DAIRY FARMING: A PROFITABLE VENTURE

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This e-book is a compilation of resource text obtained from various subject experts for the Collaborative Online Training Programme of Karnataka Veterinary Animal and Fisheries Sciences University (B), Karnataka & MANAGE, Hyderabad, Telangana on "DAIRY FARMING: A PROFITABLE VENTURE" conducted from 20th – 22nd June, 2023. This e-book is designed to educate extension workers, students, research scholars, and academicians related to veterinary science and animal husbandry about innovations in dairy management. Neither the publisher nor the contributors, authors and editors assume any liability for any damage or injury to persons or property from any use of methods, instructions, or ideas contained in the e-book. No part of this publication may be reproduced or transmitted without prior permission of the publisher/editor/authors. Publisher and editor do not give warranty for any error or omissions regarding the materials in this e-book.

Published for Dr. P. Chandra Shekara, Director General, National Institute of Agricultural Extension Management (MANAGE), Hyderabad, India by Dr. Srinivasacharyulu Attaluri, Program Officer, MANAGE and printed at MANAGE, Hyderabad as e-publication.

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.

In agriculture, dairy farming refers to the long-term production of milk that is handled (either on the farm or at a dairy factory, both of which may be referred to as dairies) in preparation for the potential sale of a dairy product. Dairy farming has always been a small-holder activity in India. Dairy farming on a commercial scale has been adopted by milk producers to take advantage of market possibilities since milk and milk products are in high demand. Since the individual animal is the smallest production unit in the dairy industry, effective management of a dairy farm must prioritise individual animal care in addition to group or herd management.

This e-book covers an array of subjects, Dairy Farming: A profitable Venture. I would like to extend my appreciation to, KVAFSU, Bidar & EAAS Centre, MANAGE, Hyderabad for the tremendous effort in compiling this ebook. I also thank the authors, editors, and designers who have contributed to this ebook creation.

Dr. P. Chandra Shekara
(Director General, MANAGE)

FOREWORD

Dairy farming is an enlightening journey into the world that not only sustains livelihoods but also promises to be an exceptionally profitable endeavor. This exploration into the realm of dairy farming unveils the intricacies, the challenges and the remarkable rewards that come with nurturing and harnessing the potential of these gentle bovine companions. It is far more than just a means of producing milk, it embodies a harmonious blend of science, technology and compassion. From the initial steps of selecting the right breed and establishing the farm infrastructure, to the delicate processes of animal care, nutrition, and sustainable practices – this venture demands dedication, knowledge and an unwavering commitment to excellence. While embarking on this journey, aspiring dairy farmers must be prepared to embrace the challenges that lie ahead. From managing the well-being of the herd and maintaining hygiene standards, to navigating the ever-evolving landscape of market demands and technological advancements – the path to profitability may be dotted with obstacles. However, it's precisely within these challenges that opportunities for growth and innovation arise.

Dairy farming's profitability isn't confined to financial gains alone. It extends to nurturing the rural economy, providing employment opportunities and contributing to food security. As the global population continues to burgeon, the demand for high-quality dairy products shows no signs of abating, making dairy farming an industry of immense significance. In this journey, knowledge becomes your most valuable asset. Furthermore, you'll glean wisdom from experienced voices who have weathered the trials and triumphs of dairy farming, offering invaluable advice for those just setting foot on this path. As you delve into the realms of dairy farming through this training programme, I encourage you to approach this venture not just as a pursuit of profit, but as a commitment to nourishing communities and contributing to a sustainable future. May this exploration ignite participants passion, broaden their horizons and empower them to embark on dairy farming as a profitable and fulfilling endeavor.

This e-book on the training program “Dairy Farming – A Profitable Venture” will offer insights into breeding practices, animal welfare, modern milking technologies, sustainable farming methods and value added technologies. KVAFSU Bidar is one of the leading Veterinary University of the county and is striving its best evolving farmer friendly technologies and disseminating to the end users. Veterinary College, Hassan (HVC) has emerged as the fourth constituent Veterinary College of KVAFSU, Bidar and it renders Teaching, Research and Extension services with the mission to cater Rural Oriented and Farmer Friendly services for the betterment of the farming community. In establishing path-breaking milestones over the decade, the college has instrumentally kept pace with new frontiers and horizons of innovations in the area science, technology and human resource development relevant to the society. I congratulate the entire team of Veterinary College, Hassan and MANAGE Hyderabad in publishing this e- book on “Dairy Farming – A Profitable Venture” and am sure that all the stakeholders will benefit immensely from the rich and sound content of the publication.

Dr. M. C. Shivakumar
(Dean, Veterinary College, KVAFSU, Hassan)

PREFACE

Dairy farming has been considered a profitable venture in the Indian context. India has been the leading producer and consumer of dairy products worldwide. Since 1998, the dairy industry continues to witness growth in the availability of milk and milk products. The demand for milk and milk products in India is driven by factors such as the growing population, rapid urbanization, improving incomes, and the inclination of younger demographics to consume higher quantities of milk. The Indian government has implemented policies to promote dairy farming and has allowed 100% foreign direct investment (FDI) in animal husbandry, food processing, and trading of food products. However, it is important to note that profitability in dairy farming can vary depending on various factors such as management practices, market conditions, and input costs. Large-scale dairy farms with several hundred cows are generally considered more profitable compared to small-scale farms. Additionally, factors like dairy processing, creativity, and good marketing can present opportunities for small dairy producers. This book is designed to provide a comprehensive guide to those who want to run a successful and profitable dairy farming operation. It covers everything from the basics of dairy farming to advanced strategies for maximizing profit. It is an essential resource for all who wants to start their own dairy farming business, as well as current dairy farmers who are looking for ways to improve their operations. The readers of the book carry a comprehensive understanding of dairy farming and the tools and techniques to build a profitable and sustainable dairy farming business.

This e-book is an outcome of collaborative online training program on "DAIRY FARMING – A PROFITABLE VENTURE" conducted from 20 June – 22 June, 2023. This book will be highly useful to Veterinary Professionals across the country and Extension workers who are working at the grassroot level. A docket of topics like opportunities and challenges in dairying, cost effective feeding technologies, scientific breeding, small holder dairying, innovative technologies in dairy reproduction, disease prevention and biosecurity measures, mindset change for entrepreneurial dairying, nutritional interventions for profitable production, value addition and marketing avenues, organic dairying, climate resilient farming, private dairy enterprises, value addition to animal waste and innovations in agricultural extension have been covered exhaustively for the benefit of the Veterinarians.

The editors express sincere thanks to Prof. K.C. Veeranna, Hon'ble Vice Chancellor, Karnataka Veterinary Animal and Fisheries Sciences University, Bidar, Karnataka, for inspiration and motivation in publishing this e-book. The financial aid provided by MANAGE, Hyderabad for this training program is duly acknowledged. We hope and trust that the valuable inputs provided through this e-book will help to improve the ability of all the stakeholders in Dairy sector to enhance dairy production for welfare of the farming community.

JUNE 2023

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Contents

Chapter 1

OPPORTUNITIES AND CHALLENGES IN INDIAN DAIRY INDUSTRY

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Introduction

The historical roots of dairy production in India can be traced back approximately 8,000 years to the domestication of zebu cattle in the Indian subcontinent. Dairy products, particularly milk, have been an integral part of Indian society, influencing various aspects such as cuisine, religion, culture, and the economy. North Indian cuisine prominently features dairy products like paneer (cottage cheese), while South Indian cuisine incorporates yogurt and milk in various dishes.

In the 1970s, Operation Flood was launched, aiming to increase milk production, improve rural income, and ensure transparent pricing for consumers. This initiative brought cooperatives into the dairy industry and facilitated the growth of the local dairy sector by utilizing donated milk products from other countries. It played a vital role in transforming the Indian dairy industry and creating a strong foundation for its future growth.

The historical development of dairy production in India can be divided into two distinct phases: pre- and post-Operation Flood. Pre-Operation Flood, the British-established military dairy farms in places like Allahabad, Bangalore, Ooty, and Karnal played a role in ensuring milk supply for the colonial army. However, their impact on civilian consumers was limited. Post-Operation Flood, with the growth of the population in urban areas, milk vending became essential, and advancements in herd improvement practices like artificial insemination began to have a more significant impact.

The significance of milk production in India is multifaceted and encompasses various aspects, including the economy, agriculture, culture, and dietary habits. *The key points that highlight the importance of milk production in India are -*

1. Contribution to the Economy: The dairy industry is a significant contributor to India's national economy and directly supports more than 80 million farmers. It is the single largest agricultural commodity, accounting for 5% of the country's GDP. The dairy

sector has compound annual growth rate (CAGR) of 6.2% from 146.31 million tonnes (MT) in 2014-15 to 209.96 MT in 2020-21, with a Compound Annual Growth Rate (CAGR) of 6.4% over the past five years. The expected marker size by 2026 is $ 314 billions.

2. Global Milk Production Leader: India ranks first in the world in both milk production and consumption. With over 302.3 million bovines (2019 census), India has the largest dairy herd globally. The milk production of India has registered 51 % increase during the last eight years i.e., during the year 2014-15 and 2021-22. In the year 2021-22, India contributed 24% of the global milk production and has employed 80 million population. Milk production amounted to 221.06 million metric tons in fiscal year 2022, up from (2021) previous year's 209.9 million metric tons. The growth rate of milk production in the country was slightly decreased from about 5.8 percent during 2021 to nearly 5.29 percent in 2022.

3. Cultural and Religious Significance: Milk and dairy products hold cultural and religious significance in India. They are widely used in Indian cuisine and play a vital role in various regional dishes. Products like paneer (cottage cheese) are prominent in North Indian cuisine, while yogurt and milk are prevalent in South Indian cuisine. Milk is also an integral part of Hindu religious practices and rituals.

4. Domestic Consumption: The majority of milk produced in India is consumed domestically. The per capita availability of milk in India has been increasing over the years, surpassing the world average. As of 2021, 48.8% of the population reported daily milk consumption, with an increasing trend in milk and curd consumption across both genders. The increasing population and rising disposable incomes have led to a higher demand for milk and milk products. This demand acts as a driving force for farmers to expand their production capabilities.

5. The advancements in animal husbandry practices, including better breed selection, improved feeding techniques, and enhanced veterinary care, have resulted in higher milk yields per animal. The adoption of modern farming technologies and practices has further contributed to the growth of milk production.

6. Moreover, the cooperative movement in the dairy sector, led by organizations such as Amul and Mother Dairy, has played a significant role in supporting farmers and ensuring fair pricing for their milk. These cooperatives provide necessary infrastructure, training, and marketing support to the farmers, thereby boosting milk production.

Top facts of India Dairy industry

- In 2020-21, the share of Livestock at constant prices in Agriculture Sector and total GVA was 30.13% and 4.9% respectively.
- The per-capita availability of milk is 444 gram/day during 2021-22 increased by 17 gram/day over previous year.
- The top 5 milk-producing states in India are: Rajasthan (15.05%), Uttar Pradesh (14.93%), Madhya Pradesh (8.6%), Gujarat (7.56%) and Andhra Pradesh (6.97%). They together contribute 53.11% of total milk production. Milk production is growing at the rate of two per cent in the world, whereas in India, its growth rate is more than six per cent.
- India's Export of Dairy products was 108,711.27 MT to the world with a recorded growth rate of 19.45 % as its export rose to $ 471 Mn in FY 2022-23 till April-December 2022 from $395 Mn in April-December 2021 of the last fiscal year. Major Export Destinations (2021-22) were Bangladesh, United Arab EMTs, Bahrain, Malaysia, Saudi Arab and Qatar.
- India's Butter, Ghee and Dairy Spreads export was valued at $ 171.2 Mn with 33,020.77 MT in 2021-2022, major destinations being UAE, USA, Saudi, Singapore and Australia.
- India exported 7,648.69 MT of Cheese worth $ 37.2 Mn in 2021-22, major destinations being UAE, Bhutan, USA, Singapore and Saudi Arabia.
- India exported 46,285.54 MT of Skimmed Milk in Powder (SMP) worth $ 132.69 Mn in 2021-22, major destinations being Bangladesh, Malaysia, UAE, Afghanistan and Bhutan. The SMP market is expected to grow at a CAGR of around 13% during 2021-2026.
- Value-added Dairy products are projected to have a rate of return of 20-30%. Cheese market is expected to be $1.5 Bn growing by 18% CAGR from 2021-26. Yoghurt market in India is expected to be $6.02 Bn growing by 15.3% CAGR from 2021-26.

Opportunities in Dairying

The dairy sector presents immense opportunities for farmers, entrepreneurs, policymakers and offers a range of opportunities that can be harnessed to boost rural incomes, employment, and food security. However, there are also inherent challenges that need to be overcome to ensure sustainable growth.

Rising Demand for Milk and Dairy Products

- The growing population and increasing per capita income contribute to the rising demand for dairy products. The demand is not limited to traditional dairy products

like liquid milk but also includes value-added dairy products such as butter, spreads, and processed dairy foods. This presents an excellent opportunity for dairy farmers and processors to expand their operations and cater to the market's needs.

Employment Generation and Rural Development

- Dairying has the potential to generate significant employment opportunities, particularly in rural areas. The establishment of dairy cooperatives and self-help groups can empower small-scale farmers, create jobs, and contribute to rural development.

Value Addition and Diversification

- There is a growing trend of value addition in the dairy sector, with increased demand for processed dairy products such as cheese, butter, yogurt, and ice cream. Consumers are willing to pay a premium for these products, creating opportunities for diversification and higher profitability for dairy farmers and processors. This offers opportunities for entrepreneurs to invest in value-added dairy products and tap into new markets.

Export Potential

- India has immense potential for dairy exports, given its large milk production capacity. With improved infrastructure and quality control measures, Indian dairy products can gain a competitive edge in the global market, leading to increased export earnings. The Indian dairy industry has witnessed substantial growth in dairy exports, with products like butter, ghee, dairy spreads, cheese, and skimmed milk powder finding markets in countries like UAE, USA, Saudi Arabia, and Bangladesh

Nutritional Value

- Dairy products serve as a major source of cheap and nutritious food for millions of people in India, especially among the landless, small and marginal farmers, and women.

Technological Advancements

- Investments in technologies like Bulk Milk Coolers (BMCs), advanced milk testing kits, and IoT-enabled systems have the potential to enhance milk production, quality, and processing efficiency. Precision dairy farming with the use of sensors, automation, and data analytics, can enhance productivity, animal health monitoring, and overall farm management

Infrastructure Development

- There is a significant infrastructure gap in the dairy sector, presenting investment opportunities in setting up organized and certified farms, establishing dairy processing plants, and improving cold chain logistics.

Government Initiatives

- The Indian government has implemented various initiatives and policies to support the dairy sector. Operation Flood, a dairy farming policy, has played a significant role in increasing milk production. The government has also established the National Dairy Development Board to promote the development of the dairy industry. Programs such as the National Dairy Plan, Dairy Entrepreneurship Development Scheme and Rashtriya Gokul Mission, Pradhan Mantri Kisan Samman Nidhi Yojana, Dairy Processing and Infrastructure Development Fund (DIDF), Animal Husbandry Infrastructure Development fund (AHIDF). 100% FDI through automatic route for Animal Husbandry is permitted.

Challenges in Dairying

Lack of Quality Feed and Fodder

- One of the primary challenges faced by dairy farmers is the availability of quality feed and fodder for their livestock. Insufficient access to nutritious feed affects milk production and overall animal health. At present, India faces a shortage of 23.4 percent for dry fodder, 11.24 percent for green fodder, and 28.9 percent for concentrates (IGFRI Annual Report, 2019). Currently, the country produces fodder on only 5 percent of its cultivable land. With the increasing popularity of high breed animals, there is a huge demand for good quality feed and fodder to meet the dietary requirements of milking animals. There are an excessive number of unproductive dairy animals that are competing for feed and fodder with productive dairy animals. The small and marginal farmers and agricultural labourers engaged in the dairy farming do not have the capability to purchase adequate feeds and fodder, therefore their animals remained under fed. In standard dairy production systems, feed costs account for up to 70% of total costs. Consequently, the dairy farming profitability is affected by high-cost feeding.

Unorganized Indian Dairy sector

- The most fundamental feature of the Indian dairy industry is that it is still mostly unorganized. Only 18-20% of India's total milk production is handled in the organized sector. The unorganized sector has still not integrated into the modern processing infrastructure. Due to the perishable nature of milk, it is not possible to

procure milk beyond a 200 km radius. Cold storage and supply chain difficulties affect India's dairy industry.

Inefficient Supply Chain and Infrastructure

- The challenges are related to supply chain management, including inefficient logistics, lack of proper cold storage facilities, and inadequate transportation infrastructure. These challenges result in post-harvest losses and quality degradation. Investment in cold chain facilities, milk collection centers, and transportation networks is essential to improve the supply chain efficiency and reduce wastage. According to Assocham about 3% of the milk produced gets wasted annually.

Low Milk Processing Capacity

- Despite being the largest milk producer, India's milk processing industry is relatively small, with only 10% of the total milk being processed in dairy plants. The unorganized sector, including milkmen and vendors, handles a significant portion of the milk production, leading to inefficiencies in processing and distribution.

Limited Access to Credit and Insurance

- Small-scale dairy farmers often face difficulties in accessing formal credit and insurance facilities, limiting their ability to invest in better animal husbandry practices and expand their operations. Providing financial support and insurance schemes tailored to the needs of dairy farmers can enhance their resilience and productivity.

Low Productivity and Quality Standards

- Average milk yield of cows in India is lower than US counterparts 1,248 kgs of milk per cow in a year compared with ~10,000 kgs of milk per year.
- While India has the largest milk production volume, its productivity per animal remains relatively low. Additionally, ensuring consistent quality standards throughout the supply chain is crucial for domestic and international market acceptance. Investing in research and development, promoting best practices, and implementing quality control measures are essential to improve productivity and meet global standards.
- Ensuring quality and safety standards throughout the dairy value chain remains a challenge. Issues such as adulteration, lack of hygiene practices, and inadequate testing facilities can affect consumer confidence and market competitiveness.

Average yield per animal (kg/day) (DAHD, 2019)

Exotic cows	Crossbred cows	Indigenous cows	Non-descript cows	Indigenous Buffaloes	Non-descript buffaloes	Goats
11.67	7.85	3.85	2.50	6.34	4.35	0.45

Product Diversification

- While liquid milk dominates the Indian dairy market, there is a need for greater product diversification and value addition to cater to evolving consumer preferences. Developing and marketing value-added dairy products require innovation and market-focused strategies

Poor Returns

- Many dairy farmers in India face challenges in obtaining fair returns for their efforts. Issues such as low milk prices, high input costs, and market volatility affect the profitability of dairy farming.

Lack of Education and Training

- Limited access to proper education and training programs for dairy farmers and workers hinders the adoption of best practices, modern techniques, and technologies

Poor adoption of technology

- The already proven high-yielding varieties of fodder and technologies for feeding livestock such as urea-molasses treatment, silage and hay making are very poorly adopted by many farmers in most states. According to the Indian Ministry of New and Renewable Energy (MNRE) report, on an average, India produces 500 million tons of crop residue each year. Despite domestic and industrial applications of this as fodder as well as fuel a surplus of 140 million tons, of which 92 million tons are burned every year and could potentially be used as animal feed.
- Artificial Insemination (AI) is the most affordable and convenient method for dispersing improved genetics to farmers' doorsteps. However, AI coverage of bovines is about 30%, ranging from 71% to less than 1% in several states. Consequently, 65 percent of animals are still bred naturally either because the services are not available at the farmers' doorstep or because of poor efficacy of frozen semen or non-availability of well-trained AI technician.

Climate Change and Environmental Sustainability

- Climate change poses challenges to the dairy sector, affecting feed availability, water resources, and overall sustainability. Developing climate-smart dairy farming practices, promoting resource conservation, and adopting renewable energy solutions can contribute to the sector's long-term sustainability. Sustainable dairy farming practices, waste management, and minimizing the carbon footprint are crucial challenges that the Indian dairy industry needs to address. Promoting eco-friendly initiatives can ensure long-term sustainability

High economic losses of dairy farmer due to diseases:

- Farmers have a huge financial burden due to animal diseases. Inadequate vaccination coverage is continuously resulting in economic losses attributed to a wide variety of animal diseases. It is difficult to include accurate estimates of the losses caused by the various diseases since it is impossible to record all diseases in all locations. The direct losses evaluated based on reported diseases suggested that average yearly economic losses because of Haemorrhagic Septicaemia (HS), Foot and Mouth Disease (FMD), Brucellosis, Peste des Petits Ruminants (PPR), were in tune of Rs. 5255 crores (2014), Rs. 20000 crores (2016), Rs. 20400 crores (2015), and Rs. 2417 crores (2016), respectively. It was estimated that farmers in India suffer direct losses of over 50,000 crores per year as a result of diseases that may be completely avoided with immunization.

Inadequate veterinary facility in dairy sector

- The Indian dairy sector is suffering due to inadequate infrastructure facility. The National Commission on Agriculture (NCA)-1976 recommends one veterinary institution for every 5,000 cattle units (one cattle unit =1 cow / 1 buffalo /10 sheep / 10 goats / 5 pigs / 100 poultry) to maintain effective veterinary health care. According to VCI, India has 67651 veterinarians, while demand is between 1.1 to 1.2 lakh. As a result of this inadequacy, farmers are receiving poor and insufficient veterinary services.

How to address these challenges?

The Indian government has recognized the importance of the dairy sector and has implemented various initiatives to support its growth. Programs such as the National Dairy Plan, Dairy Entrepreneurship Development Scheme and Rashtriya Gokul Mission aim to enhance milk production, improve breed quality, and provide financial assistance to dairy farmers. These interventions help address some of the challenges and create an enabling

environment for the dairy industry. The Pradhan Mantri Kisan Samman Nidhi Yojana provides financial assistance to small-scale dairy farmers, empowering them to invest in modern infrastructure and technology.

Animal Husbandry Infrastructure Development fund (AHIDF) is one of the flagship schemes by DAHD, Government of India whereby INR 15,000 Cr fund has been setup for offering financial support to set up new units or expand existing units in areas of dairy processing & related value addition infrastructure, meat processing & related value addition infrastructure and Animal Feed Plant. The benefits are available at 3% interest subvention on loans for 2-year moratorium with 6-year repayment period. INR 750 Cr credit guarantee is earmarked.

To capitalize on the opportunities in dairying, it is crucial to focus on several key areas. Firstly, there is a need for investment in research and development to improve animal genetics, nutrition, and health management practices. This will enhance the productivity of dairy animals and contribute to higher milk yields.

Secondly, the development of robust infrastructure such as cold storage facilities, milk processing plants and efficient transportation systems minimize post production losses and maintain product quality. The integrated supply chain networks that connect farmers, milk collection centers, processing units, and markets can help streamline the supply chain and reduce wastage. Implementing technology solutions like digital milk procurement systems, cold chain infrastructure, and efficient transportation can improve the overall efficiency of the supply chain.

Promoting farmer-producer organizations, cooperative societies, and encouraging direct procurement by dairy companies can help ensure better returns for farmers.

In addition, there is a need for comprehensive training and extension services for dairy farmers. Providing technical knowledge and guidance on modern dairy farming practices, animal nutrition, and healthcare can significantly improve the efficiency and profitability of dairy operations. Farmer cooperatives and self-help groups can also play a vital role in disseminating information and facilitating collective bargaining power.

One of the major challenges in the dairy sector is the shortage of quality feed and fodder for livestock. To overcome this challenge, there should be a focus on promoting scientific techniques for fodder cultivation and preservation. Encouraging farmers to adopt modern practices like silage making, hydroponics, and growing high-yielding fodder crops can help ensure an adequate supply of feed for dairy animals.

Ensuring the health of dairy animals is vital for improving milk production and quality. So, regular veterinary care, vaccinations, and preventive healthcare measures should

be promoted among dairy farmers. Collaborating with veterinary institutions and providing access to veterinary services in remote areas can help improve the overall health of dairy animals. Improvement of germplasm through artificial insemination programs should be implemented at all farmers' doorsteps, and selective breeding can be initiated to target high-producing animals.

To address the challenges related to access to credit and insurance, financial institutions should develop customized financial products that cater specifically to the needs of dairy farmers. This includes providing affordable credit for purchasing high-quality livestock, improving infrastructure, and investing in value-added processing units. Additionally, insurance schemes tailored for dairy farming can protect farmers against risks associated with animal health, natural disasters, and market fluctuations.

Ensuring compliance with quality standards is crucial to enhancing the competitiveness of Indian dairy products in both domestic and international markets. Strengthening the enforcement of quality control measures, implementing strict hygiene practices, and promoting certifications such as the Food Safety and Standards Authority of India (FSSAI) can build consumer trust and facilitate market access.

The government's role in supporting the dairy sector cannot be overstated. Continued investment in research and development, infrastructure development, and farmer-centric schemes is essential. Additionally, policy measures to incentivize private sector investments in the dairy value chain can further boost the sector's growth potential.

Applications of Digitalization in Dairy Supply Chain for a) farm management systems enable dairy farmers to monitor and manage their operations effectively. These systems collect data on milk production, animal health, and environmental conditions. Farmers can use this data to optimize feeding, breeding, and milking processes, leading to improved productivity and animal welfare. b) IoT devices and sensors installed in milk collection centers and tanker trucks monitor milk quality, temperature, and quantity in real-time. This ensures timely collection, proper storage conditions, and traceability of milk from farm to processing facility. c) Blockchain-based systems record and store information about each step of the production and distribution process, ensuring transparency and authenticity. This enables consumers to trace the origin of dairy products and verify their quality and safety. d) Cloud-based platforms provide real-time visibility into inventory levels, expiry dates, and storage conditions. This enables efficient stock rotation, reduces waste, and ensures optimal inventory levels for uninterrupted production and delivery. e) Demand Forecasting and Planning - AI and ML algorithms analyze historical data and market trends to forecast demand accurately. Dairy processors can use these forecasts to plan production, procurement, and distribution activities. By aligning supply with demand, digitalization

minimizes stockouts, reduces waste, and optimizes resource utilization. f) Cold Chain Management - Maintaining the integrity of dairy products during storage and transportation is crucial. Digital technologies enable real-time monitoring of temperature, humidity, and other environmental factors in cold storage facilities and refrigerated trucks. This ensures optimal storage conditions and extends the shelf life of dairy products.

