in the case of buffaloes as it's slaughtering/ culling is allowed in India. The unproductive and old aged animals are sold for slaughtering providing good source of income to the dairy farmers. About 37.78 million farmers rear buffaloes in India mainly for milk purpose. The male calves are not commonly reared exclusively for meat purpose. But, if reared, these male buffalo calves can be a remunerative independent enterprise. A farmer can purchase 2-3 months old male calves from other farmers in the area and start the business of male calf rearing. The enhanced buffalo meat production in this way can be exported to earn the foreign exchange. Buffalo Broiler Mission in collaboration with private meat plants to promote fattening of buffalo calves for meat production can change the prospectus of buffalo farmers. Milk of each species has their own specialty and functionality which can be used for better return. Buffalo milk is having their own uniqueness and strength of containing higher fat, protein and minerals. Moreover, it also accounts for almost two third of total milk production in the state therefore, it can be used for such products where its compositional strength can be encashed.

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CHAPTER 7

ICT ENABLED TOOL: A NEW DIMENSION OF SMART HERD MANAGEMENT

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The livestock production system has a multi-faceted role in promoting livelihoods, alleviating poverty, building nutritional security & health and improving crop husbandry. The demand for animal-based food and animal products is rapidly growing more notably in developing countries due to rising incomes and urbanization. However, meeting such an upward demand, there is need of socially, economically and technically feasible system for sustainable and environment friendly smart livestock production system. Smart livestock farming envisages the harnessing of Information and Communication Technologies (ICT) as a decision support tool for more efficient, productive and profitable.

Smart livestock farming proposes to address challenges of traditional practices in management of herd such as detection of diseases, oestrus cycle, calving, optimize feed requirements, monitoring milk yield, health and vaccination etc. Main challenge is to get the right information at the right time to the right partners such as nutritionists, veterinarians and breeders to take accurate and in time action to keep animals productive. Keeping of records of all animals' performance is a necessary element of good livestock management. The challenge on the smart dairy farm is to have an efficient way for collection of data and analysis of the data to generate knowledge, and disseminate the knowledge with visual effects and in organized fashion for quickly understand health, production, reproduction and nutritional status of animals.

Digitalization of animal performance and environment data by manual or automated sensors such as cameras, microphones, sensors, accelerometers, gas analyzers, RFD, GPS and spectrometers is prime and most preliminary activity of smart herd management. Further, database design and development, and the database can be placed in centralized storage and which can be accessed by all stakeholders. The database coupled with advanced analytical techniques and tools is became ICT enabled system, This would be efficient aid to monitor and improve their performance and optimize required resources such as feed, water, land, and human labor and real-time decision making at individual animal. Assist to focus on profitable performance and share information with your customers regarding sale and purchase. ICT enabled smart livestock farming system can alert the animal caretakers in real-time to deliver individualized care to an animal showing altered behavior as a result of disease, stress, heat, calving, feed intake and milk yield.

Present Status:

In India, increase in number of large, well-organized dairy farms which cater to predominantly urban markets in terms of clean milk production and animal-based food products. Larger, intensive dairy farms not only profit from the economies of scale by way of optimum utilization of land, labour and resources, but also benefit and promote for implementation of easier, cost-effective and efficient technologies.

In India, almost all organized farms in the government and private sector depend on the traditional method of record keeping viz. registers. While the reliability of this system cannot be denied, the traditional data recording system has many limitations which greatly restrict their application on large dairy farms, especially in today's world where efficiency of production is the most important goal of professional livestock manager.

Though many commercial livestock management software packages like Cattle Manager, Cattle Works, Cattle Max, DeLaval ALPRO, eRanch, Livestock Management System, Stockeeper'03 are available in developed countries, they are very expensive. Further, they do not provide technical support in India, use terminologies which may be difficult to comprehend, cannot be modified as per the local requirements, and are not available in regional languages. Most herd management software run on the ubiquitous Relational Database Management System - Microsoft Access which bears other expenses also like hardware and software.

The smart ICT enabled herd management is required a scheme to digitalization, analyze, and present the results to the farmer to make sensible herd management decisions. This will also help improve the existing techniques used to monitor the livestock, production, and utilization of forage crops and pasture.

SIReDAM:

SIReDAM is a dedicated Management Information System (MIS) for bovines developed by ICAR-Central Institute Research on Cattle, Meerut and ICAR-Indian Agricultural Statistics Research Institute, New Delhi. Database has been developed and implemented in MySQL as back-end RDBMS and PHP used as server side scripting language for database connectivity and server side processes. Front-end tools and mobile apps developed using HTML and JAVA for data entry, analysis and visualization. The web-based system is implemented in Linux based apache and MySQL server at National–ICAR ICT facility, ICAR-IASRI, New Delhi server to store data.

It is established to record overall data of individual and herd wise daily activities covering the phenotypic information and animal performance such as animal basic details, growth, breeding, calving, milking, feeding, semen collection, semen analysis, vaccinations, health and etc.

Four levels users profile management module has been integrated in the system to manage hierarchy of users with different privileges. Well established data flow from entry to validation, acceptance, rejection, modification and view among the users is integrated. Advisories and forewarning messaging modules are included with email. Incorporated analysis tools using R Software.

This software is well equipped with standard detailed reports and user-defined generic reports with graphical and tabular presentation of information. Standard registry provision has been made to maintain registry by herd, center and institute wise. Dashboard and daily advices facilities has been given with summarized information and message inbox.

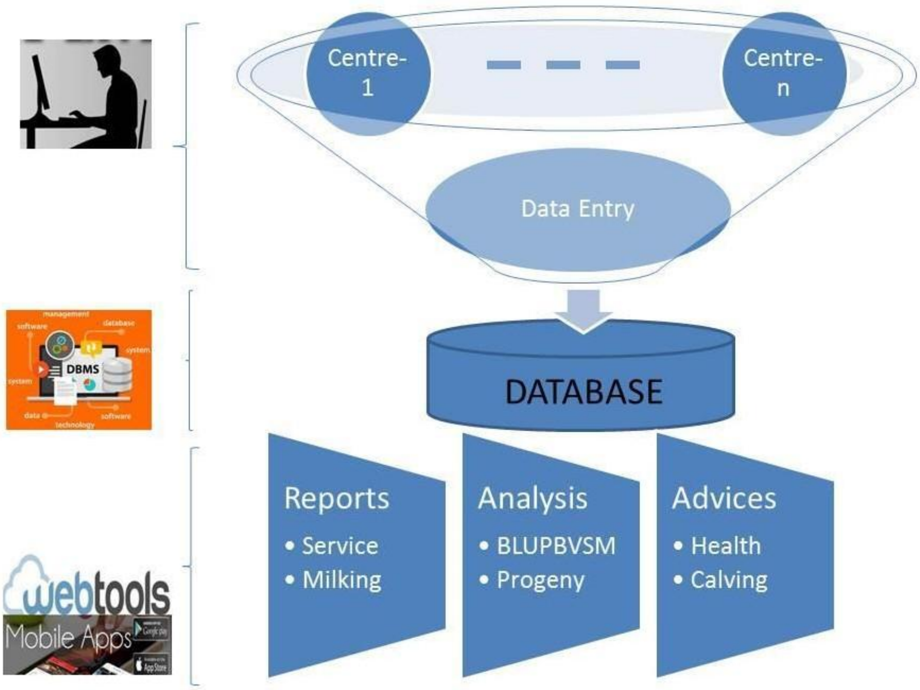

Fig 1: SIReDAM Herd Management Software Modules

Basic Information:

This is primary step of the smart herd management system and is the process of registration of animals' basic information, Basic information of each animal need to enter by registering animal in the system. Based on this further information growth, service, calving, feeding and milking etc. can be entered into the system.

Growth Record:

This is records daily wise growth records such as weights, heights, girth and maturity. For easy data entry by filling the data with previous day data, so user easy he can modify date and data before submit. Suppose data of particular day (today) is already enter then same data will appear in text box, the data can be modified and resubmitted any time and any number of times. This data would be useful for performance measurement of average daily gain and weaning management. This data can be used for animal specific ration formulation also.

Reproduction: Service activities, Confirmation and Calving:

This is encompassing of three activities such as service/artificial insemination, confirmation of pregnancies and calving. Data entry regarding service , After service, need do pregnancy diagnosis to confirm. Then finally calving details have be entered with details of calf(s) in register form. This module assists to maintain breeding activities such as current breeding status, estrous detection, review pregnancy checks, projected calving dates. Also provides statistics regrading average calving intervals, average post-partum intervals, lactation period, conception rate and birth rate. This help to generate pedigree chart and farmer to make appropriate breeding choices when to breed calves for the first time and when cows should be bred again to maintain milk production.

Milking Recording Module:

This is daily milk recording module and has provision to enter other milk parameters such SNP, fat percentage and protein along with milk yield. This is very important to track the milk yield, SNP, fat, protein and lactation period for individual animal or for group, stage, breed, unit, season, period wise. This data can be used for least cost ration formulation based on production.

Feeding:

This module has collection of daily feeding data of all animals. Here all classes of feeds/fodders such as dry, greens, concentrates, grazing time and mineral have been provided. This module assists herd managers to have feeding plan and easy to track the cost of feed and the quantity of feed consumed by each animal. This module helps to monitor growth, feed intake, feed conversion and performance of animal by scientific feeding based on nutrients available in feed ingredients and nutrient required by the animals. Helps in analyzing feeding cost and benefits from animal product and leads to formulate economic feeding strategies to minimize resources and maximize productions.

Health:

This module collects records related to health issues of animal such as symptoms, diagnosis, treatments, date, medication, dosage, administered by and etc. Monitoring of the health of each animal in the herd is crucial and helps avoid losses due to health-related issues. However, as the herd grows it becomes increasingly difficult to effectively monitor of health of each animal. It is clear that, up to date and accurate information is required about each animal of the herd in order to ensure early detection of health problems and monitoring animal health properly. Also interface with weather tracking systems that alerts users of approaching severe weather conditions and disease forewarning. There are a lot of common diseases that can be detected earlier by noting changes in animal behavior by using advanced technology such as wearable devices to collect animal behaviors, temperature, feed intake, and laboratory device to estimate parameters of blood, mild, urine and dung samples.

Vaccination:

Vaccination is less expensive to prevent disease than treatment. Monitor the condition of individual animals in terms of their health, well-being, and performance is quite often a difficult task when working with large groups of animals and with limited time, in this case mass vaccination and vaccine advisory system make easy to keep herd well-being. In this module support to enter data into the system regarding vaccination, established to make bulk animals or individual animal vaccination

Semen collection, evaluation and distribution:

Semen collection and artificial insemination is powerful tool employed for livestock improvement and considerable reduction in both genital and non-genital diseases in animals. Hence, track semen inventories is a primary key in livestock management categories like breeding, calving, milk yield and health and also this is base for conservation, proliferation and development of germplasm.

This module assists to management of semen bank activities such as production of semen from well managed and genetically superior bulls, semen evaluation processing, storage and distribution for subsequent utilization in the field. This module will aid to attain quality frozen semen production so as to ensure better fertility and conception rate, and faster genetic progress. The module attains to increase efficiency of bull usage and potential for genetic selection and decrease costs and disease transmission. This encases with three submodules such as i) Collection of semen with basic information and test parameters like collection date, freezing date, Ejaculation, volume, color, consistency, pH, mass activity, concentration, motility, expected breeding value, ii) Semen post thaw quality parameters namely post thaw motility, incubation, HOST, acrosome integrity, microbial load ii) Distribution of semen with complete inventory including wastage of semen straw.

Financial and Accounting:

Information on costs and profit of the herd is very rare in herd management software, here finance and accounting module has been introduced in the system to record all financial transactions related to herd. Easy trace out and compare economics and farm performance between among animals, various herd units, breeds, and various category of animals. Economic analysis between performance of production and reproduction.

This is integrated with business intelligence engines for calculating animal's herd values according to factors like breed, pedigree, location, age, and market conditions and profit based on feed intake and milk yield. Employed optimization technique to minimize feeding cost using least cost ration included grazing hours to individual animal optimal nutritional intake-based production and reproduction potential. This module will provide wide financial management operations over all income and expenses of complete herd including feed, instrument, and medicine purchase. User can generate various types of standard and customized reports and balance sheets.

Registers:

Maintain and keeping registers is elementary process of record keeping in organized livestock farm. This is an easiest way for summarized reports about herd dynamics and quick view of present status, and a key component for efficient management of livestock farm. A livestock summary can be used to summarize stock numbers and account for all increases due to births and purchases, and all decreases due to sales, deaths and transfer. These registers are reflects based on users' level. Unit level user can access these registers at unit level only, if user is herd level then the user can view these registers at complete herd level. Similarly, project head or project principal investigator can view all animals comes under him/project.

- Livestock register: This register has records of the number of the animals with details
- Birth register: This register maintains the records of birth with details regarding date of calving, calf number, sex of the calf, sire number, dam number, birth weight etc.
- Service register: Details of breeding practices such as cow number, dam number, date of services along, date of successful service, service done by pregnancy diagnosis records, confirmation done by, expected date of calving, actual date of calving, calf number etc.
- Growth register: Day wise records on weight, height, girth, length of the young stocks.
- Disposal register: Details about disposal of animal regarding death, sale, transfer, culling, donate with date and remarks
- Treatment register: Record of the illness of animals along with symptoms, diagnosed disease, treatment given and name of the veterinarian.

- Calving register: Maintains the records of calving with dam and sire number of the calf, calf number, sex and date of birth and type of calving.
- Milking register: Maintain records of the daily milk yield of the animals.
- Feeding register: Details about the amount of concentrate, dry fodder, green fodder and other feeds given to the animals daily.
- Vaccination register: Vaccination details of animal includes vaccination date, vaccination, doses details.
- Mortality register: Maintain mortality with animal id, date, mode of death, book value and actual value.
- Semen collection register: Keeps semen collection details such as bull id, date maturity, date of first freezing, and date of ejaculation along with complete test parameters of semen.
- Semen distribution register: Record about distribution of semen to users, which includes date of distribution, semen id with bull id and collection details, and number of doses, from center, to center etc.
- Group register: This register will used to keep animals record on category or stages base.

Reports:

The standard record keeping registers are not enough for quick view of herd dynamics and these are permanent record keeping process. Reports can be generated based on the user need on operation and performance of animals. Finally, dynamic and need based reports are most valuable while decision making such as animal/breed selection, performance of individual animal or group or herd wise profitability, performance measures is becoming more and more important. In view of analysis of animal performance and decision making, here some standard reports and generic report provision has been made. Standard report is given based on user requirement which are frequently used. Generic report is a single module, using this user can generate his own variety of reports by selecting columns from list and minimize row view by defining condition on fields. Using this module, user can create numerous varieties of reports. These reports represent data in tabular and graphical forms. This report module has uniform privileges to all users, they can define their own query to get report of animal's details stored in the system.

Analysis:

Primary objective of herd management software is to collect, classification, tabulation and presentation of the data for quick decision making. In addition to this, the system can be strengthened by providing analytical tools, which would be helpful for scientific inference to stakeholders are involved in research and development on animal production and reproduction. The genetic worth of sire cannot be measured directly, but it can be estimated on the basis of phenotypic performance or observed value of a trait in the sire itself or its relatives in case of sex-limited characters such as milk yield. These genetic properties of traits are the prerequisite in breeding. The methods, Least Square Method and Best Linear Unbiased Prediction are generally used for sire evaluation on a single trait milk yield of daughter. Hence, here analysis module has been provided for easy and quick analysis of data available in the system. This module encompasses of four tools such as 1) Descriptive statistics 2) Least Square Analysis 3) BLUP breeding value of Sire and 4) Least cost ratio.

Advises:

SIReDAM software helps livestock stakeholders on various aspects in strategic, tactical and operational planning and optimization of resources. This tool puts all of livestock performance and operations under unified control system. Livestock farm deals with multiple risks estrus cycle, low milk yield, diseases, calving, vaccination schedule, artificial insemination, pregnancy status and etc. These are easy manageable if you know in advance and avoid finance loss by take appropriate action at early stage. These issues can be traceable and immediately visible and further can be represented to stakeholders in real-time for necessary action to prevent losses and damages. In this, seven advisory services have been provided on advance and real-time context. 1) Disease outbreak, 2) Feeding, 3) Vaccination, 4) Estrus cycle, 5) Calving, 6) Milking and 7) Feed In-take

Advantages and Features of Smart Herd Management:

Ease of entering data: The manager needs to enter all information into one console instead of searching for the relevant page in many registers.

Error-checking: The system is more prone to human error in the form of erroneous figures/dates. SIReDAM software can be programmed to warn the operator regarding entry of erroneous data.

Easy to use: All modules are easily accessible by any internet enabled device and user friendly Graphical User Interface (GUI) interface, which can be operated by any person with knowledge of computer and internet browsing.

Data security: User need to log in with a username and password before he can start accessing data, data entry and data securely stored in centralized database server. Further, various levels of access like data entry operator, herd manager, unit head and administrator. These different levels of users can be created with different privileges for each.

Generates information automatically: Provision for automatically generates information based on the data fed in the system and no need of any analysis such as lactation milk yield, peak yield, and average yield, calculate tentative date for heat, calving, vaccination, lactation period, estrus.

Visual indicators: All types of visual indicators like graphs, pie charts etc are incorporated. which assist comprehending the trends behind the numbers and aid to proper decision making.

Efficiency indicators: Automatically generate productive, reproductive and economic efficiency indicators like persistency of milk yield, milk yield/day of lactation, milk yield/day of calving interval, milk yield/day of body weight at calving, number of lactations, lifetime milk yield, growth studies etc. A new feed additive experiment can be conducted on the diet of one group of cows and their milking performance compared instantly with control group.

