EDITION 2021

Approaches for Improving Livestock Productivity through Nutrition and Animal Health Management

Edited By

Dr S. K. Maiti
Dr. M.K. Gendley
Dr. Shahaji Phand

SAU - Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg, Chhattisgarh

National Institute of Agricultural Extension Management (MANAGE), Hyderabad

DSVCKV, Durg, Chhattisgarh & MANAGE, Hyderabad

Approaches for Improving Livestock Productivity through Nutrition and Animal Health Management

Programme Coordination

SAU - Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg, Chhattisgarh

Jointly Published By

SAU-DSVCKV, Durg, C.G

&

MANAGE, Hyderabad

Approaches for Improving Livestock Productivity through Nutrition and Animal Health Management

Edited by: Dr. S. K. Maiti, Dr. M.K.Gendley, Dr. Shahaji Phand

Published by: SAU- Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg, Chhattisgarh & National Institute of Agricultural Extension Management (MANAGE), Hyderabad, India.

Publisher's Address: National Institute of Agricultural Extension Management (MANAGE), Rajendranagar, Hyderabad – 500 030, Telangana State, India.

Printer's Details: e-Book from MANAGE, Hyderabad.

Edition's Details: First Edition 2021. All rights reserved.

ISBN: 978-93-91668-10-5

Citation: Maiti, S.K. Gendley, M.K. and Shahaji Phand (2021). Approaches for Improving Livestock Productivity through Nutrition and Animal Health Management [E-book]. Hydearbad: SAU- Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya & National Institute of Agricultural Extension Management (MANAGE).

This e-book is a compilation of resource text obtained from various subject experts of SAU-DSVCKV Durg, Chhattisgarh & MANAGE, Hyderabad on Approaches for Improving Livestock Productivity through Nutrition and Animal Health Management. This e-book is designed to educate extension workers, students, research scholars, academicians related to Veterinary science and Animal Husbandry about nutrition and animal health management for improving livestock productivity.

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

The 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.

Nutrition is process of providing and obtaining the food necessary for health and growth of animals. Animal nutrition has pronounced direct impact not only on animal health but also on human health through animal products. The nutrient requirement varies not only among different species but also among animals under same species among different states (pregnancy, lactating and growing calves). So, due to lack of balance diet, there may be chances of development of deficiency signs in dairy animals. Effective management of animal health and nutrition is key for success of animal husbandry. It is fact that feed cost shares a major expense for animal husbandry practices in dairy animals.

It is a pleasure to note that, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg, Chhattisgarh and MANAGE, Hyderabad, Telangana is organizing a collaborative training program on "Approaches for improving livestock productivity through nutrition and Animal health management" from 21-23 July, 2021 and coming up with a joint publication as e-book on "Approaches for improving livestock productivity through nutrition and Animal health management" as immediate outcome of the training program.

I wish the program be very purposeful and meaningful to the participants and also the e-book will be useful for stakeholders across the country. I extend my best wishes for success of the program and also I wish SAU- Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg, Chhattisgarh many more glorious years in service of Indian agriculture and allied sector ultimately benefitting the farmers. I would like to compliment the efforts of Dr. Shahaji Phand, Center Head-EAAS, MANAGE and Dr S.K. Maiti, Professor, Head and Local Coordinator, DSVCKV, Durg CG for this valuable publication.

Dr. P. Chandra Shekara
Director General, MANAGE

दाऊ श्री वासुदेव चंद्राकर कामधेनु विश्वविद्यालय
दुर्ग 491001(छत्तीसगढ़)

Ph. : +91-788-2623462
E-mail : vccgkv2012@gmail.com

DAU SHRI VASUDEV CHANDRAKAR VISHWAVIDYALAYA
DURG 491001 (CHHATTISGARH)

डॉ.एन.पी.दक्षिणकर
कुलपति

Dr.N.P.DAKSHINKAR
Vice Chancellor

No. HVC/DO/22
Date 14/07/2021

FOREWORD

It gives me immense pleasure to know that Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg, Chhattisgarh and MANAGE, Hyderabad, Telangana is organizing a collaborative online training program on " Approaches for improving livestock productivity through nutrition and Animal health management " from 21-23 July, 2021 and in this occasion an e-book on "Approaches for improving livestock productivity through nutrition and Animal health management" is to be published as immediate outcome of the training program for stakes holders. Livestock sector plays an important role in Indian Economy. It also provides employment to about 8.8% of the population in India. Livestock sector contributes 4.11 % GDP and 25.6% of total Agriculture GDP. The basic purpose of this training programme is to update the knowledge of Veterinary officers regarding advances in technologies and innovations for better management of animal health and nutrition, as they are key players towards transferring the technologies among the farmers. So the topic of training is rightly chosen in present context.