In conclusion, the opportunities in dairying in India are vast, with the potential to drive rural development, enhance food security, and contribute to economic growth. However, overcoming the associated challenges is crucial to realizing this potential. By addressing issues related to feed and fodder, supply chain efficiency, access to credit, productivity, and quality standards, India can strengthen its position as a global leader in the dairy industry. With concerted efforts from farmers, entrepreneurs, policymakers, and stakeholders across the value chain, the Indian dairy sector can flourish, benefitting both the economy and the livelihoods of millions of dairy farmers.

Case Studies: Success Stories in Indian Dairying

To further illustrate the opportunities and challenges in dairying in India, let's explore a few success stories from different regions of the country.

Amul Cooperative Model

- The Amul cooperative model, pioneered by the Gujarat Cooperative Milk Marketing Federation (GCMMF), is a remarkable success story in the Indian dairy sector. Amul began as a cooperative movement in the 1940s, empowering farmers to collectively market their milk and establish processing units. Through effective management, quality control, and value addition, Amul has become one of India's leading dairy brands, with a strong presence both domestically and internationally. The Amul model highlights the power of collective action and farmer empowerment, emphasizing the potential of cooperative dairying in driving rural development.

Pashu Sakhis in Uttar Pradesh

- Uttar Pradesh implemented a unique initiative called "Pashu Sakhis" to empower rural women and enhance the productivity of dairy animals. Under this program, women are trained as Pashu Sakhis or "animal friends" to provide doorstep animal healthcare services and advice to small-scale dairy farmers. The Pashu Sakhis, equipped with knowledge on animal nutrition, vaccination, and preventive healthcare, play a crucial role in improving animal health and productivity. This initiative not only promotes women's empowerment but also addresses the challenge of limited access to veterinary services in remote areas.

Karnataka Milk Federation's Dairy Processing Units

- The Karnataka Milk Federation (KMF) has successfully established dairy processing units across the state, particularly in rural areas. These processing units facilitate the collection, processing, and packaging of milk and milk products, ensuring quality and reducing wastage. KMF has also invested in value addition by manufacturing products like cheese, butter, and ice cream, enabling farmers to fetch higher prices for their milk. This model demonstrates the importance of decentralized processing facilities in enhancing farmer incomes and reducing post-harvest losses.

Future Outlook and Recommendations

To fully leverage the opportunities in dairying and overcome the challenges, several recommendations can be considered:

- Strengthen Research and Development: Continued investment in research and development is crucial for improving animal genetics, nutrition, and health management practices. This will lead to enhanced productivity, disease resistance, and improved quality of dairy animals.

- Enhance Infrastructure: Focus on developing robust infrastructure, including cold storage facilities, processing units, and efficient transportation networks, to minimize post-harvest losses, maintain product quality, and expand market reach.

- Promote Entrepreneurship and Value Addition: Encourage entrepreneurship in the dairy sector, particularly in value-added products. This can be achieved through skill development programs, access to finance, and market linkages.

- Strengthen Extension Services: Expand extension services and training programs to educate dairy farmers on best practices, modern technologies, and market trends. This will improve their skills and enable them to adopt efficient farming practices.

- Improve Access to Credit and Insurance: Facilitate easy access to credit and insurance facilities tailored to the needs of dairy farmers. This will enable them to invest in infrastructure, purchase high-quality livestock, and manage risks effectively.

- Streamline Quality Control: Strengthen the enforcement of quality control measures throughout the dairy value chain. Promote adherence to hygiene practices, implement certifications, and create awareness among dairy farmers and processors about quality standards.

- Foster Public-Private Partnerships: Encourage collaborations between the government, private sector, and farmer cooperatives to foster innovation, technology transfer, and market linkages. Public-private partnerships can drive investments, improve efficiency, bring in expertise, technology, capital and promote sustainable growth in the dairy sector.

- The government, dairy farmers, entrepreneurs, and stakeholders must work collaboratively to implement strategies and interventions that promote sustainable growth.

- By investing in research and development, strengthening infrastructure, enhancing extension services, improving access to credit and insurance, and streamlining quality control, India can overcome the challenges in dairying and capitalize on the opportunities it presents.

- Moreover, promoting entrepreneurship and value addition, as demonstrated by success stories like the Amul cooperative model, Pashu Sakhis, and Karnataka Milk Federation's dairy processing units, can drive innovation, increase farmer incomes, and create employment opportunities.

Conclusion

The future outlook for dairying in India is promising. The challenges such as low milk processing capacity, quality standards, supply chain management, product diversification, and environmental sustainability need to be addressed for the industry to reach its full potential. The opportunities are vast, and by effectively addressing the challenges, India can build a sustainable and prosperous dairy industry for the benefit of all stakeholders involved. Future success of dairy requires collaboration, innovation, and sustainable practices.

References

1. Ministry of Agriculture and Farmers Welfare. (2020). National Dairy Plan Phase-I. Retrieved from http://www.nddb.coop/sites/default/files/NDP%20Phase-I%20book%20-%20Final.pdf
2. Rashtriya Gokul Mission. https://dahd.nic.in/schemesprogrammes/rashtriya-gokul-mission.
3. National Bank for Agriculture and Rural Development. (2021). Dairy Entrepreneurship Development Scheme. https://www.nabard.org/Content.aspx?id=569&catid=23.

4. Hindustan Times. (2021). Pashu Sakhis give fillip to dairy farming in Uttar Pradesh. Retrieved from https://www.hindustantimes.com/cities/lucknow-news/pashu-sakhis-give-fillip-to-dairy-farming-in-up-101616157603028.html
5. Gujarat Cooperative Milk Marketing Federation Ltd. Retrieved from https://www.amul.com/m/aboutus
6. Karnataka Milk Federation. Retrieved from https://kmfnandini.coop/
7. All India Dairy Business Directory. (2021). Retrieved from https://www.indiadairy.com/
8. Singh, A. (2018). Opportunities and Challenges in Indian Dairy Industry. https://www.researchgate.net/publication/330098678_Opportunities_and_Challenges_in_Indian_Dairy_Industry
9. Food Safety and Standards Authority of India. Retrieved from https://www.fssai.gov.in/home.
10. Tadesse Kenea Amentae and Girma Gebresenbet (2021). Digitalization and Future Agro-Food Supply Chain Management: A Literature-Based Implications. Retrieved from https://www.mdpi.com/2071-1050/13/21/12181.
11. K.S.Kanna and R. Amudha. (2022). Role of Digitalisation and Technology in Dairy Supply Chain Management. International Journal of Advanced Research in Computer and Communication Engineering, 11(1): 255 - 259.
12. Transforming Milk Hauling Operations Through Digitalization. https://www.dairybusiness.com/transforming-milk-hauling-operations-through-digitalization/.
13. https://www.investindia.gov.in/sector/food-processing/dairy.

Chapter 2

STRATEGIES TO SUSTAIN DAIRY CATTLE PRODUCTION IN THE CHANGING CLIMATE SCENARIO

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Introduction

While climate change is a global phenomenon, its negative impacts are felt more severely by poor people in developing countries, who rely heavily on the natural resource for their livelihoods. Rural poor communities depend a lot on agriculture and livestock for their survival. Further, animal agriculture is amongst the most climate-sensitive economic sectors in India. Dairy farming provides employment, sustainable income and social security to a large population across the globe. Climate change and global warming cause great threat to entire livestock population across the world. Impact of climatic extremes and seasonal fluctuations on herbage quality and quantity are considered as imperative source of influence on the well-being of livestock in extensive production systems. This can result in impairing reproduction and production efficiency of grazing animals. The extreme heat during summer months negatively impacts grazing animals, and is capable of inducing nutritional imbalances. In arid and semi-arid areas, livestock are often considered to be one of the most important means of food and economic security for poor and marginal farmers. Inadequate and low quality feed is a major factor in under-production of animals in arid and semi-arid tropical regions. Under-nutrition in livestock can occur in late spring and summer due to increased energy output for thermoregulation and concurrent reduction in energy intake. While understanding the science of animal nutrition continues to expand and develop, most of the world's livestock, particularly, small ruminants in pastoral and extensive mixed systems in many developing countries, suffer from permanent or seasonal nutritional stress. This chapter is an attempt to collate information on different strategies to improve livestock production under the changing climate scenario.

Climate change impact on livestock production

The climate change has great influence on the livestock industries affecting production, reproduction, animal health, input costs, product prices, and natural resources management. Climatic factors, such as ambient temperature, relative humidity, solar

radiation, and wind speed, influences dairy animals, especially cattle. The direct effect of climate change on cattle is thermal stress while the indirect effect being the low pasture availability and water scarcity and the increased incidence of pest and diseases. Heat stress and nutritional stress are the major factors that severely affect the reproductive performance of dairy cattle under the changing climate. Increased ambient temperature leads to heat stress and decline in fodder and pasture availability due to increased temperature and decreased rainfall have detrimental effect on reproduction in dairy cattle. Effect of heat stress includes reduced dry matter intake, increased water intake, Increase sweating and panting to maintain core body temperature, Energy is shifted from milk production to maintenance, increased mortality and morbidity, increased rectal temperature and respiratory rate.

Climate change has the potential to impact the quantity and reliability of forage production, quality of forage, water demand for cultivation of forage crops as well as large-scale rangeland vegetation patterns. The most visible effect of climate change will be on the primary productivity of forage crops and rangelands. Most of the impacts of climate change on livestock production are mediated through non availability of feed resources as well as affecting the quality of existing feed resources. Climate change impacts livestock production by affecting feed crops production and grazing systems. Grasslands cover about 70% of the world's agricultural area and they face a wide range of challenges from climate change including the effects of elevated atmospheric carbon dioxide, higher temperatures, changes in precipitation regime and increasing concentrations of ground level ozone. These changes can adversely affect productivity, species composition and quality, with potential impacts not only on forage production but also on other ecological roles of grasslands.

Production efficiency, profitability, and sustainability of commercial livestock production are depended on reproductive efficiency. In summer, heat stress may reduce the fertility of dairy cows by poor expression of estrus due to a decreased estradiol secretion from a dominant follicle developed in a low luteinizing hormone environment. Productivity of dairy cows is also negatively affected due to long inter-calving intervals, which occur due to low conception rate (CR), long sexual inactivity after parturition and poor expression of oestrus. Level of nutrition plays an important role in reproduction. Decreased levels of the antioxidant vitamins are associated with poor fertility and production levels in ruminants. Poor reproductive efficiency is observed in lactating dairy cows because of low fertility and low rates of estrus detection. The relative importance of reproductive management in the efficiency of dairy production vary according to the environment, genotypes, scale of inputs and outputs, managerial skills of the farmers and economic as well as sociological considerations. Disease outbreaks as a result of climate change have adverse effects on reproductive performance of dairy cattle. Immune responsiveness of domestic animals is reduced due to heat stress. Veterinary assistance should be given if the conditions such as abnormal discharges persisting more than 15 days after calving, no heat observed by 60 days

after calving, absence of conception after more than three repeated services, abnormal discharges during heat like flaky mucus or pus, calving difficulties, retained placenta or other reproductive disorders occurs in heifers or cows.

Strategies to sustain livestock production in the changing climate scenario

This section discusses in detail the various strategies such as (i) shelter management; (ii) nutritional interventions; (iii) animal genetics and breeding and (iv) animal health management.

Management strategies to improve dairy production in the changing climate

Animal housing is one of the approaches to alleviate the impacts of climate change on cattle. Shade reduces the severity of heat stress in animals that are being exposed to sun. It is an effective method to protect the animals from radiant heat load and helps to cool the animals. Shades can be made artificial or natural. Aluminum or galvanized steel roofs are artificial shades while the roofs made out of straw are of natural means. Provision of trees and other vegetative covers over the surrounding area will reduce the effect of radiative heat load on the cattle. Roofing materials should always be a bad conductor of heat and the best housing will have roofs painted in white so as to reflect the radiation of sun. Physical protection with artificial or natural shade presently offers the most immediate and cost-effective approach for enhancing reproductive efficiency of animals. Evaporative cooling also can be effective. Various shade management systems have been evaluated extensively and generally result in improved feed intake and productivity. The orientation of the shed should be in north-south direction in the northern hemisphere so that the direct incidence of solar radiation into the shed is avoided. For effective heat dissipation in cattle, there should be free flow of air inside the shed, this can be done by increasing the ventilation by means such as keeping half side wall i.e., open housing system, use of fan, increasing the height of the building etc. Shade alone will reduce a cow's respiration rate by 30%, and adding sprinklers will reduce the respiration rate by 67%. Both methods of cooling will also lower rectal temperatures. Use of shade plus fans and sprinklers has an additive effect. Use of fans is important, especially in confined structures, because fans help to move warm air from cows' bodies.

One of the best practices to reduce heat stress is to provide adequate fresh, cool, clean drinking water. Other methods of cooling include shade, commercial coolers, tunnel ventilation, shower/fanning stations, fans, cooling ponds and center pivots. Cows generate approximately 20% of their gross energy as body heat, which is released to the surrounding air, making them feel hot, especially under heat stress conditions. Fans remove this body heat via convection, thereby cooling down the surface of the animal. Sprinklers are used to soak the cow's hair coat to the skin with water, allowing the loss of body heat via conduction.

Fans plus sprinklers allow for conduction and evaporative cooling, as the fans help to vaporize the water that has been warmed by the release of body heat. Marked relief was observed in cows by the use of fans plus sprinklers, which reduced respiration by 50% to 50 breaths per minute.

Water and air movement becomes the major agents by which the microenvironment inside the barn is cooled and evaporative cooling by the animals is augmented. Enhancing heat loss with the help of sprinklers/misters/foggers along with fans and installation of air conditioners in extreme hot climates are the main strategies for mitigating the heat stress. Sprinkling animal in the morning is more effective than sprinkling in the afternoon. Certainly it is recommended to start cooling strategies prior to animal showing signs of heat stress (panting). Sprinkling of pen surfaces may be as much or more beneficial than sprinkling the animal. Cooling the surface would appear to provide a heat sink for animal to dissipate body heat, thus allowing animal to better adapt to environmental conditions vs adapting to being wetted. In handling studies, moving animal through working facilities requires an expenditure of energy causing an elevation of average body temperature between 0.5 and 1.0 °C (.9 and 1.8 °F), depending on the ambient conditions. So during hot days minimal handling of animal is recommended for promoting animal comfort. Some farmers even acclimatize their animals intentionally by exposing them to artificial thermal conditions in order to prepare themself before the season and thus preventing stress losses. Reducing the stocking density during hot weather will help the animals in dissipating the body heat more efficiently and during cold conditions the stocking density can be increased. And also the cattle should be provided bedding and warmth to protect them from extreme cold weather.

Nutritional strategies to manage dairy cattle under changing climate

Water, the most important nutrient for the dairy cow, must be readily available, clean and cool to encourage consumption. Cows will drink 50% more water when the ambient temperature is 80°F compared with 40°F, so instead of consuming the average 30 gallons per day, their intake may increase to 45 gallons or more. The water consumed is used to cool cows' bodies via respired moisture and sweating as discussed above. The chilling of drinking water to 50°F alleviates heat stress as evidenced by decreased respiration and rectal temperature, resulting in increased feed intake, rumen motility and milk yield. It is important to provide at least 2 inches of trough space per animal in confinement barns to maximize access to water. It should be noted that excessive lowering of rumen temperatures by offering very cold water may suppress microbial activity and slow the fermentation process, subsequently requiring more feed energy and heat production, which is very inefficient.

During hot dry summer there is decrease in dietary feed intake which is responsible for the reduced productivity. In this situation the efficient practical approaches like frequent

feeding, improved forage quality, use of palatable feeds, good nutrition balance and greater nutrient density are required. Because there is greater heat production associated with metabolism of acetate compared with propionate, there is a logical rationale for the practice of feeding low fiber rations during hot weather. Changes in diet are needed during hot weather to maintain nutrient intake in order to maintain homeostasis. Optimizing ruminally undegraded protein improves milk yield in hot climates. The recommended level of crude protein in the diet should not exceed 18 % and the level of rumen degradable protein should not exceed 61 % of crude protein. The Mineral losses via sweating especially potassium and changes in blood acid-base chemistry resulting from hyperventilation reduce blood bicarbonate and blood buffering capacity and increase urinary excretion of electrolytes and as a result the supplementation of electrolytes are essential. Of the three main rumen-produced volatile fatty acids, propionate is the one primarily converted into glucose by the liver. Highly fermentable starches such as grains increase rumen propionate production, and although propionate is the primary glucose precursor, feeding additional grains can be risky as heat stressed cows are already susceptible to rumen acidosis. Heat production is lower when the cattle are fed with feed ingredients such as concentrates and fats, whereas forages have a greater heat increment and in addition to that the feeding of high fibrous diets will lead to production of more acetate which has more heat of nutrient metabolism in comparison to propionate. Ruminant diets with grain and low fiber produce less heat stress for lactating cow because of their lower heat of digestion. However a good quality of roughages should be fed in order to prevent acidosis. Improved dietary energy density and the lower heat increment associated with the inclusion of dietary fat must be coupled with limitations to fat feeding to avoid ruminal and metabolic disorders. There are studies demonstrating that dietary fat can be added to the ration at up to 3–5% without any adverse effects to ruminal micro flora. Improved efficiency and lower heat increments should make fat especially beneficial during hot weather. Ruminally protected fats allow the inclusion of a substantial quantity of fat in the diet, which could lower heat increment significantly. Supplementation of saturated fatty acids at 1.5 or 3.0% of diet dry matter increases the milk yield, milk fat content and yield, and reduces the peak rectal temperatures in heat stressed cows. The feeding time also has great significance as the feeding behavior of the animal changes, studies state that feeding during the cooler hours of the day and also increasing the number of daily feeding proves beneficial against the heat stress. Increasing the feeding frequency will also help to minimize the diurnal fluctuations in ruminal metabolites, increase the feed utilization efficiency in the rumen and it further enhances the animal's ability to cop up with the heat load during the summer.

Addition of monenesin increases propionate production. In addition, monensin may assist in stabilizing rumen pH during stress situations. Propylene glycol is also typically fed in early lactation that may be an effective method of increasing propionate production during

heat stress. In a study where heifers were supplemented with increasing amounts of chromium the insulin sensitivity increased, suggesting that chromium plays an essential role in glucose metabolism in ruminants. Because glucose use predominates during heat stress, chromium supplementation may improve thermal tolerance or production in heat-stressed animals. For instance, supplementing heat-stressed early lactation dairy cows with chromium reduced the degree of weight loss, improved milk production, reduced the concentration of plasma non esterified fatty acid (NEFA) and improved rebreeding rates. Feed additives like Niacin, Na bicarbonate buffer, antioxidants, fungal yeast culture, Lipoic acid and Thiazolidinediones supplementations are good practices for alleviating heat stress. Somatotrophin treatment in cows is known to increase the milk yield upto 15 % in even severely heat-stressed dairy cows. In addition to all these *ad libitum* quantity of non-contaminated water should be provided as it is a crucial necessity for livestock survival and productivity. It is a well-established fact that during heat stresses the water requirement of the animal increases about 2 to 4 times. Water management strategies for both surface and ground water resources should be undertaken like interlinking of rivers, integrated water resource management, improved water harvesting techniques etc. at both local and national levels. Another major constraint in the tropics is the non-availability of the feed resources during the summer. This can be overcome by the use of non-conventional feed resources like castor bean meal, neem seed cake, tomato pulp, vegetable wastes, pineapple silage, azolla, areca sheath etc. Also the forage management practices like growing of hydroponic grasses, silage preparation, feeding of hay and growing of summer or drought tolerant varieties like Bahiagrass.

Nutritional tools, such as antioxidant feeding (Vit-A, selenium, zinc etc.) and ruminant specific live yeast can help. Studies have shown that addition of antioxidant in diets of cows is able to reduce stress and is a good strategy to prevent mastitis, optimize feed intake and reduce the negative impact of heat stress on milk production. Moreover, the use of antioxidant such as Vit-E, Vit-A, selenium and selenium enriched yeast help reducing the impact of heat stress on the oxidant balance, resulting in improved milk quality and cow health. A recent study in cattle showed that the supplementation of Vit-E help in reducing the heat stress and improves the antioxidant status and lowers the incidence of mastitis, metritis, and retention of placenta.

Body condition scoring as a simple nutritional tool to optimize livestock production

Condition scoring is a system of describing or classifying breeding animals by differences in relative body fatness. It is a subjective scoring system but provides a fairly reliable assessment of body composition. Body condition scoring is a simple but useful procedure, which can help producers making management decisions regarding the quality and quantity of feed needed to optimize performance. Under Indian farming condition, 5-

point body condition scoring system similar to the one followed in United States is preferable. Body condition scoring provides a reasonable indicator of status of cows at different production phases, which allow to assess cow's nutrition level and to decide when, and how to supplement the herds. It is desirable to have cows in 3 or 3.5 BCS at the time of mating to get higher calving rate and as well as more birth weight of calves per calving. It is therefore essential to have a simple and reliable indicator like BCS at hand, which allow to assess nutrition level of cows particularly in production systems where the availability of feed is not constant and to decide when and how to supplement the herd for getting maximum productivity.

Reproductive management of dairy cattle during stress condition

Estrus synchronization, embryo transfer, hormone assay, ultrasonic imaging are some of the modern reproductive technologies which has wide range of potential applications. Application of these modern technologies can play crucial role in reproductive management of dairy cattle under changing climate scenario. Estrus synchronization offers scope for better planning of breeding activities and wider use of AI. This can improve estrous detection rates. Treatment of prostaglandin F2α in early diestrus resulted in the greatest degree of estrus synchrony and in conjunction with estradiol decreased the interval to estrus and ovulation. Synchronization with prostaglandin F2α was successful when cows were bred to a detected estrus, because rates of estrus detection increased and management of AI was more efficient than daily detection of estrus. Some of the management strategies for reducing the impact of heat stress include temperature and humidity control, mineral and vitamin supplements, embryo transfer, hormonal therapy. Effects of heat stress on fertility can be reduced, using shade, fans, air-conditioning and sprinkler systems to cool animals. Antioxidant supplementation can increase the incidences of estrus, increases the fertilization rate, increases the conception rate, and prevents the dystocia and other reproductive tract complications. Using of embryo transfer will bypass the harmful effects of heat stress on oocyte quality that limit embryonic development. Decreased plasma levels of LH and estradiol are in heat stressed cows is one of the main factors contributing to low fertility during the hot months of the year. Use of reproductive hormones to stimulate fertility is an alternative approach to improving summer fertility. Effective reproductive management of dairy cattle is essential for obtaining good production under the changing climate scenario.

Exploiting the genetic potential of local/indigenous breeds

In the face of changing climate scenario, efforts are needed to exploit the genetic potential of indigenous livestock breeds of different species. Productive traits need to be targeted to assess the performance of such indigenous breeds. After thorough assessment appropriate breeds needs to be developed which are able to survive to the local

environmental conditions. With the advancement in molecular biotechnological tools, it is possible to identify and characterize genes responsible to adapt to drought and heat stress. Efforts are also equally needed to carry out several simulation studies involving programming various ranges of temperature and humidity in the climate controlled chambers. Such efforts can help to identify important biomarkers for climate change associated environmental stresses which can be used in Marker Assisted Selection (MAS) breeding to evolve suitable breed which has the ability to survive in different agro-ecological zones in India.

Improved health service

Increase in temperature and humidity due to climate change is strongly associated with emerging and re-emerging animal diseases by (i) increasing the diffusion of insects Culicoides imicola) that are the main vectors of several arboviruses (e.g. bluetongue, and African sickness); (ii) increasing the survival of viruses from one year to the next; (iii) improving conditions for new insect vectors that are now limited by colder temperatures (Mellor and Wittmann, 2002; Gould et al., 2006). This will lead to production losses. Thus, improved diseases control strategies and health service at a big scale is required.

For prevention, monitoring and control of livestock diseases good data exchange mechanism are required at both state and national level. These should cover the distribution of animal diseases, ecological conditions including climate, and associated drugs and chemotherapeutants. In this contest, epidemiological surveillance is a critical component and it not only involves the early identification of emerging diseases and trends but also for resource planning and measuring the impact of control strategies. A global approach to epidemiological surveillance should be taken and should involve collaboration between professionals involved human, animal and environmental health. Such surveillance programmes are essential in allowing us to recognize and respond to emerging risk to climate change. We can also use the geographic information system (GIS) by which we can both monitor the level of stress and how our climate is changing and monitor the spread of diseases. We can use it to look for periods or heavy rainfall using a spatial analyst and illustrate it using GIS. This system tells us which pathogens will flourish, under their preferred condition. This tool can also help to pinpoint period of continually high minimum temperature. Likewise predictive modeling system can also be used to predict the probability of an outcome. It has potential to predict the probability of global climate change on ecological system and emerging hazards. Furthermore, laboratory and field research will also help in illuminating how climate changes influence pathogen characteristics, and models will help researchers and producers predict and plan for pathogen threats.