Reminders: Herd activates like vaccination, deworming, insemination, pregnancy diagnosis, calving, milk yield test, which will assist in carrying out non-routine operations in a timely manner and enable to prioritize and organize his activities for the day.

Generates reports: Pre-Defined reports, generate daily, monthly or annual reports, or reports for a specific time-period as standard reports. Provision has been made used defined reports can be generated as per the user’s requirements.

Scalability: This is developed under centralized big storage capacity and can be used for small dairy farm to very large dairy farm with number herd and unit in hierarchy.

Easy backup of data: All data in digital form and can be securely backed up time to time. Implemented simple backup facility.

Data transmission and export: Data/information can be transferred/exported instantly to excel or CSV form or other database format.

Integration with newer technologies: This system has database, analysis and presentation tools, which are basic and essential requirements for smart herd management software. Further, it can be strengthened by introducing newer technologies like Radio Frequency Identification Devices (RFID), advanced machine milking, IOT based analysis/testing devices in order to improve farm efficiency.

Further improvement with wearable device, AI, IoT, WoT, FT:

Adoption and adaption of Geographic Information Systems (GIS), GPS, Real time location systems (RTLS)**,** RFID and RFT to smart herd management to view and planning herd movements. In advancement of this module, wearable neck belt can be developed and incorporated with various sensors to collect animal phenotypic data, calculate intake of food quantity and rumination, temperature, blood pressure and heart rate of animals. The device can be integrated with herd management software with wireless data logger to transfer data to the system. This would be helpful for monitoring the animal's rumination behavior is leads to detect abnormality and ketosis in advance before a serious problem develops. Prior to developing the disease, cows spend less time eating and may show other behavioral symptoms, including changes in gait/walk. These other physical activities changes may be recorded using the wearable device. This type of device can enhance other automation solutions and cattle management. Information from various sensors can be used to automatically and instance solution according to their individual needs.

Integrating and tagging lab test results to the herd management system, which automatically analyzed and represented to users measures in real-time context. For example, level of progesterone in milk for reproductive status, indicates heat and the right insemination time, animals for final pregnancy confirmation, indicates early abortion and diageneses the animal with risk for cysts and prolonged anestrus, lactate dehydrogenase (LDH) in milk. The enzyme LDH is highly correlated to somatic cell counts and is closely linked to the presence of mastitis further an infection can be detected several days advance. Machine learning and artificial intelligence techniques would be used on image annotation, video annotation, Visual data annotation for sickness detection and health monitoring, can label images of animals in a variety of states of health to accurately assess the condition of any animal and early warning of sickness.

Internet of Things (IoTs) points to the promise of a framework through which diverse data from sensor networks, can be captured and managed. Similarly, a Web of Things (WoTs) approach has been demonstrated in an experimental smart farming. Future Internet (FI) is seen as a mechanism through which a diverse series of systems and services can be seamlessly integrated with any domain.

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CHAPTER 8

FSSAI RULES WITH SPECIAL REFERENCE TO MARKETING OF MILK AND MILK PRODUCTS

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Food Safety and Standards Authority of India (FSSAI) was established under the Food Safety and Standards (FSS) Act, 2006 (Act No. 34 of 2006) primarily to lay down science-based standards for articles of food and to regulate their manufacture, storage, distribution, sale, and import to ensure the availability of safe and wholesome food. It ensures the food products undergo quality checks thereby curtailing the food adulteration and sale of sub-standard products. Section 16 of the FSS Act of 2006 outlines its specific mandate. The Act was operationalized with the notification of Food Safety and Standards Rules (FSSR), 2011 w.e.f. 5th August, 2011. After the enactment of the Act and Rules, FSSAI had made Regulations under FSSR, 2011 for the implementation of the Rules. These Regulations have been broadly categorized into (I) Food Safety and Standards Regulations, 2011 and (II) Food Safety and Standards Authority of India Business Transaction Regulations, 2010. Former category is related to regulation of foods while later is for the regulation of the working of FSSAI. These Regulations are as follows:

I. Food Safety and Standards Regulations, 2011:

1. Food Safety and Standards (Licensing and Registration of Food Businesses) Regulation, 2011
2. Food Safety and Standards (Food Products Standards and Food Additives) Regulation, 2011
3. Food Safety and Standards (Prohibition and Restriction of Sales) Regulation, 2011
4. Food Safety and Standards (Packaging and Labelling) Regulation, 2011
5. Food Safety and Standards (Contaminants, Toxins and Residues) Regulation, 2011
6. Food Safety and Standards (Laboratory and Sampling Analysis) Regulation, 2011
7. Food Safety and Standards (Health Supplements, Nutraceuticals, Food for Special Dietary Use, Food for Special Medical Purpose, Functional Food and Novel Food) Regulations, 2016
8. Food Safety and Standards (Food Recall Procedure) Regulation, 2017
9. Food Safety and Standards (Import) Regulation, 2017
10. Food Safety and Standards (Approval for Non-Specific Food and Food Ingredients) Regulation, 2017
11. Food Safety and Standards (Organic Food) Regulation, 2017
12. Food Safety and Standards (Alcoholic Beverages) Regulation, 2018
13. Food Safety and Standards (Fortification of Food) Regulation, 2018
14. Food Safety and Standards (Food Safety Auditing) Regulation, 2018
15. Food Safety and Standards (Recognition and Notification of Laboratories) Regulation, 2018

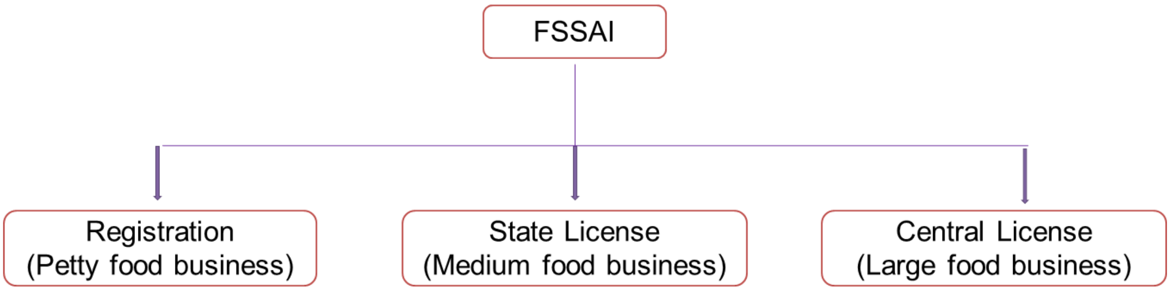
16. Food Safety and Standards (Advertising and Claims) Regulation, 2018
17. Food Safety and Standards (Packaging) Regulation, 2018
18. Food Safety and Standards (Recovery and Distribution of Surplus food) Regulation, 2019
19. Food Safety and Standards (Safe food and balanced diets for children in school) Regulations, 2020
20. Food Safety and Standards (Foods for Infant Nutrition) Regulations, 2020
21. Food Safety and Standards (Labelling and Display) Regulations, 2020

II. Food Safety and Standards Authority of India Business Transaction Regulations, 2010

22. Food Safety and Standards Authority of India (Transaction of Business at its Meetings) Regulations, 2010
23. Food Safety and Standards Authority of India (Procedure for Transaction of Business of the Central Advisory Committee) Regulations, 2010
24. Food Safety and Standards Authority of India (Salary, Allowances and Other Conditions of Service of Officers and Employees) Regulations, 2013
25. Food Safety and Standards Authority of India (Transaction of Business and Procedure for the Scientific Committee and Scientific Panel) Regulations, 2016
26. Food Safety and Standards Authority of India (Recruitment and Appointment) Regulations, 2018

Registration and Licensing of Food Business:

As per Food Safety and Standards (Licensing and Registration of Food Businesses) Regulation, 20111 every food business operator in India that manufactures, processes, stores, distributes, or sells food goods must get an FSSAI Registration or License. FSSAI Registration differs from FSSAI License and food business operator (FBO) must get the appropriate registration or license in line with the FSSR requirements. Applicant establishments may be eligible for a registration, central license, or state license, depending on their installed capacity, turnover, or location.



Obtaining a FSSAI license or registration can provide the food business legal benefits, build goodwill, ensure food safety, create consumer awareness, and assist in business expansion and it also helps regulate, manufacture, storage, distribution and sale of import food.

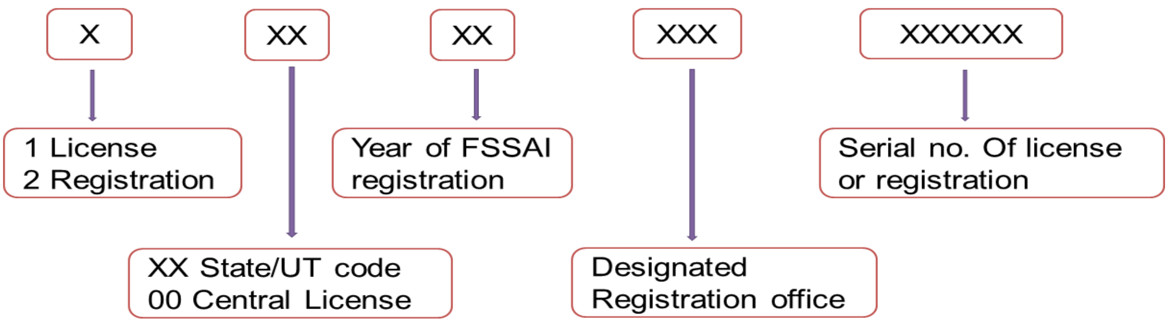
The “Petty Food Manufacturer” is get registration under FSSAI. Any food manufacturer whose production capacity of food (other than milk and milk products and meat and meat products) does not exceed 100 kg/liter per day procurement or handling and collection of milk up to 500 litres per day is referred to as a "petty food manufacturer." In terms of turnover any FBO having a turnover of less than 12 lakhs per annum must go for basic FSSAI registration.

Registration procedure: Every small food business operator must register with the Food Safety and Standards Authority of India (FSSAI) by submitting an application in Form A under Schedule 2 of the FSSAI Regulations. The Department has 7 days from the date of receipt of an application to accept or reject the application, and the denial must be communicated to the applicant in writing. If the application is approved, the department will provide a registration certificate with the registration number, which the FBO must prominently display at the location of operation.

Apart from small-scale businesses, all other FBOs require an FSSAI license. FSSAI licenses are divided into two categories: state FSSAI licenses and central FSSAI licenses, depending on the size of the firm (medium or large scale). The FBO must have a turnover of between Rs 12 lakh and Rs 20 crore in order to apply for a State License. Other requirements include manufacturing units with a capacity of 2MT per day and dairy units with a daily volume of up to 5000 litres. 3-star hotels, repackers, relabeling units, clubs, caterers, and any other catering businesses, regardless of turnover, must apply for a state license.

A FBO must have a turnover of more than Rs. 20 crores and operates in two or more states to apply for a central license. Dairy units including milk chilling units equipped to handle or process more than 50,000 litres of liquid milk/day or 2500 MT of milk solid per annum, all food processing units including relabellers and repackers having installed capacity more than 2 MT/day except grains, cereals and pulses milling units, 100 % Export oriented Units, all Importers importing food items including food ingredients and additives for commercial use, food catering services in establishments and units under Central government Agencies like Railways, Air and airport, Seaport, Defense, etc. All food manufacturers who utilise ingredients that have never been used safely before or are being introduced to the country for the first time must obtain central license.

The license will be valid for a maximum of 5 years and a minimum of 1 year. A 14-digit number is written on all food products as a licence or registration number. The format of registration/license number is as mentioned below:



Benefits of an FSSAI Registration/License:

Having an FSSAI registration/license comes with many additional benefits, in addition to the ability to freely make and distribute food.

1. **Legal advantages:** A food business operator's registration or license needs them to pass through a number of checkpoints. Obtaining an FSSAI license before starting a business can provide you significant legal advantage as it verifies that a company is eligible and qualified.
2. **Quality Assurance:** Registration or licensing by FSSAI gives an opportunity to use FSSAI logo associated with business brand name and can help in spreading trust and quality assurance among the target crowd.
3. **Business expansion:** Before investing, many collaborating companies and other brands check for an FSSAI license. Having an FSSAI license will help you promote your brand and attract prospects to build your business and enhance your turnover profit. In order to use most meal delivery apps, the restaurant must have an FSSAI license.
4. **Raising awareness**: FBO's FSSAI license permits it to help raise public awareness about kitchen safety and hygiene.

Non-Compliance of FSS Act by Registered or Licensed Food Business Operator:

The FSSAI requires anyone who is registered or licensed to obey the rules and regulations set forth in the FSS Act of 2006. The food safety officer inspects the food business operator's facilities on a regular basis and determines the level of compliance. The food safety officer assigns a grade based on the level of compliance:

1. Compliance (C)
2. Non-compliance (NC)
3. Partial compliance (PC)
4. Not applicable/Not observed (NA)

Wherever required by Section 32 of the FSS Act, 2006, the food safety officer may issue an improvement notice based on partial compliance. If the business owner does to comply with the improvement notice, the FSSAI may suspend or revoke his license. The punishment for non-compliance is defined in the FSS Act of 2006 and is as follows:

SNo.	**Particulars**	**Fine**
1.	Food quality not in compliance with act	5 Lakh For Petty manufacturer should not be more than 25,000/-
2.	Sub-standard food	5 Lakh
3.	Misbranded Food	3 Lakh
4.	Misleading advertisement or false description	10 Lakh
5.	Extraneous matter in food	1 Lakh
6.	Failure to comply with Food safety officer direction	2 Lakh
7.	Unhygienic processing or manufacture	1 Lakh

8.	Possessing adulterant	Adulterant not injurious to health: 2 Lakhs Adulterant injurious to health: 10 Lakhs
9.	Punishment for unsafe food	No injury 1 Lakh with 6-month jail Non-grievous injury: 3 Lakhs with 1 year jail Grievous injury: 5 Lakhs with 6 years jail

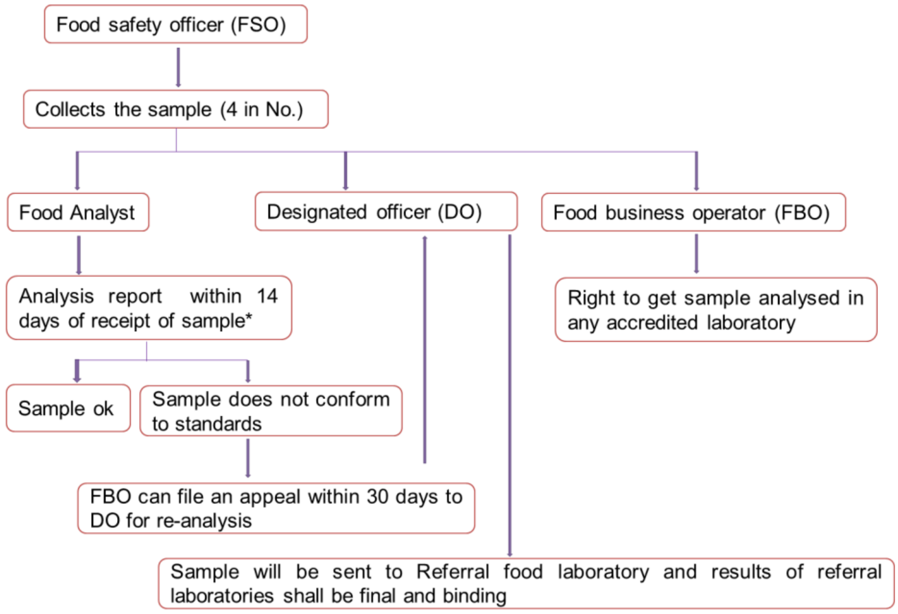
Prohibition and restriction of sale under FSSAI:

As per Food Safety and Standards (Prohibition and Restriction of Sales) Regulation, 2011; sale of certain admixtures is prohibited under FSSAI where no person shall either by himself or by any servant or agent sell:

1. Milk which contains any added water.
2. Ghee which contains any added matter not exclusively derived from milk fat.
3. Skimmed milk (fat abstracted) as milk.
4. A mixture of two or more edible oils as an edible oil.
5. Vanaspati to which ghee or any other substance has been added.
6. Turmeric containing any foreign substance.
7. Mixture of coffee and any other substance except chicory.
8. Dahi or curd not prepared from boiled, pasteurised or sterilized milk.
9. Milk or a milk product specified in food safety and standards (food products standards and food additives) regulations, 2011 containing a substance not found in milk, except as provided in the regulations.
10. Any multi source edible vegetable oil containing mustard oil manufactured on or after 8th June, 2021.