I wish the program be very purposeful and meaningful to the participants and I am in firm belief that participants will be benefitted from this three days training programme. This e-book will be very useful for stakeholders across the country. I extend my whole hearted thanks to Director General, MANAGE for giving opportunity and extending support, and also express thanks Dr. Shahaji Phand, Center Head-EAAS, MANAGE for this training programme. Lastly I would also like to compliment Dr S.K. Maiti Professor and Head (TVCC), Local Coordinator DSVCKV, Durg CG for efforts in bringing out this valuable publication.

I extend my best wishes for success of the program.

(DR.N.P.DAKSHINKAR)

PREFACE

This e-book is an outcome of collaborative online training program on “Approaches for improving livestock productivity through nutrition and Animal health management”. This compendium is intended for Veterinary officers, who are key players in the livestock sector as they are to address the problems of livestock owners in regards to nutrition and animal health for optimal livestock production. So, there is need to update their knowledge regarding advances in technologies and innovations for better management of animal health and nutrition.

The content of proposed training programme has been designed in such a way, so that it can provide updated information towards capacity building in proposed area. Attempt has been made to cover topics about advances in nutritional management with special reference to formulation of ration and precision feeding, alternative feed resources during scarcity etc for livestock. Topic like Nutritional Management in dairy animals during transition period has also been included. Topics related to advances in health management of animals include management strategies for control of endemic and emerging infectious diseases and haemoprotozoan diseases in animals have been dealt, as these diseases are causing huge economic loss to the livestock sector. Topics on Advances in the control and management of production and deficiency diseases and therapeutic management of primary ruminal disorders in dairy animals have also been included looking to the common problems of dairy animals . Looking in to the common reproductive problems in field conditions, topic like Advances in improving reproductive efficiency in livestock under filed condition and also therapeutic and management practices of common gynecological conditions in livestock have been included. Approaches for therapeutic management of common surgical affections in animals under field condition have also been incorporated for benefit of veterinary officers.

The valuable suggestions for future improvements are always welcome.

July, 2021

Editors

CONTENTS

CHAPTER 1

ADVANCES IN THE MANAGEMENT PRACTICES OF DAIRY ANIMALS FOR OPTIMUM PRODUCTION

Dr.A.K.Santra[1] and Dr D Bhosle
Prof. & Head[1], Department of Livestock Production and Management
College of Veterinary Sci. & A.H.,DSVC Kamdhenu Viswavidyalaya,Anjora, Durg
Associate Professor[2], Department of Instructional Livestock Farm Complex, College of Veterinary Sci. & A.H.,DSVC Kamdhenu Viswavidyalaya,Anjora, Durg.

Dairy farming from being a traditional family run-business today has grown hugely on an organised dairy industry with technological specialization in every part of the process. With an annual production of 187.7 mt (2018-19) India continues to be ranked number one in the world in milk production since 1991. The huge bust in the industry has created a lot of farming jobs for the people. But many of the dairy farms, however, still manage and run organic dairy farms mostly in villages supply milk to get processed by large companies and finally sell to the retail outlet.

To be successful, dairy farmer must have knowledge about all inputs of scientific management of dairy animals as well as management of dairy business. The knowledge about selection of animal, breeding method, feeding strategies, management of housing and health care are important. The best approach is to create and run a sustainable dairy farm that gives maximum profits to the farm and allow take care of the effects of dairy farm on environments and animals for longer period. But in the recent past dairy farming as a viable commercial enterprise has been invariably popular among farming communities.

Commercial dairy farming provides important source of income to farmers and dairy enterprises. Traditional dairy farm has been an important means of generation of supplemental income and employment for agriculture farming community particularly those putting to the small and marginal categories.

As stated that dairy farming is mainly taken by small holders who rear animals on crop residues and commonly they are handicapped by low capital and lack of resources and training. Therefore, precision in dairying has been underlying the ability to apply fine-scale management within farming systems through the use of technology aimed at collecting and analysing data for decision making. Automation technologies such as plant wash, vat wash, yard washing, teat spraying, in-bail feeding, data computed technologies, electronic milk meter, mastitis detection are the advanced management practices for dairy animals. The profitability and sustainability of dairy farming in India linger on increased production and efficiency through the adoption of improved practices that enhance nutrition and livelihood security.