Adaptation strategies to sustain livestock production under changing climate

Adapting to climate change entails taking the right measures to reduce the negative effects of climate change or to exploit the positive impacts by making appropriate adjustments and changes. The highly adapted indigenous breeds identified by marker assisted selections can be used as an efficient tool for developing thermo-tolerant breeds through improved breeding programs. Promotion of such breeds can improve the production efficiency and may lead to less greenhouse gas emissions. Further, women hold rich knowledge and wide skills for maximizing the use of natural resources. Hence, occasional training and participatory research approach into the roles of women assists tackling of climate change in the rural areas. In addition, well-organized early warning systems avoid severe damages due to unexpected disasters by providing sufficient time to prepare effective response. Development of skilled disease surveillances supported with effective health services may effectively control the spread of the climate change related diseases in goat. Furthermore, improved water resource management should be developed to meet the water requirements for goat production in tropical regions. Cultivation of drought tolerant fodder varieties in extreme hot areas is an efficient adaptive strategy to ensure sufficient supply of feed during scarcity period. Finally, strengthening extension services and building awareness through capacity building programs helps the livestock keepers to improve their adaptive capacities against climate change. Adaptation strategies related to cold stress includes advanced cold tolerant breeding programs, migration in extreme winter and adoption of proper cold management practices. Hence, there is an urgent need to develop better policies and practices that ensure cost effective adaptive strategies to tackle climate change.

Conclusion

Stress is continually imposed upon dairy cows to produce more and more milk. To maximize yield, it is imperative to keep cows as comfortable as possible and maintain feed intake for conversion into milk. Heat stress negatively affects cow comfort, dry matter intake and, subsequently, milk yield; thus, management strategies must be applied to counter hot/humid environmental conditions that can lead to mastitis, increased SCC and reduced milk quality. Control is based on provision of fresh, cool, clean drinking water, and increased energy density of rations and use of feed additives, as well as the use of cooling mechanisms including shade, fans, sprinklers, tunnel ventilation, commercial coolers and cooling ponds. Scientific research can help the livestock sector in the battle against climate change. Research must continue developing new techniques of cooling systems such as thermo-isolation, concentrating more than in the past on techniques requiring low energy expenditure. New indices that are more complete than THI to evaluate the climatic effects on each animal species must be developed and weather forecast reports must also be developed with these indices, to inform the farmers in advance. Above all to beat the climate change or

in any case not to let the climate beat livestock systems, researchers must be very aware of technologies of water conservation.

References:

1. Aleena, J., Sejian, V., Bagath, M., Krishnan, G., Beena, V and Bhatta, R (2018). Resilience of three indigenous goat breeds to heat stress based on phenotypic traits and PBMC HSP70 expression. International Journal of Biometeorology, 62(11): 1995-2005.
2. Amitha, J.P., Krishnan, G., Bagath, M., Sejian, V and Bhatta, R (2019). Heat Stress Impact on the Expression Patterns of Different Reproduction Related Genes in Malabari Goats. Theriogenology, 1321: 169-176.
3. Angel, S.P., Bagath, M, Sejian, V., Krishnan, G and Bhatta, R (2018). Expression patterns of candidate genes reflecting the growth performance of goats subjected to heat stress. Molecular Biology Reports, 45(6):2847-2856.
4. Archana, P.R., Sejian, V., Ruban, W., Bagath, M., Krishnan, G, Aleena, J., Manjunathareddy, G,B., Beena, V and Bhatta, R (2018). Comparative assessment of heat stress induced changes in carcass traits, plasma leptin profile and skeletal muscle myostatin and HSP70 gene expression patterns between indigenous Osmanabadi and Salem Black goat breeds, Meat Science, 141: 66-80.
5. Carvajal, M.A., Alaniz, A.J., Gutiérrez-Gómez, C., Vergara, P.M., Sejian, V and Bozinovic, F (2021). Increasing importance of heat stress for cattle farming under future global climate scenarios. Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2021.149661.
6. Ngambi, J.W., Alabi, O.J., Alabi, D. N. J., Norris, D (2013). Role of goats in food security, poverty alleviation and prosperity withspecial reference to Sub-Saharan Africa: a review. Indian J. Anim. Res. 47, 1-8.
7. Pragna, P., Sejian, V., Bagath, M., Krishnan, G., Archana, P.R., Soren, N.M., Beena, V and Bhatta, R (2018). Comparative assessment of growth performance of three different indigenous goat breeds exposed to summer heat stress, Journal of Animal Physiology and Animal Nutrition, 102: 825–836.
8. Rashamol, V.P, Sejian, V., Bagath, M., Krishnan, G., Beena, V., Bhatta R. 2019. Effect of heat stress on the quantitative expression patterns of different cytokine genes in Malabari goats. International Journal of Biometeorology, 63(8): 1005-1013.
9. Reshma Nair, M.R., Sejian, V., Silpa, M. V., Fonsêca, V. F. C., de Melo Costa, C. C., Devaraj, C., Krishnan, G., Bagath, M., Nameer, P. O & Bhatta, R. (2021). Goat as the ideal climate resilient animal model in tropical environment: Revisiting advantages over other livestock species. International Journal of Biometeorology, DOI: https://doi.org/10.1007/s00484-021-02179-w

10. Sejian, V., Bagath, M., Krishnan, G., Rashamol, V.P., Pragna, P., Devaraj, C., Bhatta, R (2019). Genes for resilience to heat stress in small ruminants: A review. Small Ruminant Research 173: 42–53.
11. Sejian, V., Bhatta, R., Gaughan, J.B., Dunshea, F.R and Lacetera, N (2018). Review: Adaptation of animals to heat stress. Animal 12(s2):s431-s444.
12. Shilja, S., Sejian, V., Bagath, M., Mech, A., David, I.C.G., Kurien, E.K., Varma, G and Bhatta, R (2016). Adaptive capability as indicated by behavioral and physiological responses, plasma HSP70 level and PBMC HSP70 mRNA expression in Osmanabadi goats subjected to combined (heat and nutritional) stressors. International Journal of Biometeorology, 60:1311–1323.
13. Sophia, I., Sejian, V., Bagath, M and Bhatta, R (2016). Quantitative expression of hepatic Toll-Like Receptor 1–10 mRNA in Osmanabadi goats during different climatic stresses. Small Ruminant Research 141: 11–16.

Chapter 3

RECENT ADVANCES IN RUMINANT NUTRITION – A REVIEW OF TECHNOLOGIES

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Introduction

Advances in the field of ruminant nutrition during recent times have been numerous and involve a wide range of subjects. It is beyond the scope of this review to do justice to the large number developments that have, and continue to enable us to improve the rate and efficiency of meat, milk and wool production from ruminant animals. Throughout much of this century there has been a tendency towards more intensive feeding of animals which has involved the greater use of concentrated grain-based diets. Easy methods of adoption of recent technologies in ruminant nutrition for the benefit of field vets have been discussed appropriately.

Green Fodder production

1. Hydroponic fodder Production

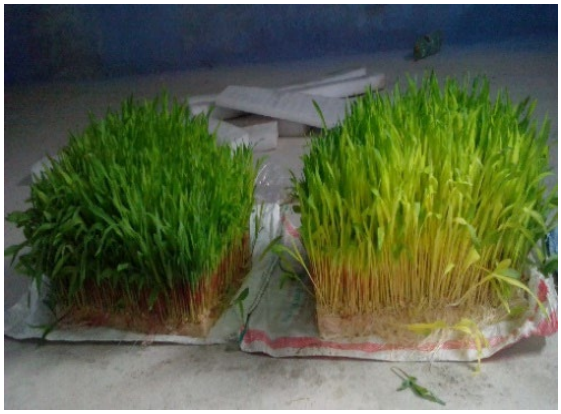
Growing the much essential green fodder for farm animals is not an easy task, especially during droughts. But one of the latest developments in veterinary science, called hydroponics, has made growing fodder easy and eco-friendly. Here, with minimum usage of water, time, space and absolutely no soil, fresh green fodder can be produced. Generally, one needs at least 60-80 liters of water, sufficient lab our, agricultural land and about 45 days to produce one kg of green fodder. But through hydroponics, it would take only 10 days, very less manual work and only about 12-18 liters of water to get the same amount of grass.

How it works?

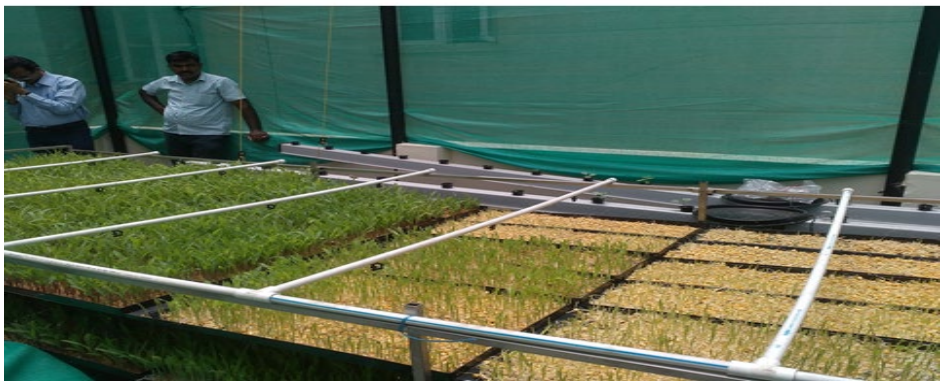
First, seeds are treated with fungicides and soaked in water for a day and then transferred to gunny bags that are pre-wetted with water. They are left alone for four days so that seeds can sprout. On the fifth day, seeds are transferred to plastic trays and spread evenly. Inside the unit, iron frames are fitted in such a way that trays could be arranged like railway bogies. If one tray is pushed from one end, the last tray comes out from the other end. Calculated amount of sprouted seeds are spread on the trays and loaded every day. The amount of seeds used depends on the quantity of target fodder production. Though crops like wheat, finger millet, oats, sun hemp, cowpea, horse gram can be grown using this method, yellow maize is the most suitable option.

Hydroponic fodder has good amount of nutrients and is relatively free from chemicals and pesticides. Through hydroponics, every kilogram of yellow maize will yield about six kg of green fodder (8-12 inches) in 10 days. As the whole plant including the roots is fed, wastage is minimal. Up to 20 kg of this fodder can be fed to a crossbreed cow daily and around half a kilo for a sheep or a goat. After this, one can expect an increase in milk production and improvement in the fertility of the cattle. This method also helps farmer save a lot of money on commercial cattle feed as the production cost of each kg of hydroponic fodder comes to only about Rs 3.00.

Hydroponic fodder is more relevant in sustainable dairy farming, especially in the event of inadequate land and water, or poor soil fertility. This technology comes extremely handy in the event of severe drought like the one we are witnessing this year. Hydroponic fodder machines with production capacities ranging from 25 kg to 1,000 kg are available commercially and the cost would be about Rs. five lakh for a 500 kg machine which is based on the concept of a greenhouse and costs around one lakh for a 100 kg unit. This unit is made of two layers of shade nets supported by poles and houses an iron framework to hold plastic trays that are arranged at a slight inclination. The unit is fitted with micro sprinklers (controlled by an electronic sensor), which sprinkles microbe-free RO water on the trays containing growing fodder.



Ready to feed Hydroponic Maize Fodder of 10 days



Hydroponic Fodder growing Machine


Ready to feed Hydroponic wheat grass of 10 days

2. Tree Fodders

The perennial fodder tree species of ***Sesbania*** establish easily, grow in difficult sites and do not require complex management to maintain productivity. Sesbania is saline resistant species which is capable of fertilizing drought affected saline lands for optimizing affected saline lands. For optimizing fodder yield and to increase productivity per unit land area, Sesbania can be intensively cultivated with application of organic manure or fertilizers and regular irrigation for economic and sustainable livestock production throughout economic and sustainable livestock production throughout the year

On-farm feeding trials were conducted to demonstrate the effect of supplementation of Mean daily milk yield was higher in cows supplemented with Sesbania forage, by 12.51% in first trial and by 11.40% in second trial (average 11.97%), both being significantly) higher than in those not supplemented with Sesbania forage.

3. Unconventional Green fodder production- Cactus Spineless

Opuntia ficus-indica is a slow growing perennial shrub up to 3-5 m high. The root-system spreads horizontally. Stems (cladodes) are very thick, succulent, oblong to spatulate, 30-40 cm long (up to 70-80 cm) and 18-25 cm wide. The epidermis is very thick and waxy, thus very water repellent and sun reflecting. Leaves are generally reduced to thorns but may exist on young cladodes (they soon wither and quickly fall). Some varieties are spineless. Flowering occurs on 1-2 year-old. *Opuntia* species used for animal feeding are abundant, easy and cheap to grow, palatable and can withstand prolonged droughts. Such characteristics make these species a potentially important feed supplement for livestock, particularly during periods of drought and seasons of low feed availability. The majority of *Opuntia* plant biomass is pad material rather than fruits and it can be fed to livestock as fresh forage or stored as silage for later feeding.

The importance of cacti became evident when research results showed cacti are capable of developing high productivity in water-stress regions, because of their high water-use efficiency and their above-ground productivity. Cactus is not a balanced feed and should rather be considered as a cheap source of energy. Cladodes have low crude protein content

and consequently need to be supplemented by protein sources. They are also low in phosphorus and sodium. The combination of spineless cactus with cereal straw is a nutritionally satisfactory solution for maintaining small ruminants in arid zones. Generally cacti are highly palatable. The gut fill value is low but, unusually, feeding cactus enhances intake of fibrous feeds (straw). Combining straw with cactus increases straw intake and consequently animal performance. *Opuntia ficus-indica* can be harvested 3 years after seedling. Its productivity is between 5 and 6 t/ha/yr under water-limited conditions). In good conditions, 40 t/ha of dry matter can be achieved.

Dry Fodder Enrichment:

The crop residues are essentially the energy feeds, but their energy content is inadequate even to meet the maintenance requirement of ruminants. The major constraints in utilization of crop residues for growth and milk production are low voluntary intake, digestibility and imbalance of absorbed nutrients which is partly due to physico-chemical structure and low microbial protein production in rumen. Feeding of large quantities of crop residues like straws, stover/kadbis and hay with unbalanced supply of critical nutrients leading to uncoupled rumen fermentation. This type of feeding results in diversion of feed carbon atom into gases and less into microbial protein synthesis. The feed conservation for body weight gain can be achieved by selecting feedstuffs for microbial biomass synthesis efficiency. Since fermentation rate factors are responsible for altering nutrient efficiency, the rate of fermentation is regarded as the strategy for improving nutrient efficiency in rumen.

Enrichment of Straws/Kadbis with Tween-80 and Cellulolytic enzymes

Improvement in digestibility of fibrous and low quality roughages require loosening and or partial breakdown of rigid cell wall structure of forage resulting in greater accessibility of fibre degrading bacteria and their associated enzymes to forage plants. Recently surfactants are recognized for better penetration and facilitation of enzyme-substrate interaction. The non-ionic surfactant Tween 80 (T-80) is well known as an effective surfactant that stimulates the release of enzymes from a range of aerobic fungi. The effects of surfactants have been attributed mainly to action on cell membrane causing increased permeability, promoting release of bound enzymes and to decrease growth rate of microbes due to reduced oxygen supply. The adsorption and orientation of surfactant molecules at the solid liquid interface could render the substrate readily wettable by the enzymes and thereby providing a highly localized substrate concentration causing better utilization of fibre. T-80 may help to improve energy availability by increasing fermentation of structural carbohydrates in rumen. The positive effects of T-80 on cellulose degradation could be maximized and the negative effects on protein degradation minimized at lower concentrations of T-80 in the diet. There are studies on the effect of this surfactant on the

anaerobic growth of rumen microbes and fungi and body weight changes and feed efficiency in feedlot cattle diet. It is hypothesized that the positive growth response is related to improvements in fibrous carbohydrate fermentation resulting in increased energy availability for microbial protein synthesis and body weight gain.

The uses of exogenous fibrolytic enzymes as feed additives have been investigated in the last decade as a means to improve forage utilization by ruminants. Cellulolytic enzyme additions have been shown to enhance colonization of feed by ruminal microorganisms and increase the rate of degradation in the rumen. Some products have been demonstrated to be stable in the rumen and to survive passage to the duodenum, suggesting exogenous enzymes may function ruminally and post ruminally. The use of fibrolytic enzymes in the diet of ruminant livestock has been found to improve the digestibility and body weight gain in wheat straw based diets.

Feeding of large quantities of crop residues like straws, stover/kadbis and hay with unbalanced supply of critical nutrients leading to uncoupled rumen fermentation. This type of feeding results in diversion of feed carbon atom into gases and less into microbial protein synthesis. The feed carbon conservation for body weight gain can be achieved by selecting feedstuffs for microbial biomass synthesis efficiency. Since fermentation rate factors are responsible for altering nutrient efficiency, the rate of fermentation is regarded as the strategy for improving nutrient efficiency in rumen. This can be achieved to some extent by supplementary feeding of surfactant and cellulolytic enzymes to improve energy and nutrient availability from crop residues.

Materials required:

a) Straw/kadbis b) Water c) Polythene sheet d) Rose can

Procedure:

1. It is ideal to use 0.1 % Tween -80 and 0.5% Enzymes mix.
2. Calculate the approximate quantity of straw for treatment and required straw should be chaffed to 3-4 inches by using chaff cutter.
3. Take polythene sheet and spread it over to transfer required quantity of chaffed straw for treatment.
4. Dissolve 100 ml Tween 80 and 500 g Enzymes in 20 litres of water and using rose can sprinkle over 100 kg chaffed straw
5. This should be followed by another batch of straw.
6. The treated straw can be fed immediately to the Cattle/Buffaloes. Animals consume biotechnologically treated straw with avidity. It is seen that animals consume about 10-20% more treated straw and minimizes the manger loss.
7. The cost of concentrate can be reduced by 5-10% on biotechnologically treated straw feeding.

8. Animals maintained only on treated straw should be given Vitamin-A supplementation periodically.

Feed Formulations based on RDP, UDP and Amino acids Composition:

For many years, crude protein (CP) content has been used in formulating diets for lactating dairy cows because little was known regarding the response to dietary protein of varying quality. In addition, many researchers postulated that the high-quality microbial protein (MCP) synthesized in the rumen would complement deficiencies in the quality of dietary protein that escaped ruminal fermentation. For high-yielding cows, microbial protein synthesis supplies a decreasing proportion of the required protein, and significant amounts of dietary protein must escape ruminal degradation in order to meet protein needs. However, we now have information that demonstrates that we have to be careful not to overfeed rumen undegradable protein (RUP) as it lowers the efficiency of use of metabolizable protein (MP) for milk protein production. The protein balance for the lactating cow is a challenge. Degradable protein needs to be balanced for the microorganisms in the rumen, and MP and amino acids (AA) are needed to meet the requirements of the cow for lactation, pregnancy, and growth.

Ruminally synthesized MCP, RUP, and, to a much lesser extent, endogenous CP (ECP) contributes to the passage of MP to the small intestine. Metabolizable protein is defined as the true protein that is digested postruminally and the component AA absorbed by the intestine. Amino acids and not protein are the required nutrients. Absorbed AA, used for the synthesis of proteins, are vital to the maintenance, growth, reproduction, and lactation of dairy cattle.

The goals of ruminant protein nutrition are to provide adequate amounts of rumen degradable protein (RDP) for optimal ruminal efficiency and to obtain the desired animal productivity with a minimum amount of dietary CP. Optimizing the efficiency of dietary CP requires selection of complementary feed proteins and non-protein nitrogen (NPN) supplements that will provide the types and amounts of: RDP that will meet, but not exceed, the N needs of ruminal microorganisms for maximal synthesis of MCP, and digestible RUP that will optimize the profile and amounts of absorbed AA. The nutritive value of MP for dairy cows is determined by its profile of essential AA (EAA). Improving the efficiency of protein and nitrogen (N) usage while striving for optimal productivity is a matter of practical concern.

Incentives include reduced feed costs per unit of lean tissue gain or milk produced a desire for greater and more efficient yield of milk protein, creation of space in the diet for other nutrients that will enhance production, and concerns for waste N disposal.

Research studies have shown that milk protein content and yield can be increased by improving the profile of AA in MP, by reducing the amount of surplus protein in the diet, and by increasing the amount of fermentable carbohydrate in the diet.

Grasses and legumes contain the highest and most variable concentrations of NPN. Hays and especially silages contain higher amounts of NPN than the same feed when fresh because of proteolysis that occurs during wilting and fermentation. Reported concentrations of NPN in CP of grasses and legume forages are within the following ranges: fresh material, 15%; hay, 25%; and silage, 65%. The NPN content of most non-forage feeds is 12% or less of CP.

Make sure you meet the cow's RDP requirement. A deficiency will suppress the growth and activity of the microorganisms, decrease feed intake, and decrease the efficiency of MCP. Decreased MCP almost always has the net effect of decreasing Lys in MP. This occurs because of the resulting decreased contribution of MCP and thus increased contribution of RUP to MP. Do not feed excessive amounts of RDP. Clearly, there is no benefit to this, and at the very least, it decreases the efficiency of use of dietary protein for milk protein production. Do not overfeed RUP as it lowers the efficiency of use of MP for milk protein production. Overfeeding RUP decreases efficiency of use of MP for two reasons: 1) supply of MP exceeds MP requirements, and 2) on average, RUP has lower concentrations of Lys and Met than microbial protein.

Best and Least cost formulated feed without any cakes

Maize- 40.00
Wheat bran 40.00
DORB -14.00
Urea -2.00 RDP 12.50 % RUP -5.00 %
Salt - 2.00 Energy of 11-12 MJ/kg
Min.mix 3.00
==========
Total -100.00 Kg
==========

Feed Additives to be used:

Amino Acids – Lysine 50 gms & Methionine 50 gms
Zinc Sulphate- 10 g and Copper Sulphate 5 gms
Soda.Bica(Cooking Soda) – 100 gms
Live Yeast Powder 20n Billion cfu/g - 100 gms

The formula cost is Only Rs.16.00 per kg as per prevailing market price

RDP/UDP Requirements

Nutrient	Requirement	Heifer 50 Kg	Heifer 100 Kg	Heifer 150 Kg	400 Kg Cow with 10 liters of milk
RDP for maintenance	0.8-0.9 gm/Kg body weight	-	-	-	360
RDP for maintenance (Growing calves)	1.2-1.4 gm/kg body weight	55	140	210	-
RDP for milk production	60 gm/Liter of milk	-	-	-	600
UDP if the cow is giving more than 25 Liters of milk	5-10 gm/Liter of milk	-	-	-	-
Total		55	140	210	960

Chemical Composition (RDP & UDP) of Ingredients

Ingredients	Protein %	RDP	RUP /Bypass protein
Maize	9.00	2.70	6.70
Rice polish	12.0	6.10	5.90
Wheat bran	16.0	11.70	4.30
Deoiled Rice bran	14.0	9.10	4.90
Ragi	10.0	3.20	6.80
Bajra	12.0	3.80	8.20
Ground nut cake	45.0	31.50	13.50
Ground nut extraction	48.0	40.80	7.20
Cotton seed extraction	36.0	13.70	22.30
Sunflower extraction	30.0	16.50	13.50
Soybean extraction	46.0	27.60	18.40
Lucerne fresh	20.0	15.20	4.80

Berseem	26.0	12.70	13.20
Maize fodder	16.50	9.60	06.90
Para grass	7.10	3.40	3.70
Paddy straw	4.00	1.50	2.50
Cattle feed Type-II	16.00	11.20	4.80
Bypass Feed	22.00	08.00	14.00
Urea	287.00	287.0	-

Feed additives

1. Trace Minerals supplementation as Inorganic and Chelated form

Trace minerals or micro minerals are needed for blood synthesis, hormone structure, normal reproduction, vitamin synthesis, enzyme formation, and immune system integrity. Trace minerals are added to dairy cattle rations in milligram levels per animal per day and their concentration are expressed in the ration as parts per million. A major challenge for nutritionists and dairy managers is deficiencies do not immediately impact milk yield or growth. Reduced reproductive performance or impaired health can take several months before a deficiency appears.

The researchers have addressed the role of zinc, iron, copper, and selenium in disease resistance of swine and dairy and reported complex antioxidant systems keep free radical concentrations low through superoxide mutases (need manganese, zinc, and copper), catalase (iron containing enzyme), and glutathione peroxidase (selenium containing enzyme). These enzymes are water soluble and protect components within the cytosol (cell solubles). With zinc deficiency, thymus weight is reduced with a reduced number of lymphocytes. The thymus is important in T cell formation and immune capacity. Young animals may be more affected because they are not as immune-competent as mature animals. Zinc supplemented animals (350 mg per head per day) had improved gain and reduced treatment day in stressed cattle. Zinc serum levels were significantly higher (.97 ppm) in healthy calves compared to sick calves (.69 ppm) when challenged with bovine respiratory disease. Iron deficiencies affect antibody formation associated with B cells. Copper affects the antibody forming cells of the immune system and susceptibility to infection.

Role of trace minerals

Cobalt is essential for ruminants as it is incorporated into vitamin B12 by rumen microbes. Vitamin B12 is needed to metabolize propionate. Symptoms of cobalt and vitamin B12

deficiencies include loss of appetite, rough hair coat, stumbling gait, and anemia. Higher supplemental cobalt levels can be found in the field (.3 to 2 ppm).

Copper is needed for blood formation and copper dependent enzymes. Deficiency symptoms include reduced growth and milk yield, severe diarrhea, stiff joints, changes in hair coat color and texture (greying), loss of hair, and reduced reproductive performance. Recently, Kentucky workers have reported that higher levels of copper can reduce mastitis severity and duration. Molybdenum and cooper are antagonistic with a maximum of 6 ppm molybdenum in the total ration dry matter. Higher levels of copper have been reported in the field to improve hoof hardness. Jersey cattle are more sensitive to copper toxicity than other dairy breeds.