Interaction of Food Business Operator with Food Safety Officer (FSO):

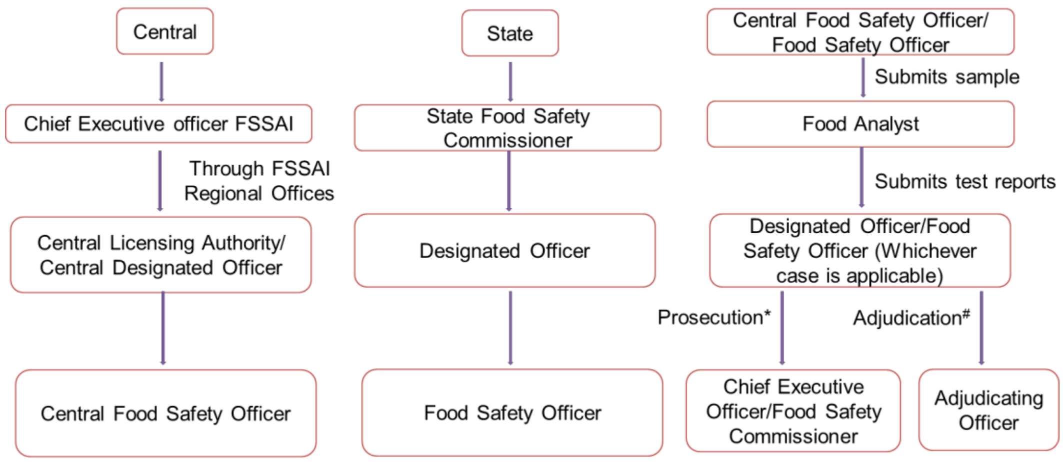
Under the FSS Act, the FSO has a very delicate and vital duty. The FSO) is the face of food regulation and the FSSAI, and he or she communicates with food business operators (FBOs) on a regular basis. As a result, it is critical that the FSO embodies and personifies the FSS Act's intent, and serves as a counsellor and guide to the FBOs in our country. More importantly, the FSO's functions and responsibilities will ensure that India produces and consumes safe food. Because the FSO has the most direct contact with FBOs and the food industry as a whole, he may help raise knowledge of the Act and encourage compliance. Keeping this in mind, inspections should be oriented on encouraging and supporting compliance rather than simply looking for non-compliance, resulting in more sustainable food safety in India. Rather of being stern enforcers, FSOs should act as helpers.



*In case can not be analyzed , shall inform designated officer with reasons and specify the time required for analysis

Enforcement of FSS Act:

The Act is enforced by the State/UT Commissioner of Food Safety (CFS) and Designated Officer, Food Safety Officer, Food Analyst, and Panchayat Raj/Municipal bodies in each state. The enforcement structural and functional framework is presented below:



*in case of unsafe
in case of misbranded/substandard or both

The main puprose of FSSAI Act, Rules and Regulations is to provide safe food to consumers in a regulatory environment. With the changing time, FSSAI is also doing ammendments in its ACT, Rules and Regulations. Food Buisness Operators should keep themseleves updated to avoild any legal hassle lateron.

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CHAPTER 9

TECHNOLOGIES FOR BUFFALO MEAT VALUE ADDITION

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In Indian economy, livestock sector is a vital component of the agriculture. The livestock rearing is considered as a vital component in India, next only to crop raising. In addition to providing milk and manure, they serve as a major source of animal protein for the millions of people (in domestic and international markets) and animal by-products, which if handled properly can earn sizeable foreign exchange in addition to meat. Hence, it forms an important livelihood activity for most of the farmers, supporting agriculture in the form of critical inputs, contributing to the health and nutrition of the household, supplementing incomes, offering employment opportunities, and finally being a dependable "bank on hooves" in times of need. It acts as a supplementary and complementary enterprise. India is bestowed with a huge and diverse livestock wealth unique in the world. It ranks first in cattle, buffalo and goat population, 2nd and 5th in sheep and chicken population, respectively. In spite of that there is a limited development in meat processing and processed meat development enterprises. It is a source of livelihood over 3 hundred million of rural population and also an enormous potentiality for drought power with enough production of organic materials for the use of agricultural production. As far as livestock resource of India is concerned, the Buffalo is considered as triple purpose bovine animal for its outstanding contribution in milk, meat and draught sectors and is also popularly termed as "Black Diamond".

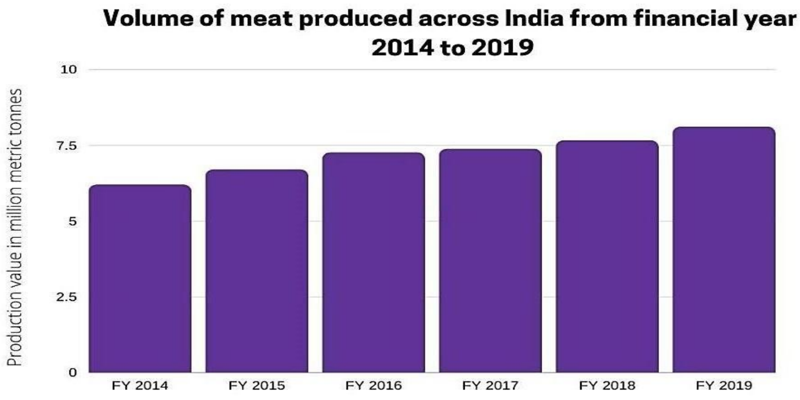
Buffaloes are mostly found in Asian countries like India, Pakistan, China, Vietnam etc. and hence called as the 'Asian Animals'. Buffaloes have originated from their wild counterparts Arni. There are two types of buffaloes (*Bubalus bubalis*) viz. riverine buffalo and swamp buffalo. They can produce protein rich quality lean meat due to their unique utilization and converting capability of course feeds, green grasses, paddy straws and other agricultural crop residues. Buffalo meat (known as 'buffen', 'carabeef' or 'beef' in world/ US trade) is the top agri-export from now which has overcome the export value of Basmati rice and is an important foreign exchange earner, hence also called the 'black gold' of India. Among red meats, carabeef is considered as healthiest meat probably due to low in calories and cholesterol content. The dark buffalo meat possesses superior processing characteristics due to its chemical composition, structural components and excellent functional properties (water and fat binding properties) and is preferred in different processed product manufacture (Kandeepan et al., 2009, Minh et al., 2019). Currently most of the buffalo meat is exported in chilled and frozen form and rest is sold as 'hot meat' immediately after slaughter in domestic market. A little buffalo meat is undergoing processing into various meat products. Several studies to understand the technologies used internationally for preparing value added products from buffalo meat should be done to fetch more profit (FICCI, 2014). Moreover, meat consumption habits are changing worldwide and buffalo meat has all the properties to be converted into value added meat products like other meats. Furthermore, development of value-added processed meat products is considered a solution for the utilization of buffalo meat available from old and unproductive animals and lower value cuts. Therefore, buffalo meat has a lot of scope for value addition and is a potential subject for the meat technologists in the coming years.

Meat Production sector:

Meat sector development is directly and indirectly associated with dairy sector by way of culled animal utilization and productivity improvement, leather sector by providing quality hide and skins as well as poultry sector with quality animal protein, energy and mineral supplies through meat cum bone meal and tallow. Sustainability of buffalo production is also dependent on meat sector prospects by way of improved utility and demand at higher prices for the surplus and culled animals. Meat consumers are conscious about the nutritional value of meat and its products for maintaining and improving the human health and well-being. The meat processing industry is driven by increasing consumers demand for high quality and healthier meat and both convenient and enriched meat products with fiber and reduced level of fat, sodium and nitrite content as well as with fresh appearance and natural flavor. Importance of buffalo meat and processing techniques of its products such as patties, sausages, nuggets and rolls, designer products, enrobed and restructured products, shelf stable and heritage meat products and their packaging have been presented. Strategies are also suggested for development of Indian processed meat sector. According to data available, meat production in India is estimated at 6.3 million tons annually and **is ranked 5th in the world in terms of production volume.**

India though have largest livestock population (515 million) in the world, is merely producing little more than 3% of the total meat production in the world. Indian meat production and meat industry achieved a healthy and positive growth rate. It is mainly known for generating reasonable returns for the farmers or producers. In India, beef and pork serve as valuable nutrition-filled consumables and are available at relatively lower prices. The per capita meat consumption in India every year is around 5.2kg. Chicken and fish have the highest consumption rate. The consumption of poultry meat in India was over 3.9 million metric tons in 2020. India is the second largest producer of buffalo meat in the world. The poultry meat segment is the largest sub-sector in the country's meat industry and owned almost 50% of the total meat production in 2012-13.

It is followed by beef/buffalo meat, goat meat, pork meat, sheep meat, and lamb meat. The country has exported 10,85,619.93 MT of buffalo meat products to the world for the worth of Rs. 23,460.38 Crores/ 3,171.19 USD Millions during the year of 2020-21 (Source-APEDA statistics).



Source: https://startuptalky.com/meat-industry-india/

Unique features of buffalo meat:

- The buffaloes are reared and managed on vast succulent green pastures and on various crop residues from field (Indian buffalo meat is nearly organic in nature).
- Less common practices regarding random use of chemicals such as hormones, growth promoters, antibiotics etc to improve growth and fattening of buffaloes.
- During processing of buffalo carcasses major external fats are separated, removed and sold in domestic markets; hence buffalo meat is practically lean meat.
- The buffalo meat is not processed with radiation and hence is completely from any unwanted materials produced due to radiations.
- The buffaloes are slaughtered and processed as per the Islamic rules and formalities, hence buffalo meat is purely Halal
- The buffalo meat specially frozen one has competitive price in international markets.
- The acceptability of processed meat products from buffalo meat among the buyers and consumers of more than 64 countries is exceptionally well specially in global market.
- Buffalo meat has low calorie and cholesterol content.
- Buffalo meat is ideal for processing as it blends with other meats easily.
- White fat of buffalo meat is carotene rich.
- There are no restrictions on buffalo slaughter by the government.
- Similar taste of he/she buffalo meat.
- No religious biasness for buffalo meat like that of pork.
- Rearing male buffalo calves and salvaging for veal production in profitable.
- Indian buffalo meat is safe and has good image in global markets due to free from BSE (Mad cow diseases), Rinder Pest (RP) and Contagious Bovine Pleuro-pneumonia (CBPP) (OIE Article 8.5.23, 2008 edition of Terrestrial Animal Health Code).

Buffalo meat quality:

Though the main purpose of buffalo rearing in India is for the milk. Whereas meat from buffalo is considered as adjunct; often the male calves and unproductive males and females are used for meat production (Bardhan et al. 2019). The different quality characteristics such as chemical composition, physico-chemical properties affect the meat quality of buffalo meat and influence the processing aspects and acceptability of final products (Stasio and

Brugiapaglia, 2021). Buffalo meat is well comparable to beef in many of the physicochemical, nutritional, functional properties and palatability attributes (Anjaneyulu et al. 1994, 2007). As the demand for lean red meat has been increasing consistently worldwide, buffalo meat is expected to get consumer preference due to its leanness and lower cost. Male buffalo calves rearing for meat/ veal production fetch better income to farmers due to higher demand for tender meat. Buffalo meat especially in global market has attained increasing popularity among consumers because of healthy image (Kandeepan et al., 2013). The carcass composition varies greatly with the body confirmation and dressing percentage of buffalo carcasses. Normally, percentage of meat, bone and fat also varies with dressing percentage, for example when buffalo carcasses having dressing percentage about 44-45% are mainly composed of meat (65-70%) fat (5-10%) and 20-24% bone, whereas theses percentage of meat, fat and bone (66.8% meat, 9.7% fat and 23.5% bone) varies greatly in case of dressing percentage of buffalo broiler (Bhat and Lakshmanan, 1998). The buffalo carcasses are found to have round ribs, a good proportion of lean and a lower proportion of bone and fat than beef (Kandeepan et al., 2009). Buffalo meat quality plays a great role in its value addition and has a huge economic potential in future.

Value Addition of Livestock Products and its importance:

Value addition is an important avenue for efficient utilization of livestock resources with increased demand and higher returns. There is an increasing trend in higher demand of animal protein such as meat, eggs and milk especially in developed and developing countries which is a positive sign for our Indian livestock sectors where more trade opportunities are there. Moreover, value addition not only essential for efficient utilization of tough meat or spent animal meat, increases the convenience to the consumers but also increases the employment opportunities. In other way, the growth of this processed meat sector assures the buffalo raiser a regular and uninterrupted sale of their produces (animals) at affordable price and also provides variety to the consumers. During ddevelopment of value-added comminuted meat products, buffalo meat and other components are minced to reduce their particle size and other ingredients are incorporated to improve the processing quality, reduce cost, increase yield and palatability. There are number of innovative and simple processing techniques developed for preparation of high-quality buffalo meat products including patties, burgers, sausages, loaves, kabobs, meat blocks, nuggets and rolls as well as restructured products. Again, value-addition as well as processing also intern help in preservation, transportation, distribution of products, employment potential, entrepreneur development, export potentials and their marketing aspect to a larger base of consumer. Another aspect of value addition is that it increases the conveniences of consumer by reducing processing time, minimizing processing stems and also increases the possibility of formulation of products with various flavour and taste with improved shelf life.

Technologies used for value addition of buffalo meat:

In our country, most of the buffaloes are sacrificed at end of their productive or working life and therefore, the meat from buffalo is invariably dark, coarse, less succulent and tough. Moreover, there is a clear-cut diversion in the Indian meat industry; the organized sector caters to the export demand and the unorganized sector meets the domestic requirement (Bardhan et al. 2019). Hence with the present food safety prerequisites, hygienic meat from modern slaughterhouses should be used for processed meat products to meet the global standard. Various technologies as given below are employed for value addition of buffalo meat.

a) Freezing:

Reports are available regarding freezing of buffalo meat and its quality improvement. Kandeepan and Biswas (2007) reported the improvement of texture, tenderness, juiciness due to freezing of buffalo meat for a longer period of time. In an experiment conducted by Ziauddin et al., (1993) reported that higher score for texture, juiciness and aroma of buffalo meat when it was plate frozen. They also indicated the overall quality improvement of buffalo meat according to taste panel score when meat stored in both plate and blast frozen condition.

b) Drying:

Minh et al., (2019) investigated several factors affecting to buffalo meat drying and reported that the optimal parameters for the dried buffalo meat production were as follow: steaming in 10 minutes at 100oC; sugar 25%, salt 3%; drying in 240 minutes at 650C. They developed a value-added dried buffalo meat product. A study by Malek et al., (2010) suggested that salt drying may be a useful method of buffalo meat preservation.

c) Electrical stimulation:

In general, electrical stimulation of large animals like buffalo carcasses reported to different quality parameters such as tenderness, water holding capacity and flavour. There is a significant variation reported in sensory tenderness scores between electrically stimulated and non-stimulated buffalo meat. Biswas et al. (2007) reported a 32% more improvement in tenderness in electrically stimulated carcasses.

d) Use of Additives-

Non-meat additives found to have great role in influencing the quality and acceptability of meat and meat products. Among additive, most common additives used in meat products are sodium tripolyphosphate, sodium ascorbate, whey protein concentrates, soy protein isolate etc. Sodium ascorbate (500ppm) when mixed with ground or minced buffalo meat obtained from aged and culled female buffalo, increased the pH, colour, chroma value but dreacreased cooking loss, met- myoglobin formation and lipid oxidation (Sahoo and Anjaneyulu, 1997a). Mendiratta et al. (2002) used calcium phosphate to replace sodium tripolyphosphate and prepared low-sodium and calcium-fortified restructured buffalo meat rolls. They indicated that calcium phosphate enhanced tenderness and binding ability without influencing chemical composition and microbial aspect of meat rolls. Suman and Sharma (2003) showed significant improvement in sensory attributes of low-fat mined buffalo meat patties when combination of hydrocolloid fat substitutes (sodium alginate and carrageenan) was used. Similarly, Modi et al. (2003) also reported the possibility of quality and highly acceptable meat burgers with low fat minced buffalo meat could be prepared with binders like different legume flours. Many other studies are also reported that various additives improved the quality and shelf life of buffalo meat products like sausages prepared with foxtail (Setaria italica) millet (Nayeem et al. 2017), buffalo meat emulsion type sausage with whey protein concentrate (Ahmad and Badpa, 2014) and sausages with soy protein isolate (Ahmad et al. 2010).

e) Preblending:

Preblending is suggested as one of the vital processing steps for development of any comminuted valued added meat products. It has been suggested by many researchers that tough meats specially from culled or spent animals need to be preblended with other meat or non-meat components for development of good quality processed comminuted meat products. When salt and polyphosphate were used in preblending, there was a significant improvement in functional properties of buffalo meat essential for product processing (Anjaneyulu et al. 2007). Again, improvement in shelf life from day 6 to day 8 of ground buffalo meat was reported when tocopherol acetate was used during preblending (Sahoo and Anjaneyulu, 1997b). Similarly, when carnosine, a natural antioxidant was used in preblending, it enhanced the shelf life of minced buffalo meat upto 8 days during refrigerated storage (Das et al. 2006). Effects of salt and ammonium hydroxide on the quality of ground buffalo meat were also studied.

f) Use of antioxidants:

Recently, many researchers are giving importance to the use of agri-food wastes as they contain different bioactive substances which are useful in preventing deterioration of meat products. As meat and meat products are prone to lipid and protein oxidation and perishable in nature, natural antioxidants are highly affecting in retarding the oxidation process during storage and help in development of healthier meat products (Das et al. 2020, 2021). Naveena et al. (2004) marinated buffalo meat chunks with combination of powdered cucumin (2% w/v) and ginger extract (5% w/v) for 48 hours at refrigerated temperature. They reported the significantly improvement in flavour, tenderness, juiciness and acceptability scores after sensory evaluation. Incorporation of apple pomace powder in sausage prepared with buffalo meat increased cooking emulsion stability and cooking yield (Younis and Ahmad, 2015). In other cases, quality and shelf life improvement study of different value-added meat products were highlighted like buffalo meat sausage using nisin and butylated hydroxy anisole (Sureshkumar et al. 2010), use of safe oil in dry fermented buffalo meat sausage (Abu Salem and Ibrahim, 2010), combination of natural antioxidant and vacuum packaging in nuggets prepared from buffalo meat (Sahoo and Anjaneyulu, 1997). Low sodium, high fiber restructured buffalo meat fillets fortified with natural fruit-based antioxidants viz. apple peel and kinnow (citrus fruit) rind was stored at refrigeration for 21 days under aerobic conditions (Ahmad et al., 2021). Blade tenderization of tripe from buffalo rumen along with 5% ginger extract also effective in development of acceptable smoked meat product from rumen (Anandh and Laxmanan, 2014).

g) Comminuted/ emulsion-based products:

Indian domestic meat market is primarily for hot and fresh meat from any meat animals based on the consumer preference but certain portion of fresh meat is being used for development of various processed meat products. Similarly like chicken and goat meat, buffalo meat is also used in the preparation of different value-added processed products such as buffalo meat patties (Kulkarni et al., 1993), buffalo meat burgers (Modi et al., 2003), buffalo sausages (Sureshkumar et al., 2010; Younis and Ahmad, 2015; Nayeem et al., 2017), buffalo meat loaves (Devalkal et al., 2004;), buffalo meat cubes (Naveena et al., 2004; Kandeepan et al., 2009), patties (Kandeepan, 2009) etc.

h) Combination of meats and use of by-products/offals:

Development of comminuted meat products is another efficient way to utilize various by-products from meat industries like pork, chicken fat and meat from other low value cuts. For example, Krishnan and Sharma (1990) prepared a highly acceptable buffalo meat sausage by using 80% meat and 20% pork back fat. In case of meat part, they used 70% buffalo skeletal prime meat and 30% offal meats mainly rumen and heat meat. A high quality and acceptable buffalo meat loves was developed with buffalo meat, liver and various vegetables (Devatkal et al. 2004). An investigation was carried to study the impact of heart meat incorporation (0%, 15% and 20%) and increasing levels of fat (20% and 25%) on quality and shelf life evaluation of fermented sausages of buffalo meat (Ahmad and Srivastava, 2007). Similarly, Anandh et al. (2014) used a combination of buffalo tripe and skeletal buffalo meat for preparation of cooked tripe rolls and studied its quality changes during refrigerated vacuum packaged condition. Development and assessment of shelf-stable spicy snacks were also prepared from buffalo tripe by Sherpa et al., (2018).

i) Fermentation:

Many research findings and reports are available on various quality aspects, storage stability and consumer acceptability of different fermented processed buffalo meat products. Dry fermented sausage was prepared from buffalo meat using sage oil extract (Abu Salem and Ibrahim, 2010). Ahmad and Srivastava (2007) evaluated the quality characteristics and storage life of fermented sausages of buffalo meat.

j) Packaging:

Packaging is considered as important aspect of processing chain to maintain and preserve the quality, safety of products and marketing of meat and meat products in an effective way. Better flavour scores and acceptability were reported when buffalo meat products like sausages were vacuumed packed under refrigerated condition (Deenathayalan, 1997). Packaging like aerobic, vacuum and modified atmosphere packaging are being extensively used for quality and shelf life improvement of meat and meat products. Similarly, Thomas et al. (2006) reported improvement in quality and shelf life of nuggets prepared from buffalo meat under refrigerated storage condition. Carbon dioxide and vacuum packaging of buffalo sausages significantly reduced the microbial counts during refrigerated storage (Sachindra et al. 2005). Similarly, effect of modified atmosphere packaging on structural and physical changes in buffalo meat was examined by Sekar et al. (2006). Jaberi et al. (2019) studied the physico-chemical quality and microbial profile of ground buffalo meat under vacuum and high-oxygen modified atmosphere packaging condition. Again, Malik and Sharma (2014) evaluated the shelf life of hurdle treated spiced products, a ready-to-eat buffalo meat products under both aerobic and vacuum packaging condition at 30°C for 7 weeks. In an anther study, carrageenan based edible film was prepared with oleo-resins of black pepper to study the quality aspect of steaks from buffalo meat (Manjunath et al. 2019). In a similar line of work, recently, shelf life of buffalo meat was enhanced by applying the Plantago major seed mucilage and Citrus lemon essential oil based edible packaging under refrigerated condition (Noshad et al. 2021).

k) Extruded products:

Extruded meat-based snacks are also made from meat products after mixing different non-meat ingredients in optimum ratio. Main advantage of extrusion process is to prepared food products in different shape, size and forms. Extruded food products are popular among consumers for their shelf life, crispiness and convenience too. Many researchers have developed various meat-based snacks food products such as curls, murruku, chips, nimkee, snacks from tripe of buffalo and samosa (Sharma and Kondaiah, 2005).

l) Restructured and enrobed meat products:

Restructuring is a processing technique used for developing convenience food products with texture similar in between intact steak and a comminuted food product. It uses modern meat processing techniques such as blade tenderization, flaking and tumbling to improve the product yield, binding, texture and sensory attributes of the products. Kumar et al. (2004) prepared and evaluated the quality of restructured meat blocks from buffalo meat by mixing milk co-precipitates. Whereas Thomas et al. (2006) evaluated the quality and storage stability of emulsion and restructured meat nuggets from buffalo meat during refrigerated storage. Calcium lactates significantly influenced the physico-chemical, textural and a sensory property of buffalo meat loves (Irshad et al. 2016). Ahmad et al. (2021) developed functional restructured buffalo meat fillets with dietary fibre and antioxidants from natural sources and they also evaluated the filled under aerobic storage condition. Enrobing or application of coating is another way of value-addition that increases the shelf life, appearance, taste and acceptability of meat and meat products. Eyas Ahmed et al. (2007) prepared enrobed buffalo meat cutlets using various combinations of binders and evaluated the quality, shelf life and acceptability during refrigerated storage period.

m) Traditional meat products:

Traditional meat products are unique in their spicy flavour, appearance, specific ingredients used, simplicity and ease of preparation. Popular indigenous meat products are seekh kebab, shami kabab, tikka and kofta tandoori chicken, etc. Pastırma is a traditional Turkish meat product which produced by using whole meat pieces obtained from water buffalo and beef carcasses. Akköse et al. (2018) prepared various types of pastrima using meat of water buffalo and evaluated for its textural, microbiological and various sensorial quality parameters. Kandeepan et al. (2013) developed processed meat curry from buffalo meat and compared its quality both at room temperature and refrigerated storage condition. Whereas Anandh et al. (2012) tried to develop a traditional styled fried tripe product from buffalo and goat tripe and evaluated its acceptability and quality among consumers. The effect of buffalo meat on composition, instrumental and sensory characteristics of Traditional Greek Sausages was studied by Petridis et al., (2015). Pastrami (dry cured meat) was prepared from buffalo lean round muscles by Ibrahim, (2001). An attempt was made to explore the fusion of oven and microwave to reduce the drying time in the preparation of buffalo jerky (Wen et al., 2018). Buffalo meat could be utilized to prepare high quality meat pickles of higher palatability (Khate, 2002). Quality and acceptability of tripe pickles from goat and buffalo rumen meat was studied by Anandh, (2017).

Strategies to improve processed meat sector:

Following strategies must be considered for improving the Indian processed meat sector:

- ✓ A large-scale male buffalo calf rearing for veal production at national level is essential for tender quality products to cater the domestic and international markets.
- ✓ Electrical stimulation of carcasses can be practiced in modern abattoirs to improve the quality of meat, in particular tenderness.
- ✓ Use of mechanical blade tenderizer would enhance the palatability of tough meat from aged animals.
- ✓ Production of shelf stable meat products using retort pouch processing would facilitate their distribution and marketing in the absence of cold-storage network.
- ✓ Technologies need to be further standardized for utilization of edible offal like tripeincorporation into other comminuted and snack products.
- ✓ Product diversification and commercialization is required to cater to the needs of different consumers for the sustainability of meat-based food industry
- ✓ Reduction of custom duties and /or GST on imported meat processing equipment would encourage the growth of the meat processing sector.
- ✓ Pragmatic long-term slaughter policy of meat animals by Govt. of India would help to attract private investments for production of wholesome meat, safe and nutritious meat products for developing sustainable meat industry
- ✓

Conclusion:

There is vast potential of buffalo meat processing for meat products of consumers' choice with contemporary processing techniques and adequate quality control to find their entry into national and global markets and fetch higher returns. There is challenge for the processing industry to choose appropriate ingredients to enhance palatability, shelf life as well as without detrimental effect on health. Enormous research work has to be carried out for developing healthier meat products of global standards. Again, the increasing demand by the health conscious consumers for healthy functional meat products is boosting factor for the development of various value added meat products. Inexpensive buffalo meat especially from aged, culled and spent animal holds the huge potential for production several value-added processed buffalo meat products. Presently, the meat industry is using various processing technologies and innovations developed in laboratory to add value to buffalo meat and byproducts which needs scale up in competitive level for a clear economic advantage at global market.

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CHAPTER 10

REARING OF BUFFALO BROILER

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The global buffalo population is about 198.88 million, of which approximately 94.6% is contributed by Asian countries, including India, Pakistan and China (FAOSTAT, 2012). As opposed to European countries where beef production is sustained with high-quality concentrates, Asian countries mainly rely on grazing and crop by-products for beef production due to the scarcity of good quality feedstuff. Further, a significant portion of the buffalo population is owned by small landholders. Buffalo meat production has a significant contribution in providing good quality protein to fulfil human beings' needs across the globe. Modern lifestyle changes, increased awareness for the importance of protein and no associated taboos are the major factors contributing to the increasing popularity of buffalo beef. Buffaloes contribute 3.59 million tonnes of meat to global meat production (FAOSTAT, 2013). Asian countries, namely India, Pakistan, and China, top the list with the highest share in global meat production (Table 1). India exports approximately 1,20,000 culled buffaloes every year.

Table 1: Share of major buffalo meat producing countries:

Rank	Country	Buffalo meat production (mT)	Percent share of world meat production
	World	3.59	
1st	India	1.53	42.6
2nd	Pakistan	0.80	22.3
3rd	China	0.62	17.3
4th	Egypt	0.40	11.1
5th	Nepal	0.16	4.45

Source: FAOSTAT (2013)

Advantages of buffalo beef over other meat-producing species:

1) Generically, in comparison with poultry and swine, beef cattle have lower feed-to-meat conversion efficiency. Nonetheless, these metrics do not consider that beef cattle produce high-quality protein from feeds that are not utilized efficiently by other livestock species, while monogastrics need high quality concentrates. Most of the requirements for protein & energy can be met with low- to medium quality forage, which is the common feeding practice in Asia.

2) No taboos associated with the species, unlike cattle in *Hindu* and swine in *Muslim* communities.

3) Lesser chances of incidences of zoonotic diseases as compared to monogastric animals such as, avian and swine flu.

4) Male calves, generally culled from dairy herds, can be diverted and utilized with no extra investment in beef production. About 10 million male calves are born in India annually and they are culled. Considering 10% mortality, we can still raise these 9 million calves for profitable beef production.

Table 2: Characteristics of buffalo meat:

Characteristics	Values
Moisture	74- 77%
Protein	17 -23%
Energy value	6.8 kcal/ g DM
Total lipids	1.37 g/100 g (Lowest among red meats)
CLA	1.83 mg/g fatty acid methyl esters
Marbling	Poor
Fatty acids	Rich in palmitic, stearic, oleic, and linoleic acids
(n-6)/(n-3) Fatty acid ratio	7

Input – output system of buffalo rearing:

Buffalo rearing is one of the most important occupations of rural society and constitutes the livelihood of rural poor belonging to the lowest to medium socioeconomic strata. The rural people lack knowledge, literacy, social awareness which arise the requirement of improvement. in knowledge about buffalo's foundation stock, their proper housing, feeding and management. Livestock is an important component of India's economy in terms of income, employment and foreign exchange earnings. The distribution of livestock is more justifiable and its growth is considered to be a major contributor as an anti-poverty and equity-oriented. Under normal condition, low input- low output sysyem prevailing in our country, though educated and progressive farmers and commercial farms are adopting intensive feeding and management system of rearing. Feed cost among the recurring cost is major one, contributing about 65-70% and medicine/ health care system requires about 5%, hence, feed and medicine cost is the major one where farmers can explore increase the income and profitability. Output in dairy farms are many viz., milk, dung, hair, urine and calves. If the female calves coming, its welcome but farmers deprive the male calves by not supplementing colostrums and proper nutrition, which leads to malnutrition, diarrhoea and stunted growth and death. Rough estimate says that almost 10 million male calves are removed due to lack of knowledge and utilizing the male calves in economic return.

Management of calves for beef production:

Feeding strategies for beef calves are formulated, keeping in focus breeding management, the functional efficiency of the rumen microbiome, and the source and composition of feed. Strategies to increase cattle production efficiency are required for the long-term intensification required to meet future beef demand. The most critical aspect in profitable beef production is the high percentage of calf crop, i.e., a live calf from a cow each year. The management of buffalo calves varies according to the production system under consideration; (Ramakrishna, 2007) reported high mortality rates of up to 51.8 per cent in calves under one month of age in a semi-intensive system due to improper management and feeding. Nonetheless, in commercial intensive rearing systems, the mortality rate due to poor management is higher. Poor management practices include inadequate colostrum feeding, milk feeding, navel cord infection, and timely veterinary care during the pre-weaning period (Tiwari et al., 2007).

A) Milk replacer and calf starter:

According to NRC (2001), calves should be given liquid feed (milk/milk replacer) at 10% of their body weight. Young calves have little or body reserves; and no immunity. Milk acts as a concentrated source of energy, protein, minerals and immunoglobulins. Liquid feeding is one of the most essential and cost-intensive components in modern calf rearing practices. In some places, the market price of weaned buffalo calves is more economical than the cost of milk feeding. Hence, farmers prefer feeding milk replacer to calves, and selling the milk. Milk replacer, an effective alternative to whole milk, is more economical (80-85% of the whole milk) and can be fed if the calf does not suckle the dam or the milk prices are high. Milk replacer is synthesized as a by-product of milk processing, constituted primarily by whey as the major source of protein. Azim et al., (2011) investigated the effect of milk replacer feeding rate and early weaning on growth performance of Nili-Ravi buffalo calves, and concluded that feeding calves MR at 4% of BW, and weaning at 45 days is an effective and economical system for buffalo calves.

B) Creep feeding:

Creep feeding is practised to allow calves access to ad-libitum feed while still being fed cow milk. Milk production starts to decline after 100 days postpartum, and there is a need to provide additional nutrients to the calf. Creep feeding is generally practised when the pasture is short and poor in quality. It is highly digestible, provides additional nutrients to calves and helps in rumen development. It consists of protein-rich sources, e.g., 30% cracked corn, 30% cracked oats, 30% cracked barley, 5% molasses, and 5% soybean meal. Calf starters are precisely nutrient-dense feed for calves laden with fermentable carbohydrates, with fibre just enough for normal rumen function. It is the first solid feed introduced to the calves; hence the quality is of paramount importance. NRC (2001) recommends that an ideal calf starter should have 20% CP and 3100 Mcal of ME/kg. Adequate intake of starter feeds in cattle calves facilitates early weaning. Calves start consuming the solid starter feed at 14 days of age. During the first few weeks, calf starter intake is low and partially replaces the milk consumption, which increases gradually.

Advantages

- Higher average daily gain and weight at weaning
- Better body condition & uniformity of calves at weaning

Disadvantages

- Requires extra labour, equipment, feed, and management

- Over-fattened calves have a slower during the first 2 to 3 months of age. Once they are moved into the feedlot stage, they may also finish at a lighter weight.

C) Implanting:

Implanting is a practice in which tiny pellets consisting growth stimulant is administered to the calves, which is gradually released in the body over a period of time; stimulating the secretion of somatotropin and insulin-like growth factor. An increase in growth hormone stimulates muscle growth. Implanting at 60 to 90 days of age will boost weaning weight by 9-10 kg, surplus to the gain obtained by creep feeding.

D) Weaning: Beef calves are commonly weaned at 6 to 9 months of age, which is considered appropriate for completion of vaccinations and testing performance of calf sales and replacement heifers.

Advantageous of early weaning:

- Early weaning is practised to improve rebreeding of heifers as suckling delays the onset of estrus, causing monetary losses. It reduces incidences of stress and ensures early heat and conception. Nevertheless, to ensure proper development and optimum weight of calves, they should not be weaned before five months of age.
- The growth performance of early-weaned calves is comparable to those weaned later through increased consumption of low-cost starter feed.
- Calves consume a lesser amount of milk in early weaning programs, and save the cost of milk feeding

E. Preconditioning calves:

1) Preconditioning of calves before despatching to feedlot stage ensure better health and feed conversion efficiency.

(2) It serves as an adaptation period for the calves to get acclimatized to feed bunks and water troughs at the feedlot. Calves should be provided *ad-libitum* water and adequate amount of minerals before shipping

(3) Vaccination for diseases like infectious bovine rhinotracheitis (IBR), para-influenza (PI3), Pasteurellosis, castration, dehorning, and deworming should be done three weeks before the sale.

F) Finishing Cattle:

- The target during this period is to improve marbling and meat quality
- Concentrate: roughage ratio should be 85: 15 or higher
- During finishing stage, quicker gains are obtained by higher concentrates

Veal stage: Live weight of calves is about 200-250 kg, reached at about 210-230 days of age. Feed intake per kg body weight gain is lower as compared to beef stage, so Feed conversion efficiency is higher. Carcass characteristics like dressing percentage are better if a high concentrate diet is fed.

Beef stage: Live weight is about 359-400 kg, reached at about 300-320 days of age. Feed conversion efficiency is lower at this stage, and hence cost of maintenance is higher. However, the recovery rate of organs and bones is higher at this stage.

Purpose and lessons for rearing male calves:

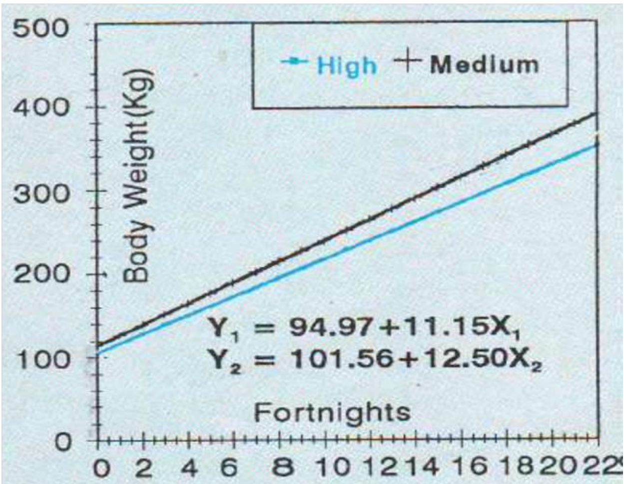
Before starting the actual business, one must remember the tips

- Raising for meat, milk or to produce offspring for sale should be decided first.