Animal breed:

Pure exotic breeds such as Holstein-Friesians and Jersey are noted for their high milk production abilities. However, rearing of exotic animals especially in hot and humid areas in India has some disadvantages. They usually consume a lot of feed thus can be expensive to maintain, and have low tolerance to tropical diseases. On the other hand the indigenous breeds have low milk production thus income from milk sales is less than from exotic breeds. However it has some advantages that include low feed consumption, less cost to maintaining, better adaptive to local environment and have high tolerance to topical bovine disease. Crossbred combines best traits from both exotic and indigenous breeds perform well in the tropic. Indian cattle breeds like Sahiwal, Gir, Red Sindhi and Tharparkar are important for milk production and buffalo breeds like Jaffrabadi and Murrah are very popular among farmers in India.

Feed:

A scientific feeding practice with adequate nutrition is important for proper growth of dairy animal. An animal with less than 5 litre milk production offers 15 kg green fodder, 5 kg dry fodder, and 2 kg concentrate, while animal having 5-10 litres of milk production may be given 17.5 kg green fodder, 5.5 kg dry fodder and 3 kg concentrate. Increasing concentrates after calving with chopping forage into small pieces, and peak period between 70-140 days after calving is important. Supplemented feed in the diet should 16-20 % crude protein, and sufficient crude fibre must be provided to pregnant and lactating animals.

Forages such as hybrid napier, berseem maize, lucerne etc. should be produced at least a proportion of the required forages in farmer's own land in order to reduce the cost of production. Feed ingredients such as wheat busa, oil cakes, molasses, poultry waste, and feed additives- minerals and vitamins are provided to the dairy animals. Legume and non-legume fodder is maintained in the ratio of 1:3. Azolla containing 20-30% protein is provided to the dairy animals. An area specific mineral mixture can be fed to the animals in order to reduce the mineral deficiency of animals from mineral deficient zones.

The National Dairy Development Board (NDDB) of India has developed user-friendly computer software for advising milk producers on their doorstep to balance the ration of their lactating animals with the available feed resources and area-specific mineral mixtures. In order to balance rations in the field, 'Nutrition masters' were created. These 'Nutrition masters' have data on the chemical composition of commonly used feed ingredients across various agro-climatic regions and on the nutrient requirements of lactating cows and buffaloes for milk production and other physiological functions, such as maintenance, and pregnancy. Farmers using smart phones can also formulate the balanced rations using mobile apps.

Care and management of calf:

It includes removing mucus, cutting naval cord 2.5 cm from naval region, allow calf to suckle colostrums within an hour of birth and continue for 3 days, feeding of calf starter after one month of age, green fodder after 4 months of birth, deworming calf with in 7-10 days and weaning at 4-8 week after birth .Commercial colostrum can be given(bovine haemoglobin, cheese whey or colostrum from immunized cow). Other management practices include disbudding, ear tagging and castration are important for care and management of calf.

Care and management of milch animals:

This include supply of green fodder, extra concentrate of 1 kg for every 2 to 2.5 kg of milk, and training cow to let down milk without calf suckling. The other management practices include regular exercise for keeping animal fit, grooming for animal coat clean, glossy hair, stimulate urination and clean milk production; care in holding, control of bad habits , manure disposal and bedding materials, isolation of sick animals, insuring animals, and disposal of carcass are essential for improvement of animal’s productivity.

Housing management:

Over the last 100 years, changes in housing management have been made for productivity, health, milk quality, reproduction, animal well-being, and farm profitability. All housing systems are moving toward improved cow comfort. Stalls in tie stall and free stall systems are now designed to accommodate cows based on body size and, in some cases, stage of lactation. Looking to the future, external pressure and public perception may push farmers to consider other alternatives to total confinement. Housing that allows natural expression of behaviour while maintaining cow cleanliness and health may improve the lives of cows and farmers. Now a days free stalls and compost bedded brands are popular due to distinct advantages.

Animals can be reared under three rearing systems - extensive or grazing, semi-intensive and intensive systems of management. Shelter management is most essential in current global scenario to provide comfortable microclimate to dairy cattle and buffaloes. Proper designing and orientation of shelter will improve the integration of feeding, watering, milking, cleaning, efficient manure disposal and proper utilization of labour.

In loose housing with conventional shed, a single cow requires 3.5 sq.mt. covered area and 7.0 sq.mt. open area, while 1 sq.mt. covered and 2 sq.mt. open areas are required for 5-10 young calves. For keeping 50 buffaloes, 4.0 sq.mt. covered area and 8.0 sq. mt. open area are required.

Animal Health:

Animal health is utmost important priority for dairy animals. Important health management practices include animal welfare (free from hunger, thrust, malnutrition, discomfort for pain, injury), environment (over grazing, climate change, pollution, green house gas emission) and vaccination to animals against diseases like FMD, BQ, HS, and anthrax are the key indicators for management of dairy animals. Rapid changes to high energy feed may cause acute indigestion leading to acidosis that impairs rumen function and digestion. Feeding of excessive legume pasture may cause accumulation of gases in rumen (Bloat). Foot rot, grass tetany, mastitis, milk fever, mouldy feed toxicity, udder oedema and urea toxicity are some of the health issues must be addressed for dairy animals.