Iodine is required for the synthesis of thyroid hormones which regulates the rate of metabolism. Excessive iodine causes secretion of mucus from lungs and bronchial tubes, nervous-ness, rapid pulse and breathing, and coughing. Deficient cattle exhibit enlarged thyroid glands (goiter), especially in newborn calves which can be weak or dead. Approximately 10 percent of dietary iodine is secreted in milk which can be a human concern if multiple sources of iodine are added to the ration.

Iron is involved in cellular respiration and oxygen transport as components of hemoglobulin, myoglobulin, and enzyme systems. Early signs of iron deficiency include anemia and low blood hemoglobin. Later deficiency signs include weight loss and reduced appetite.. Ferric oxide is added to trace mineral premixes as a coloring agent (has low iron availability). Forages can be high in iron (over 500 ppm), but may be low in availability due to soil contamination or association with fiber.

Selenium was initially studied as a toxic element leading to sudden death and signs of distress. Chronic selenium toxicity (alkali disease) includes lameness, sore feet, deformed hooves, and hair loss from the tail muscle disease in young calves, cardiac and skeletal muscle degeneration, heart failure, and paralysis of the hind legs. Marginal deficiencies can cause retained placenta, an increase in mastitis duration and severity, and reduced reproductive performance. Whole blood selenium levels should be over 100 ppb (parts per billion) while blood serum should be over 70 ppb. Calcium and sulfur in the ration can reduce selenium absorption. Injected selenium has a half live of 14 days. Feeding supplemental selenium requires several weeks to months before blood levels increase. Supplemental vitamin E complements selenium, but does not replace it.

Zinc activates enzymes and is a component of metalloenzymes. Deficiency signs include skin dermatitis (parakeratosis), lesions, failure of wound healing, and reduced reproductive performance. Organic zinc can improved foot hardness, decrease sole abscesses, and reduced somatic cell counts.

Trace Mineral Guidelines

Important aspect of mineral supplementation is to maintain an optimum relationship with other minerals that can impact availability and/or absorption. The following mineral ratios can be used to evaluate mineral balance (based on the total ration dry matter).

Minerals	Proportion
Zinc to Manganese	1:1
Zinc to Copper	4:1
Copper to Molybdenum	6:1
Iron to Copper	20:1
Potassium to Sodium	5:1
Sodium + Potassium	
Calcium + Magnesium	< 2:1
Dietary cation-anion	
balance or DCAD	
Dry cows	<-100 meq/kg
Lactating cows	> 250 meq/kg

Recommended amounts of inorganic trace minerals in dairy cow

Minerals	Milligrams/day
Cobalt	2
Copper	225
Iodine	12
Iron	1000
Manganese	1200
Selenium	6
Zinc	1200

Delivery Systems - To feed Inorganic – 100 % + 25% Chelated Minerals

Chelation refers to a bonding formed between a metal ion (mineral) and ligand (protein or amino acid). A mineral complex is a mixture of mineral and organic compound. The biological role of chelated trace minerals is important. To be beneficial in dairy cows, it should be stable in the rumen and digestive tract and the beneficial response of chelated mineral may relate to the form of mineral rather than quantity. Absorbed chelated minerals could stimulate certain physiological responses or enter target tissues at higher levels.

Cows experiencing environmental stress (moisture, heat, or humidity), embryo transfer, disease risk, reproductive stress situations, and health stress are target animals for organic trace minerals. Zinc, copper, manganese, iodine, cobalt, magnesium, potassium, and

selenium complexes and chelates are commercially available. Producers, veterinarians, and nutritionists should evaluate economic responses on a case-by-case situation. Responses to measure and evaluate include improved immunity (less disease or sickness), reproductive performance (shorter days open, higher conception rates, or less embryonic loss), and herd health.

Economic response is the key concern. Chelated minerals cost 10 to 15 times more per milligram of mineral compared to inorganic sources. Commercial chelated mineral programs cost more per cow per day (depending on the combination and level of chelated minerals selected). Two approaches are listed below.

1. Supplement one-third of selected trace minerals as chelated mineral (400 g of zinc as organic zinc) and two-thirds as inorganic mineral (800 g of zinc as zinc sulfate for example).
2. Feed recommended levels as inorganic minerals (1200 g as zinc as zinc sulfate) plus an additional 25 percent as chelated zinc (300 g of zinc as organic zinc for example

BIS Type –II Mineral mixture Specification for cattle

Sl.No.	Minerals as %	Requirement	Extra If Required
1	Moisture (Max)	5.0	-
2	Calcium	20.0	20 - 30
3	Phosphorous	12.0	12 - 15
4	Magnesium	5.0	5.0-8.0
5	Iron	0.4	0.4-0.6
6	Iodine	0.026	
7	Copper	0.10	0.10-0.2
8	Zinc	0.8	0.8-1.6
9	Manganese	0.12	-
10	Cobalt	0.012	-
11	Sulphur	1.8-3.0	-
12	Sand silica((Max)	3.0	
13	Total Ash	78-85	
14	*B.anthracis*	Negative	

Dosage: Cattle - 100 gms/day

Sheep and goats -25 gms/day

Pigs -50 gms/day

Feed formulation – 3.0% of total feed

Strategic supplementation through Feeds-Fodder and Deficient minerals

Districts	Deficient Minerals	Feeding Advice to livestock	Sources of Minerals
Bangalore, Kolar	Ca, P, Cu, Fe	Legumes, Tree leaves, Green fodder, Cakes and Brans	DCP, CuSo4, Feso4,
Mandya, Tumkur	P, Zn	Green fodder, Brans, Cakes, Rice polish	DCP, Znso4
Mysore, Hassan	Ca, P, Mg, Zn, Cu	Legumes, Tree leaves, Local grasses, Green fodder, Conc. Supplements	DCP, Znso4, Cuso4, Mgco3
Coorg, Chikamagalur	Ca, P, Cu, Zn, Mg	Legumes, Tree leaves, Local grasses, Green fodder, Conc. supplements	DCP, Znso4, Cuso4, Mgco3
Chitradurga, Chikamagalur	Ca, P, Cu, Zn, Mg	Legumes, Tree leaves, Local grasses, Green fodder, Conc. Supplements	DCP, Znso4, Cuso4, Mgco3
Bellary, Dharawad	Ca, P, Cu, Zn, Mg	Legumes, Tree leaves, Local grasses, Green fodder, Conc. Supplements	DCP, Znso4, Cuso4, Mgco3
Dharawad, Haveri	Ca, P, Cu, Zn, Fe	Legumes, Tree leaves, Local grasses, Green fodder, Conc. Supplements	DCP, Znso4, Cuso4, Feso4
Mangalore Karwar	Cu, Zn	Cultivated fodders, grasses	Cuso4, Znso4
Raichur, Gulbarga	Ca, Zn	Legumes, tree leaves, local grasses	Caco3, Znso4
Bidar	Ca, P, Cu	Cakes, Brans, Legumes, Tree leaves, Cultivated fodders and grasses	DCP, Cuso4

(Report By: ICAR – NIANP, Adugodi, Bangalore 560 030)

2. Toxin binders to bind Mycotoxins:

HSCAS (Hydrated Sodium Calcium Alumino Silicate): HSCAS is dipolar clay because it is an ILLITE / CHLORITE, which has a mix of negative and positive charges.

Selectively adsorbs and immobilizes the mycotoxins. Has high affinity for aflatoxins and drastically reduces bio-availability of mycotoxins absorbs excess moisture in feed and acts as an anti-caking agent.

High capacity for binding aflatoxins and rapidly forms a stable chemisorption's complex. This makes it more effective at binding and has *a wide spectrum of adsorption of Mycotoxins* because many toxins have both negative and positive charges or have only one charge. HSCAS should be administered orally at the rate of 100 -200 gms per day/cow or it can be added in the feed at 0.5% in the cattle feed.

3. **Mannan oligosaccharide (MOS) - as Immunomodulator and Toxin Binder:**

It is derived from the outer layer of yeast cell walls. Oligosaccharides are carbohydrates that yield 2 to 10 monosaccharides upon hydrolysis. MOS is a combination of several molecules of mannose.

Mannans (Mannose) found in the cell wall of yeast *Saccharomyces cerevisiae* has been shown to induce an antigenic response in humans. The cell wall of the yeast organism consists of carbohydrates and protein in the form of chained and branched structures of glucose, mannose and N-acetyl glucosamine

It has been shown that mycotoxins are adsorbed by the polysaccharides (glucan and mannan) and not by the proteins or fatty acids of yeast cell walls. The cell wall containing polysaccharides, proteins and lipids exhibited numerous adsorption mechanisms such as hydrogen bonding, ionic bonding or hydrophobic interaction.

The idea to use yeast MOS in cattle feeds evolved from the concept that certain sugars, particularly mannose, could be used to largely block the colonization of intestinal pathogens such as *Clostridia/Salmonella* species and *Escherichia coli*, which contain type 1 fimbriae with mannose-seeking lectins. When they bind to the MOS product, the pathogens are prevented from attaching to intestinal mannose, proliferating, and producing toxins.

A second reason for using the MOS because of the effectiveness of some strains of live yeast at binding and reducing intestinal pathogen counts.

MOS may directly interact with immune cells and induce changes in expression of molecules involving immune regulation such as cytokines, chemokines, PRR, etc. When they bind to the MOS product, the pathogens are prevented from attaching to intestinal mannose, proliferating, and producing toxins.

A second reason for using the MOS because of the effectiveness of some strains of live yeast at binding and reducing intestinal pathogen counts In addition, feeding MOS to animals increased the immunoglobulin levels in their plasma, bile, and colostrum.

These results show that MOS affects immune function, but the specific effects require clarification. In particular, it is important to know the impact of MOS on secretion of cytokines under various conditions. 40 Cytokines that are synthesized by cells of the innate

immune system, such as macrophages, not only regulate immune function but also alter many metabolic processes.

Therefore, a balance between pro-inflammatory (e.g. IL-1, IL-6, tumor necrosis factor-α), and anti-inflammatory (e.g. IL-10) cytokines plays an important role in growth responses and in maintaining the appropriate and efficient activity of the immune system in response to surrounding immunological challenges.

MOS at the rate of 10 gm per day/cow or 0.1% inclusion in the feed can be of choice to bind mycotoxins, as immune modulator and to also to maintain gut health in dairy cattle.

4. Activated charcoal:

Activated charcoal" is similar to common charcoal, but is made especially for use as a medicine. To make activated charcoal, manufacturers heat common charcoal in the presence of a gas that causes the charcoal to develop lots of internal spaces or "pores." These pores help activated charcoal "trap" chemicals.

To be effective, activated charcoal must physically come into contact with the toxicant. Because activated charcoal has a large surface area, it is able to adsorb many chemicals and drugs especially pesticides and heavy metals ingested through feed and water through ion-ion hydrogen binding, dipole, and van der Waals forces in the upper GI tract, preventing or reducing the toxicant's systemic absorption. The effectiveness of adsorption is related to molecular size and polarity of the molecules, with nonpolar compounds binding to activated charcoal well. Other factors influencing adsorption of toxicants to activated charcoal include the solubility of the poison, the presence of inorganic salts, the ionization state of the poison, the pH of the toxicant, and the presence of gastric contents. Dosage: 1-2% of feed formulation or it can be given in water in 1000 times dilution

Conclusion:

To optimize the productivity of livestock, it is advisable to implement user friendly and least cost innovative technologies which ultimately benefits the farming community.

Chapter 4

ORGANIC DAIRYING

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Introduction

The adverse effects of chemical based input intensive agriculture practiced during the last 40-50 years, coupled with an enhanced consumer awareness of food safety issues and environmental concerns have increased the demand of organic food products internationally and locally in India as well. This has led to rapid developments in the area of organic farming all over the world. India with its enormous indigenous bovine population and indigenous methods of agriculture production has comparative advantage in conversion to organic farming. The Indian dairy farmers who are contributing towards India's number one position in milk production in the world may find it worthwhile to try and contribute to the organic milk production as well, which depends on certain rules, procedure and certification standards to be observed. A farmer who would like to switch over from conventional milk production to organic milk production should be familiar with the organic livestock farming standards and organic dairying standards in particular. This article, therefore, presents some of the fundamental requirements for conversion to organic milk production at the level of farmers.

Indian economy is increasingly looking forward to its livestock sector for growth, since India owns about 15% of world's livestock. Indian livestock sector is vibrant with high potential for growth including for the development of organic animal husbandry due to certain favorable features like mixed farming system, native breed adaptability to local situations and its disease resistance and its on-farm diversity. Considering these natural advantages India has in conversion to organic farming; organic animal husbandry may offer an added opportunity. With increasing concern for environment and rising consumer awareness about safe and quality foods, the organic foods are attracting ever-increasing number of consumers. Moreover, the demand for organic products has created new export opportunities for the developing countries. In view of the increasing demand for organic livestock products, Indian dairy farmers who are contributing towards India's number one position in global milk production should have a clear idea of organic dairy farming and its requirements to meet the demand of export and also the local demand in future. The farmers

willing to switch over to organic dairy farming should have knowledge and skills required for the organic production process.

Organic production systems unlike traditional systems of production are governed by a set of standards to be followed strictly by the producers of organic food. The compliance with these standards is verified by certification agencies authorized by the government. Organic certification gives assurance to the consumers about the quality of production, which often more appeals to the consumers. In case of conventional products, there is no way to guarantee the production procedure, but in organic farming production procedure is certified to be safe and sound as well as environment friendly.

Landless organic animal husbandry is forbidden

Organic dairying starts from the ground up. The basic requirement is more of a farmland than the cows or buffaloes. Organic farming including livestock production is basically a land based system, and landless animal husbandry system is forbidden in organic livestock farming. So, landless livestock farmers are not eligible for organic farming unless they go for land leasing. Farmers can raise suitable forage crops to feed their cattle and surplus can be marketed to needy farmers of that region. Forage crops should be grown without any chemical fertilizers and pesticides. Animal manure should be diverted to fields to maintain the fertility of the soil. There should be recycling of nutrients between plants and animals. In nutshell, the feed and fodder requirements have to be met on farm as far as possible. The landless farmers may find it difficult to meet this requirement of organic dairying, unless they have control on land for growing feed and fodder.

Selection of breeds as a prelude to organic farming

Farmer has to choose a breed that suits local conditions in terms of its disease resistance, maintenance cost and adaptability. If possible, pure breeds have to be maintained. A farmer can maintain an organic farm with local *desi* cattle whose genetic and production potential can be up-graded with bulls of good producing records, if necessary. Farmer can go for native breeds like Ongole, Vechur, Deoni, Tharparkar and many other indigenous breeds which are proven for their genetic potential and adaptability to local conditions

As per organic standards, all animals should be born and raised on the organic holding. However, a beginner can procure calves from conventional farms, which are of 4 week old that received colostrum and full milk diet. In the same way, breeding stock to a maximum of yearly 10% can be brought in from conventional farms. Animal production record is important along with mothering ability, hardiness and thriftiness, resistance to disease and parasites, ability to forage etc., for which Indian native breeds are naturally endowed. Farmers have to follow natural reproductive techniques. However, technique like

artificial insemination is allowed, which is accepted to meet international standards of organic farming. Practices like embryo transfer technique, hormonal treatment, induced birth and genetically engineered breeds, which are high capital intensive, are not allowed in organic farming practices.

Housing as a means of providing natural habitation

Housing in organic farming should be according to the behavioral pattern of animals. Farmer should see that there is sufficient free movement with accessibility to fresh air and natural daylight besides protecting the animals from excessive sunlight and rain. Animal should have access to fresh water to meet its requirement. Herd animals shall not be kept individually and tethering is not allowed in organic farming. If tethering is to be done, it should allow the animal to move freely with sufficient space.

Space requirements for different category of cattle

S.No	**Group of animals**	**Indoor Space m^2/animal**	**Solid floor space (indoor) m^2/ animal**	**yard space (outdoor) m^2 /animal**
1.	Breeding bulls	10.00	5.0	30.0
2.	Dairy cows	8.0	3.0	4.5
3.	Young stock < 100 kg	1.5	0.75	1.1
4.	101-200kg	2.5	1.25	1.9
5.	201-350kg	4.0	2.0	3.0
6.	350kg	5.0	2.5	3.7

Overcrowding shouldn't be done in order to avoid conflict behavior and associated health problems.

Feeding of livestock in an organic farm

A farmer should feed an animal according to its physiological requirements. Diet should be according to animal's natural feeding behavior and digestive needs. Farmer should raise forage crops organically on his/her own, to feed the livestock. S/he should see to maximize production of feedstuffs on his farm and the rate of success of organic farm depends on self-sufficiency in feed production. As a rule, 80% of feed should be from organic sources, however, at times of difficulties and emergencies feed from conventional farm may be given with a dry matter content of 15% which has to be gradually reduced to 10% within 5 years. When formulating rations, diet of animal should be balanced by adjusting the protein percentage to complement the forage levels. For example, when rations

are based on high protein forage, care should be taken to ensure that energy levels are met by straw or hay to balance the excess protein. Growth regulators, artificial coloring agents, urea, medicated feeds, hormones, chemically extracted feeds, synthetic appetizers etc. are strictly prohibited in feeding the livestock of organic farms.

To supplement the feed of animals, plant based products, by products of food industry like molasses; fodder preservatives like bacteria, fungal and enzymatic elements, vitamins, trace elements can be added as per requirement. Raising of calf is more important, as it is the future organic milch animal. Calf be allowed to suckle according to its natural requirement and proper weaning be done unlike in conventional systems. In case of emergencies, calf may be given milk from non-organic farming systems or dairy substitutes so long as they contain neither antibiotics nor synthetic additives.

Preventive health management plays a major role

Health care starts with selection of a breed, which has natural immunity against diseases and with good adaptability to local situation. Health care of livestock depends on the manner in which they are raised and the quality of feed offered, which result in maximum disease resistance. In organic livestock farming, preventive management plays major role and moreover, if any illness occurs, farmer should try to find out the cause, and change the managemental practices accordingly in order to prevent future outbreaks.

For treating the sick animals, farmer should give importance to natural medicines and methods including homeopathy, ayurvedic medicine and acupuncture. However, conventional medicines can be used, when no other alternative is available, as the well being of the animal is the primary consideration in organic farming. But, if the animal is on allopathic treatment for two subsequent times, it loses the status of organic. Farmer can vaccinate his/her animals when diseases are known or expected to be a problem in his/her farm region that too with legally required vaccines only. Genetically engineered vaccines are prohibited. Instead of relying on medication, the farmer should strengthen the animal, so the immune system can do its job. So, farmer should be well aware that, health care in organic farming starts with selection of suitable breeds, raising the livestock according to its natural requirement; feeding good quality feed along with required grazing to strengthen the immune system of the animal and providing suitable housing to avoid related stress and associated health problems.

Marketing of organic products

Farm branded organic milk can serve as an effective way for a small producer to establish an identity and market niche and present possibilities for supplying to national and

international markets. Development of other processed foods may itself create a demand for organic products such as milk powder or butter as ingredients in biscuits and confectionary.

Organic livestock products suitable for Indian urban markets

Product	*Market*
1. Organic indigenous cow milk	Old persons, young children, patients with terminal diseases like cancer, etc.
2. Organic cow *ghee*	Temples, Ashrams, old persons
3. Leather products from organic buffalo farms	Export market

Record maintenance - A must

Farmer has to maintain the records - right from the procurement of livestock, it's feeding, breeding, health care, production, till to the marketing of the product along with the type of labor involved (child labor is not allowed), method of processing, inputs to the farm and animal welfare measures taken which is a must for inspection purpose and certification of the farm and products as organic. Farmer should not be ignorant of this, in spite of his illiteracy and amazing memory, as it is a valuable tool for assessing the performance of one's herd or flock by the certifying agencies, which is mandatory for the milk to be labeled as 'organic'.

To bring a conventional farm to the organic status, the whole farm including dairy animals should be converted according to the standards set down as per the guideline sof National Programme on Organic Production (NPOP, 2014). The milk can be sold as organic only after the farm has been under conversion for at least 12 months, provided the organic production standards have been met for the appropriate time. Once conformity with organic standards has been verified by a certification body, the product is accorded organic label which carries the name of the certification body and the standards with which it complies. To the informed consumer, this label functions as a guide and an assurance of purity. Certification bodies evaluate operations according to different organic standards and can be formally recognized by more than one authoritative body. In India, currently 29 certification agencies are accredited by the Agricultural and Processed food products Export Development Authority (APEDA) for inspection and certification of the organic farms and products. Out of these, about 7 certification bodies are accredited to certify organic livestock operations too.

Conclusion

Apart from growing technology and highly sophisticated life, people all over the world are becoming increasingly conscious about the naturally available products and their importance in their daily life. Looking at growing demand for organic dairy products, branded and certified organic milk and milk products are increasingly available now in developed countries as also in Indian metros. Also, some private dairy companies have started exporting certified organic milk products like butter oil/ghee and *paneer* to several countries in Gulf. So, it is the Indian dairy farmers, who have to en-cash the emerging demand. Many dairy farmers including dairy cooperatives are moving towards certified organic milk production by converting conventional dairy farms to organic dairy farms. Thus, demand for information on how to do organic farming is increasing at the level of farmers. The extension agencies especially those who are responsible for catering to the information and skill needs of dairy farmers must equip themselves with the knowledge and skills on organic dairy production particularly about the conversion requirements, organic standards & guidelines.

References

1. Chander, Mahesh. 2001. Organic milk in India: Looking beyond Tomorrow. Indian Dairyman, 53, (12): 35-39.
2. Chander, Mahesh and Reena Mukherjee .2005. Organic Animal husbandry: concept, Status and Possibilities in India – A review. Indian Journal of Animal Sciences, 75 (12): 1460-1469.
3. Chander, Mahesh 2005. Prospects of Organic milk and meat production in India. pp.486-92. (Eds) Rowlinson P. Wachirapakorn C, Pakdee P and Wanapat M . Integrating Livestock –Crop systems to meet the challenges of globalization, Volume 1. British Society of Animal Science, pp 510.
4. Chander, Mahesh & Subrahmanyeswari, B. Organic Livestock Farming. Indian Council of Agricultural Research (ICAR), 2013, 293p.
5. Chander, Mahesh & Subrahmanyeswari, B. (2007). Setting up an Organic Dairy Farm. Indian Dairyman, 59, 2, pp. 59-63.
6. Chander, M., B. Subrahmanyeswari, Reena Mukherjee and S Kumar.2011. Organic livestock production: an emerging opportunity with new challenges to producers in tropical countries. Rev.Sci.Tech.Off. Int. Epiz, 30 (3), 969-983.
7. Chander, Mahesh, B Subrahmanyeswari & Reena Mukherjee. Organic Animal Husbandry. In: Handbook of Animal Husbandry, pp 365-382, ICAR, 2013.
8. NPOP. 2014.National Programme for Organic Production. Department of Commerce, Min. of Commerce and Industry, New Delhi, 115p.

https://apeda.gov.in/apedawebsite/organic/ORGANIC_CONTENTS/National_Programme_for_Organic_Production.htm.

9. Organic Animal Husbandry Standards, Proceedings of the National Workshop, November 26-27, 2002, Indian Veterinary Research Institute, Izatnagar, U.P., India.

Chapter 5

SCIENTIFIC BREEDING IN DAIRY FARMING

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Introduction

Human population growth, increasing urbanization and rising incomes are fuelling a massive increase in demand for food of animal origin (milk, meat, eggs) in developing countries. Globally, livestock production is growing faster than any other sector, and by 2050 the livestock sector is predicted to become the most important agricultural sector in terms of added value. Since Robert Bakewell's time, there has been a well-documented increase in the overall performance of dairy cattle thanks to genetic improvement. However, despite changes in the climate, environment, the availability of fodder and feed, and the emergence of newer diseases, human desire to further increase or sustain production has forced breeders to innovate and exploit new generation technologies like biotechnology and bioinformatics in the field of animal breeding.

Despite having a diverse animal population and an environment that is favourable for animal husbandry, the majority of emerging nations lag behind some dairy developed nations in terms of quality milk production. Selection of the breed and dairy cattle, their identification, recording and analysis of various types of data, such as phenotypic, genomic, and epigenomic data for the selection of breeding stock using bioinformatic tools, and finally the manipulation and distribution of germ plasma using biotechnology tools needs to be adopted to achieve desired progress in dairying.

Selection of Dairy Breed:

Breed selection is crucial in the dairy industry. The chosen animal should perform to its best in a given environment with the available resources. The most popular milk breed worldwide is the Holstein Friesian, followed by the Jersey breed. These two breeds are also widely utilised even in India for dairy farming. In India, HF and Jersey make up 43.3% and 54.9% of the exotic and crossbred population, respectively,. However the average milk production from crossbred is just 8.09 kg/day indicating lower utilization of their genetic potential. Major reasons for lower yield is imbalance of exotic inheritance of the animal and production environment; and culling being not practiced. Recent studies have indicate strong potential for genomic selection to improve milk production of smallholder in India. Further,

India has 50 indigenous cattle breeds of which only few ie., Red Sindhi, Shahiwal, Gir and Tharparkar are popular as dairy breeds. Gir is the world famous milch breed of Indian origin with an average lactation yield of 1600 kg. Brazil, have imported and genetically improved the breed for milk production, where the average lactation yield is 3500kg. Globalisation has opened the doors for import or export of better dairy breeds or animals. The frozen semen and embryo technology have made exchange of superior genetic material across the countries easier compared to transit of live animals. In India, import or export of Bovine germplasm is as per 2018 guidelines of Department of AHDF, Government of India.