- On a small scale, raising cows for milk only can be costly, hence, budget, banking for loan, land for rearing, storing of feed and fodder should be optimum.
- Raising buffaloes for meat, one must know where to process the buffalo meat and storage space of feed/ fodder during lean period (store house and slaughter house)
- Marketing of the final product and byproducts to sell/ retail chain/ consumer/ export. In case of retail chain and export, one must aware about the existing law in the country to be exported.
- Quality of product and byproducts must be maintained as per existing law in our country to convince the consumer/ local market.
- The best animal breed where you live suitable to its climate, e.g., Murrah, Nili Ravi is suitable to North India and Mehsna is suitable to western part of the country, hence, to be remember for starting the business.
- Health care and timely vaccination must be followed routinely to avoid any disease outbreak, which may create havoc in the farm economy and income.
- Vitamin and mineral supplementation is to be done regularly as intensive agriculture exhausted all the vital trace minerals from soil, and hardly any fertilization is done which may create hidden hunger among the animals and subsequently in human. Most of the cases farmers do not provide any supplementation to the males as these are not directly providing milk which may lead to malnourished death.

Research findings:

ICAR- National Dairy Research Institute, Karnal conducted study to raise male buffalo calves for carabeef production on different feeding regimen. It has been seen that roughage to concentrate ratio of 40:60 was beneficial than 20:80. Feed conversion, palatability, growth performance feeding cost, dressing performance and income from the male buffalo rearing for meat was beneficial under 60:40 concentrate to roughage ratio. Intramuscular fat, juiciness, tenderness etc of meat was better for under 40:60 roughage concentrate ratio, indicating that there is a great scope in broiler buffalo production under Indian subcontinent. Figure 1 and table 1 depicts the body weight changes over the period of experiment, and meat quality of experimental buffalo calves fed high (80%) or low (60%) concentrate mixture.



Parameter	Experimental ration		Experimental ration	
	High concentrate	**Low concentrate**	**High concentrate**	**Low concentrate**
	Veal stage		**Beef stage**	
Dressing percent	51.5[a]	46.7[b]	52.3	51.7
Meat, %	69.4	68.1	67.4	66.4
Bone, %	23.6	23.6	21.6	22.8
Fat, %	7.0[b]	8.3[a]	11.0	10.8
Meat: Bone: fat	9.9:3.4:1.0	8.2:2.8:1.0	6.12:1.97:1.0	6.15:2.2:1.0

Conclusion:

Buffalo meat production has an exponential increasing demand globally, while the buffalo population is majorly concentrated in Asian countries. Milk feeding and calf starter are key components of buffalo beef calf rearing, and should be religiously followed for profitable beef production. Hence, there is a need to improve the efficiency of buffalo beef calf production as a prerequisite for the long-term intensification required to meet future meat demand.

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CHAPTER 11

FEEDING MANAGEMENT OF HIGH YIELDING BUFFALOES UNDER HEAT STRESS CONDITION

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Water buffaloes (*Bubalus bubalis*) are second only to cattle in terms of the value of dairy products produced in the world (Sindhu and Arora 2011). Buffalo milk is favored in the production of dairy products like mozzarella cheese, cream, yogurt, and butter because it has a greater fat (6-8% fat) and protein (4.0-4.5%) content than cow milk (Arif *et al*., 2019). Between 1994 and 2016, the overall dairy buffalo population increased by 54 percent due to globalization and changes in global consumption preferences. The Buffalo population in India is 109.85 million and contributes around 20.50% of the total livestock population in India.

Some background information of buffaloes:

Nutrient requirements and strategies to combat heat stress in buffalo are reproduced from cattle but due to their different physiology of digestion and metabolism specific focus on the species for better production is the need of time. Buffaloes do have a larger rumen-reticulum complex with more developed rumen papillae and larger populations of cellulolytic, proteolytic, amylolytic, and lipolytic bacteria and fungi under identical dietary conditions compare to cattle and thus have better ruminal digestibility of fibrous feed (Eyup *et al*., 2020). The passage rate is lower in lactating buffaloes than in cattle (Paul *et al*., 2003). The efficiency of feed for the fat corrected milk is higher in the case of buffaloes than the cattle. Buffaloes produce less fasting heat as compared to cross-bred cattle (Singh *et al*., 2018). The lacking part in the buffalo is lower production compare to HF crossbred and pure HF cows and efficiency improves with increasing production level.

Heat stress in buffaloes causes various changes in the biological functions that include a decrease in feed intake, efficiency and utilization of nutrients, disturbances in metabolism, mineral balances, enzymatic reactions, hormonal secretions, and blood metabolites. Such changes result in impairment of reproduction and productive performances (Das *et al*., 2014). Buffaloes do have fewer sweat glands and darker coat color compare to cattle which makes this species more vulnerable to heat stress (Upadhyay *et al*., 2008). Evaporative heat loss differs dramatically between cows and buffaloes. Buffaloes lose just 12% of their body heat by sweating and 88% through panting due to fewer sweat glands. Cows, on the other hand, lose 85% of the heat by sweating and 12% of the heat by panting (Jenkinson, 1972). Under direct sunlight, cows' body temperatures rise by 0.2 to 0.3 °C, whereas buffaloes' body temperatures rise by 1.3 °C, as a result of higher heat absorption (Mullick, 1960). Under heat stress, dairy buffaloes had higher blood levels of ketogenic amino acids and gluconeogenesis than Holstein cows. These amino acids are the primary building blocks of milk proteins, although they are more heavily involved in gluconeogenesis and amino acid metabolism under heat stress circumstances to boost energy generation (Tian *et al*., 2016). Protein synthesis was hindered by heat stress, and these branched-chain amino acids are involved in the tricarboxylic acid (TCA) cycle, which produces energy to compensate for energy shortages (Zhang *et al*., 2017). Immune cells also oxidize branched-chain amino acids for the production of new immune cells, which helps to boost immune function and resist oxidative stress (Negro *et al*., 2008). High branched-chain amino acid levels in the blood may suggest that buffaloes have a superior capacity to maintain energy balance through gluconeogenesis and immunological capabilities than Holstein cows under heat stress.

Heat stress:

Heat stress occurs when an animal's body temperature rises over the optimum range for normal activity because the total heat load exceeds the capacity for heat dissipation (Bernabucci et al., 2010). Heat stress is becoming a serious problem because of the negative impacts on ruminant performance. As global warming advances and genetic selection for milk production continues, the detrimental effects of heat stress will grow more severe in the future. In reaction to weather change, heat-stressed animals alter their metabolism and physiology. Heat stress reactions in dairy cows have a detrimental influence on their body temperature, health, and several productivity features, such as increased rectal temperature and respiration rate, as well as decreased feed intake, milk output, milk quality, and reproductive function (Atrian and Shahryar 2012). When nutritionists approach the ration formulation, they should take into consideration changes in nutrient partitioning as well as changes in the rumen and intestinal functioning due to heat stress.

High-producing buffaloes have a greater metabolic rate than low-producing, implying that they have more difficulty in dissipating body heat during the hot season. To reduce the impacts of heat stress, three management techniques have been established: (1) change in micro-environment, (2) genetic identification of heat-tolerant breeds, and (3) enhanced feeding and nutritional strategies. The purpose of this chapter is to explain the effects of hot weather on nutritional requirements and feeding methods to reduce the impact of heat stress on buffaloes.

Nutritional strategies:

Heat-stressed individuals exhibit a reduction in energy use efficiency. This is due to the increased maintenance needs to reduce excessive heat load (Bernabucci, 2012). Energy is usually the most limiting nutrient, thus reducing forage and increasing concentrate content in the diet is a popular strategy for increasing energy density. Heat stress inhibits the appetite center in the hypothalamus, resulting in a decrease in intake (Kumar, 2018). Additional sources of heat generation from the cow might come from digestion and metabolism.

Fiber:

When fiber is fermented in the rumen, acetic acid is produced, which is used as an energy source and a main precursor of fat in milk. However, too much fiber causes more acetic acid to be produced, and acetate metabolism produces more endogenous heat than propionate metabolism via dietary protein (Linn, 1997). More blood circulation in the periphery is required to dissipate this heat, resulting in a decreased blood supply to the gastrointestinal tract, which affects digestion.

High-fiber diets may enhance heat production, as evidenced by research demonstrating that conversion of metabolizable energy to milk efficiency was 54, 61, and 65 percent for meals containing 100, 75, or 50 percent hay, respectively (Coppock and West, 1986). Lakhani et al., (2021) suggested maintaining 34.5 percent dietary NDF and 8.4 percent metabolizable protein in the diet as an ameliorative strategy to combat the adverse effect of heat on nutrient intake, apparent digestibilities, the efficiency of nutrient utilization, and in turn milk production in buffaloes under heat stress. Milk fat decreases with a low fiber (<30% NDF) and protein diet. When buffaloes are fed with a lower level of NDF along with higher Metabolizable protein, rectal temperature decreases.

Under hot conditions, high fermentable carbohydrate diets can enhance calorie intake, but this benefit must be weighed against the risk of rumen acidity associated with high-grain diets (West et al., 2003). Maintaining normal rumen function is critical to avoiding this condition ADF and NDF should be in the diet at the levels of no less than 18% and 28% on a dry matter basis of the diet, respectively (West. 1999).

Protein:

When DMI is lowered owing to heat stress, protein intake is also reduced, and nitrogen shortage arises in the rumen, suspending microbial population growth. Increased protein content in the diet can help, but if the rumen's energy and protein synchronization is impaired, it can lead to an excess of nitrogen in the rumen. The cost of metabolizing extra nitrogen over needs is 7.2 kcal/g of nitrogen (Tyrrel et al., 1979). During heat stress, if rumen degradable protein was fed in excess, it can cause lower DMI and milk output (Huber et al., 1994).

Under heat-stress situations, the quality of the protein source, in addition to the amount of protein provided, should be evaluated. The lower level of metabolizable protein increases the breathing rate (Lakhani et al., 2021) and reduces the feed digestibility (Sediqi et al., 2017) in the buffaloes that are facing heat stress. The amount of ruminally undegradable protein had no influence on DMI during hot weather, according to Belibasakis et al., (1995). In the case of a diet high in undegradable protein, milk production improved and blood urea decreased. Essential amino acids in the diet may help to reduce the risk of heat stress. Heat stress inhibits RNA transcription and translation, resulting in a decrease in milk protein production (Sonn et al., 2002). For dairy cows, methionine is one of the most important limiting amino acids. Methionine supplementation improves production and antioxidant capacity, lowers lymphocyte apoptosis, promotes Bcl-2 gene expression in lymphocytes, and suppresses the Bax gene (Han, 2009).

Fat:

As previously stated, a lower forage to concentrate ratio enhances nutrient utilization efficiency in animals exposed to heat stress. Including fat in the diet of buffalo during heat stress may be the best way to get a good outcome as it enhances the energy density of the feed and produces less metabolic heat compare to fiber and starch. Without any high-fat feeds, most diets contain around 3% fat on a DM basis. Whole seeds can provide the remaining 2 - 3% fat. As a result, rations containing 5 - 6% fat are produced. Any excess fat should be added to the rumen as rumen inert fat or bypass fat. Fat should not account for more than 7 to 8% of total dry matter in ration. Because fatty acids limit calcium and magnesium absorption in the intestine, when fats are consumed, the need for these minerals increases.

Holter et al., (1992) added 15% whole cottonseed, or15% whole cottonseed + 0.54 kg/d calcium salts of fatty acids, and found that heat generation over maintenance decreased by 6.7 and 9.7%, respectively, while total heat loss decreased by 4.9 and 7.0 percent. When prilled fat was supplied to the lactating buffaloes at the dose of 100g/animal/day, it reduced rectal temperature, increased milk yield by 13.8%, improved Fat percent ($P<0.05$) over control (Yallappa et al., 2019).

Water:

Water is necessary for milk production, but it is also necessary for maintaining thermal homeostasis. Higher respiratory water loss and evaporative loss in buffaloes during hot climate conditions increase the requirements of water. While the water excreted by milk yield corresponds to roughly one-third of the amount of total water intake under thermo-neutral conditions (Khelil-Arfa et al., 2014), a shift in the distribution of water across the various bodily compartments is observed in the heat-stressed animals (Olsson et al., 1995). As a result of heat, stress water is reduced in the feces to spare the water for evaporative loss. Water limitation causes variations in blood metabolites concentrations, which should be addressed separately in acute and chronic water deprivations. Because of the reduced blood volume, serum protein and albumin rise during acute water deprivation; however, both metabolites tend to decrease with chronic water deprivation. Acute water deprivation causes the kidney to decrease glomerular filtration and enhance urea re-absorption, resulting in a rise in plasma levels of creatinine and urea, while chronic water deprivation causes these plasma metabolites to decrease (Chedid et al., 2014).

The evolutionary adaptability of species and breeds has an impact on their capacity to cope with water restrictions in hot environments. In this regard, it is important to note that buffalo evolved in warm and humid habitats, which explains why heat-stressed buffalo secrete more vasopressin than cattle (Koga et al., 2002). The temperature of the water is the key physical property of importance during heat stress. The favourable impact on thermal balance caused by drinking water's low temperature is generally underestimated. Stermer et al., (1986) found that drinking water at 10 °C reduced body temperature and respiratory rate in nursing cows more effectively than drinking water at 28 °C.

Minerals and Vitamins:

The lower feed intake seen in hot weather has an impact on vitamin consumption, which is critical for immunological function and performance. Micronutrients such as vitamin A, vitamin E, and trace elements (particularly Se, Cu, and Zn) are crucial for mammary gland immunity and health, especially during heat stress (Sordillo et al., 1997). Because heat stress may produce oxygen-free radicals, vitamin C supplementation may be beneficial, as ascorbic acid is one of the most essential antioxidants in the body. Selenium and vitamin E are also essential antioxidant components. Selenium is a component of glutathione peroxidase, which eliminates free radicals in the cytoplasm, and therefore protects tissues from oxidative stress. As tocopherols act as an antioxidant, their role in the prevention of chronic illnesses thought to be linked to oxidative stress (Brigelius and Traber, 1999).

Niacin is a subcutaneous vasodilator and it increases evaporative heat dissipation from the body as well as decreasing the effects of heat on cells. Since niacin is quickly metabolized in the rumen, it does not reach the small intestine in such form if supplied unprotected

(Campbell et al., 1994). Feeding rumen-protected niacin at 12 gms/day increased free plasma niacin levels, evaporative heat loss and was linked with a minor but noticeable decrease in rectal and vaginal temperatures in heat-stressed dairy animals (Zimbelman et al., 2013).

Selenium is perhaps the most important trace mineral for supporting the cow's antioxidant defence under heat stress. An experiment comparing Selenium-yeast, Sodium-selenite, and no selenium supplementation in heat-stressed cows found that Selenium-yeast (Sel-Plex; Se yeast) had a positive effect on the reduction of circulating thiobarbituric acid reactive substances, as well as lower plasma reactive oxygen metabolites, implying that cows fed Selenium-yeast have better preventive antioxidant systems (Calamari et al., 2011). Optimal levels of selenium (0.25 mg Se/kg DM) helps to maintain levels of endogenous antioxidants in tissues.

Chromium is a micronutrient that assists insulin action more effectively on glucose, lipid, and protein metabolism. Because glucose is most often used during heat stress, chromium supplementation may help to mitigate the harmful consequences of the condition. Incorporating Cr into the feed of buffalo calves enhanced heat tolerance, immunological status, and growth performance without altering nutritional intake. Kumar et al., (2015) supplied 0.5, 1.0, and 1.5 mg of inorganic Cr/kg dry matter to the buffalo calves and reported that with a rise in Cr levels, lymphocyte proliferation, neutrophil phagocytic activity, plasma immunoglobulin, and FRAP value all improved considerably ($P<0.05$). Cr supplementation reduced insulin, cortisol, and Hsp 70 concentrations in summer-exposed buffalo calves ($P<0.05$).

Electrolytes:

Mineral supplementation in heat stress must be regarded not just as a simple means of covering the essential turnover of a particular nutrient, but also as a means of buffering the impact of feed and temperature (Calamari et al., 2007). Bovines utilize potassium (K^+) as the primary osmotic regulator of water secretion from their sweat glands. During heat stress, the body has a higher need for cations, especially Na and K, as urinary excretion of these ions in heat stress may rise by up to 80% and 18%, respectively, as compared to excretion in a cooler environment (Sanchez et al., 1994). Potassium and sodium are principal cations involved in maintaining acid-base balance. Acid-base disturbances can occur in hot weather and supplementation of $NaHCO_3$, K_2CO_3 and $KHCO_3$ increases feed intake and performance of dairy cows, boosting milk production and fat content. Positive DCAD increases amino acids available for protein synthesis by substituting amino acids that would otherwise be required for acid-base balance maintenance. By keeping the DCAD at a healthy lactating level (+20 to +30 meq/100 g DM) remains a good strategy under heat stress. (Wildman et al., 2007). Care should be taken for the advanced pregnant animals and only the upper safe limit of DCAD should be provided.

Summary:

- The roughage to concentrate ratio should be optimized as the metabolizable energy is used more efficiently from the concentrate than the forage under heat stress.
- Rumen-protected fat and protein should be supplied to reduce fermentation heat and to enrich the diet with dense nutrients.