Advances in technologies for management of dairy animals

Application of modern technologies has made work easier for the dairy farmer. Additionally, it has enhanced productivity, making the industry more competitive and profitable. Let's take a look at the role of technology in the modern-day dairy farming industry.

Some of the most prominent livestock management technologies include:

RFID tags: These tags help to keep track of the whereabouts of cows.

Fitbits: Fitbits for cows help to track the activity of individual cows every day. They make it easy for farmers to identify inactive cows that might need help from the veterinary

Collar Technology: This technology uses a transponder to track a cow's milk production, health, milking frequency, and eating habits and sends the information to the farmer.

Facial Recognition Technology: This technology uses fine details such as distance between eyes, length of the face, and pelt patterning to identify each cow in a herd. It gathers data on the behaviour of every cow and alerts you when your herd is behaving abnormally.

Swinging cow brushes: Keeping your cows clean has never been easier. Swinging cow brushes begin to move on contact with a cow, which helps to groom the cow and has been associated with increased blood circulation.

Health Tracking Devices for Cattle: These are wearable animal gadgets to track health and well being of animals.

Robotic Milking Machines: The robotic milking machines have arms or cups with sensors that can be attached individually to cows' teats. The sensors can detect whether the cow or which of its teat is ready for milking or not. Once the milking starts, the machines can also identify impurities, colour and quality of milk. If the milk is not fit for human consumption, it is diverted to a separate container. The machines can also automatically clean and sanitize the teats once the task is over.

Cattle Monitoring Drones: Farmers are required to keep a manual vigilance whenever the livestock moves out of the farm for grazing. There are high chances of the cattle getting lost, stolen or being attacked by other animals. The cattle monitoring drones can keep track of the cattle and herd them back from fields to barns. Some drones are equipped with thermal sensing technology, which helps to track the cattle from the heat of their bodies. Drones can also capture the pictures of pasture areas and relay information as to whether these are suitable for cattle grazing.

Automated Cattle Traffic Management: It can be an extremely tedious task to manage and move cattle to milking stalls and back to barns. There is also a risk of injuries to the cattle. Automated cattle traffic management system has computer-controlled gates which opens and closes electronically. These gates can sort the livestock on the basis of their readiness to milk. The livestock ready to be milked is moved to the milking area while the others are either put in the waiting area or returned to the barns.

* * * * *

CHAPTER 2

NUTRITIONAL MANAGEMENT: FORMULATION OF RATION AND PRECISION FEEDING FOR OPTIMIZING LIVESTOCK PRODUCTIVITY

M.K. Gendley[1], and R.C. Ramteke 2
1. Associate Professor, 2. Assistant Professor
Department of Animal Nutrition, College of Veterinary Science and A.H, Anjora, Durg
(Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya)

INTRODUCTION:

Feed represents the greatest single expenditure associated with livestock and poultry production. Nutritional research in livestock and poultry has therefore centred on issues related to identifying barriers to effective digestion and utilization of nutrients, and on approaches for improving feed utilization. Although livestock and birds are highly efficient in converting feed to food products, they still excrete significant amounts of unutilized nutrients.

One of the main objectives of raising- livestock and poultry is to produce unadulterated wholesome food in the form of milk, meat and eggs to the consumers as a profitable enterprise with least contribution to climate change. Towards meeting this, they need to be fed with wholesome feed. Nutrition involves various chemical reactions and physiological processes that transform foods into body tissues and activities. It involves the ingestion, digestion and absorption of the various nutrients, their transport to all body cells, and the removal of unusable elements and waste products of metabolism. (Reddy., *et al* 2009).

Precision feeding provides the animal with the feed that precisely meet its nutritional requirements for optimum productive efficiency to produce better quality animal products (milk, meat and eggs) and to contribute cleaner environment and thereby ensure profitability. Cleaner environment means reducing the enteric emission of methane, excretion of nitrogen (ammonia), phosphorus and other compounds into the environment. It is aimed at supplying the nutrients to the animals matching their requirements to improve not only the animal physiology and health but also the enrichment of their products for the well being of the consumer. (Reddy.,*et al* 2009).

Precision feeding is formulating the ration to meet the nutritional requirements of livestock and poultry. This concept is about doing the right thing, in the right place, in the right way, at the right time. Precision feeding is based on the fact that birds within a flock / farm differ from each other in terms of age, weight and production potential and therefore each have different nutrient requirements. Precision feeding involves the use of feeding techniques that allow the right amount of feed with the right composition to be provided at the right time to each livestock and bird in the farm. Precision feeding may be a powerful approach in reducing feeding costs and improving nutrient efficiency by reducing excesses of the most economically and environmentally detrimental nutrients without jeopardizing bird's performance.