Selection of breed and level of exotic inheritance in crossbed cattle should be based farmers capacity to provide quality feed and fodder, care to the animals, veterinary services and market demand for type of milk. In India, farmer can choose HF cross bred if they can provide more care, quality feed, frequent veterinary aid and demand is for fluid milk otherwise Jersey cross bred will be better. Further, dairying with Indigenous breeds can be profitable if milk is used for preparation of various dairy products and sold at premium price.

Selection of Dairy Cow

Selection of cow will not be just for present generation performance it should also possess good genes for next generation as well. It is always good to induct cows after first lactation, where in one can ascertain animals own performance. The animal should have true breed characters and features of a good dairy cow. Holstein foundation have published a handbook on dairy cattle judging, which break downs the morphological traits into four major group as Frame (15%), Dairy strength (25%), Rear feet and Legs (20%) and Udder (40%).

Animal Identification:

An international NGO called the International Committee on Animal Recording (ICAR) works to promote more effective and sustainable animal production all around the world. It offers a network for members and stakeholders to collaborate, share, and support one another in creating and implementing international standards for animal production. The mission of ICAR is to advance the genetic evaluation, performance recording, and development of agricultural livestock identification processes. Animal identification systems must adhere to international standards, which are set by ICAR. The National Dairy Development Board (NDDB) in India is a member of ICAR and the main organisation authorised by the Indian government to provide Unique Animal Identification numbers to the whole nation's cattle population. The first 11 digits of a Unique ID are running serial numbers, while the last digit is a check digit. Any type of tagging system, including RFID, barcoded, and plastic, can use this. In order to implement its programmes, the Indian government has made the ear tagging of cattle with a unique identification number essential.

The government of India has recommended and provided yellow-colored plastic tags with a unique I.D. number and barcode.

Particularly in dairy farms with a fully automated data recording system, radio frequency identification (RFID) of animals is becoming a common method of animal identification. The International Committee for Animal Recording (ICAR) has been permitted by the International Organisation for Standards (ISO) to register and certify the producer of an animal RFID system in compliance with ISO 117842 and ISO 11785. The most popular RFID tag is one with an Alien H3 chip since it offers a read range of up to 8 to 10 metres, which is crucial for a complete RFID animal tracking solution. Only a few private farms in India are adopting an RFID tagging system with a unique ID number supplied by NDDB to establish a fully computerised data recording system.

Animal Data Recording:

Regular recording of data regarding production performance, health, feeding and breeding are crucial to know economic viability, culling of the excess stock and selection of future breeding stock. Manual hand written recording being laborious especially in large herds is becoming obsolete. Majority of developed dairy nations have sizable dairy herds. In UK, where computerised animal data tracking is practised, the average herd size is 148. The average herd size in India is under 2, and performance recording is hardly ever done. As a result, the Information Network for Animal Productivity and Health (INAPH), an application database for dairy cattle data recording in India, was established by NDDB in partnership with INFOSYS, an Indian software company. By using the INSPRM programme, INAPH also covers the recognized semen stations with registered bulls. Animal breeding, progeny testing, nutrition, and health programmes are all supported by INAPH, which also assists in evaluating and estimating the breeding values of bulls and bull mothers on the ground. Through a field-based progeny testing programme, INAPH assists in documenting the activities of animal breeding, progeny testing, nutrition, and health programmes. It also assists in evaluating & estimating the breeding values of bulls & bull mothers based on the performance of their daughters. INAPH application can be installed on a desktop computer, a PDA, a Windows Mobile phone, and a notebook. The Indian dairy industry urgently needs to promote the use of INAPH mobile applications among Indian dairy producers.

Traits to be recorded:

In addition to milk production features, other traits like milk quality, udder health, hoof score, etc. need to be taken into account when choosing animals. However, these are rarely considered in dairy developing nations. Additionally, it's anticipated that consumers will seek more varied breeding objectives in the near future, including features like animal welfare, animal disease, product quality, and environmental footprint.

a. Production data recording:

Section 2 of the ICAR Guidelines provides new recommendations for dairy cattle milk recording that are widely accepted. Additionally, the ICAR provides up-to-date data on milk production features, which are crucial for managing and breeding dairy herds. The milk recording process starts with animal identification, recording calving date of milking cows, the amount of milk given, flow of milk, duration of milking, date and time. Obtained milk sample is analysed for milk. Milk sample is obtained and its constituents as SNF, Fat, Protein etc analysed. The results of the analysis plus the data about milk yield and time of milking are stored in a database. Subsequently a number of parameters, cumulative yields and indices are calculated and stored in the database.

b. Breeding data recording:

Ideally it is best to have a calf a year for profitable dairy farming. Breeding data recording is essential component of dairying. The traits to be recorded include age and body weight at puberty, age at first calving, service period, conception rate, inter calving period, numbers of calving in life time and ease of calving.

c. Conformation and Bovine Functional traits:

The traits that need to be highlighted during the selection of breeding stock include body conformation and condition score, bovine functional traits as dairy cattle health traits, female fertility traits, udder health traits, claw health scores, and lameness scores. The list of such traits, methods of recording, and decision support systems for evaluating the animals for such features are all periodically updated by ICAR and are found in sections 5 and 7 of its Guidelines. To further harmonise on an international level, all organisations should rank this list of characteristics in the same way.

d. Behaviour, welfare and other traits under evaluation:

The inclusion of milking temperament, oestrous behaviour, mid-infrared spectroscopy of milk, reproductive tract ultrasound, video image analysis, transcriptomics (i.e., gene expression profile at a given time period), and experimental - extensive phenotyping (e.g., immunological challenge) of a smaller number of animals divergent for a characteristic under investigation are being studied. With the use of technology, some data can be automatically collected and converted into information that is helpful for herd management and animal breeding. The MIR spectrum can be used to measure methane emissions and other performance characteristics as well. udder health assessment using milk electro-conductivity, Progesterone profiling for ovulation and pregnancy detection, Pedometers are used to evaluate potential health and oestrus. Algorithms based on data from pedometers can be used to predict the length of grazing and consequently feed intake in grazing animals. There are

numerous more potential technological advancements, such as the use of sensor and communication technologies in rumen boluses to monitor rumen conditions or the use of GPS technology to track a herd of cows. A coordinated, multi-disciplinary, and international effort will be needed to compile all available data sources into a format that can be returned to the user via a decision support tool.

Selection:

Phenotype based selection:

Previously, breeding stock was chosen based on their individual performance histories, which were influenced by regional environmental factors and herd-specific management techniques. Daughter-dam comparisons have been employed for more than 30 years, which has led to more genetic advancement than earlier techniques. Modern (herdmate) comparison techniques made it possible to account for environmental factors more accurately, which accelerated genetic progress. Later, the data from progeny testing programmes and pedigree information became the accepted method for choosing breeding stock, particularly breeding bulls. The employment of mixed linear models, maximum likelihood, and best linear unbiased prediction techniques, which made optimal use of pedigree and performance data and permitted precise selection judgements, was made possible by advances in computation and robust statistical approaches.

Genome based selection:

The selection of dairy cow has been changed by whole-genome sequencing technology, and significant genetic advancement have been made. Whole-genome prediction and models that incorporate reliable data analysis techniques like G-BLUP and SNP-BLUP, Bayesian regression models (BayesA and BayesR), and machine learning algorithms have replaced pedigree-based models. The principles of genetic inheritance and epigenetic alteration in important biological pathways will probably be clarified in the future, and genomic data will be combined with information from on-farm sensors to enable precision management on contemporary dairy farms.

Marker-Assisted Selection: Using molecular genetics tools like RFLP or microsatellite markers, which measure variation at the genome level, geneticists can search for underlying functional mutations or QTL with significant impacts. Numerous approaches for marker-assisted selection were developed between the 1980s and the 2000s. Linear models were used to pick QTL after several strategies to identify them were combined. The anticipated genetic advancement over and above the standard approach, however, was not realised. Due to strict significance thresholds, the impacts of significant markers were frequently overstated, and numerous QTL with minor effects were ignored.

Whole-Genome Selection: Dairy cattle breeding was revolutionised by the development of Next-Generation Sequencing techniques and low-cost, high-throughput genotyping devices for SNP markers. The whole genome selection of dairy cattle involved the development of dozens of techniques and algorithms. The first barrier in genomic selection was the statistical analysis of massive datasets of SNP effects and their correlation with phenotypes. However, improvements in bioinformatics, greater computing power, and the creation of appropriate robust statistical approaches made the process easier. BLUP SNP-BLUP, sometimes known as SNP-BLUP, is a method for estimating SNP effects that can be added together to obtain the genomic EBV of new selection candidates. When calculating genomic EBV, a genomic relationship matrix (G) that is equivalent to a pedigree-based relationship matrix (A) can be created from SNP genotypes. GBLUP is appealing since animal breeders who have been using BLUP for years are already familiar with it and can use it with ease.

Bayesian Regression Models: Bayesian regression was used to create yet another set of models for genomic prediction. When there are more explanatory variables (SNP) than data points, ordinary least squares regression cannot handle the problem. However, in Bayesian regression models, the SNP effects are considered as random samples from an underlying distribution. When QTL with moderate or large effects are present, Bayesian regression techniques typically outperform GBLUP, however GBLUP performs exceptionally well when inheritance approaches the infinitesimal model.

Machine Learning and Artificial Intelligence methods: Machine learning, a subfield of artificial intelligence, is used in the study of animals to predict the breeding potential of unobserved individuals by using highly flexible algorithms on the results of observed individuals with known breeding potential. The reference population or training set in animal breeding refers to older animals with known genotypes and phenotypes as the basis for the validation of the population or testing set of selection candidates with known genotypes. There are numerous machine learning algorithms, but no single approach consistently produces the best predictions—the best algorithm and its parameters change depending on the application. The use of machine learning to improve genetic selection and dairy herd management is very promising. Examples include deep learning algorithms and multi-layer artificial neural networks. Numerous potent algorithms are accessible in the public domain as open source and commercially. When dealing with enormous amounts of genomic and phenotypic data, machine learning algorithms must be flexible in order to forecast the breeding values of selection candidates.

A permanent subcommittee of the ICAR, INTERBULL aims to conduct an international genetic examination of bulls from member countries. It provides information on the procedures and benchmarks that must be met when evaluating a bull's genetic makeup.

The genomic breeding values for different traits are published by INTERBULL, who also ranks them globally. It supports the genetic advancement of their dairy cow and allows various nations to import the greatest genetic material. India is not an INTERBULL member.

Genomic selection in India:

In 2014, the National Dairy Development Board began implementing genomic selection for cattle and buffaloes in India with the goal of developing appropriate methodologies for animal selection based on more trustworthy genomic breeding values (GBV) under the small-scale dairy system of the nation. The reference population from the location and population in which genomic selection is conducted determine the efficiency of the process. NDDB, a widely used database for milk records and animal DNA. To generate a large reference population for the purposes of genomic selection, cattle and buffalo breeds that were subject to various progeny testing and pedigree selection procedures were used. For genotyping Indian cattle breeds and their crosses, NDDB created a special SNP chip called "INDUSCHIP," which has now been replaced by the 53K SNP INDUSCHIP2. Using INDUSCHIP, the genomic breeding values of Gir and HF crossbred cattle were calculated and published in 2018 and 2019, respectively. In 2020, buffalo genotyping was started using a medium density (59K) bespoke genotyping chip called the BUFFCHIP, which was created with technical help from the USDA. Currently, genomically chosen bulls for crossbreeds, Gir, and Murrah breeds are provided to semen stations for speedier genetic improvement in a variety of cattle.

Advanced Breeding Techniques:

Artificial Insemination (AI): Artificial insemination is a widely used advanced breeding technique in the dairy cattle industry. It involves collecting semen from genetically superior bulls and introducing it into the reproductive tract of cows using specialized techniques. AI allows dairy farmers to access superior genetics from across the globe, improving the genetic potential of their herds.

Embryo Transfer (ET): Embryo transfer is a technique that enables the production of multiple offspring from a single superior cow. It involves collecting embryos from a genetically superior donor cow and transferring them to recipient cows. ET allows for the propagation of superior genetics rapidly and extensively.

Sexed Semen Technology: Sexed semen technology has gained popularity in India as it allows for the production of desired gender offspring. This technology helps dairy farmers meet specific market demands, such as the preference for female calves for milk production or male calves for meat production.

Conclusion:

Growing demand for animal-origin food in developing countries is due to population growth, urbanization, and rising incomes. Genetic improvement, biotechnology, and bioinformatics are the driving innovation in animal breeding. But, Quality milk production is lagging behind in emerging nations compared to developed countries. Breed selection, identification, data analysis, and germ plasma distribution needs to be improved with adoption of bioinformatic and biotechnological tools for progress in dairying. INAPH application for dairy cattle data recording and evaluation in India is in progress. NDDB is implementing genomic selection for cattle and buffaloes using INDUSCHIP and BUFFCHIP.

References:

1. Dairy judging – Holstein Foundation; http://www.holsteinfoundation.org /pdf_doc/workbooks/Dairy_Judging_Workbook.pdf

Chapter 6

AUGMENTATION OF LIVESTOCK PRODUCTIVITY THROUGH ASSISTED REPRODUCTIVE TECHNIQUE IN DAIRY ANIMALS

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Introduction

Reproductive inefficiency is one of the most important causes of economic losses in animal industries and it is realized throughout the world. Despite of the remarkable advancement that has been made in the field of reproductive physiology in recent years, infertility due to low conception rate and high embryonic mortality rate remains a major problem. On the other hand, there is an increasing necessity to produce animals with high genetic potential to increase the productivity of animal unit instead of increasing the number of animal herds to achieve high quality and quantity production.

To meet future needs and to be able to sustain agricultural production, agricultural research and its applications need to use all emerging technologies one of which is the modern reproductive biotechnologies. The various assisted reproductive techniques have been developed and refined to obtain a large number of offspring from genetically superior animals or obtain offspring from infertile (or subfertile) animals in addition to disease control.

The various recent available assisted reproductive techniques which may be helpful in improving the current status of livestock reproduction are

1. Multiple Ovulation and embryo transfer (MOET)
2. Semen Sexing
3. Cloning
4. Artificial Insemination

1. Multiple Ovulation and embryo transfer (MOET)

The term MOET was coined by Nicholas and Smith (1983) to consider embryo transfer and related technology in the context of optimizing genetic improvement of cattle. Multiple ovulation and embryo transfer (MOET) is often referred as the Assisted Reproductive Technology (ART) that is “to the female, while AI is to the male”, i.e. a method of producing more offspring from a genetically valuable female than would be possible by natural

breeding. Embryo transfer technology is an important tool to improve livestock at faster rate as well as gives an opportunity to utilize the genetic contribution of both male and female at the same time. By MOET the selection intensity in females can be doubled in elite herds, thus increasing the possibility of producing high yielding bulls and heifers.

Embryo Transfer

Removal of embryos from biological dam (donor) and placement into a surrogate mother (recipient) for development of viable calf. Rapid method for multiplication of desired germplasm and practiced throughout world for production of breeding bulls. Surgical methods for embryo collection and transfer are increasingly replaced by non-surgical methods, which are much more practical and less expensive in selection programmes.

Benefits of Embryo Transfer

Traditionally, cows produce only one calf per year. ET allows the production of many offspring within a year from a single cow. It can increase the genetic potential of a herd in a relatively short period of time. It can increase milk production in dairy herds. It can increase weaning weights in beef and dairy herds. It allows other producers to take advantage of superior genetics because frozen embryos can be shipped almost anywhere. ET preserves superior genetics for future generations due to embryo freezing. However, it is expensive, labor intensive and requires trained personnel.

Selection of Donor and recipient cows

The cows with high milking ability, high growth rate and outstanding reproductive capacity are selected as donor. In donor cow progesterone concentration **≥3ng/ml** prior to superovulation as such donars show better ovarian response to superovulation treatment**.** The estrogen **concentration a**t luteal phase and esrus phase should be 1-6pg/ml and 10-15pg/ml and cows with estrogen concentration ≤10-15pg/ml should not be selected.

Recipient Cows should have normal reproductive efficiency and normal genetilia. The recipient cow must be able to maintain her pregnancy to term and produce an adequate milk supply for her calf. It should have completed at least 2 gestations. In recipient the progesterone concentration is more important than estrogen. At estrus concentration of progesteroe should be 0.1 to 0.8 ng/ml and on 9 to 16 days it should be 4.5ng/ml. The cows having progesterone concentration ≤4.5ng/ml should not be selected.

Estrous Synchronization

Correct uterine environment is very critical for embryo survival. Synchronization refers to the process of programming a group of animals (recipient) to come in estrus at approximately

the same time as the donor animals, which is being superovulated. Optimally 12 hours of variation in synchrony is a good acceptable limit. However it should not exceed beyond thirty six hours. This is a management technique that makes use of hormones to control or reschedule the estrous cycle. Out of most protocols available, the most commonly used protocol in cattle and buffalo is by use of Prostaglandin F_2 α which is based on the fact that it shortens the life span of corpus luteum. Two PGF_2 α injections at 11 or 12 days apart synchronizes estrus in 90% of the animals. The b**asis for synchronization of Eetrus is either to m**anipulate life span of CL or to manipulate growth of follicles and timing of ovulation.

The crucial steps of ET

1. Donor cows of good pedigree animals are treated with hormones (FSH and LH) to increase the number of eggs released at ovulation - multiple ovulations (MO) or superovulation.

2. Then the cows are artificially inseminated using semen from a proven bull or sexed semen.

3. After 6-7 days, the embryos are flushed out non-surgically using a catheter placed into the uterus. This is possible because, in cattle, there is a delay in embryos becoming implanted in the uterine wall. On average, 4-7 embryos are collected.

5. Embryos may be frozen and stored, using techniques similar to those applied to semen, (though precise control of the regime is somewhat more critical).

Thus, embryo transfer has the potential to bring about genetic improvement twice as fast as AI alone. Moreover, the use of MOET technique could lead to increased selection intensity and reduced generation intervals, resulting in improving genetic gains. Embryo transfer as a part of other biotechnology will in principle remain as a bottom line technique of other advance technologies such as stem cell research, cloning and transgenesis etc.

2. Sexing of Sperm

The ability to preselect or predetermine the sex of offspring prior to conception is a highly desired technological tool for assisted female breeding programs specifically for milk production, and in males, for meat production and increasing livestock numbers. The current technology is based on the well-known differences in X- and Y-sperm in the amount of DNA.The technology uses modified flow cytometric instrumentation for sorting X- and Y-bearing sperm.

The limitations of sexed sperm technology

- The equipment for sexing sperm functions quite well, but is fairly complicated and expensive, over $350,000 per sperm sorter.
- Skilled operators are required, which results in training costs. Because of these large fixed costs, most sorters are operated in shifts for 14–16 h or more per day.
- Typically, a dose of frozen bull sperm for artificial insemination contains $\geq 20\times10^6$ sperm. However, for most bulls, fertility is satisfactory at 10×10^6 sperm, and for some bulls fertility remains high at 2×10^6 frozen sperm per dose.
- Routine operation of a flow cytometer/cell sorter for sexing sperm results in sexing about 10×10^6 sperm/h of each sex
- Using fewer sexed sperm per dose usually 2×10^6 sperm.
- The calves produced are phenotypically normal. Genetic damage likely is very low, or does not occur at all.

Applications of sexed sperm for cattle

- Because sexed sperm have been used to breed heifers successfully on many occasions, one obvious application is to breed heifers to have female calves. These should result in excellent replacements for beef and dairy herds, since the youngest cattle in any herd with a genetic improvement program are genetically superior to the older cows.
- A major additional benefit is that on the average, female calves weigh about 2 kg less at birth than male calves, so the incidence of dystocia in first calf heifers will decrease with this application.
- Another application is to obtain male calves from the very best cows in the herd to use as breeding bulls. Sexed sperm could be especially useful for superovulation, in which case it often is desirable to obtain calves of one sex or another for a particular mating.

3. Cloning

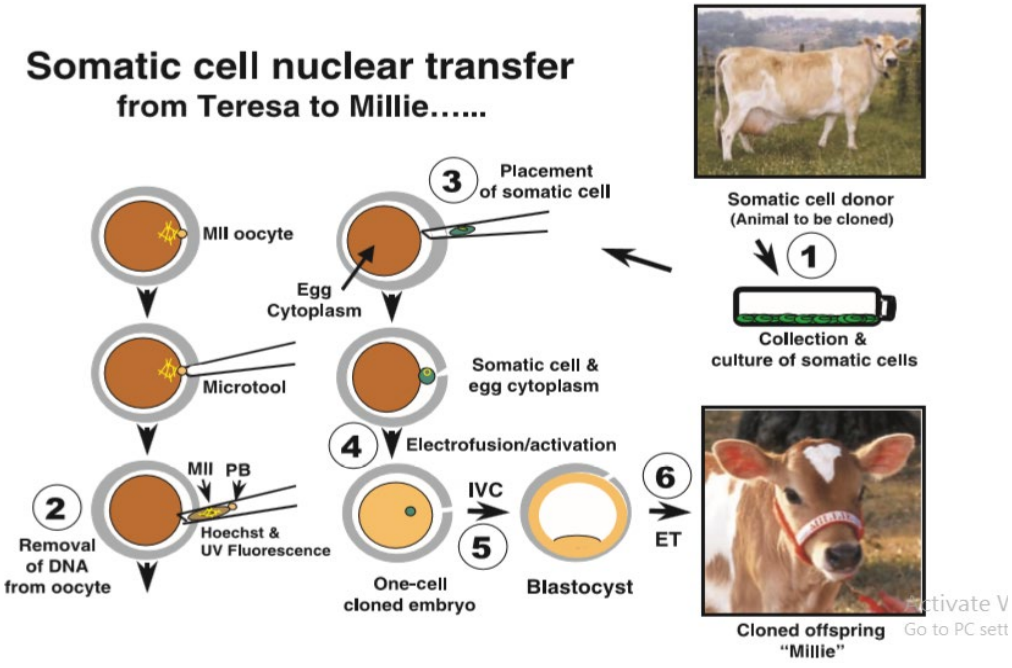
Cloning is a powerful technique and potentially it could be used for multiplication of elite animals and minimize the genetic variation in experimental animals. It can be used for the conservation as well as tool for the production of stem cells for therapeutic purposes, as therapeutic cloning. Cloning using somatic cells offers opportunities to select and multiply animals of specific merits. Numerous types of somatic cells are used as donors in somatic cloning; foetal fibroblasts, adult fibroblasts, granulosa cells, hepatocytes, lymphocytes etc.

First animal obtained by somatic cloning was a sheep called “Dolly”. She was derived from cells that had been taken from the udder of a 6-year old Finn Dorset ewe and cultured

for several weeks in the laboratory. Individual cells were then fused with unfertilized eggs from which the genetic material had been removed.

Two hundred and seventy seven of these reconstructed eggs' – each now with a diploid nucleus from the adult animal – were cultured for 6 days in temporary recipients. Twenty nine of the eggs that appeared to have developed normally to the blastocyst stage were implanted into surrogate Scottish Blackface ewes. One gave rise to a live female lamb, Dolly, some 148 days later. Dolly was born on July 5, 1996.

Somatic cell nuclear transfer (SCNT) was used successfully for cloning cattle (Cib, pig and goat procedure using embryonic stem cells (ESCs) is called Nuclear Transfer-derived Embryonic Stem Cell (NTESC). However, although ESCs were derived for humans and some laboratory animals, derivation of farm animal embryonic stem cells (faESCs) is still unsuccessful . The alternative to faESCs could be embryonic germ cells (EGCs) and spermatogonia stem cells.



4. Artificial Insemination

Artificial insemination was the first assisted reproductive technology to be applied commercially for the genetic improvement of animals in the mid -1900s. This technology has now become a practical technology in commercial dairy cattle programs in both developed and developmental countries. Artificial insemination (AI) is the process of collecting sperm

cells from a genetically superior male animal and manually depositing them into the reproductive tract of a female.

The first successful insemination was performed by Spallanzani, (1784) in a bitch. Pioneering efforts to AI were begun in Russia in 1899 by Ivanoff. Ivanoff (1922) had studied AI in domestic farm animals, dogs, foxes, rabbits, and poultry. Use of frozen semen (*Polge et al.*, 1949) revolutionized the AI program through worldwide transport of semen. Initially, the AI was used to spread improved indigenous breeds which were followed by the introduction of crossbreeding, hence grade up the local low yielder breeds.

The AI technology maximizes the use of outstanding males, dissemination of superior genetic material, improve the rate and efficiency of genetic selection on the male side, introduction of new genetic material by import of semen rather than live animals and thus, reducing the international transport costs, enabling the use of frozen semen even after the donor is dead and reduces the risk of spreading sexually transmitted diseases.

Various aspects of AI technology have been globally standardized for each species. A large number of AIs are performed globally, more than 100 million cattle, 40 million pigs, 3.3 million sheep and 0.5 million goats are artificially inseminated every year (Boa-Amponsem and Minozzi, 2006).

The conception rate from AI programs in developing countries is relatively low and therefore the desired goal from it has not been achieved, which may be due to the lack of proper management and poor technical skill. The AI will become more effective and economic only when farmers will have access to considerably better technical and organizational facilities.

Conclusion:

Reproductive inefficiency impacts animal industries globally, causing economic losses. Despite advancements in reproductive physiology, infertility due to low conception and high embryonic mortality remains an issue. To enhance animal productivity, emerging technologies like reproductive biotechnologies, such as Multiple Ovulation and Embryo Transfer (MOET), Semen Sexing, Cloning, and Artificial Insemination, are crucial. These technologies enable faster genetic improvement, sex selection, and disease control, contributing to sustainable agricultural production.

References:

1. Hansen P J. 2020. The incompletely fulfilled promise of embryo transfer in cattle-why aren't pregnancy rates greater and what can we do about it? J of Anim sci. 98(11): 1-20.