- Highly digestible fiber should be supplied and the total NDF level should be reduced but at least 28% of NDF and 18% ADF should be supplied for the optimum rumen function.
- Adlib water and its temperature can be the major strategy to reduce the heat stress in the animal.
- Enzymes and microbes can be supplied to improve fermentation and enhance the nutrients available at the lower gut for animal usage.
- Trace minerals and vitamins should be given as per the requirement of heat stress to cope with the stress level.
- Generally, forages dry up and lose nutrients under bright sunlight, which makes them less digestible and nutrient scars so, ration formulation should be done on the actual composition of the forages instead of table values.

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CHAPTER 12

MANAGEMENT OF BREEDING BULLS AND COLLECTION, PROCESSING AND PRESERVATION OF SEMEN

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Cryopreservation techniques for cells opened up new vistas in biological sciences and provided vast opportunities for conservation and propagation of diverse cell populations for numerous researches, clinical and pharmaceutical applications. The widest application of this technique was made in cryopreservation of germplasm, particularly semen, from livestock species. Some cryopreservation and semen handling aspects have been discussed in this lecture.

1. Selection of Bulls: The bulls should be selected for semen production taking the following points into consideration

- Parental Records of bull and their performance- milk production performance of both the parents and bulls siblings (sister's and cousin's performance).
- Breeding soundness evaluation of bulls- Testicular growth & health, libido, semen quality etc
- Karyotyping of all the bulls- chromosomal status of the bull.
- Health certificate- Bull should be disease free which may transfer through semen etc

2. Management of Bulls:

Bull should be managed taking following things in view.

- The bulls should get hygienic environment.
- The coat should be kept clean and short by clipping the hair.
- The preputial hair should be cut regularly.
- The animals should be cleaned properly before semen collection, specially the underside ofthe abdomen.
- In case of swelling of preputial orifice and adjoining areas it should be cleaned with soap and detergents followed by thorough rinsing and drying.
- Preputial washing should be done on a regular basis with diluted $KMnO_4$ (0.02%) followed by rinsing with sterile saline solution. In case of invasion of microorganisms, antibiotic saline solution may be used for washing.
- Before semen collection, person making collection should make sure that the bull is clean and that it is not carrying any litter or particles of feed on its body or its hooves as such materials are always heavily contaminated and body should be dry.

Preparation of Artificial Vagina (AV):

- For buffalo bull, barrel of 30 cm length is more suitable. Preferably use latex cone and liner. At least cone must always be silicon.

- After semen collection, remove water from the AV and separate the barrel from liner and cone. Wash barrel, liner and cone in warm (about 50 ^{0}C) water containing disinfectant with neutral soap.
- Rinse twice with clean water, once with distilled water and finally with 70% alcohol. Dry all the parts in dust free indoor area.
- Finally assemble the AV, cover both open ends of AV and cone with aluminium foil and keep assembled AV in an incubator for next collection.
- Before collection, fill AV with water at 42 0C and develop appropriate pressure with air. Pressure and temperature of AV can vary with individual bulls and should be standardized as per the need of the particular bull to improve the semen quality and quantity.
- Lubricate upper portion of the AV with sterilized lubricating plain Vaseline / jelly for better penetration of penis.

Bull Preparation:

- Give a good bath to the bull and allow it to drip dry.
- Underbelly is cleaned with a soaked towel, while ensuring that there is no dirt / hair etc. in the prepucial area.
- Prepuce is a main source of microbial contamination in the semen therefore this area should be cleaned properly before the collection is made.
- An apron is tied just behind fore-legs of the bull before collection to avoid contamination from the perineal region of the teaser.
- Semen Collection:
- From mature cattle/buffalo bull semen can be collected twice weekly with the help of an AV on a fellow bull/treasure bull.
- Collection should be made in a dust-free, clean and quiet area away from the traffic, usually during early hours i.e. between 4 to 6 AM.
- Bull should be given false mounts which help in increasing ejaculate volume.
- Two ejaculates are usually collected on a single day using separate AV for each ejaculate. These ejaculates are either mixed or preferably processed separately if the initial quality of two is found different.
- Semen collector should wear clean hand-gloves/ use disinfectant and take precaution that the penis is not touched during collection.

Preparation of Extender:

Buffalo bull:

Buffer for semen extender is prepared one day prior to the day of semen collection. Buffer comprises of the following components:

• TRIS	–	30.284 gm
• Citric acid	–	16.750 gm
• D-Fructose	–	10 to 12 gm
• Double distilled Water/ Millipore water	–	1 Litre

Antibiotics - Streptomycin: 1mg/ml
Benzyl penicillin - 1000IU/ml

- The above components are mixed, and if needed pH is adjusted to 6.8 with citric acid crystals.
- The buffer is then autoclaved, allowed to cool before adding the antibiotics and then stored refrigerated until required.
- Fresh eggs are prepared by thorough washing with water and detergent, followed by wiping with alcohol swabs and dried. Yolk is separated from the albumin on a sterilized filter paper.
- On the day of semen collection, fresh egg yolk @ 20% of the buffer volume and glycerol @ 6.4% of final volume are added aseptically under a laminar flow and mixed properly on a magnetic stirrer.
- The semen dilutor is now ready for use and is kept at 30±2ºC in a water bath in conical flasks.
- Cattle bull:

Composition of the extender for cryopreservation of cattle bull semen

- Sodium Citrate – 29.0 gm
- Citric acid – 1.0 gm
- D-Fructose – 7.81gm
- Double distilled
- water/ Millipore water – 1 Litre
- On the day of semen collection, fresh egg yolk @ 20% of the buffer volume and glycerol @ 7% of final volume are added aseptically under a laminar flow and mixed properly on a magnetic stirrer.
- Rest of the procedure remains same as for buffalo bull

Semen Evaluation and Processing:

- Warm stage of the Phase contrast microscope is put ON before semen collection starts for proper initial semen evaluation.
- Under hygienic precautions, semen collection tube containing ejaculated semen is detached from the AV on receipt in the semen Lab., covered with aluminium foil and kept in water bath already kept in a laminar flow.
- Volume of semen (ml), its Colour (creamy, milky, pink etc.) and Consistency (thick, watery) are recorded in the graduated collection tube itself.
- A small drop (10 µl) of semen is placed on a clean warm glass slide under microscope and Mass Activity is recorded under 10x objective by assessment of swirls / waves and scored from 0 to +++++ (0-100%, each + denotes 20% mass activity). If it is < +++, then the semen is not processed further and is discarded.
- Sperm concentration is recorded with Photometer and a dilution rate is worked out to provide approx. 20 million sperm cells in each straw (French mini-0.25 ml), in order to

contain at least 10 million motile and good proportion of progressively motile spermatozoa per insemination dose after thawing.

- Semen sample is accordingly diluted in a graduated cylinder with the already prepared diluent kept in water bath. Semen evaluation and dilution are done as quickly as possible.
- An appropriate number of semen straws are then printed using Ink-Jet Straw Printer and sterilized under UV rays for 15 minutes in laminar flow.
- With subjective judgment, initial motility of diluted semen sample (individual sperm motility in percentage) is recorded under 20x objective of the phase contrast microscope.
- Care should be taken that everything coming in contact with the semen during processing is maintained at the temperature equal to that of the semen.

Cooling, Freezing and Thawing of semen:

- Diluted semen in the graduated cylinder / conical flask is then kept in cold cabinet and the cooling cabinet is put ON. This gradually brings down the temperature of diluted semen sample from 30 0C to 5 0C in a span of 1½ to 2 hours. A further equilibration time of 3½ - 4 hours is allowed at this temperature.
- At this stage, pre-freezing sperm motility is recorded, and samples with >60% pre-freezing sperm motility are processed further while those having <60% motility must be discarded. This minimizes the loss of straws due to rejection of batch because of poor pre-freeze motility.
- Semen filling and sealing machine, kept in the cold cabinet, is used for filling of semen in the straws and sealing them.
- Semen filled straws are then spread on straw racks and allowed to cool on liquid nitrogen vapours for 12 minutes either in a thermocol box or a wide mouth LN2 container OR biofreezer, followed by plunging of straws in the LN2.
- For recording the post-thaw sperm motility, preferably on the next day, a sample of frozen straws is drawn from each batch and thawed in a water bath at 37-40ºC for 30 second. Only the batches recording post-thaw motility of >50 percent are retained while other batches are discarded.
- Frozen straws are stored in properly identified goblets in the LN2 cryocans.
- Semen distribution should be made with due care to ensure that the straws always remain dipped in LN2 and do not get exposed at any stage > 3 second to the outside environment.

Semen Evaluation with Computer Assisted Semen Analyzer:

- In routine, semen is evaluated for ejaculate volume, color, consistency and mass activity after collection and individual sperm motility immediately after dilution. Pre-freezing and post- thaw sperm motility are recorded at respective stages. However, these criteria of semen assessment are subjective.
- Computer Assisted Semen analyzer performs objective and accurate analysis of semen. It can evaluate many sperm kinematics and velocity parameters simultaneously.
- At some advance semen Labs frozen semen of bulls is evaluated for sperm motility and viability parameters with the help of CASA. These semen parameters can also be correlated with the IVF and field conception rates for prediction of bull fertility.

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CHAPTER 13

ESTIMATION OF FARM PROFITS IN DAIRYING: METHODOLOGICAL ASPECTS

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The profitability of dairy farming varies widely in the country due to variations in agro-climatic conditions, seasons, species and breeds of animals and estimation methodology for working out the costs and returns. This lecture note gives a brief account of the methodological issues and outlines the standardised methodology that was the outcome of a multi-location project in the country.

How to apportion joint costs?

There are several items on the dairy farm households, such as the cattle sheds, dairy equipments and machinery that cater to the entire animal herd on the farm, rather than being specific to individual animal. The cost incurred on these items is joint costs. Similarly, the land rent, interest on capital funds, labour cost, recurring expenses on repairs, etc. are all joint costs and hence, need to be apportioned on some scientific basis.

The animal herd can comprise of animals of different types (indigenous cows, crossbred cattle and buffaloes), sex (male, female) and age-groups. Considering that the extent of utilisation of fixed assets and labour will be different across these categories of animals, apportionment of joint costs attributable to these inputs becomes necessary. For this purpose, the different categories of animals are converted into homogenous animal units by using certain conversion coefficients also called Standard Animal Units (SAUs).

Table 1: Standard Animal Units for different Regions in India

		Adult male	Adult female	Young stock M < 1	Young stock F <1	Young stock M ≥1	Young stock F ≥1	Heifer
North	CB	1.23	1.27	0.41	0.41	0.61	0.52	0.78
	LC	1.08	1.00	0.39	0.39	0.54	0.46	0.73
	BU	1.25	1.35	0.43	0.41	0.65	0.51	0.79
South	CB	1.12	1.62	0.24	0.3	0.63	0.52	0.86
	LC	0.97	1.00	0.22	0.27	0.54	0.47	0.82
	BU	1.04	1.24	0.24	0.28	0.6	0.51	0.77
West	CB	0.87	1.18	0.39	0.37	0.55	0.42	0.51
	LC	0.72	1.00	0.36	0.35	0.40	0.38	0.40
	BU	0.82	1.22	0.4	0.38	0.46	0.42	0.48
East	CB	1.07	1.20	0.25	0.24	0.51	0.38	0.71
	LC	0.92	1.00	0.27	0.24	0.41	0.37	0.64
	BU	1.02	0.86	0.25	0.23	0.42	0.38	0.63
Hill	CB	1.48	1.71	0.41	0.72	0.71	1.08	1.24
	LC	1.11	1.00	0.29	0.63	0.55	0.82	0.98
	BU	1.43	1.7	0.35	0.63	0.73	0.94	1.09

Note: CB- Crossbred cattle; LC- Local cow; BU-Buffalo; M- Male; F-Female

Adult male and female ≥3 years for LC and BU and ≥ 2.5yrs for CB

The state level classification of regions is as follows:

- North (Northern Plains)- Punjab, Haryana, U.P., M.P.
- South- A.P., TamilNadu, Kerela, Karnataka
- West- Maharashtra, Gujarat, Rajasthan
- East (including NE)- Bihar, Jharkhand, W. Bengal, Orissa, Chattisgarh and all 7 NE states
- Hills- J&K, Himachal and Uttrakhand

How to estimate fixed cost?

Fixed costs do not vary with the level of output and remain unchanged over a short period of time. It comprises of the capital costs that is the cost of durable assets used in the production process, the rental value of land and interest on fixed capital investment.

Cost of durable assets can be accounted for by charging depreciation based on the purchase cost (or current value of the asset when purchase cost is not available) or using the Capital Recovery Cost (CRC) Method. In case of former, usually the straight-line method is adopted that is simple division of the value of asset by its useful life. The CRC method is defined as the annual payment that will repay the cost of fixed input over the useful life of input and provide an economic rate of return on investment. This approach used extensively at the international level, has an advantage over the straight-line depreciation method as it accounts for the fact that if the farmer did not purchase the input, the money could have been invested in some other on- or off-farm activity. The interest on fixed capital does not need to be accounted separately when CRC approach is followed.

Capital Recovery Cost of Civil Structures, Machinery and Equipments: The formula for estimation of CRC is:

$$R = Z\left[\frac{(1+r)^n\ r}{(1+r)^n - 1}\right]$$

Where: R= Capital recovery cost, Z= Initial value of the capital asset, r = interest rate , n = useful life of the assets.

Capital Recovery Cost of Milch Animals: The formula for CRC estimation is same as above but the important aspect is ascertaining ‘n’ i.e. the useful life of the animal or in other words its productive life. Like different type of fixed assets would have different useful life, eg. say, pacca cattle shed 50 years, katcha shed 10 years, manual chaff cutter 6 years, power operated chaff cutter 10 years, etc.; the useful life of milch animals also vary with the type of animal (local, crossbred or buffalo). As per the subject matter specialists, at the field level, useful productive life of milch animals, defined in terms of age (years) and order of lactation viz. average number of calvings per animal is:

Local cow:10 years, 6 calvings; **Crossbred cow**: 8 years, 5 calvings; **Buffalo**:10 years, 6 calvings

Rental Value of Land: As per the prevailing practice, none of the studies on cost of milk production include the rental value of land. In case the farm has been established on the rented land, the paid out rental value is to be included as cost item. In case when farm is operating on own land, earmarked exclusively for the purpose, as is the case for large commercial dairy farms; or for smallholder dairy production systems, if the cattle shed and farm buildings are located outside the household premises, then the imputed rental value of land is taken into account.

How to calculate Variable Cost?

Variable costs are those costs, which are incurred on the variable factors of production and can be altered in the short run. Variable cost includes four items: feed and fodder cost, labour cost, veterinary cost and miscellaneous expenditure.

Feed and Fodder cost: The cost of feed and fodder is one of the most important cost components accounting for 50-80 per cent of the total cost depending upon the livestock production system followed. This includes the cost of feeding dry fodder, green fodder and concentrates.

Grazing Cost: One important aspect in feed and fodder cost relates to the valuation of the grazing cost. Most studies only consider the labour cost of grazing the animals. However, it is also important to include the imputed cost of fodder intake through grazing. Two components, required for working out the same are; quantity of feed intake from grazing and its imputed price. An indirect but scientific approach to estimate the intake from grazing in any region is as follows:

$$\text{Quantity intake from grazing (GZ\_QTY)} = \frac{\text{Dry matter Intake from Grazing (GZ\_DMI)}}{\text{Av. dry matter content in grazed input (DMGZ)}}$$

Labour costs: The labour cost comprises of cash and kind payment to hired labour, both, permanent and casual, and the imputed cost of family labour.

Veterinary and Miscellaneous costs: The expenditure on breeding and health care of the animals is covered under the veterinary expense. The miscellaneous expenditure include expenses on repair of fixed assets, petroleum, oil and lubricants, water and electricity charges, insurance premium and any other incidental charges.

What is included in Gross Returns?

The returns from animal wastes and milk production are taken into consideration for computing the gross returns.

4.1 Returns from dung: This is an important and regular source of returns to the farmer. Dung is either used as manure or for fuel purpose after drying. Therefore, to estimate the monetary value of dung, weighted price of manure and dung-cakes is taken, weights being the utilisation proportion of dung into manure and dung cakes. In case these products are used on own-farm the imputed value based on the prevailing rates in the village is taken.

4.2 Returns from Urine: Returns from cow urine are to be included in those areas where organized system for procurement of cow urine is prevalent. In other areas this item is not relevant.

4.3 Returns from Milk: The estimation of milk yield should be done on actual weighment of milk drawn in pail at the time of milking usually twice a day, i.e. during morning and evening. In case there is a calf at heal, the milk fed to the calf is to be considered based on the approximate estimate of the udder milk yield fed to calf.

How to arrive at Net Cost and Returns?

The fixed and variable cost components discussed above can also be classified as operating, capital and opportunity cost. The first one includes all the paid-out costs; the second covers the capital recovery cost on fixed assets, and the last is the imputed value of family labour, grazed feed and rental value of own land.

The non-milk returns are subtracted from the gross cost to arrive at the net cost and then it is divided by milk yield to get cost on per litre basis.

As in case of cost of cultivation scheme for principal crops in India, various cost concepts are used for milk production. Three variants of the cost that are relevant are:

Short-term= (Operating cost – (Value of dung + urine))/Milk yield

Medium-term= (Operating cost + Capital Cost– Value of dung + urine))/Milk yield

Long-term = (Operating cost + Capital Cost+ Opportunity Cost – Value of dung + urine))/Milk yield

These cost concepts are adapted from Farm Accountancy Cost Estimation and Policy Analysis used in Europe for estimating the cost of production of crop and livestock output in the EU nations.