The essential elements for precision feeding includes:-

1) Proper evaluation of the nutritional potential of feed ingredients,
2) Precise determination of nutrient requirements,
3) Formulation of balanced diets that limit the amount of excess nutrients, and
4) Concomitant adjustment of the dietary supply and concentration of nutrients to match the evaluated requirements of birds.

Advantages: -

- Improved feed conversion
- Greatly reduced feed wastage
- Minimized growth stunts
- Better growth performance
- Better Reproduction Potential
- Increase Milk/Meat/Egg Production
- Decrease Metabolic/Production Diseases
- Reduce CO_2, Methane & N_2O Production (Green House Gases in Atmosphere)

Points to be considered while Precision feeding: -

- Formulate rations based on amino acids instead of crude protein
- Select feeds with low nutrient variability
- Use "digestible amino acid digestibility" to formulate rations closer to amino acid requirements
- Include additives that reduce nitrogen excretion and enzymes that increase bird performance and diet utilization
- Avoid and control anti-nutritional factors that impede the bird's ability to absorb nutrients
- Use phase feeding
- Select ingredients with readily available phosphorus
- Use Phase Feeding with Least Cost Ration Formulation
- Feeding Total Mixed Ration and Complete Feed
- Use Protected Nutrients including Bypass Protein & Fat
- Use Ingredients with Readily Available Ca and P & Area Specific Mineral Mixture
- Strategic Supplementation of Roughage: Concentrate

Several factors influence the nutrient requirements in livestock and Poultry includes:

S.	Factors	S.	Factors
1	Livestock/Bird type	9	Environmental Temperature
2	Breed and Strain	10	ANF/ Toxins in feed
3	Age	11	Feed Density
4.	Sex	12	Feed Processing
5	Productive State of the Livestock/Bird	13	Feed Form
6	Energy Concentration	14	Deficiency or Excesses of Nutrients
7	Digestibility of Nutrients	15	Nutrient Imbalance& Interactions
8	Management	16	Water quality

Considering the requirement figures given by different agencies (ARC, NRC, ICAR, Dugessa etc.), for Energy, Protein/AA, Fat, Vitamins and Minerals, various feeding standard/ practices adopted in India and world. (Reddy.,2003)

<u>Precision/Phase feeding in dairy cattle</u>: -

The growth/production cycle of an animal changes as the age advances. This phenomenon is more or less common with the different species of livestock. Thus, one of the most important feeding managemental is the precision feeding, which involves the manipulating the feed quantity/quality as per the nutrient requirement of the animal. The precision/phase feeding is a common practice used to implement feed programs. Ideally, to get maximum benefit from phase feeding, diets to be fed and feed budgets are established based on actual animal performance and profitability/performance goals. The correct diets and feed budgets must be established for each stage of production.

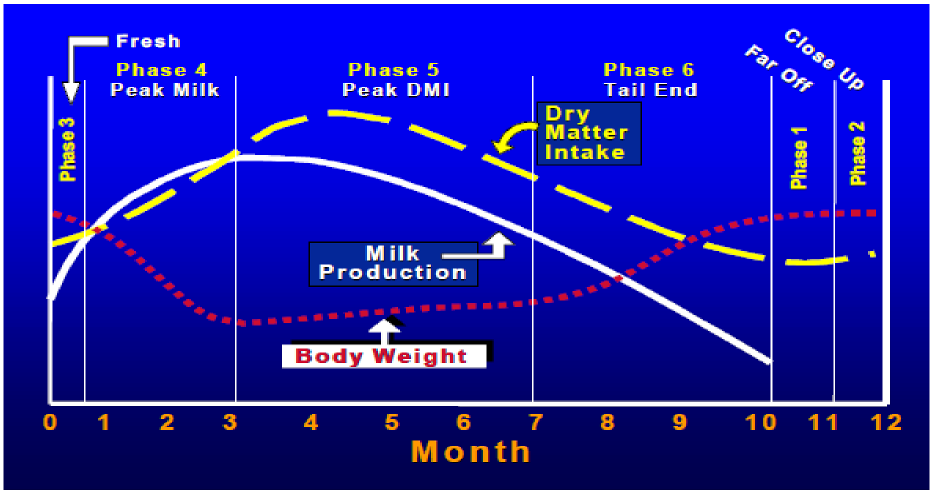
The feeding of livestock causes the major portion of rearing (About 65-75% in various species of livestock). Thus, any managemental step to reduce the cost of feeding will definitely improves the overall profitability of livestock farming. The feed provided should closely matches the animal’s nutrient requirements and minimize the over- and under-feeding of nutrients. Thus, livestock gets the sufficient nutrients to meet to profitability/performance goals and can be prevented from the various parturition-disease complex with maximum production. Use of phase feeding has been estimated to reduce N and P excretion by at least 5 to 10 percent. However, the disadvantages of moving from one feed to a phase feeding system includes greater complexity in ordering feed and the potential need to install additional feed bins on the farm (ICAR, 2013).