2. Statistics of embryo production in domestic farm animals. 2020. IETs. data retrieval report.
3. Purohit G N. 2019. Reproductive Biotechnologies in Indian cattle. J of Vet Sci and Res. 3(1)1-4.
4. Ivanova M., Gradinaska D., Daskalova. 2015. Reproductive biotechnology in animal husbandry- current status and future prospects. 4th International congress. New perspective and challenges of sustainable livestock production. Serbia.
5. Hadgu A., Fasseha H.2020. Reproductive biotechnology options for improvinglivestock production: A review. Adv. Food. Technol. Nuyr. Sci. 6 (1):13-20.
6. Hernandez and Gifford. 2013. Role of reproductive biotechnologies in enhancing food security and sustainability. Animal Frontiers 3(3): 14-18.

Chapter 7

DISEASE PREVENTION AND BIOSECURITY MEASURES

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Introduction

Agriculture and animal husbandry are important contributors to the Indian economy and the interdependence of these two sectors has a critical role in overall food security. According to the 20th livestock census, the population of bovines, sheep, goats, and pigs is 303.76 million, 74.26 million, 148.88 million, and 9.06 million respectively. Livestock which is an important subsector significantly contributes to the Indian economy and acts as a principal livelihood activity for most farmers, providing critical inputs to agriculture, contributing to household health and nutrition, supplementing income, providing employment opportunities, and finally serving as a reliable "bank on hooves" in times of need. It serves as an additional and complementary enterprise. The success of any type of livestock operation in terms of production and reproduction is closely related to the disease level of the animals. The economic losses due to diseases are mainly attributed to death, medication costs, and condemnations. Poor growth, poor production, poor feed conversion, and downgrading are additional factors that can be less obvious but have a significant impact on chronic and parasitic diseases. For improving the food safety, food security, and animals and human health, measures to be taken to reduce the risk of disease introduction and spread among the animal and or human populations. The purpose of the present talk is to sensitize the participants on the ways to implement the biosecurity measures and prevent the disease spread in the animals.

Infectious diseases of cattle and buffaloes

- Anaplasmosis
- Babesiosis
- Cysticercosis
- Campylobacteriosis
- Tuberculosis
- Bovine viral diarrhoea
- Haemorrhagic septicaemia
- Infectious bovine rhinotracheitis
- Malignant Catharral Fever
- Theileriosis
- Trichomonosis
- Trypanosomiase

Infectious diseases of sheep and goats

- Caprine arthritis/encephalitis
- Contagious caprine pleuropneumonia
- Maedi-visna
- Peste des petits ruminants
- Sheep pox and goat pox

Infectious diseases of pigs

- Classical swine fever
- Influenza A virus of swine
- Porcine cysticercosis
- PRRS
- Swine influenza
- Transmissible gastroenteritis

Infectious diseases of multiple species

- Anthrax
- Bluetongue
- Cryptosporidiosis
- Dermatophilosis
- Brucellosis
- Echinococcosis
- Foot and mouth disease
- Rabies
- Trichinellosis
- Japanese encephalitis
- Leptospirosis
- Paratuberculosis

Historically, disease management of animals did not begin until one or more animals in a group became sick. The outcome of the illness and management steps taken may result in partial or complete recovery or death resulting in economic loss to the producer. Due to this, there has been a change in attitude from fighting diseases in individual animals to preventive health management for the whole population. An integral part of health management is the biosecurity of the herd/farm. A biosecure herd/farm is one in which the chance of disease entry either through other animals or mechanical transmission by vectors is minimal.

Biosecurity

Biosecurity is defined as the combination of various precautionary measures put in place to reduce the risk of disease entry and spread on the farm. These measures can be implemented at various levels such as a farm, a region, a herd or a flock or even an individual animal. The main aim of this concept is to prevent and protect the animals as well as human health from the infectious agents. Certain infectious agents cause serious disease outbreaks and the consequences may place an entire enterprise at risk. Therefore, effective biosecurity measures will form the basis for disease prevention, and should be supplemented by other preventive measures such as vaccination, management of the animals and addition of the feed additives. Overall, this process will have a significant impact and will reduce the costs associated with curative treatment.

Biosecurity and its components:

Bio-exclusion or external biosecurity – It focuses on the measures that must be taken to prevent disease pathogens from entering the farm through any means. This also includes the concept of Bio-containment, which is a method of preventing disease transmission from one herd to another. External biosecurity is comprised of the following major components:

- ✓ Purchase of animals and animal products
- ✓ Transport of animals, removal of manure and carcasses
- ✓ Supply of fodder, water and equipment
- ✓ Access of personnel and visitors
- ✓ Bird Control
- ✓ Location and environment

Bio-management or Internal Biosecurity – This mainly focuses on the prevention of disease spread within the herd. The following are the components of the internal biosecurity:

- ✓ Disease management
- ✓ All-in-all out system
- ✓ Stocking density
- ✓ Working lanes
- ✓ Cleaning and disinfection

Disease transmission:

Pathogens that are transmissible in nature, such as viruses, bacteria, fungi, and parasites, cause various diseases in animals. All pathogens have unique characteristics, and the infection cycle is a more complex and multi-faceted process that necessitates the fulfilment of numerous conditions. To spread and cause disease, all pathogens follow some common steps in pathogen transmission such as entry, incubation, replication, and persistence. The disease can be transmitted in a variety of ways, including airborne, droplet, and contact transmission, which can be direct or indirect. Understanding of major transmission patterns and the factors that influence them contribute to the disease prevention and control strategies.

Principles of biosecurity measures:

A successful biosecurity program utilizes three important factors:

1. Increase the animal's ability to resist the disease
2. Minimize the number of contacts that result in disease
3. Eliminate the sources of the infectious agent.

Increase the animal's ability to resist disease:

Resistance to disease can be non–specific, meaning that an animal is in good enough health to generally fight infection; or resistance can be specific, meaning that the animal's immune system is prepared to defend against a particular disease agent. Vaccines increase an animal's specific resistance to disease. Developing immunity to a disease is the protective response stimulated within an animal by vaccination. However, vaccinated animals may still become sick because of the following reasons:

- ✓ Pathogens different from those included in the vaccine were involved;
- ✓ The immune system was overwhelmed by the infection; or
- ✓ The vaccinated animal failed to mount a protective immune response.

As a result, it is recommended that vaccination programmes should be viewed as a supplement to, rather than a replacement for, other disease control measures.

VACCINATION SCHEDULE FOR CATTLE AND BUFFALO

S.no	Name of Disease	Age at first dose	Booster dose	Subsequent dose
1	Foot and Mouth Disease (FMD)	4 months and above	-	Six monthly
2	Haemorrhagic Septicaemia (HS)	6 months and above	-	Annually in endemic areas.
3	Black Quarter (BQ)	6 months and above	-	Annually in endemic areas.
4	Brucellosis	4-8 months of age (Only female calves)	-	Once in a lifetime
5	Theileriosis	3 months of age and above	-	Once in a lifetime. Only required for crossbred and exotic cattle.

6	Anthrax	4 months and above	-	Annually in endemic areas.
7	IBR	3 months and above	1 month after first dose	Six monthly (vaccine presently not produced in India)
8	Rabies (Post bite therapy only)	Immediately after suspected bite.	4th day	7,14,28 and 90(optional) days after **first** dose.
9	Lumpy Skin Disease	Any age (>3-4 months)	-	Annual

Minimize the number of contacts that result in disease:

The number of effective contacts that may result in disease transmission can be reduced by physically separating animals. Methods of physical separation include quarantine of animals; segregation, often by age or class of animal; isolation of individuals; or reducing animal density by diluting the number of animals over a larger geographical area.

Eliminate the sources of the infectious agent:

Reservoirs of infection for sheep and goats are other animals or objects that the agent depends on for survival; including other sheep and goats, cattle, birds, rodents, manure, soil, people, and others. Infectious agents may reside in carrier animals that are infected but show no clinical illness or they may survive in the environment waiting to be transmitted to the host animal by direct or indirect contact. The infection status of a herd is often classified as disease-free, usually meant in terms of specific diseases. This claim is often supported by disease testing or lack of incidence of a particular disease in that herd. When searching for new stock, it is best to acquire animals only from source herds that are known to be free of infected animals.

General Biosecurity measures

The following steps are recommended for establishing a bio-secure farm:

- Keep a flock or herd history. This records the details of all individual animals.
- Start a herd or flock with good, healthy individuals.
- Design and follow a quarantine protocol for animal additions to the herd.
- Prevent unplanned contact with other animals over which you have no control.
- Provide medication only as necessary, or as recommended by veterinarians.

- Practice good sanitation and keep the farm clean.
- Provide adequate housing and shelter for all sheep and goats.
- Minimize animal stress through good management practices.
- Provide sufficient feed in a balanced ration formulated for different seasons of the year.
- Limit visitors to the farm.
- Limit vehicle traffic onto the farm to those that are essential for farm business and provide an area outside the farm to disinfect tires.
- Control insect populations and the access of wildlife, rodent, bird, and domesticated animal populations to your farm.
- Ensure that feed is not contaminated by manure or urine.
- Disinfect reusable equipment between animals.
- Examine the herd for diseases.
- Design and implement a disease control program as soon as potential diseases are detected inside the farm.
- Consult animal health personnel and vaccinate the herd against clostridial and other important locally endemic diseases.
- Formulate and follow a strategic deworming program designed to prevent internal parasite problems and maintain dewormer drug effectiveness.
- Treat animals returning from the market or exhibition as new additions to the herd and follow a quarantine protocol for these animals.
- Necropsy all animals that die on the farm as a means to diagnose any diseases present.

Disease Surveillance

Animal disease surveillance entails the systematic collection of long-term data on disease events, risk factors, and other relevant parameters, followed by analysis to arrive at a conclusion so that necessary preventive measures can be taken. Disease surveillance is a very useful tool in disease control programs. It lets someone know how a disease control program

is working at various points in time. There are two general methods to survey the level of disease in a herd, examining animals and examining data collected from animals.

Conclusion:

Disease control and prevention necessitate a multifaceted approach that includes a thorough understanding of the current disease situation in an enterprise, potential disease threats, and how the risk of introduction can be reduced. A solid understanding of disease transmission and spread, risk factors for disease, and disease prevention methods is required for such an approach. It is concluded that biosecurity is critical to ensuring the health and productivity of livestock within an enterprise, region, and country and that knowledge of surveillance of the disease is required for developing sound biosecurity practices

Suggested reading:

1. Jeroen Dewulf and Filip Van Immerseel. 2018. Biosecurity in Animal Production and Veterinary Medicine: From Principles to Practice. 1st Edition, Acco Publishers.
2. Hussein abdel hay ka-oud. 2015. Biosecurity (health protection and sanitation strategies) in animal farms: Bio security in farms. 1st Edition, CreateSpace Independent Publishing Platform.
3. Merck. 2016. The Merck Veterinary Manual.2010. Merck Veterinary Manual, 11th Edition, Elsevier Publishers.
4. James F. Zachary.2011. Pathologic Basis of Veterinary Disease. 6th Edition. Mosby.

Chapter 8

UNDERSTANDING THE MIND SET CHANGE FOR ENTREPRENEURIAL DAIRYING

Enhancing Professional Zest

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"Learn – Unlearn – Relearn" is the key to open the lock of closed mind"(Ramkumar 2020)

Introduction

The earlier scholarly works in Extension Science over one and a half century has crystallized Extension Science tuned to the territories(countries!) and across. This is a brief introduction to an attempt of consolidating few thoughts on "Mindset" and how it can have an explicit influence on decision making, from a perspective of entrepreneurship. In this present decade it is important and urgent to look into a perspective of professional competency, considering the fast changes happening in technology and nature of dairying. These need to be imbibed, for this science to effectively deliver to farmers and the growth of the country

The Context

The nature of Dairying is undergoing changes in India. The history, importance and relevance of dairying in India has changed with time and technology and policies. Of the various characteristics of Indian dairy farming that is changing, one of the pertinent ones is the nature of dairying which is undergoing changes, with "entrepreneurial dairying" gaining wide importance and adoption, along with the subsistence and subsidiary farming nature of dairying, which had been in vogue for many decades.

This paradigm shift to entrepreneurial dairying needs support and coordinated efforts from various stakeholders to fulfil its purpose. The farmers, entrepreneurs, veterinarians. Dairy professionals, Extension professionals, Universities, Institutes and many others have a relevant role in promoting "entrepreneurial dairying" that meets the daily needs suited to the present times.

Of the various factors one of the important factor is the Mindset of stakeholders involved. The Mindset has to be understood as a process, rather than a standalone factor.

The process is how we "think" as professionals and deal with the situation. It is the *mindset* we possess to understand and attempt to find solutions to issues and help stakeholders in the fast-changing times. It is the psychological state which fuels the success. While applying Extension we also need to know the requirements of exploring attitude and methods to help. The process also has an exciting phase of facilitating generation of ideas and innovations, making decisions to translate them into workable technologies or innovation processes and grow with the success and failures as we advance in each step. For the present day extension this is quite important to promote potential entrepreneurs. The extension professionals need to improve their capacity on this.

Though there are many factors in improving our mindset (from that of a fixed one, probably *calcified over years* (part of the words used by Grant, 2021) to unwind a little bit to become flexible with times. I try to focus on two important points mentioned in the outer ring of the model and other few relevant thoughts for extension professionals:

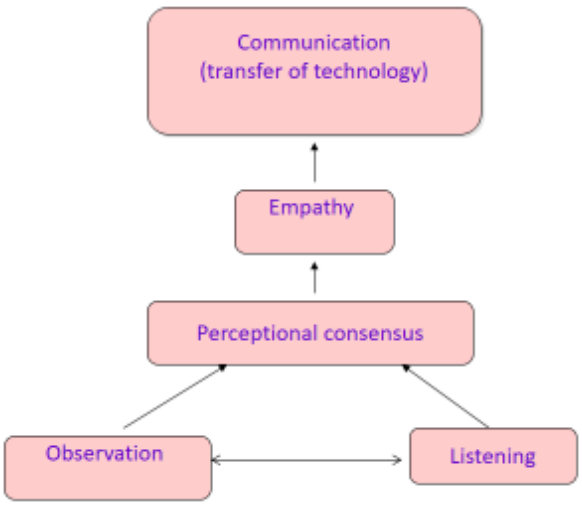
1. Mind set model: Perceptional Consensus

2. Rethinking Cycle Vs Over confidence cycle

3. Technology adaptation

4. Transformational learning.

1. Mind set model: Perceptional Consensus



Transfer of technology depends on what is shared as "common knowledge" regarding ideas, practices and information.

To share this, active listening is the starting point (observation can also be sometimes considered as a part of Listening).

Eg.to understand and objectives of the entrepreneurship dairying a person wants to be involved; to encourage, accept, appreciate and understand what the prospective entrepreneur is saying; Encourage speaking by the entrepreneur

Perception - the science of impressions. It is the selection, organizing and interpreting the evidence from our senses. As extension professional we need to be reminded more than others that "Meanings are within people" and "We see objects as we are and not as they are".

The prospective entrepreneurs or the entrepreneurs have their meaning for dairying and its importance and relevance to their lives. Are professionals able to understand that? Are we able to select the important factors. The selection is influenced by Attention (usually we *pay attention to events that interest us)* Motivation, Emotional state and Personality.

Active listening helps us to focus on what is to addressed, which is of concern to an entrepreneur.

2. Rethinking Cycle Vs Over confidence cycle

Rethinking is the ability to reflect and think again. Once we are have a set mind, and work over a period of time its possible that the mind set becomes fixed, and thinking, if at all happens is withing an expected or a path we desire. That usually happens when we are overconfident in the field we work or live. In the overconfident model we assume we "know"things (which we would have learnt months or years back) and the mndresents to the beautiful phenomenon of "rethinking".

"Scientific thinking favours humility over pride, doubt over certainty, curiosity over closure. We shift out of Scientist mode, the rethinking cycle breaks down, giving way to an overconfidence cycle. If we are preaching we can't see gaps in our knowledge: we believe we have already found the truth. Pride breeds conviction rather than doubt, which makes us prosecutors: we might be laser-focused on changing other people's minds, but ours is set n stone. That launches us into confirmation bias and desirability bias. We become politicians, ignoring or dismissing whatever doesn't win the favour of our constituents-our parents, our bosses, or the high school classmates we are still trying to impress. We become so busy, putting on a show that the truth gets relegated to a back stage seat, and the resulting validation can make us arrogant. We fall victim to the fat-cat syndrome, resting on our laurels instead of pressure testing our beliefs"

Ultimately the intellectual humility, that we do not know many things, is the starting point of rethinking cycle which facilitates doubts, unleashing curiosity and discovery. This is more important in the complex and ever-changing factors of the CONTEXT discussed earlier.

Confidence is a measure of how much you believe in yourself,- that's distinct from how much you believe in your methods.

When we lack the Knowledge and skills to achieve excellence, we sometimes lack the knowledge and skills to judge excellence. Prone to overconfidence in situation where its easy to confuse "experience" for"expertise".

Extension professionals need to build the ability of "rethinking". These have direct relevance to the Extension professionals.

Confirmation bias: seeing what we expect to see

Desirability bias: seeing what we want to see. These biases, if we are not cautious about, lock our ability to "rethink".

Blind spots in Knowledge & Opinions (we all have!). It leaves us blind to see our blindness. The blind spots give us false confidence in our judgement and blocks rethinking. The blind spots prevent us from applying our intelligence. They can contort our intelligence into a weapon against truth. The tragedy is that we are usually unaware of the resulting flawsin our thinking.

"Ideal state of the mind is the one that retains the flexibility of youth along with the reasoning powers of the adult. Such a mind is open to the influence of others." (Greene 2018). A bit more humility about what we know would make us all more "curious" and "interested" in a wider range of ideas.

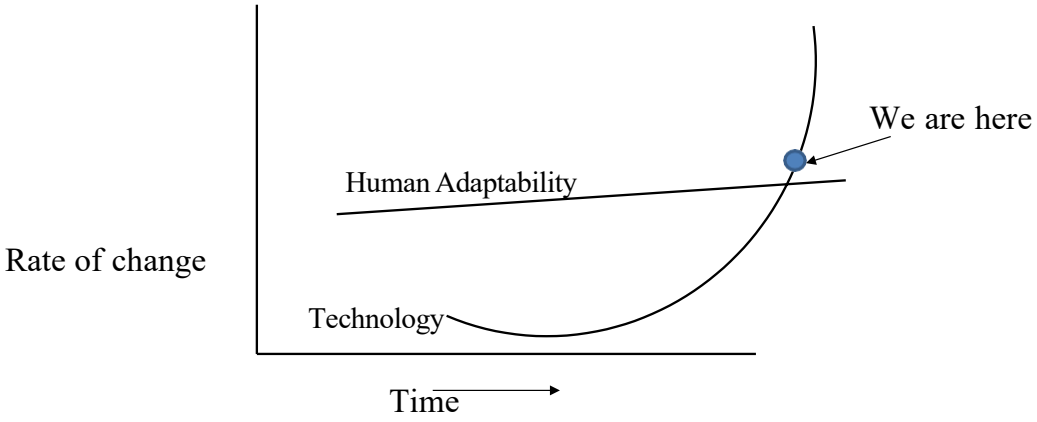
3. Technology Adaptation

An example given by Wric "Astro" Teller, the CEO of Google's Rand D Lab which produced Google's self driving car among other innovations (as quoted in :Friedman. 2016. Thank You for Being Late: An Optimist's Guideto Thriving in the Age of Accelerations.

Over the recent times, the technology has gone steep up in the rate ofchange. The human adaptability to change usually goes in a steady slanting pace, which was alright for a few days back. We had time to adapt to the technological change. Now

we are expected to be at “we are here. But the adaptability stands short of the proportionate rate ofchange which technology has shot up.

*Technology and adaptation (*Friedman, 2016)



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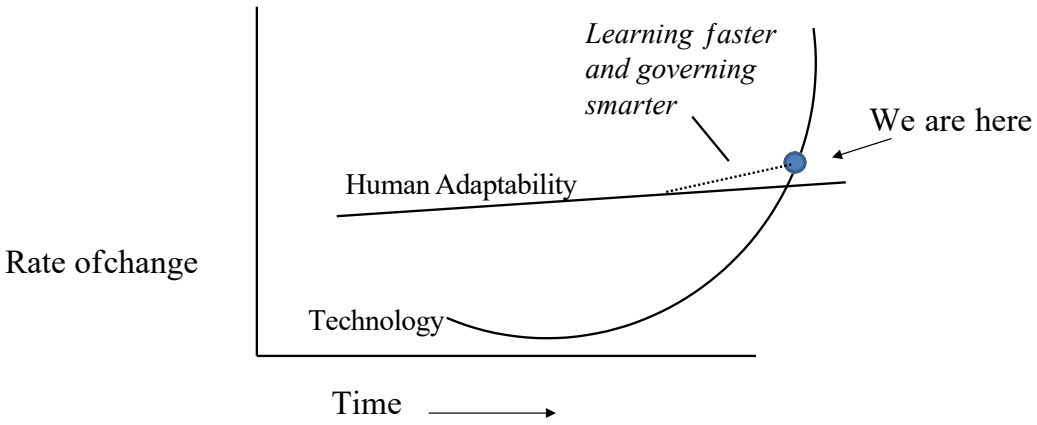
The dotted line in the next figure down, shows how we need to lift up and reach that spot of technology where we are supposed to be. It essentially means the professionals need to learn faster and govern smarter.

Technology and adaptation (Friedman2016)



Those are the two key words which describe the immediate need for extension professionals: ***learn faster*** **and** ***govern smarter***. If these have to happen, the fixed mind set should give way to "rethinking". Some of the most annoying things people say instead of rethinking

- *" That will never work here"*
- *"That's not what my experience has shown"*
- *"That's too complicated, lets not overthink it"*
- *That's the way we've always done it !*
- *I have seen it not successful.*
- *Let's not waste time on this*

These are examples which block the rethinking and hence the road tolearn faster and govern smarter.

4. Transformational learning

The instructional design aims to open up a learner's mind to critically analyse their assumptions and beliefs (Mezirow, 2003). Acquisition of five skills

- Active listening
- Emotional regulation,
- Respectfulness
- Empathy
- Confidence

Conclusion:

Dairying in India is undergoing transformation due to technology and policy changes. "Entrepreneurial dairying" is gaining importance alongside traditional farming practices. The support of various stakeholders is essential for the success of entrepreneurial dairying. The role of stakeholders, especially extension professionals, is crucial in promoting this change. Mindset is a process that influences how professionals think and solve problems. It's crucial for understanding stakeholder needs in a rapidly changing environment. Active listening and understanding perceptions play a vital role. Technology is advancing rapidly, challenging professionals to learn faster and govern smarter. Extension professionals must keep pace with technology to succeed. Rethinking fixed mindsets is essential for effective adaptation. Instructional design aims to encourage critical analysis of assumptions and beliefs. Five

skills – active listening, emotional regulation, respectfulness, empathy, and confidence – are vital for transformational learning.

References

1. Frankopan, P. The Earth Transformed. An untold History.2023. Bloomsbury Publishing. London.
2. Friedman, L. T. 2016.Thank you for being late: an optimist's guide to thriving in the age of accelerations. Allen Lane, Penguin Random House, UK
3. Grant, Adam. 2021. Think Again: the power of knowing what you don't know. Penguin Random House, UK
4. Greene, R. 2018. The Laws of Human Nature. Profile Books Ltd. London
5. Harari, Yuval Noah. 2018. 21 lessons for the 21st century. Jonathan Cape London, Penguin Random House, UK
6. Malhotra, R. 2021. Artificial Intelligence and the Future of Power. 5 Battle grounds. Rupa Publications, New Delhi.
7. Mezirow, J.2007. Transformative learning. Athens: Metaichmio
8. Pfeiffer, L.J et al. 2022. Issues – 360TM An analysis of transformational learning in a controversial issues engagement initiative. The Journal Agricultural Education and Extension. Vol 28, No 4. 439 -458
9. Ramkumar,S. 2020.Honing creativity: the Top secret in STRANDOM. Dream Space Publications, Pondicherry.
10. Smith , E, H, J. 2022. The Internet is not what you think it is. History, a philosophy, a warning. Princeton University Press, New Jersey.
11. Sulaiman, R. V et al. (Eds) 2019. Taking Stock and shaping the Future: Conversations on Extension. AESA Publication.

Chapter 9

SUSTAINABLE SMALLHOLDER DAIRYING: ISSUES AND OPPORTUNITIES

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Introduction

The Dairy sector in India has grown substantially over the years. Dairy farming has been playing a key role by improving household incomes and food security for rural communities in India. As a result of prudent policy interventions, India ranks first among the world's milk producing nations, achieving an annual production of 221.06 million tonnes during the year 2021-22 as compared to 209.96 million tonnes during 2020-21 recording a growth rate of 5.29%. FAO, Food Outlook (November 2022) reported 1.34% increase in world milk production from 912.6 million tonnes in 2020 to 924.8 million tonnes in 2021 (estimates). This represents a sustained growth in the availability of milk and milk products for the growing population.

Dairy sector is a sustainable, equitable and powerful tool for achieving economic growth, food security and poverty reduction because dairying provides a regular source of income, provides nutritious food, diversifies risk, improves the use of resources, generates on- and off-farm employment, creates opportunities for women (e.g., milk money), provides financial stability and social standing (e.g., store savings, asset creation).

Dairying sectors have played prominent socio-economic role in India. Traditional, cultural and religious beliefs have also contributed in the continuance of these activities. They also play a significant role in generating gainful employment in the rural sector, particularly among the landless, small and marginal farmers and women, besides providing cheap and nutritious food to millions of people. India continues to be the largest producer of milk in the world. Several measures have been initiated by the Government to increase the productivity of livestock, which has resulted in increasing milk production significantly.