The medium-term cost concept given above broadly conforms to Cost A2 under Cost of Cultivation Scheme in India and the long-term cost concept conforms to Cost C concept therein.

The major concepts of return that are to be estimated are:

Gross return = Value of milk + Value of Dung + Value of urine

Cash Farm Income (Gross Margin) = Gross Returns – Operating Costs

Farm Income (Net Margin) = Gross Returns – Operating Costs – Capital costs

Entrepreneurs' Profits (Net Economic Margin) = Gross Returns – Operating Costs – Capital costs- Opportunity Cost

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CHAPTER 14

ENTREPRENEURSHIP OPPORTUNITIES IN VALUE ADDED BUFFALO MILK PRODUCTS

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Livelihood security in rural sector of India primarily depends on agriculture and livestock sector is a major contributor. The milk alone accounts for 65% of the value of output form livestock sector and with increasing widespread demand it will continue to be among the major contributor to rural economy. About 75 million small and marginal farmers with an average of 2-3 animals produce more than 50% of the milk in the country. Dairy sector has major share in agricultural GDP and played a major role in our quest for food and nutritional security. India contributes to about 22% of global milk production with over 198.40 MT in 2019-20 with an annual growth rate of 6.3%. The projected demand of milk offers newer opportunities for marginal and small dairy farmers. Buffalo milk because of their unique nutrient and chemical composition offer great opportunity for quality improvement of dairy products.

Buffalo contribute 49% of milk production and production is limited to about 18-20 countries around the world with India contributing a maximum in the total buffalo milk production. Buffalo offer promise of raising milk production because of their adaptability to varied climactic conditions and easier management. Growth of Indian dairy sector would definitely coincide with the consistent supply of good quality raw milk directly from the milk producer or alternatively by promotion of value addition at the producer's level itself. Statistics and predictions related to growth of Indian dairy sector has generated a great amount of interests among the milk producers and pace for adoption of scientific dairy farming practices has increased. Dairying would remain a major contributor to nation's GDP and lucrative source for livelihood options. There has been growing interest among entrepreneurs towards establishment of dairy farms, milk or food processing units on commercial scale.

2. Status of Milk Value Chain in India:

Milk value chain like many agro-commodities is highly complex. Various types of value chains are existing in our country depending on the several factors, usually these value chains are very long and the presence of large number of intermediaries results in poor net return to dairy farmers. Since majority lies in the traditional milk sector and it is facing following problems:

- Non-availability of good quality milk
- Non-adoption of scientific dairy farm practices
- Malpractices resulting in empathy among consumers for small milk producers
- Lack of hygiene and non-adoption of food safety interventions
- No emphasis on value addition in milk at producers level

- Poor return to the dairy farmers

Even though, India has made a remarkable growth in milk production, the achievement is considered insignificant when it is viewed against the challenges faced by the dairy sector. Huge cattle and buffalo population in the country, very low productivity of milch animals, lack of feed and fodder, longer calving interval, reproductive problems and huge expenditure involved in planning and implementation of various dairy development programmes. On the milk procurement and processing front, fragmented milk production, lack of cold chain, poor emphasis on value addition at processors level and also under-utilization of large installed capacities of dairy plants appears to be major bottleneck. The role of dairy cooperatives in milk marketing has been appreciable in the past, but it is facing tough competition in terms of procurement price and marketing cost from the private plants and the milk suppliers. Being highly perishable commodity marketing of milk requires a strong base of intra-structural development in terms of roads, transport, cold chain etc. that will have a definite impact in reducing the wastage and maintaining quality of milk and milk products delivered. The share of milk handled by organized sector is only 17% and unorganized sector which handles more than 80% of milk suffer with multitude problems. Majority of dairy products are manufactured by *halwai's* and belongs to traditional dairy products (TDP's) segment. As liquid milk is no longer an economical proposition, there is need for "diversification" towards high value-added dairy products. In such context, TDP's, dairy beverages, fermented milk products, western dairy products (cheese, frozen desserts), dairy ingredients and functional dairy products could be of great significance. Market growth rate for some of these products is in the range of 15-20% per anum. The cost of milk production is among the lowest in the world. With increasing demand for milk and milk products, both for consumer and industrial market, technological advancements in dairy sector, implementation of FSSAI act, availability of best quality plant, machinery and packaging systems and government initiatives, offers emerging opportunity for Indian dairy sector.

3. Characteristics of Buffalo Milk Vis-A-Vis Cow:

Specific gravity, viscosity, curd tension, pH; oxidation reduction potential (Eh), thermal conductivity, and thermal expansion are all higher in buffalo milk. However, it has a lesser heat capacity and rennet stability than cow milk. Buffalo milk is as stable as cow milk in its fluid state, but the thermal stability of concentrated milk is substantially lower than that of cow milk concentrates. Milk from the two species reacts differently when used for the manufacturing of various products due to variations in their physical qualities. Buffalo milk proteins, particularly whey proteins, are more resistant to heat denaturation if compared to cow milk.

he reconstitution behaviors of dried milk products made from buffalo milk is indistinguishable from those made from cow milk, even though the concentration of denatured proteins is higher it it. Dried buffalo milk may be preferred over dried cow milk for those technological applications where higher levels of undenatured whey proteins would be more desirable like bakery, confectionary and meat-based products.

4. Value Addition of Buffalo milk:

4.1 Indian Traditional Dairy Products:

Conversion of milk to traditional dairy products such as curd, ghee, khoa, chhana, paneer, shrikhand is gaining interest owing to the increased availability of milk during the flush season and the lack of facilities to maintain the fresh quality of liquid milk during its transportation from rural areas to urban markets. In addition, traditional dairy product manufacturing adds value to milk while also providing significant employment opportunities. About 50% of total milk produced in India is converted into traditional milk products. Compositional variations in cow and buffalo milk fetch most of the traditional dairy products with better quality and higher yield when manufactured from buffalo milk, while few products prepared from cow milk possess superior quality. The following are descriptions of the quality and technological advancements of some of the most well-known Indian traditional dairy product manufactured from buffalo milk:

4.1.1 Khoa: Khoa serves a base material for a variety of sweetmeats including burfi, peda, gulabjamun, milk-cake, kalakand and kunda. It is prepared by continuous boiling of milk until desired concentration (65 to 72% TS) and texture is achieved. Minimum 30 % milk fat (on dry matter basis) is required in Khoa (PFA, 1955), and this can be achieved using cow and buffalo milk containing minimum 4 % and 5 % fat, respectively. Moist surface, salty taste, sticky and gritty texture of Khoa from cow milk makes it unsuitable for sweetmeat preparation, whereas, buffalo milk has higher yield of Khoa with smooth and mellowy texture owing to higher emulsifying capacity of buffalo milk.

4.1.2 **Rabri**: Rabri is a partially concentrated and sweetened milk product containing several layers of clotted cream (malai) and is quite famous in northern and eastern parts of the country. It is prepared by simmering the whole milk for a long time followed by the addition of sugar, once the desired concentration is achieved. Storage in an open and shallow container by Halwais often results in significant compositional variations and contamination from environment.

4.2 Heat-And-Acid Coagulated Products:

4.2.1 Chhana: Rasogolla, sandesh, chum-chum, chhana murki, chhana podo and rasomalai are the Indian sweetmeats which are prepared using Chhana as base. Cow milk is considered to be excellent for the preparation of Chhana as it provides soft and smooth texture with velvety body, while chhana manufactured from buffalo milk is dry, hard, and chewy. Several workers, however, have made attempts to correct these defects with the addition of sodium citrates, dilution of buffalo milk with 20-30% water, coagulation at low temperature and homogenization.

4.2.2 Paneer: Typical white colour with sweetish taste, mild flavor, spongy body and close-knit texture are considered to be attributes of good quality paneer. Buffalo milk is more suitable for the preparation of paneer than cow milk because the latter yields a very compact and fragile body. Higher concentration of triglycerides with high melting point, more total and colloidal calcium content and higher concentration of micelle casein with bigger size in buffalo milk coupled with higher yield are the main factors responsible for producing desired quality of paneer. However, to achieve this criteria and PFA requirements, milk should be standardized to fat and SNF ratio to 1:1.65.

4.3 Chhana Based Confections:

4.3.1 Rasogolla: Rasogolla is manufactured by thoroughly kneading chhana and shaping it into small balls, which are then boiled in clarified sugar syrup and cooled slowly in a sugar syrup with a lower concentration. Rasogolla has a snow-white colour and a spongy, chewy substance with a silky texture. It is ideally manufactured from cow milk chhana because buffalo milk chhana is hard and lacks the proper sponginess, body, and texture.

5. High Value-Added Dairy Products from Buffalo Milk:

Coffee whiteners, edible casein and caseinates, ice-cream and infant and health foods are some of the high value-added products made from buffalo milk because of its higher protein, fat and calcium content. Better functional properties of buffalo milk including emulsifying capacity and presence of whole casein in micelle stage with bigger size often results in higher yield of these products as well as, desired texture and improved digestibility.

6. Cheeses from Buffalo Milk:

Mozzarella and white pickled domiati cheese, Bajalo Sala Mureno sirne, Beli-sir-U Kariskama, Teleme, lovi and brinza are some of the varieties of cheese typically made from buffalo milk. However, hard varieties of cheeses are mainly prepared using cow milk as higher buffering capacity of buffalo milk and faster renneting time due to its higher calcium and casein content results in slow acidity development. These defects in buffalo milk cheese have been overcome to a considerable extent by the alternation in the procedure adopted at NDRI and at some other centers such as addition of 1% sodium chloride to milk, higher inoculum (2.5 %), supplementing the starter with *Lactobacillus casei* (0.5 %), low setting temperature (28^0C) and low cooking temperature (36 -37°C), addition of lipase and protease, using partially lactose hydrolyzed milk, partially curing the cheese at 15^0C and blending of buffalo milk with goat milk (9:1).

7. Value Addition in Buffalo Milk: Objectives and Design Aspects of Processing unit:

- Promote conversion of raw milk into primary processed dairy products including concentrated milk, khoa, chhana during flush season
- Value addition at producer's level to enhance better return to dairy farmers and minimize the stakeholders in dairy value chain
- Applying stringent product and process control interventions for energy and water conservation, minimization of waste and deliver best quality products

Concept of Production Facility:

The process line consists of reception dock to receive raw milk, chiller to cool the milk to 4^0C and and stored in silos. The whole pilot plant can be divided into five sections besides office space, quality assurance laboratory, stores and support section.

Broadly process lines will be divided into the following sub -groups:

I. **Indigenous Dairy Products Processing Line:** The production line may be semi-automated to improve the uniformity, quality and safety of resultant products. It will consist of process vats of 1000 & 2000 L capacity, continuous khoa making machines, conical process vat, ghee boiling kettle, ghee clarifier, ghee packaging machine, paneer press, moulds, packaging lines for sweets and paneer.

II. **Liquid/Beverage Processing Line:** The facility includes modular pasteurizer along with form-fill-seal machine, or membrane processing with pasteurizer and packaging system. The section could be utilized for the commercial production of market milk, flavoured milk, innovative dairy beverages (in combination with fruit/malt components) and fortified dairy beverage, with enhanced shelf-life.

III. **Fermented Milks Processing Line:** The fermented milk production line consists of Tubular heat exchanger, insulated double jacketed vat with stirrer, Inoculation tanks, incubation chamber, basket centrifuge, curd-cup filling line, Planetary mixer and syrup making tank.

IV. **Support Section:** It will include boiler, refrigeration section; cold room (cold and frozen storage) and store for the spares, raw materials.

V. **Quality Assurance Lab:** The facility will include milk analyser, Gerber centrifuge, lactometer, laminar flow, BOD incubators, water baths and refrigerator for the analysis of raw milk and finished product.

Unique Feature of Processing unit:

The proposed plant is unique in following ways: -

- The equipment proposed are modular and have flexibility to process wide range of dairy products
- Most the equipment proposed are provided with process control features and of International standards
- Plant will also have quality assurance lab for regular monitoring of quality raw and finished food products

Table 1: List of Equipment (For processing of about 10000 L per day):

S. No.	Equipment	Cost (Rs. In Lakh)
1	Dump Tanks 2000 L capacity (Two)	10.00
2	Bulk Milk Cooler 1000 L (2 no.)	8.00
3	Modular Pasteurizer (provided with balance tank, clarifier, cream separator, homogenizer, PHE, FDV) 2000 L/h	20.00
4	Continuous khoa making machine/Multipurpose Processing Vat 200 L/batch (Two)	4.00
5	Double jacketed Mixing Tanks provided with stirrer and temperature control/monitoring devices 1000 L capacity	7.50

6	Fermented Milks Line 1000 L/h (Inoculation tank, Cup filling line, Incubators/Incubation chamber of matching capacity)	15.00
7	Process vat 500 L	7.50
8	Kulfi making machine	2.00
11	Form-Fill-Seal Packaging Machines (Two)	7.00
12	Cold storage-cum-Walk-in-Cold Room Cold storage (Frozen) -20^{0}C	15.00 5.00
13	Boiler (Two ton)	10.00
14	Ghee preparation unit (100 kg per batch)	5.00
15	Butter churner (50 kg batch)	5.00
16	Instruments and equipments for Quality Control Lab	15.00
	Total Cost	**136.00**

Conclusion:

Buffalo can be considered as backbone of our dairy sector which needs to be capitalized on. Comprising less than half the total population of dairy animals in the country, contribution of buffaloes in country's milk pool is enormous. Its better adaptability to wider range of climates and excellent feed conversion efficiency make them ideal livestock for Asian countries. Moreover, nutritional makes up and therapeutic components of buffalo milk may also serve in enhancing the nutritional security. The demand for buffalo milk-based products is increasing in developed and developing countries. Efforts must be made to harness this strength by developing technologies both for production and processing of buffalo milk.

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CHAPTER 15

FEEDS AND FODDER TECHNOLOGY, SILAGE PRODUCTION, FEED BLOCK AND SUPPLEMENTS

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India inhabits 15% of world livestock population on 2% geographical area with 5.23% cultivated fodder area. With current availability of 462 MT of green fodder and 394 MT of dry fodder, contribution of crop residue, cultivated fodder and grasslands is 54, 28 and 18%, respectively. In India, cultivated fodder is limited to less than 4.5 per cent of the area under cultivation. Present area under fodder crops in India is around 8.6 million hectares and the country are deficient in 23% dry fodder, 32% green fodder and 36% concentrates.

Importance of Green Fodder:

Green fodder is the primary source of vit A for lactation which is essential for maintenance and function of the mucous membrane, directly related to vision. It is crucial for conception, maintenance of pregnancy and shedding of placenta. It is also important for respiratory tract. It is vital for the urinary tract and deficiency causes stones in the kidney, ureter, bladder. During lactation, 2000 I.U. of Vitamin ‘A’ is eliminated in every litre of milk. Green forages have cooling effect on the animal body, more palatable contain easily digestible nutrients, provide fresh effectively utilizable nutrients in natural form and laxative. Cheap source of Vitamin’A’, source of minerals, crude protein, total digestible nutrients and CLA.Generally leguminous fodder contain 8-12% DCP and 45-60% TDN. The phosphorus content of leguminous fodder is poor. It is advisable to supplement a ration containing a large amount of leguminous fodder with a limited quantity of wheat or rice bran, which is rich inphosphorus. The non-leguminous fodder is having 2.5% DCP and 45-60% TDN on dry matter basis. Green fodder is highly digestible (55 – 65%) mostly when harvested at a proper time.

Importance of Silage:

In our country, the rainfall is seasonal and more than 80% of the annual precipitation occurs in a time span of only 3-4 months. As a result, plenty of grass is available just after the onset of monsoon, all of which is not properly utilized. During this season, farmers can also produce a large amount of green fodder. Therefore, a surplus stock of fodder can be accumulated in this season which can be used for cattle feeding during the lean months viz. November to December and April to June. The ideal and simple method of conserving this surplus fodder and grass is to make their silage.

Silage is produced by controlled fermentation of high moisture forage by anaerobic microorganisms that grow in the absence of oxygen. Producing good quality silage is dependent on: 1) rapid removal of oxygen from the silo, 2) an adequate amount of soluble carbohydrates to produce lactic acid, 3) the correct moisture level, and 4) lactic acid producing bacteria dominating the silage fermentation.

Oxygen is present when forage is blown into the silo. During the early stage of silage fermentation, aerobic bacteria, yeast, and molds grow rapidly, and ferment water soluble carbohydrates to carbon dioxide and water until oxygen is depleted from the silo. Prolonged exposure to oxygen during the fermentation process is associated with poor palatability and reduced dry matter and energy content of silage. Aerobic organisms are replaced by anaerobic bacteria once oxygen is depleted from the silo. Anaerobic bacteria convert soluble carbohydrates to organic acids, such as acetic, butyric, and lactic acid, causing a reduction in pH of the silage. A rapid decrease in pH helps inhibit the growth of anaerobic bacteria, such as clostridia, that are associated with reduced silage quality. When silage pH drops to approximately 5, the anaerobic fermentation is dominated by lactic acid producing bacteria. As the pH of silage is reduced to 4.5 or lower, further microbial activity is inhibited by the low acidity. At this point the silage is stable and can be stored for a considerable period. Lactic acid is the primary acid found in good quality silage. Conversion of soluble carbohydrates in forages to lactic acid results in the lowest losses of dry matter and energy during silage fermentation. Silage rich in lactic acid is also highly palatable to animals. A good quality silage has little or no butyric acid. Silage high in butyric acid results from fermentation by clostridia bacteria, and has a lower energy value and reduced palatability.