However, with increased pressures on profitability, these disadvantages must be weighed against the benefits of improved animal performance and profitability.

A dairy cow produces milk for about 305 days, followed by a dry period of about 60days. During such cycle of 365 days, several aspect of the cow depends largely on the stage of lactation. The nutritional requirements vary with the stage of lactation.

For feeding practices, during this 365-day period, 5 distinct phases will be categorized: -
Phase 1: Early lactation: 0 to 70 Days in milk (Peak milk production)
Phase 2: Mid lactation: 70 to 200 Days in Milk (Peak DM feed intake)
Phase 3: Late lactation: 200 to 305 Days in Milk (Restoration phase)
Phase 4: Dry period: 60 to 14 days before the next lactation
Phase 5: Transition or close-up and Fresh period: 14 days before and after calving

.t



Transition or Close-Up Period Nutrition:

Transition period is a time frame from 3 weeks before calving to 3 weeks after calving. Feeding during transition period determines the cows productivity during the preceding lactation period. Providing the right nutrition during this period greatly improve the calving ease, cow and calf welfare, milk production and reproductive performance. Smooth transition from pregnancy to lactation is essential for the better productive and reproductive performance of the dairy cattle. Failure in transition leads to lowered milk production, immunosuppression, poor reproductive performance. Decline in Dry Matter Intake (DMI) during transition period results in negative energy balance (NEB) which leads to increase the level of NEFA and ketone bodies in blood (Krishnamoorthy. 2013). This predisposes the animal to metabolic disorder like milk fever, ketosis and increase the incidence of mastitis, which affects the productivity of cow. Precision feeding significantly reduces the amount of DMI, and lowers the release of N and P into the environment. It also reduces ration costs and costs associated with manure management. (Praveen.,*et al* 2018)

Various changes occur during transition period includes:

1. Behavioral changes:

This feeding program is critical to adjusting cows, and due in-calf heifers, to the lactation ration to prevent metabolic disorders. The introduction of concentrate is necessary to begin changing the rumen from an all-forage digestion to a mixed forage and concentrate environment. This is the turning point in reproductive & productive cycle of cow. During this period no milk production, increase in body weight and decrease in feed intake.(Praveen.,*et al* 2018)

Experiment found that during transition period there is regrouping of cows and primiparous cows ate less than multiparous cows during the transition period. Similarly, showed that primiparous cows ate less than multiparous cows during wk −1, 1, and 2 after calving.(Proudfoot et al.,2009) In another study conducted by (Proudfoot et al., 2010)Cows diagnosed with lesions in mid lactation spent more time standing than cows without lesions during the 2 wk before (832+/-29 vs. 711+/-29 min/d) and 24 h after (935+/-46 vs. 693+/-46 min/d) calving. These differences were driven by an increase in the time spent perching with front feet in the stall (241+/-22 vs. 147+/-22 min/d at 2 wk before calving) and an increase in standing bout duration (101+/-10 vs. 56+/-10 min/bout at 24 h after calving). Compared with cows without lesions, cows with lesions consumed feed at a faster rate (86+/-3 vs. 77+/-3 g/min) during the 2 wk before calving and consumed more feed (17.9+/-0.9 vs. 12.3+/-0.9 kg/d) during the 24 h after calving. The number of displacements at the feeder was not different between groups. These results indicate that a combination of feeding and standing behavior during the transition can serve as early indicators of claw horn lesions in mid lactation. In another study Hosseinkhani *et al*., 2008, found that during transition period Holstein Cow consume less and large meals which leads to ruminal acidosis.

2. Biochemical changes:

Allen and co-workers (Allen *et al.*,2009) proposed that a major regulator of DMI in ruminants, and particularly dairy cattle, was hepatic energy status. This is largely driven by oxidation of fuels such as propionate derived from ruminal fermentation of rapidly fermentable carbohydrates and non-esterified fatty acids (NEFA), which are increased in the bloodstream during periods of negative energy balance and body fat mobilization. In periods when oxidative fuel metabolism by the liver exceeds liver energy requirements, the brain is signalled to decrease DMI.