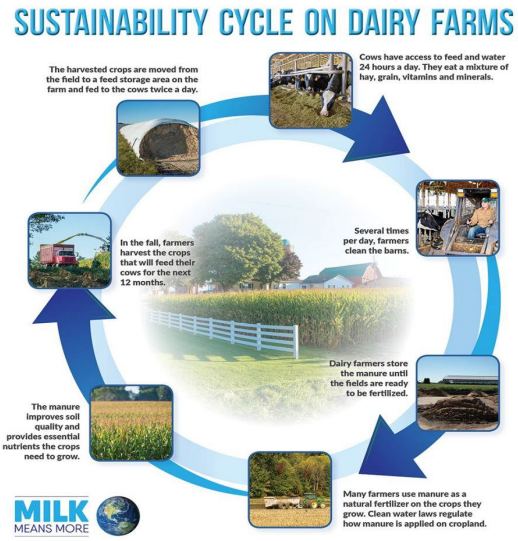
Dairying has become an important secondary source of income for millions of rural families and has assumed the most important role in providing employment and income generating opportunities particularly for women and marginal farmers. The per capita availability of milk has reached a level of 444 grams per day during the year 2021-22 which

is more than the world average of around 320 grams per day in 2021 (estimates) (Food Outlook Nov'22).

Table.1 Production and Per Capita Availability of Milk in India

Year	Production (Million Tonnes)	Per Capita Availability (gms/day)
2011-12	127.9	290
2012-13	132.4	299
2013-14	137.7	307
2014-15	146.3	322
2015-16	155.5	337
2016-17	165.4	355
2017-18	176.3	375
2018-19	187.7	394
2019-20	198.4	406
2020-21	209.9	427
2021-22	221.0	444

Source: Annual Report, 2022-2023, Animal Husbandry Statistics, DAHD & F, GoI



Flow chart of sustainability in dairy farming

Smallholder Dairy Farming; Important Components

- **Housing:** Animal housing is also very important in harnessing the maximum potential of the animal. Stressful conditions significantly reduces productivity and it is therefore important to protect the animal from inclement weather. The floor space requirements may be followed as per the recommendations with a focus on economic status of the farmers.
- **Land and land development**: Location, area, suitability, proximity to road, site map etc.
- **Proposed capacity / No. of Milch Animals:** This is very essential for the farmers to decide the investment depending on the economic status. Hover, the farmers may also get the support from various schemes of government and non-government organizations.
- **Equipment and Plant and Machinery:** Chaff cutter, Silo pit, Milking machine, Feed grinder and mixer, Milking pails/milk cans, Biogas plant, Bulk coolers, Equipment for manufacture of products.
- **Selection of Animal/breed:** Proposed species, proposed breed, source of purchase, place of purchase, distance, cost of animal etc. are very essential in smallholder dairying.
- **Production parameters:** The production parameters like order of lactation, milk yield (ltrs. per day), lactation days, dry days, conception rate, mortality (%) etc. are very important in smallholder dairying. The concepts like calf per year need to be well adopted.
- **Feeding management**: Source of fodder and feed (Green fodder, Dry fodder, Concentrates), scientific feeding practices, fodder cultivation expenses, homemade concentrate preparations would help in low cost of production in dairying.
- **Breeding Facilities**: Animal breeding related aspects like source of semen, location/distance from AI centre, availability of semen, availability of staff, and management of pregnant animals play an important role in smallholder dairying.
- **Animal health care:** Disease management is very essential in terms of knowing the symptoms of different diseases, isolation, vaccination, deworming etc. in dairying. In this context, the medicines utilized, veterinarian services, visits etc. may be noted to calculate the expenditure per animal per year.
- **Electricity**: Source, Approval from SEB, Connected load, Problems of power failure, Arrangements for generator.

- **Water:** Source, Quality of water, Availability of sufficient quantity for drinking, cleaning and fodder production, if investment has to be made, type of structure, design and cost.

- **Marketing of milk and other products**: Source of sales, place of disposal, distance (km.), price realized - (Rs. per liter of milk), basis of payment, periodicity of payment etc. would lead to sustainable dairy farming. Other products and byproduscts like urine, dung, milk products also help in sustainable dairying.

- **Other components:** Milking management, calf management, cleaning management, manure handling, record keeping and bio-security are also very essential in effective dairy farming.

Issues/ Challenges of the Diary sector in India

The Indian dairy sector is different from other dairy-producing countries as emphasis is placed on both cattle and buffalo milk. In order to achieve greater profitability, quality standards need to be improved. Following are some of the practical dairy farming challenges in India.

- **Feed and fodder:** Scientific feeding pattern will ensure adequate nutrition and consequently proper growth of the dairy animal. Shortage of feed and fodder has occured mainly due to reduction in grazing land. In addition, a significant requirement of feed and fodder gets added due to unproductive animals. Further, non-supplementation of mineral mixture causes mineral deficiency diseases and metabolic disorders. Higher feeding cost decreases the profit of the dairy industry. With the increasing popularity of high breed animals, there is a huge demand for good quality feed and fodder to meet the dietary requirements of milking animals. There are an excessive number of unproductive dairy animals that are competing for feed and fodder with productive dairy animals. In the recent years, grazing areas have been shrinking significantly due to industrial development, which has resulted in a shortage in feed and fodder supply. In standard dairy production systems, feed costs account for up to 70% of total costs. Consequently, the dairy farming profitability is affected by high-cost feeding.

Table 2. Demand and Supply scenario of Fodder Resources in India

(*in Million Tonnes*)

Year	Demand		Supply		Deficit		Deficit as %	
	Green	Dry	Green	Dry	Green	Dry	Green	Dry
1995	947	526	379.3	421	568	105	59.95	19.95

2000	988	549	384.5	428	604	121	61.10	21.93
2005	1,025	569	389.9	443	635	126	61.96	22.08
2010	1,061	589	395.2	451	666	138	62.76	23.46
2015	1,097	609	400.6	466	696	143	63.50	23.56
2020	1,134	630	405.9	473	728	157	64.21	24.81
2025*	1,170	650	411.3	488	759	162	64.87	24.92

*Projected demand and supply Source: IGFRI Vision 2050

- **Breeding system:** Experts have identified prolonged period to attain maturity, increased calving interval, poor conception rate, poor semen maintenance, lack of AI staff as the major challenges in dairy animal breeding. These factors also affect the efficiency of animal performance or reproduction system. Further, crossbreeding of indigenous species with exotic stocks to enhance the genetic potential of different species has been successful only to a limited extent. However, in the last fifty years, due to several constraints, the average conception rate through AI is not going beyond 30-40 percent at field level.

- **Animal health and disease management:** Adequate veterinary health care, lack of veterinary staff, improper vaccination and deworming, lack of timely treatments, high cost of treatments, distant location of veterinary hospitals or dispensaries are the major challenges under animal health category, need to be ensured for sustainable production. Farmers have a huge financial burden due to animal diseases. It is difficult to include accurate estimates of the losses caused by the various diseases since it is impossible to record all diseases in all locations. The frequent outbreaks of diseases like Food and Mouth Disease, Black Quarter infection, Influenza etc. continue to affect livestock health and lowers productivity.

- **Lack of high yielding germplasm or low productivity:** Low productivity and yield of Indian dairy animals is the major challenge face by the Indian farmer. Improving the productivity of farm animals is one of the major challenges. The average annual milk yield of Indian cattle is 1172 kg which is only about 50% of the global average. Although India possesses a large livestock population and is the world's largest producer of milk; however, productivity of dairy animals has been extremely low, turning this vital asset into a liability for the poor.

- **Hygiene conditions:** Unhygienic farming practice leads to disease of cattle and buffalo. This also leads to compromise in the quality of milk resulting in spoilage of both milk and milk products.

- **Farmers' milk selling price:** It is often noted that milk producers do not get the legitimate price of milk due to presence of middleman and vendors in the supply chain. Although milk cooperatives and few private dairies are working in this aspect, but the major share is through unorganized sector in Indian dairying. Structured marketing facilities and extension services can improve the situation further.

- **Education and Training:** Education and training on scientific dairy farming practices is an essential requirement for the small holder dairy farmers. They need to be exposed to different scientific practices like feeding, chaffing, CMP, milking calf management, right time for insemination etc.

- **High cost of milk production:** The cost of milk production in India needs to be reduced in order to get good income from milk. The main reason of the high cost of milk production is the low average milk yield of Indian cattle, i.e. 987 kilograms/year compared to 6273 kilograms/year in Denmark, 5462 kilograms/year in the United Kingdom, 7038 kilograms/year in the United States, and 11000 kilograms/year in Israel. Therefore, this high yield can be achieved through proper feed, water management and housing, in addition to superior germplasm.

- **Marketing and Pricing:** Dairy market faces a volatile market like as most milk and milk products are perishable in nature. This necessitates the balancing in supply and market demand with regards to both domestic and global markets. Storing milk in to get higher shelf life is a good option but is very costly for the smallholders. The most fundamental feature of the Indian dairy industry is that, it is still mostly unorganized. Only 18-20% of India's total milk production is handled in the organized sector. The unorganized sector has still not integrated into the modern processing infrastructure.

- **Poor returns:** There have been perennial complaints from milk farmers about low milk purchase prices paid to them by milk companies as compared to the final milk price in the market. This leads to the cornering of profits by companies while actual producers get poor returns. Further, there is no MSP (Minimum Support Price) for milk unlike major agricultural commodities in India which may support the farmers to greater extent as they do not get the remunerative price for milk and milk products.

- **Fragmented supply chain:** Maintaining quality and quantity within a diverse supply base is the primary difficulty in the dairy sector. Dairy sector requires more intricate supply chain operations and logistics due to its perishable nature to maintain freshness and safety. Since 60% of the dairy industry lies in informal system, it becomes difficult to ensure regular flow and quality of milk. That is why the adulteration of milk remains a perennial issue in India.

- **Poor adoption of technology by Indian dairy farmer:** There are already proven high-yielding varieties of fodder and technologies for feeding livestock such as urea-molasses treatment, silage and hay making. Unfortunately, these technologies are very poorly adopted by many farmers in most states. Many technologies like AI, crop residue management, health care etc. needs to be emphasized.

- **Inadequate veterinary facility in dairy sector:** The Indian dairy sector is suffering due to inadequate infrastructure facility. The National Commission on Agriculture (NCA)-1976 recommended that one veterinary institution be established for every 5,000 cattle units (one cattle unit =1 cow / 1 buffalo /10 sheep / 10 goats /5 pigs / 100 poultry) to maintain effective veterinary health care. According to VCI, India has 67651 veterinarians, while demand is between 1.1 to 1.2 lakh.
- **Inadequate extension services:** Providing technical services to animals, supplying technical inputs, and educating livestock farmers are the three components of livestock service delivery to the farmers. In addition to transfer of technology and strengthening of various infrastructure and support services, extension services need to focus on building the capabilities of the farmers.
- **Poor record keeping and data deficiency:** Informality of the sector also leads to a lack of data regarding total milk production, wastage of milk, and financial flows in the sector which further inhibits the formalization of the sector. Further, there is also lack of data at individual farmer level.

Opportunities in Dairy sector

With the opening up of the Indian economy, dairy farmers have huge opportunities to sell their products in domestic and international markets. Innovative technologies can help dairy farms improve productivity, efficiency, and profitability. Some of the important opportunities in Indian dairy sector are:

1. Production of Milk and Other Products:

i. **Milk**: Milk and any of the foods made from milk, including butter, cheese, ice cream, yogurt, and condensed and dried milk. Value addition of milk helps the farmers in improving the income generation in dairy farming.

ii. **Cow urine:** Cow urine-based fertilizers augment soil fertility, inhibit pests, and manage diseases effectively, thus forming a major component in eco-friendly agricultural systems. They are used in a plethora of agricultural operations as a biofertilizers and biopesticides. Cow urine can be marketed through different platform in the present days.

iii. **Cow dung:** Cow dung is being used for different purposes as farm yard manure, biogas production; vermicompost production etc. The smallholder dairy farmers may involve in these activities for better income generation along with milk production.

iv. **Vermicompost:** Vermicomposting is an organic and biological process in which earthworm species are primarily used to convert organic matter or biodegradable wastes into manure. Vermicompost is a nutrient-rich fertilizer as well as a soil conditioner. It has been shown to increase plant growth and yield as well as suppressing key pests and diseases of horticultural plants in the green- house and in field soils.

2. Fodder production: Fodder production is one of the most important activities in dairying contributing to the profitability of the business. A year round supply of fodder can be assured if farmers cultivate seasonal and perennial fodder crops by adopting suitable crop sequences and surplus green fodder is preserved properly in times of abundance for use during lean periods. This activity can also be considered as revenue generating activity along with dairying in the present context.

3. Silage production: Silage is a fodder that has been 'pickled which means it is used to preserve the fodder for animals for feeding during the lien season. Silages are considered as an important source of nutrients and carbohydrates for the animals. When feeding animals with silage of any kind, the most critical point having effect on the production of animals is the quality of silage.

4. Effective role of Organizations: Forming new cooperatives of farmers to more formalization of the dairy sector assures better milk quality and quantity in the market. It will also generate more data that can be used in further planning in the dairy sector and hence better resource mobilization. Farmer organizations like cooperatives, SHGs, FPOs etc. can assure a better market for the dairy farmers. The elimination of intermediaries could ensure a good quality product at competitive price. This provided a stable income for marginal farmers in lean seasons as well because there are no intermediaries to take the income.

5. More dairy sector-related research and extension activities: should be promoted from production to logistics. Production data analysis and demand analysis should be done to cater better to the needs of the producers and consumers.

6. Promote more start-ups: and new private dairies in the dairy industry like Country Delight, fresh to home, big basket etc. This will help increase competition in the market and thus break the monopolies of a few big names and bring down prices. The central and

state governments are making necessary efforts to encourage start-ups through funding supports.

7. **Improve infrastructure and transportation**: The infrastructures in the form of more refrigerated trucks, bulk coolers etc. may be employed for a faster and fresh delivery of milk and milk products.

8. **Improve health care and breeding services:** Efforts are made by various government and non-government agencies for improving the health care services across the country with different veterinary institutions. However, there is a need to address the issues with priorities for vaccination, deworming, emergencies etc. Effective breeding services also play an important role in dairying. Creating a veterinarian service facility will increase the effectiveness of the artificial insemination program and would improve the affordable veterinary services to farmers' doors regularly.

9. For the development of the dairy sector, cooperative banks and other national banks should step up and offer generous loan facilities to farmers, especially small and marginal farmers. The governments may give support to the dairy sector farmers by providing subsidies, proper prices, and market facilities through these financial institutions.

10. The newer concepts like entrepreneurship development, dairying in context of climate changes, organic dairy farming are coming-up in India and hence, require suitable support from the government and non-government organizations. The necessary assistance for the producers to meet these newer concepts must be delivered in time.

Conclusion

Dairy sector has sustainable contribution in generating employment opportunities with relatively low level of risk. The productivity of these farmers can be enhanced if they run their business in a scientific manner. To ensure maximum production and profits from dairy farming, it is essential that these farmers adopt proper business plans and good dairy management practices. Although there are different issues/challenges in dairy farming, there is a need to explore the opportunities as dairy farming plays a key role in the sustainability of rural areas in particular. The governments have to support the dairy farmers in the best possible ways by providing subsidies, proper prices, and market facilities.

References:

1. GoI (2019), 20th Livestock census (2019), Ministry of Fisheries, Animal Husbandry and Dairying, Department of Animal Husbandry and Dairying, Krishi Bhawan, New Delhi. Government of India.

2. GoI (2023), Annual Report, 2022-2023. Department of Animal Husbandry and Dairying Ministry of Fisheries, Animal Husbandry and Dairying, Krishi Bhawan, New Delhi. Government of India.
3. IGFRI Vision 2050.
4. NDDB (2018), Hand book of Good Dairy Husbandry Practices, NDDB, Gujarat.
5. Pramod Prabhakar., Sanjay Kumar Bharti., Promod Kumar.,(2020), Challenges and strategies for sustainable dairy farming in India: A Review, *Int. J. Curr. Microbiol. App. Sci*., Special Issue-11: 4065-4071.
6. Sarkar, A., and Dutta, A., (2020), Challenges and opportunities of dairy sector in India vis-à-vis world: a critical review, *Explor. Anim. Med. Res*., 10(1): 9-17.
7. Sonwane Rajkumar Sopanrao.,(2018), Dairy industry in India: development and challenges, *Int.J. Creative Res, Thoughts*, 6(2): 751-757.

Chapter 10

VALUE ADDITION AND MARKETING AVENUES IN DAIRY SECTOR

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Introduction

Dairying in India has been a vital component of the agricultural sector and plays a significant role in the country's economy. India is the largest milk-producing country globally. The dairy sector in India has shown consistent growth over the years and our country is endowed with the largest livestock population in the world comprised of 537 million livestock. Being the largest milk producer in the world, India has immense resources of livestock which forms an important segment of the economy and a steady source of nutrition. Animal husbandry plays a significant role in the Indian economy, providing livelihoods to millions of people. Livestock rearing and dairy farming are among the major components of animal husbandry in India. Dairying is a source of livelihood for millions of rural households in India. It provides employment opportunities both on-farm (animal care, milking, etc.) and off-farm (processing, marketing, etc.). Dairy farming has the potential to generate income and uplift the socio-economic status of small-scale farmers.

Milk marketing Channels in India:

In India, the milk marketing system can be broadly classified into two channels; unorganized channels and organized channels.

Unorganized Channels:

Unorganized channels refer to the traditional and informal methods of milk distribution in India. These channels are characterized by small-scale local vendors, milkmen, and small dairy cooperatives. Here are some key features of unorganized milk marketing:

a. *Local Vendors:* Local vendors typically procure milk directly from farmers or small dairy farmers in the nearby rural areas. They often collect milk in cans or containers and distribute it within their local communities.

b. *Milkmen:* Milkmen, also known as 'doodhwala' in Hindi, are individuals who deliver milk directly to households. They usually collect milk early in the morning from local vendors or dairy farmers and deliver it to customers' doorsteps.

c. *Small Dairy Cooperatives:* Some small-scale dairy cooperatives also operate within the unorganized sector. These cooperatives are community-based organizations that collect milk from local farmers and distribute it locally.

d. *Lack of Standardization*: Unorganized channels often lack standardized quality control measures, packaging, and branding. Milk is often sold loose or in non-branded containers, which can lead to concerns about hygiene and adulteration.

Organized Channels:

Organized channels refer to the modern and formal methods of milk marketing in India. These channels are characterized by large-scale dairy companies, cooperatives, and brands. Here are some key features of organized milk marketing:

a. *Dairy Companies and Brands*: Large dairy companies and brands, such as Amul, Mother Dairy, Nestle, and Britannia, operate within the organized sector. They have established processing plants, distribution networks, and retail outlets across various cities and regions.

b. *Cooperative Dairies*: Cooperative dairies, like Gujarat Cooperative Milk Marketing Federation (GCMMF) that operates Amul, are an essential part of the organized sector. These cooperatives are owned and controlled by milk producers themselves, who collectively undertake milk collection, processing, and marketing activities.

c. *Quality Control and Standardization*: Organized channels focus on quality control and standardization. Milk is processed, pasteurized, and packaged under hygienic conditions. Brands often provide branded and packaged milk products with labels indicating the source, fat content, and other relevant details.

d. *Retail Outlets and Modern Retail Chains*: Organized channels have retail outlets and tie-ups with modern retail chains. They distribute milk through supermarkets, grocery stores, and their exclusive outlets, making it easily accessible to consumers.

e. *Technology Adoption*: Organized channels often employ advanced technologies for milk collection, processing, and distribution. They may have automated milk collection systems, chilling centers and cold chain infrastructure to maintain the quality and freshness of milk.

It's important to note that both unorganized and organized channels coexist in India, catering to different segments of the population based on factors such as price, convenience, and accessibility. The organized sector has been growing steadily over the years, but

unorganized channels still play a significant role, especially in rural and semi-urban areas (40% of organised and 60% of unorganised milk sector share as per Annual Report for 2021 of Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture & Farmers Welfare, GOI, co-operatives & private dairies).

Latest technologies in Dairy marketing Sector:

Data Analytics and Artificial Intelligence (AI): Data analytics and AI technologies are used to analyze consumer behavior, market trends, and sales data. These insights help dairy marketers to make data-driven decisions, personalize marketing campaigns, and target specific consumer segments effectively.

Augmented Reality (AR) and Virtual Reality (VR): AR and VR technologies are utilized to enhance the consumer experience by providing immersive and interactive content. Dairy marketers can create virtual tours of farms, demonstrate product usage, and engage consumers with virtual reality experiences related to dairy farming and production processes.

Influencer Marketing: Influencer marketing involves partnering with social media influencers who have a significant following and influence in the target market. Dairy marketers collaborate with influencers to promote their products and reach a wider audience through sponsored content, reviews, and product placements.

Social Media Advertising: Social media platforms like Facebook, Instagram, Twitter, and YouTube offer advanced advertising options that enable dairy marketers to target specific demographics, interests, and behaviors. Marketers can create engaging content, run targeted ad campaigns, and measure the effectiveness of their marketing efforts and share relevant content to build brand awareness and loyalty.

User-Generated Content (UGC): UGC is content created by consumers themselves, such as reviews, photos, and videos. Dairy marketers encourage consumers to share their experiences with dairy products on social media platforms and websites. UGC helps build brand trust, authenticity, and social proof.

Mobile Marketing: With the widespread use of smartphones, mobile marketing plays a crucial role in reaching consumers. Dairy marketers leverage mobile apps, SMS marketing, push notifications, and location-based services to engage with consumers, offer promotions, and provide personalized offers.

Online Ordering and Delivery: Online platforms and mobile apps facilitate convenient ordering and home delivery of dairy products. Dairy marketers can partner with e-commerce platforms or develop their own online stores to provide a seamless purchasing experience for consumers.

Personalization and Customer Relationship Management (CRM): Dairy marketers leverage CRM systems and personalization techniques to create tailored experiences for consumers. By collecting and analyzing customer data, marketers can offer personalized recommendations, loyalty programs, and targeted promotions.

IoT (Internet of Things): IoT technology can be used in milk packaging to track the freshness and quality of the product. Smart packaging can communicate information such as expiration dates, storage conditions, and nutritional content to consumers via mobile apps or other interfaces.

Digital Payment Systems: Cashless payment methods, such as mobile wallets and online payment gateways, have become popular in India. Dairy companies can integrate these systems into their marketing strategies, making it easier for consumers to make purchases.

Value added market scenario:

Over 80 per cent of milk consumption in India is that of liquid milk and over 55 per cent of the revenue of large co-operatives, such as Amul and Nandini, comes from selling liquid milk. There are still limited takers for value-added dairy products such as cheese, yogurts or flavoured milk, but this is where much of the action is taking place today simply because of its higher margins, and the ability to differentiate and introduce new products. Equally, the fact that the milk cooperatives did not tap this market until the multinationals came in made it an area where the competition was relatively equal.

The Indian consumer – especially the affluent urban consumer – is consuming more value-added products, which bring in bigger profits for dairy companies than raw milk. The phenomenon of working couples, single men and women with high disposable income also provided the impetus to look at the category with fresh eyes. The fact that the Indian cooperatives had largely stuck to basic milk, butter, processed cheese slices and ice cream for many decades, had left a gap in the market that allowed some of the new players to come in with new product offerings.

Value Addition and Marketing Avenues in dairying:

Dairying offers numerous value addition and marketing avenues that can help dairy farmers maximize their profits and reach a wider consumer base. Here are some key avenues in dairying for value addition and marketing;

Dairy Processing: Setting up a dairy processing unit allows farmers to add value to their milk by producing various dairy products such as butter, cheese, yogurt, ice cream, flavored milk, and more. Processing the milk into these products not only increases its shelf life but

also opens up opportunities for higher-priced products that cater to specific consumer preferences.

Organic and Specialty Products: Producing organic dairy products or specialty products like lactose-free or A2 milk can differentiate your brand in the market and command premium prices. These products cater to the growing demand for healthier and specialized options and often have a dedicated consumer base willing to pay a premium for them.

Direct Sales and Retailing: Establishing direct sales channels, such as on-farm stores or farmers' markets, allows farmers to sell their dairy products directly to consumers. This approach provides better control over pricing, branding, and customer relationships. Additionally, farmers can explore retail partnerships with local grocery stores or specialty food shops to expand their market reach.

Online Sales and E-commerce: Creating an online presence through a dedicated website or online marketplaces enables dairy farmers to tap into the digital marketplace. Customers can place orders directly online, and products can be shipped to their doorstep. Online platforms also provide opportunities for marketing, customer feedback, and building a loyal customer base.

Value-Added Services: Apart from dairy products, consider offering value-added services such as farm tours, educational programs, or workshops related to dairy farming and milk processing. These services not only generate additional revenue but also help create awareness about your brand and build relationships with customers.

Export Opportunities: Explore the possibility of exporting dairy products to international markets. Conduct market research to identify potential export destinations where there is demand for your products. Understand the regulations and requirements for exporting dairy products to those countries and establish the necessary certifications and quality standards.

Collaboration and Partnerships: Collaborate with local restaurants, cafes, bakeries, or other food businesses to supply your dairy products. These partnerships can help increase your brand visibility and provide a steady market for your products.

Branding and Packaging: Investing in attractive and informative packaging can make your dairy products stand out on the shelves. Create a strong brand identity that resonates with consumers and communicates the quality and uniqueness of your products.