The crop for silage making is generally harvested at the flowering stage when it has the maximum amount of nutrients. For maize it is about the early dent stage (well-matured stage generally harvested for seed) of maturity. Sorghum is harvested at late dough stage (stage at which seeds are soft and immature) at the earliest. Silage materials containing less than 25% dry matter (more than 75 % moisture) will form a very sour silage juices during storage, incurring a considerable loss of nutrients. Thus, plants for silage making should be allowed to mature till the dry matter content attains 35-40 per cent. Silage material should be cut to a proper size in order to fit it in silo and ensure good quality of silage. The length varies from a fraction of an inch to over an inch in length. Grass silages requires to be finely chopped than maize or sorghum. Wilted and dry forages and forage with hollow stems should be chopped more finely than forage of high moisture content, thus permitting thorough packing and eliminating most of the air pockets.

Some important preservatives used for silage making:

1. **Molasses:** When the lactic acid in silage is about 1-2%, the product is invariably well preserved and palatable because the pH value is usually below 4 and there is no butyric acid. About 1 to 2 % sugar is required to produce this amount of lactic acid. The common and cheapest source of sugar for silage making is molasses.
2. **Urea:** Adding urea at the rate of 0.5 % of fresh forages, has several advantages including a way to feed urea more uniformly throughout the day than when it is fed with concentrates at particular time. The very idea of adding urea is to enrich the silage with nitrogen as cereal forages are mostly deficient in this element.
3. **Limestone:** This is calcium carbonate and may be added at a level of 0.5 to 1.0% to maize silage to increase acid production. It neutralizes some of the initial acids as they are formed, allowing the lactic acid bacteria to perform longer and to produce more desirable acids.
4. **Salt:** Salt makes the silage more palatable. It does not inhibit bacterial activity. At the most it may speed up the release of juices from the cells by plasmolysis and thus help to provide conditions suitable for fermentation in the early stage.

Procedure of Silage preparation:

Filling the silo: An utmost care should be taken in distributing the silage material uniformly in the silo. The material should be trampled, especially well near the walls of silo. It is believed that keeping the centre higher than the outside while filling the upper part of the silo loosens the tendency of the silage to draw away from the wall as it settles. To avoid a large amount of spoilage at the top, the silage should be leveled off and trampled thoroughly from the lower few metres. It. will be better if leveling, trampling, addition of preservatives etc. are done after every 30 cm layer of packing. If the materials are too dry, sprinkle water over each layer.

The filling of the pit should be completed within the least possible time say 3-4 days. Avoid filling silo when it is raining. To create favourable anaerobic condition inside the silo, adequate compression of the material through trampling is essential. It helps in driving air pockets from the silo which may otherwise spoil the silage.

Covering and sealing the silo: It is essential to keep off air from the silage materials of silo. An anaerobic atmosphere in the silo is essential for proper fermentation of silage. Therefore, the silo, should be covered with wet straw, sawdust or other materials and plastered with 4-5-Inch-thick layer of clay soil. If possible, put plastic sheet before plastering with soil. After covering, weights such as paving slabs, concrete posts, concrete cylinders and wooden logs should be kept for better compression. Check the seal from time to time and if any cracks are seen, seal them. A small door (hole) should be opened in one corner, near the surface of the silage to allow the carbon dioxide to escape.

Opening the silo: The silage is ready within the 42-45 days after covering of silo. Some mouldy material is invariably found at the top most portion and also on the sides. This should be discarded and not fed to the cattle. The accumulation of by-products of bacterial metabolism will tend to preserve the forage material as silage for an indefinite period unless air is permitted to enter the silo.

Changes occurred during fermentation at silo:

When green crops are cut and packed in airtight silos, fermentation occurs to convert it into silage. Different constituents of green material undergo chemical changes.

Carbohydrates: The important water-soluble carbohydrates of forage are glucose, fructose, sucrose and galactose. Sucrose and fructose are rapidly simplified into glucose and fructose. The soluble carbohydrates which are not decomposed easily are fermented by a variety of microorganisms. Lactic acid bacteria will also soon dominate the fermentation by rapidly making conditions inhibitory for other unwanted type of bacteria. The complex forms of carbohydrate are gradually converted into organic acids like lactic acid, butyric acid and small quantities of alcohol. When the fodder contains 65-75% moisture and sufficient sugar in the plant juices, anaerobic lactic acid bacteria becomes active to produce eventually a good clean smelling silage of high quality. It is thus essential that the forage used as silage material should contain a high percentage of carbohydrate.

Bacteria Lactobacilli that produce lactic acid from carbohydrates are widely distributed and are sometimes present on the fresh crop. For proper functioning of lactic acid bacteria, a temperature of 27-37°C, is most conducive. They grow best in low concentration of oxygen or in the absence of oxygen. However, the factor of acidity is of equal importance to that of temperature. When a crop is ensiled, the lactic acid bacteria start growing almost at once on the sugar and rapidly use the fermentable sugars and produce so much acid that undesirable bacteria are prevented from developing molds.

Nitrogenous compounds: At the time of harvesting of forage crop, a large portion of protein in plant body is proteolyzed (disappear) and dry matter percentage is increased. In well preserved silage, about 50% net breakdown of the protein may take place. In addition to proteolysis, changes to the liberated amino acids occur because of both plant and microbial activity. In silo, the major change in amino-acids is brought about by Clostridium. A large number of organisms participate in degradation of protein. Some organic acids are produced as intermediate products. The ultimate products are nitrogenous gases like nitrous oxide and nitric oxide.

Fats and lipids: These compounds are degraded into fatty-acids and glycerol. The enzyme lipase is secreted by several microorganisms which causes conversion of fats and lipids into fatty-acids and glycerol. The later course of change results in the formation of acids as in case of carbohydrates. The pigments of the original forage material e.g. chlorophyll, carotenoids, etc. are also changed. These pigments are responsible for plant colour. Therefore, the change in original pigments of the forage, results in silage having different colour from original material.

The newly filled silo contains a little amount of oxygen despite thorough trampling. In the beginning, living plant cells continue to respire, thus rapidly using up oxygen in the trapped air and giving off carbon dioxide. In about 4-5 hours the free oxygen is all used up, but the carbon dioxide increases rapidly for about 48 hours when it comprises from 60-70% of the silo gases. Subsequent to this time due to production of other metabolites include various gases like carbon dioxide, methane, carbon monoxide, nitrous oxide, nitric oxide, etc. and the amount of carbon dioxide begins to decrease.

Loss of Nutrients while making silage:

Certain losses in nutritive value are inevitable when a crop is ensiled, no matter how successful the preservation may be. Losses fall into three categories:

1. Wastage due to charring or mould growth;
2. Loss of food constituents in any juice that drains away from the silo; and
3. Conversion to carbon dioxide and water during respiration and fermentation.

Characteristics of Good Silage:

Colour: Colour of silage serves as an important index of its quality. A good silage has uniform yellowish green colour. A dark brown colour indicates excessive heating and if colour is black the silage is useless and rotten. Too high moisture content imparts deep green to black colour. In the presence of air, moulds develop on silage and the colour of silage becomes black.

Odour and texture: Good silage is free from any objectionable smell. Strong smelling silage is not only poorly palatable but also imparts undesirable smell to milk if served to milch animals. The smell of butyric acid, ammonia or musty odour indicates a considerable loss in feed value. Silage of this kind should be avoided if possible. Too high moisture content may cause foul smell in silage.

Degree of wetness: Silage having high moisture content (75 % or more) contains less feed value per kilogram than silage having low moisture. This may be due to the loss of nutrients through seepage. If juice runs freely when silage is squeezed in the hand, it indicates that the material has very high moisture content.

Chemical properties: There are many factors which affect the chemical nature of silage. These include type of crop, age of crop, method of ensiling, degree of compaction of silo, etc. The quality of the silage is most readily assessed by determining its pH value. pH value is the measure of reaction of silage. A good silage has pH value 4.2 or less. At this pH level silage contains good amount of lactic acid (3-13 %). In general, the butyric acid concentration of good silage is less than 0.2 % and the ammoniacal nitrogen (NH_4) is less than 11 % of the total nitrogen.

Advantages of Silage:

1. Silage can be made all the year round. Thus, it can supply green fodder when rest other sources are not available.
2. Green fodder can be kept preserved in succulent stage for any length of time.
3. Grass silage preserves 85 % or more of the feed value of the crop, whereas hay making will preserve much less percentage of nutrients.
4. During and immediately after monsoon, abundant grass is available. During this season hay making is difficult. This grass can be preserved as silage.
5. Weeds are redundant plants growing in the field. They do not make a good hay but cattle relish most of the crop weeds. These weeds can be ensiled to supply nutritious feed to ruminants.
6. Silage is a very palatable feed and slightly laxative in nature.
7. It is better source of protein and of certain vitamins, especially carotene and perhaps some of the un- known factors, than dried forage.
8. With early removal of kharif crops from fields for silage purpose, enough is available for preparing the land for the sowing following rabi crop.
9. Less of storage space is needed for silage than for hay. A cubic foot of silage contains about three time more dry weight of feed than a cubic foot of long hay stored in the mow.
10. It offers many advantages over pasture including no requirement of fencing, more forage from the same acreage, harvesting at optimum maturity more uniform quality.

Disadvantages of silage:

1. It requires more labour while filling the silo and add to the cost of feeding farm animals.
2. It requires a silo in comparison with the simpler method of field curing and storing hay. This is likely to mean higher cost for small farmers.
3. Feed contains very less Vitamin D than sun-cured hay.
4. Preservatives like molasses and sodium meta bisulphite increase the cost of feed. Preservatives are also not freely available at all the places.
5. Silage can seldom be used as the sole ration unless it has the right combination of high protein legume, low protein grass and cereal crops.

Table 1: Percent Nutritive value of fodder and silage on fresh raw material basis

Sl.No	Crops	DM	DCP	TDN
1	Oats	18-20	1.5	16.7
2	Oats silage	25-30	1.2	18.7
3	Maize	20	1.2	16.9
4	Maize silage	25-30	1.0	18.4
5	Jowar prime	25-30	1.03	16.0
6	Jowar silage	25-30	0.7	15.3
7	Berseem	12-15	2.5	11.9
8	Paddy straw + Berseem silage	--	2.0	16.0

Importance of Feed Block:

The complete feed block and/ total mixed ration (TMR) is a quantitative mixture of all dietary ingredients to provide the specific nutrients requirement. In this system the animals have continuous free choice availability of a uniform feed mixture resulting in more uniform load on the rumen. This product is fed as a sole source of nutrients except water. A more even intake of feed into rumen is also associated with less fluctuation in the release of ammonia, so that non-protein nitrogen may be more efficiently utilized. As the density of energy increased in the ration there is a linear increase in feed intake, milk yield, milk protein and lactose yield. Particles size is an important factor to be considered in processing of complete feed diets to maintain the milk fat level. Diets that have smaller forage particle size results in an increase in the fractional turnover rate of ruminal DM and increased DMI and spend less time in the rumen for microbial digestion, thereby decreasing digestibility, particularly fibre digestion. Since organized dairy farms are coming up in our country so complete feed concept of feeding animals is becoming increasingly popular. Inspite of some limitations like processing cost, this technology has potential to open the field of employment for educated rural youth in our country.

The rumen microbial fermentation pattern is the key to the productive performance of dairy animals. The productivity of ruminants depends on the efficiency with which rumen microbes extract energy from feed stuffs. The poor-quality crop residues like wheat, bajra and rice straws constitute the bulky dry matter consumed by the animals under field conditions. Proportion of roughage in the diet is expected to change the pattern of microbial population which inturn may affect their capacity to colonize feed particles and may influence the supply of nutrients to improve the performance of the animals.

Physical, chemical and biological methods are the process to improve intake and digestibility of crop residues. The concept of feeding complete feed blocks containing nutrients in balanced proportion and quantities is more ideal for attaining optimum rumen fermentation, nutrient intake and production from livestock. Making of complete feed blocks soften the hard component of the dry roughages and make easy the work of rumen microbial population.

Balance feeding and Feeding Management of Buffalo:

Ruminant animals are relatively unique in the animal kingdom. They have only five key nutrient requirements viz. crude protein, energy in the form of fiber, fat, vitamins and minerals. A nutritionally balanced diet is one that meets an individual animal's nutritional needs throughout the day or year or life. An unbalanced diet can lead to poor health and performance. A well-balanced diet contains energy, protein, minerals and vitamins in a required proportion. In buffaloes 40% dry matter should come from concentrate mixture, 30% DM should come from dry roughages like wheat straw or bajra kadbi or paddy straw and 30% DM from green fodder. In green fodder one third should come from leguminous fodder. In concentrate mixture both type of cakes, mean rumen degradable and undegradable must be there for efficiently synthesis of microbial protein and directly dietary availability of protein from intestine. For adult buffalo, CP in concentrate mixture should be between 16-18 %. For heifer, CP in concentrate mixture must be 18% and for growing it must be 20-22%. Beyond this range it will increase the blood urea concentration which is harmful.

Table 3: Ingredients composition of concentrate mixture for lactating buffaloes (by parts)

S No.	Ingredients	By Parts
1	Wheat/barley/Maize	40.00
2	Cotton seed cake (expeller)	20.00
3	Mustard seed cake (expeller)	15.00
4	Wheat bran/ DORB	22.00
5	Min mix	02.00
6	Salt	01.00
7	Total	100.00

Table 4: Ingredients composition of concentrate mixture for dry, heifers and bulls (by parts)

S No.	Ingredients	By Parts
1	Wheat/barley/oats	40.00
4	Mustard seed cake (expeller)	35.00
5	Wheat bran/ DORB	22.00
6	Min mix	02.00
7	Salt	01.00
8	Total	100.00

Table 5: Ingredients composition of concentrate mixture for calves (by parts)

S No.	Ingredients	By Parts
1	Wheat/barley/Maize	40.00
2	GNC	27.00

3	Mustard seed cake (expeller)	05.00
4	Wheat/ DORB	25.00
5	Min mix	02.00
6	Salt	01.00
7	Total	100.00

Calculation of DM requirement and supplementation from different sources: DM requirement of different category of buffaloes is different and it is calculated on the basis of body weight of that category of buffalo.

Table 6: DM requirement of buffaloes on body weight basis

S No.	Category	Female Buffalo	Male Buffalo
1	0-1 year	1.8	1.8
2	1-2 year	1.8-2.0	1.8-2.0
3	Heifer/breeding bulls	2.0-2.2	1.8-2.2
4	Milking	2.8-3.0	-
4	Dry	1.7-1.8	-
5	Other	1.7-1.18	1.7-1.8

Suppose you have a lactating buffalo having 500 kg body weight and its DM requirement @3 % would be 15 kg. Now divide this 15 kg into 40 % conc mix, 30% green and 30 dry roughage.

a) DM from con mix :(40/100)*15= 6.0 Kg DM from conc mix. If DM in conc mix is 90.0 % then we have to feed (100/90)*6=6.67 kg conc mix we have to feed the buffalo.

b) DM from wheat straw: (30/100)*15= 4.5 kg DM from wheat straw. If DM in wheat straw is 90.0 % then we have to give (100/90)*4.5= 5.0 kg wheat straw we have to feed.

c) DM from green: (30/100)*15= 4.5 kg DM from green. If DM in green is 20.0% then we have to give (100/20)*4.5= 22.5 kg of green fodder we have to feed the buffalo.

If we have sufficient green fodder, then we can replace conc mix with green. For every 1.0 kg conc mix we need 10.0 green fodder. We can replace it upto 8.0 kg of milk, beyond that we have to feed conc mix for every 2.0 kg milk, feed 1.0 kg of balanced conc mix.

Use of exogenous compounds as supplements:

Inflammation Modular: High yielding buffaloes tend to produce less milk, lose body reserve and became less fertile because they suffer from inflammation which may not be clinically evident. Conjugated linoleic acid, antioxidants, Omega -3 fatty acids, Selenium, Vit E are various modular's.

Bypass fat (BPF): Under field condition CB cows and buffaloes lose 80-100 kg BW after calving. Such animals come in heat very late. We can feed oil or fat 2.5-3% of DMI without any harm to rumen microbial population but BPF up to 13% can be incorporated in diets of high yielder cows. BPF feeding improve milk yield, fat content, increase the proportion of unsaturated and long chain FA of milk fat and improve BW.

Protected amino Acids: Methionine and Lysine are the first limiting amino acids in milk production. Ideal ratio between Met and Lys is 1:3. Feeding of both RDP and UDP can meet the requirements of both. Buffalo fed protected Met and Lys produces more milk in early lactation. About 30 % of Met absorbed by ruminants is used for choline synthesis which further reduces BUN and NEFA.

Choline: Choline present in feed stuffs is degraded rapidly. It is a component of phospholipid and facilitate lipid absorption and transport and involve in milk fat synthesis. Dairy animals unable to synthesis sufficient choline to match the level of body fat mobilized during early lactation. This led to accumulation of fat in liver.

Glucogenic Precursors (Propylene glycol (PG)/glycerol: Oral drenching or top dressing of PG on TMR is advised. About 50% metabolized within 1-2 hours and 80-90% metabolized within 3 hours after feeding. It is easily and rapidly absorbed in rumen. It also prevents ketosis and increases milk yield.

Dietary Buffers: High yielding dairy animals having 50:50, R:C ratio and having 40-50 % cereal grains result in less salivation and thereby reducing rumen buffering capacity. As rumen pH drop near to 6, fibre digestion is sharply reduced. Animals go off feed and DMI reduced and ultimately decrease in milk fat percentage. Dietary buffers such as sodium bicarbonate, magnesium oxide, calcium carbonate are added to neutralize acidity in the rumen. Addition of dietary buffer @1.5% in high conc. (cereal based) ration can increase DMI, milk yield and its fat content.

Therefore, feeding with sufficient green fodder, proper concentrate mixtures, various roughage sources, feed block, silage, feed supplements as per the available feed resources will improve the production, reproduction and health status of buffaloes.

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