In view of the dynamic nature of physiological changes during the transition period, goals of nutritional and environmental management during this period can be summed up as:

- Maintain (or enhance) immune function.
- Minimize the extent of body fat mobilization around calving.
- Maintain blood calcium at and after calving.

- Maximize appetite of the cow at &after calving. (Drackley., 1999 &Praveen *et al.*,2018)

Potential Consequences of an Inadequate Transitional Program includes:

- Metabolic Disorders-Milk fever, Fatty liver and Ketosis
- Reproductive Disorders-Retention of Placenta (ROP)and Metritis
- Digestive Disorders-Subclinical Rumen Acidosis (SARA) and Displaced Abomasum (DA)
- Rapid & Excessive Loss of Body Condition in Early Lactation
- Low peak Milk yields
- Poor Fertility
- High Veterinary Costs and
- High Involuntary Culling Rates.

Nutrient Requirement and Feeding Strategies during Transition Period:

1. Nutrient Requirements:

NRC, 2001 has given nutrient requirement for transition cow and Fresh cow which is given below:-

Nutrients	Transitioning Cow	Fresh Cow
Net Energy (Mcal/kg)	1.58	2.06
Diet % CP	12.3	17.5
Diet %RDP	7.8	10.5
Diet% RUP	4.5	7.0
NDF min%	37.2	25-33
ADF min%	21.8	17-21
NFC max%	41.6	36-44
Dietary Ca%	0.98	0.74
Dietary P%	0.37	0.38
Mg%	0.38	0.27
Cl%	0.89	0.36
Se%	0.3	0.3
Vit A(IU/day)	10000	75000
Vit. E(IU/day)	1803	545

2. Feeding Strategies:-

The main aim during this phase is to prepare the rumen for the lactating period.

1. Continue with same forages as in previous stage (dry cow).
2. Increase concentrate gradually to 2.5 to 3 kg to adapt rumen bacteria
3. Remove salt from the ration if oedema is a problem.
4. If niacin (to control ketosis) and/or anionic salts (to help prevent milk fever) are going to be used, they should be included in the ration during this period.(Stroke.,2014)

Stroke has given nutrient requirement for transition cow which is given in Table:

Nutrients	**Requirements**
Dry Matter Intake (DMI)	1.75-2.0%
Forage Ration Level in the Total Ration	> 55%
Neutral Detergent Fibre (NDF)	35-40 %
Non Fibre Carbohydrates(NFC)	30%
Net Energy (NE) (Mcal/kg)	1.65-1.75 Mcal/kg
Crude Protein (CP)	14.5-15% /15-16 % of DM
Rumen Degradable Protein (RDP)	35%
Undegradable Protein (UDP)	25%
Fat	4-6%
Ca	60-80 gm/day
P	30-40 gm/day
Ca Propionate	0.11 kg/day
Niacin	6-12 gm/day)
Rumen Protected Choline (RPC)	12 gm/day
Biotin	20 mg/day

Supplementation during	**Milk yield**	**Milk Protein yield**
Prepartum Phase	1.7 kg/day	79 g/kg
Postpartum Phase	0.5 kg/day	68 g/kg

A. DMI and Ration Fiber level:

Total Dry matter intake in the ration should be 1.75-2.0% of Body Weight with more than 50-55% of fibre DMI which is 1.4% of Body weight having Atleast1.5 inches Long With NDF above 35-40% of Total Ration DM.Rumen adaptation Despite recent changes in management to provide more energy dense rations in the transition period, dry cow rations will continue to have a lower energy density than lactating cow rations and a lower content of fermentable carbohydrate, even in pasture-dominant feeding systems.

There is evidence that part of the adaptive process in the rumen involves the elongation of ruminal papillae and an increase in absorptive area of the papillae. Further, there is a need to allow rumen microbial populations to form a stable ecosystem based on greater activity of amylolytic, that is starch-utilising bacteria. These bacteria, which include *Streptococcus bovis* and *Lactobacillus* spp., produce lactic acid, a strong acid which can markedly lower rumen pH. Lactic acidutilising bacteria, including *Megaspheraelsdenii*, *Selenomonasruminatum* and *Vionella species*, produce propionate from lactate, thereby moderating the effects of starch feeding on rumen pH. A failure to successfully adapt rumen physiology to diets higher in starch places the cow at risk of sub-acute ruminal acidosis (SARA) and lactic acidosis. It has been suggested that the lower absorptive area of ruminal epithelium may reduce the rate of absorption of volatile fatty acids and lactic acid from the rumen. (Lean *et al.*, 2010).