Product Diversification: Continuously innovate and diversify your product offerings based on market trends and consumer demands. This could involve developing new flavors, introducing seasonal products, or experimenting with different packaging formats.

Marketing and Promotion: Utilize various marketing channels to promote your dairy products. This includes traditional advertising methods, social media marketing, and influencer partnerships, participating in local food events, and leveraging public relations to create a positive brand image.

Understanding your target market, conducting market research, and staying updated with consumer preferences are crucial for successful value addition and marketing in dairying.

Private players in milk marketing in India

There are several private players in India's milk marketing sector. While the dairy industry in India is primarily dominated by cooperatives, there are also private companies that play a significant role in milk procurement, processing, and marketing. Some of the prominent private players in the Indian milk marketing sector include:

Amul: Although Amul is technically a cooperative, it operates on a large scale and is one of the most well-known and successful dairy brands in India. Amul is managed by the Gujarat Co-operative Milk Marketing Federation (GCMMF), which is a cooperative federation of milk producers. It has a vast network of milk collection centers, processing plants, and distribution channels.

Mother Dairy: Mother Dairy is a subsidiary of the National Dairy Development Board (NDDB) and operates as a private company. It primarily operates in Delhi and the National Capital Region (NCR) and offers a wide range of dairy products, including milk, curd, ice cream, and butter.

Nestlé: Nestle, a multinational food and beverage company, has a significant presence in the Indian dairy market. It procures milk from farmers through various collection centers and processes it to produce a range of dairy products under its brand, including milk powder, condensed milk, and infant nutrition products. Nestle, the largest and oldest private milk player globally, has recently launched Greek yogurt, Nestle-a+ GREKYO. Greek yogurt, which is a super concentrated yogurt, is a swooping category in India and is stocked by premium retailers. It is priced considerably higher than other yogurts. Nestle is present in the entire array of dairy product categories, especially in the value-added space.

Britannia Industries: Britannia Industries, a leading Indian food company, has diversified into the dairy sector and offers a range of milk and dairy products. It procures milk from farmers and operates processing plants to manufacture products such as cheese, butter, and flavored milk.

Hatsun Agro Product Limited: Hatsun Agro Product Limited is a private dairy company based in Chennai. It operates under brands like ArunIcecreams and Arokya Milk and offers a

wide range of dairy products. Hatsun procures milk from farmers through its extensive network and operates modern processing facilities.

ITC Foods: ITC Food's much talked about entry into the dairy segment finally happened late last year, and that also in the value-added dairy segment, with the launch of 'Aashirvaad Svasti Pure Cow Ghee'.

Prabhat Dairy and Parag Milk Foods: They have set up cheese production units and facilities to produce Ultra High Temperature (UHT) milk and milk-based beverages. Since they are already into production of cheese, they have also tapped into whey protein (a cheese by-product) – which has much attention around the globe.

These are just a few examples of private players in India's milk marketing sector. There are several other regional and local private companies operating in different parts of the country, contributing to the growth and development of the Indian dairy industry.

Emerging opportunities in dairy marketing industry

The dairy marketing industry is experiencing several emerging opportunities that are reshaping the landscape and creating new avenues for growth. Here are some of the key emerging opportunities in the dairy marketing industry:

Functional and fortified dairy products: Consumers are increasingly looking for dairy products that offer additional health benefits beyond basic nutrition. Functional dairy products fortified with probiotics, prebiotics, vitamins, minerals, and other functional ingredients are gaining traction. Marketing these products as health-enhancing options can appeal to health-conscious consumers.

Premium and artisanal dairy products: There is a growing market for premium and artisanal dairy products that emphasize quality, craftsmanship, and unique flavors. Artisanal cheeses, specialty yogurts, and high-quality butter are examples of products that can target consumers willing to pay a premium for distinctive and indulgent dairy experiences.

Digital and e-commerce channels: The shift towards online shopping and the rise of direct-to-consumer models offer new opportunities for dairy marketers. Establishing an online presence, developing e-commerce platforms, and providing direct delivery options can help dairy brands reach consumers directly, expand their customer base, and gather valuable data for targeted marketing campaigns.

Sustainability and ethical sourcing: Consumers are increasingly concerned about sustainability, animal welfare, and ethical sourcing practices. Dairy companies can capitalize on this by adopting sustainable production methods, emphasizing their commitment to

animal welfare, and transparently communicating their sustainability initiatives. Marketing these practices can resonate with eco-conscious consumers and build brand loyalty.

Personalization and customization: Personalization is a growing trend across various industries, and dairy marketing can leverage this by offering customized products and experiences. Allowing consumers to personalize their dairy products, such as flavor options, packaging choices, or nutritional preferences, can enhance customer engagement and loyalty.

Storytelling and brand transparency: Consumers are looking for authentic connections with the brands they support. Dairy companies can leverage storytelling to communicate their brand values, heritage, and the people behind their products. Transparent communication about sourcing, production methods, and quality assurance can help build trust and loyalty among consumers.

Social media and influencer marketing: Social media platforms provide opportunities for dairy brands to engage with consumers, share content, and build communities. Influencer marketing partnerships with individuals who align with the brand's values and target audience can help reach a wider consumer base and create authentic connections.

Export and international markets: As global demand for dairy products increases, exploring export opportunities and entering international markets can be a significant growth avenue. Dairy marketers can leverage their brand reputation, product quality, and unique offerings to tap into new markets and expand their customer base globally.

These emerging opportunities in the dairy marketing industry reflect changing consumer preferences, technological advancements, and sustainability concerns. By embracing these opportunities and adopting innovative marketing strategies, dairy companies can stay competitive and thrive in the evolving market.

Conclusion:

Addressing these challenges requires concerted efforts from various stakeholders, including government agencies, dairy cooperatives, private sector players, and farmers' associations. Initiatives focusing on improving infrastructure, providing technical support and training, promoting value addition and processing, enhancing quality standards, and strengthening the dairy supply chain can help overcome these challenges and unlock the growth potential of the dairy industry in India.

REFERENCES:

1. https://pixelsutra.com/dairy-industry-market-analysis-and-marketing-strategies/

2. https://www.pashudhanpraharee.com/marketing-strategies-of-dairy-milk-milk-products-use-of-e-marketing-in-indian-dairy-sector/
3. https://www.linkedin.com/pulse/dairy-industry-india-shakti-sharma
4. https://www.businesswire.com/news/home/20190322005336/en/The-Dairy-Milk-Processing-Market-in-India-2018-2019-2023---ResearchAndMarkets.com
5. https://m.economictimes.com/news/economy/agriculture/more-than-50-of-indias-milk-business-handled-by-the-unorganised-sector-says-economic-survey/articleshow/70070774.cms
6. https://pixelsutra.com/dairy-industry-market-analysis-and-marketing-strategies/
7. https://www.pashudhanpraharee.com/marketing-strategies-of-dairy-milk-milk-products-use-of-e-marketing-in-indian-dairy-sector/
8. https://www.americandairymen.com/articles/value-added-dairy-products-overview-growing-market

Chapter 11

ADVANCED COST EFFECTIVE FEEDING TECHNOLOGIES TO OPTIMIZE MILK PRODUCTION

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Introduction

High cost of production, market uncertainty, and narrow profit margins are some of the major challenges for small scale dairy farmers facing today in developing countries. In addition farmers are not in a position to fix the price for their agricultural produce. In many parts of country it's the politicians, policymakers who control the dairy cooperatives and responsible for fixing the milk price. Thus, farmers have to adopt scientific cost effective methods to reduce cost of production to make the dairy enterprise profitable rather than increasing the price for their produce. Average cost of milk production in India is Rs. 30/litre (Dixit, 2022). In Karnataka the dairy cooperative successfully running is Karnataka milk federation (KMF) is paying Rs. 32.5 per liter and in addition the state government is paying Rs. 2.5 as incentive to farmers per litre of milk they produce. Whereas the gross value of selling milk in Karnataka, on the other hand is Rs. 46 to 56 which is lowest in the world. The profit margin is very narrow to the farmers.

Major factors responsible of cost of milk production are cost of purchasing animal stock, housing, maintenance, disease control and feeding management. Enhancing cow productivity and efficiency with better nutrition can promote profitability since feed costs alone represented 65-75% of recurring cost in a dairy farm. Hence, from all the possible avenues in a dairy farming system to promote greater profits to the farmer, changes in feeding management and nutrition have the greatest potential in the shortest time frame. Thus, the present discussion will provide detailed description of advanced low cost feeding technologies that can be adopted by dairy farmers for profitable dairying.

Cost of milk production

Among the major factors which affect cost of production include variation due to season I.e., variation in prices of input like green fodder, dry fodders and concentrate throughout the year. The cost also varies due to the scale of enterprise, breed of animals and the breeding, feeding and management practices being followed besides variation in agro-climatic conditions.

The studies conducted on cost of milk production as reported by Dixit, (2023) across the breeds, seasons, regions of southern India, indicated that the cost of milk production was around Rs. 28-32 per litre for indigenous cattle; Rs. 25-30 per liter for buffalo and Rs. 18-20 for crossbred cattle. Among the inputs, feed & fodder contribute to the maximum for the total cost (65 – 70 %) of milk production followed by labour (20-25 %). Since feed cost accounts for the major share in the gross production cost, efforts to reduce the cost of milk production must focus on efficient utilization of feed resources.

Example: Cost per litre of milk production in a 400 kg (Body weight)HF cross breed cow yielding 10 litre of milk/day as per thumb rule method.

DMI is 10kgs and concentrate requirement is calculated as 5kg (4.5kg DM)

10-4.5=5.5kg DM is supplied through roughage

5kg dry fodder contain 4.5kg DM

4kg green fodder contains 1 kg DM

300 g concentrate is given for each Kg of milk production

Then Cost of one litre milk production (Concentrate @ Rs.28x8kg.) + (Dry fodder @ Rs. 5x10Kg) + (Green fodder @ Rs.2.0*4Kg) = (Rs.224+Rs.50+Rs.8) = Rs.282/10 litre = Rs. 28.2 Per litre of milk production.

Advanced low cost feeding technologies include:

1. Green fodder feeding:

Rearing dairy animals on green fodder is the most economical way for the farmers as the cost of green fodder per kilo gram in India is around Rs. 2.5 to 3.0. The cost of production will vary depending upon the geographical region, availability of land, water, labour and other resources required for growing green fodder. On an average an animal requires about 25kg of green fodder per day. It is highly palatable, digestible and considered natural feed for dairy animals, which helps in maintenance of healthy rumen conditions. Green fodder can be obtained by pasture land, forest land, community land or cultivated fodder. Among these resources green fodder available from pasture / grazing land is the cheapest. Grazing-based systems of livestock management are common in traditional systems of livestock keeper's especially in rural areas and nearby forest land which contribute in important ways to livelihoods and ecosystem services. Pasture grasses are the most important single source of feed for ruminants in such systems. During the growing season they furnish most of the feed for these animals at a cost lower than for feeds. Due to urbanization and shrinking grazing resources farmers can cultivate high yielding varieties of green fodders for economical dairy farming. Increased use of green fodder in the ration of animals may reduce cost of milk production through reduced feeding of concentrates.

Ensuring year round green fodder supply is the major challenge which can be tackled by following good animal husbandry practices

1. Cultivate perennial fodder crops like maize, sorghum, hybrid Napier along with fodder legumes like cowpea, lucerne, cluster bean and velvet bean.
2. Plan for tree fodders like sesbania, moringa, subabul etc
3. Conserve excess green fodder as silage or hay
4. Chop green fodder before offering to animals

2. **Precision feeding technology :**

An optimum nutritional fulfillment is one, which enables an organism to take full advantage of heredity, but maximum size fixed by heredity can not be exceeded by nutrition. Thus, best advantage of precision feeding should be exploited for economical feeding of animals so that excess feeding can be avoided. Precision feeding technology is meeting the nutrient requirements of the animals with the maximum possible precision, ensuring thereby the most efficient and safest production of animal products, the best product quality and at the same time the lowest level of environmental pollution by reducing excretion of un-used nutrients. Precision feeding involves continual process of providing adequate but not excess nutrients to the animal and deriving a majority of nutrients from homegrown feeds through the integration of feeding and forage management for the purpose of maintaining environmental and economic sustainability. Among the benefits of precision feeding to the producer are less chance of over-conditioned animals, decreased feed costs and less waste production are major ones. Major nutrients where precision feeding required include

a) Fibre for rumen health:

Forage dry matter consumption by an average dairy cattle should be near 2% of the body weight. Out of this at least 28-30% neutral detergent fibre should be in the total ration. It is also called as effective fibre. Which should be provided at least 2 Kg of fibre a day. It can be measured by rumen PH which should be above 6.0. A lower PH could limit fiber digestion and microbial protein synthesis. Helps in maintaining butter fat content in the milk which is the major criteria for purchasing milk by dairy cooperatives. Efficient use of fibre also reduce SARA (Subacute rumen acidosis) condition thus, increasing the efficiency of the animal.

b) Energy:

It is the most critical nutrient among all, as utilization of other nutrients is affected by energy availability. energy can be supplemented to animals by carbohydrate

as well as fats. In a typical dairy cow diet largest component will be carbohydrate source. Ideally carbohydrate source should be slowly fermentable type coming from forage and concentrate feed ingredients. It is important that for maximum economic returns, over feeding of the animal should be avoided.

Bypass fat**:** another way of supplying energy to animals. Bypass fat is recommended in high yielding animals during heat stress and transition period. It increases energy density and overcome negative energy balance in dairy cows. Bypass fat is made up of calcium salts of fatty acids, instead of a glycerol as backbone in natural fatty acids. When calcium is associated with fatty acids, the fat supplement thus formed is rumen inert which means it has low solubility hence, less susceptible to microbial attack and bio-hydrogenation. However, in the acid medium of abomasum it gets dissociates and set free fatty acids and calcium apart for absorption. Feeding bypass fat to early lactating animals, during summer months increases milk and fat yield and ensures early conception. Recommended daily feeding of bypass fat is 100-150 g per day in a dairy cow.

c) Protein:

Protein supplements are the costliest ingredients hence should be used judiciously but in sufficient quantity to meet the optimum level of milk production. Lactating cows should be fed more than one type of protein sources instead of one type. Protein supplementation strategy should aim at promoting better microbial protein synthesis.

Proteins can be supplemented to ruminant animals in the following sources

1. NPN-Urea: 1/3 rd of the total protein requirement should only be met through Urea. For better utilization of urea in the ruminant it should be released in controlled manner. Urea should be fed in dairy cattle feed along with sufficient quantity of either starch/molasses/cellulose and minerals such as P, Co, & S for better utilization by microbes. Understanding or appreciating the level of urea recycling and accounting for this and the microbial utilization of the recycled N improves our ability to formulate more N efficient diet. The total quantity of urea should never exceed 80-160g/day in a dairy cow weighing 300-600 Kg body weight.

2. Rumen un-degradable protein (RUP): the ideal ratio of rumen degradable to un-degradable protein source should be 60:40.

3. Rumen bypass Protein: feeding rumen bypass protein will Reduce dietary amino acid loss as ammonia and urea, conserve energy through less urea synthesis, increase growth rate by 25-30% and milk yield by 10%. improve reproductive

efficiency. Rumen bypass Protein feeding if ideally recommended in transition period and high milk yielding animals at the rate of 100-150g per day.

4. Rumen protected amino acids: In a typical diet consisting of corn – soybean meal lysine and methionine are considered limiting amino acids. In cows which are fed more CP than is needed to meet their requirement for metabolizable amino acids leads to excess N and its is excreted in the urine and can contribute to environmental pollution. Supplementing diets with RUP or the limiting essential amino acids in rumen protected way may permit a reduction in total dietary CP.

Excess of protein feeding to ruminant animals more than the capacity of ruminal microbes to utilize will result in wastage in the form of ammonia and also contribute to excess feed cost.

3. Total mixed ration (TMR):

The term total mixed ration is defined as, "The practice of weighing and blending all feedstuff into a one complete ration which provides adequate nourishment to meet the nutrient needs of the dairy cows for one day." Each bite consumed by the animal contains the required level of nutrients (Fibre, energy, protein, minerals and vitamins) needed by the cow.

Advantage of TMR: A 4-5% increase in feed utilization, better ruminal micro flora & environment, greater accuracy in formulation and feeding, masking of the flavor of less palatable or unconventional feeds (urea, limestone, fats, and some by-pass protein sources). While blending all the feeds together in a TMR, over mixing and under mixing of ingredients need to be avoided. Compared to traditional mash feed, cost of the TMR will be slightly higher even then benefits outweigh the cost. Hence it is a practical tool to minimize feed loss and improve feed efficiency in dairy cows.

4. Mineral supplementation strategies:

Minerals are required by all categories of animals for proper health, growth and milk production. Quantity of minerals found in green fodder resources are poor and often require additional supplementation especially high milk yielding animals. it is very difficult to identify mineral deficiency as many time symptoms occur after prolonged period of underfeeding. Mineral deficiency can be sub-clinical affecting growth and production without any symptoms. The cost of the mineral is also cheaper compared to major nutrients as they are required to be supplied in larger quantity. Therefore, the correct quantity of mineral supplementation is very much important for high milk yielding animals.

Minerals can be supplemented as:

a) Powder form mixed in concentrate feed (most common technique)

b) Mineral block or Lick

c) Liquid supplements

Chelated mineral sources are the best when compared to inorganic sources. They have higher bio-availability, better absorption and can be supplemented 50% less than the inorganic sources. Feeding excess minerals are harmful and have no extra benefit but 5-10% extra will not harm. Some of the minerals are antagonistic to each other such minerals should not supplied in excess. Ideal calcium to phosphorous ratio in animals diet should be 2:1. Dairy cattle diet with high Dietary Cation Anion Difference (DCAD) (alkaline diet) tend to cause milk fever. Low or negative DCAD (acidic diet) tends to prevent milk fever. Adding anionic salts (minerals high in Cl and S relative to Na and K) or mineral acids to the diet lowers DCAD. Mineral mixture should include all the major and trace minerals in right proportion for better performance.

5. Fodder enrichment technologies - Utilization of crop residues

Primarily crop residues used in dairy farming include rice / paddy straw, wheat straw and maize stover. When these used as fodder contains less nutrition and high in lignified fibre and therefore cannot keep the animals productive for long duration. Hence, straws or crop residues cannot be a fed as sole source of fodder, it is merely an alternative source of fodder and can be useful only after enriching with other essential inputs like urea, molasses etc.

6. Fodder conservation and storage:

A good progressive dairy farmer always plan for future because in India agriculture is a gamble of monsoon. Any time in the year shortage of feed and fodder can occur. In such scarcity period the cost crop residues may sky rocket and dairy enterprise will be at loss. Green fodder resource are abundant during monsoon season. Excess green fodder should be conserved as hay or silage. Tropical environment predominant all over India favour conservation as hay, but very few farmers have adopted this technique. Now a days silage preparation has become popular and more number of dairy farmers are using this technology to supply green fodder during lean days of the year. Many farmers are burning the straws and stover in farm itself. Especially in Haryana and Punjab leading to environmental pollution. Such dry crop residues though nutritionally poor can be stored easily. These crop residues can be enriched using techniques like urea ammoniation, alkali treatment or adding molasses. Thus, by ensuring regular supply of quality forage throughout the year is the most economical way for profitable and sustainability.

7. **Unconventional / New feed resources:**

Several newer feed resource are identified and found useful for livestock feeding. Replacing part of the conventional feed resource is a wise way to bridge the deficit and can be solution reduce cost of production. Major factors which affect the use of unconventional feed resources are regional availability and suitability. Suitable processing / detoxification methods need to be adopted. And used at safe inclusion level in animals. Horticultural crop residues are new feed resources which can be used as animal feed. India is the second largest producer of vegetables and fruits. Among theses about 33% is wasted during harvesting, marketing and processing. Most of these feeds are nutritious with less of ANFs and available at cheaper rate. Major problem in using theses feed resources are they are having high moisture cntent. But they can be utilized efficiently after proper processing.

8. Feeding according to stage of lactation of the animal:

Dairy farming system should ensure optimum feeding to avoid either deficiency or surplus supply of nutrients. Nutrients requirement of dairy cattle varies physiological stage and level of production. Five distinct feeding phases/stages can be identified during lactation phase of dairy cattle to attain optimum production, reproduction and health of dairy cows. By following this scientific feeding method economical milk production can be achieved.

A. Early lactation—0 to 70 days (peak milk production) after calving (postpartum). This stage of lactation is characterized by a gradual increase in milk yield which reaches peak in 6-8 weeks post calving. Dairy cows cannot eat enough quantity of dry matter to fulfill their nutrient requirements for milk production. This results in mobilization of body fat reserves for milk synthesis. Hence, there is requirement for adjusting the cow to high energy feed which is an important management practice during early lactation. In order to increase nutrient intake during early lactation stage. Feed good quality forage. Allow constant access to fodder. Consider adding rumen bypass fat to the diet. Balance the diet for adequate CP, RDP and UDP.

B. Peak DM intake—70 to 140 days (declining milk production) postpartum. During this stage animals have a tendency to eat more dry matter. Provide free access to feed and fodder. The decline in milk yield is inevitable hence it should be minimum and cows should no longer be losing body weight. In high yielding cows, grain feeding can be increased but not beyond 2.5% of body weight. Forage quality should be high with intake of at least 1.5% of body weight should be ensured to attain maximum rumen function and normal milk fat content. Potential problems during this period include rapid drop or decline in milk production, low fat and SNF problem, silent heat and ketosis. Scientific feeding plan should aim at reducing these risks.

C. Mid and late lactation—140 to 305 days (declining milk production) postpartum. This phase of lactation is characterized by declining milk yield, cow may be pregnant and feed DMI will easily meet or exceed nutrient requirement by the animal. Compounded feed mixture feeding should be at a level to meet milk production and aim to replace body weight lost during post calving period. Potential health problems during this phase are few and farmers can easily maintain the animal.

D. Dry period—60 days before the next lactation. Most farmers may not provide sufficient dry period for the animals. A minimum of 60 days dry period is required for synthesis of proper quantity of colostrum and prepares cow for next lactation. Thus, this is a critical stage of of lactation cycle which impact on the subsequent lactation. Feeding low quality forage such as straw or grass hay is preferable to limit feeding. Requires sufficient quantity of vitamin A, D and E in ration to improve calf survivability, lower incidence of retained placenta and milk fever problem. Anionic mineral mixture is recommended to prevent occurrence of milk fever during this period. Trace minerals including selenium should be adequately supplemented in dry cow diet.

E. Transition or close-up period—14 days before to parturition. Transition or close-up dry cow feeding program is necessary to adjust dry cows to lactation ration and prevent metabolic problems. Supplementation of diet with niacin and anionic salts are also recommended to minimize the risk of ketosis and milk fever, respectively.

9. Least cost ration formulation:

Based on the chemical composition of available feed resources in the locality and as per the nutrient requirement of the animal one has to calculate (Veterinarian or animal nutritionist) or can use the software to compute the least cost balanced ration within the given constraints. Now a days there are popular mobile apps are available which can be used by farmers also. For example Feed-assist app developed by ICAR-NIANP, Bengaluru. The least cost balanced ration which is formulated using locally available feed ingredients and prepared as per animals requirement will help in reducing the cost of feeding and also increase the milk production.

Important points for effective feeding of dairy animals for maximum profit

a) Scientifically balanced ration

b) Roughage to concentrate ratio: Ideal ratio for better ruminal health is 60:40. In a high milk yielding animals with sufficient fibre particle size can increase to 50:50.

Below this ratio may predispose for ruminal acidosis and other digestive disturbance.

c) Nutritionally grouping of animals: nutrient requirement of the animals vary with the physiological stage of the animals hence, nutritionally grouping of animals Viz., Calf, Heifer, Pregnant, Dry should be done at farm level accordingly feeding should be practiced. Feeding all the animals with same quantity and quality diet may predispose for deficiency or excess of nutrition.

d) Quality of feed ingredient: Allays feed good quality feed free from mould and toxins to get the maximum benefits from feed.

e) Feeding intervals: feeding frequency shroud aim at achieving maximum feed efficiency and less wastage. High yielding animals needs more frequent feeding to fulfil dry matter requirement. Similarly during summer and pregnant animals need more frequent feeding especially cooler parts of the day. If the total feed to be fed in a day is offered in more than one meal, the efficiency of feed utilization increases. Thus, for better production high yielding animals should be fed at least six times a day with sufficient time to ruminate and rest.

f) Provide clean water throughout the day: Water is the most neglected and important nutrient in livestock nutrition.

Conclusion

There is no single perfect technology or scientific innovation which can cater to all the needs of farmers or which can reduce the cost of production. Technologies must be considered with consideration to their total cost for farmer and consumer. Technologies must be user friendly, economical, easily updated, accessible and locally available. From all the possible avenues in a dairy farming system to promote greater profits to the farmer, changes in feeding management and nutrition have the greatest potential in the shortest time frame.

Reference:

1. Importance of Green fodder production. https://www.sentinelassam.com/editorial/importance-of-green-fodder-503246. [Accessed: May 25, 2023]
2. Vidya Nimbalkar, Harish Kumar Verma and Jaswinder Singh. 2022. Dairy Farming Innovations for Productivity Enhancement. In New Advances in the Dairy Industry. Intech Open. Available from: DOI: http://dx.doi.org/10.5772/intechopen.101373. [Accessed: May 25, 2023]
3. Nurye, M. 2023. Recent Advances in Dairy Animal Nutrition, Health, and Management: A Review. J Adv Dairy Res. 11:613.

4. Dixit, P.K. 2023. Economics of Milk Production. Chapter In MOOC on commercial Dairy Farming. Conducted by ICAR-NDRI jointly with IACR-NAARM during february 01- march 31, 2023.

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