B. Managing Protein Balance:

The potential value of this strategy of supplementing ruminally protected methionine (RP-Met) has been exploited where supplementing RP-Met to a 14.7% CP diet resulted in milk protein secretion equal to that of 16% CP diet, but at 31 versus 27% conversion of dietary N to milk N. Rumen-protected amino acids improve the digestion and absorption and thus could reduce the N content in the diet and faeces simultaneously. (Reddy *et al*., 2009). Experiment conducted by Effect of Rumen Bypass Amino acids on Milk Yield & Milk Protein yield during Prepartum and Postpartum Phase found that there is increase in milk yield as well as milk protein yield. (Block *et al*.,2010)

C. Use of Fat in Transition Diet:

While the feeding of fat supplements during the pre-partum and immediate post-partum period has not traditionally been recommended (Santos *et al*,. 2003) due to the potential to reduce dry matter intakes, particularly in heifers (Hayirli*et al*., 2002), there have been several studies where potentially beneficial effects have been observed. There have also been other studies that showed no beneficial effects. The potential for any reduction in NEFA or liver triglyceride to be secondary to reduced dry matter intake during the pre-partum period means any benefits must be carefully weighed up against the detriment effect of reduced feed intake. It is possible that the form of fats may be important in modifying responses. Protected fats, that is fats that are not as available to ruminal modification, including calcium soaps and prills, may provide energy in forms that have less effect on feed intake and can provide specific fatty acids. (Lean *et al*.,2010).

Sharma *et al*., 2009 found that by supplementing fat found that there is decrease Non esterified Fat (NEFA) which reduces ketosis in dairy animals. Feeding fat 6-7% of DM during entire period abolished accumulation of Triglycerides and Decreases DMI. Decreased incidence of disease in early lactation can result in increased milk production throughout the lactation. It is stated that supplementing ration of lactating animals with bypass fat enhances energy intake in early lactation which reduces deleterious effect of acute negative energy balance on lactation (Tyagi *et al*., 2010).

D. Role of Cation-Anion Supplement in Diet

Anionic (chloride and sulfate) salts are often used in pre-fresh diets to counteract the effects that high dietary potassium (K) and sodium (Na) concentrations have on increasing hypocalcemia. Reducing K and Na concentrations and the use of anionic salts lowers the cation-anion difference (DCAD) of pre-fresh diets, which helps control milk fever, retention of Placenta, Abomasal Displacement, and ketosis. Because the addition of large amounts of anionic salts to the diet may depress DMI, we recommend that restriction of dietary potassium and sodium concentrations be considered first. Feeding forage with a high K content is often the culprit causing high DCAD diets. Alfalfa normally has a high K content (2%- 4% of DM) and, depending on soil fertility, grass and small grain forages may also test this high. Corn silage normally has a low K content (about 1% of DM), and can be used to dilute out high-K forages in the diet. Other strategies for lowering dietary K content include the purchase of low-K hay and targeted soil fertility for the production of low-K forage. Commonly used anionic salts include ammonium chloride, ammonium sulfate, magnesium sulfate (epsom salts), calcium sulfate (gypsum), and calcium chloride. Because chloride salts are more effective acidifiers of blood and urine than sulfate salts, the use of calcium chloride, ammonium chloride, and hydrochloric acid have become more common. The use of magnesium sulfate in anionic salt mixtures is still common because it is a good source of magnesium and is more palatable than most other salts. The efficacy of anionic salt mixtures can be evaluated by measuring urine pH, which should average between 6.0 and 6.5 in Holstein cows for control of milk fever. The recommended calcium concentration in pre-fresh diets containing anionic salts is 1.0% - 1.2% (DM basis). Pre-fresh diets should contain .4% magnesium (DM basis). Anionic salt products should not be fed to post-fresh cows. (Shaver *et al*., 2014).

E. Role of Feed Supplement in Diet

1. Calcium Propionate: Use @ 0.11kg/Cow/dayin transition cow diets as a glucose precursor. Sodium propionate should not be used in pre-fresh diets because it will elevate DCAD. There is limited research showing reduced serum NEFA and reduced urine ketones in response to adding calcium propionate at the rate of 4 ounces/cow/day to transition diets. Calcium propionate also enhances bunk stability and because of this may improve DMI in situations where heating of the TMR in the feed bunk is a problem. **(**Shaver *et al.*, 2014**)**

2. B vitamin Biotin: Shaver *et al.*, 2014 found that supplementing Biotin at 20 mg/cow/day has been shown to improve hoof health in several trials. Milk yield increases of 1-1.5 kg/cow/day have been observed, but not in all trials. The cost of supplementation is 5 - 7 cents/cow/day. Several months of supplementation will be required to improve hoof health.

3. Niacin: Feeding 6 to 12 grams of niacin per cow per day helps prevent ketosis and promotes dry matter intake to close-up dry cows and over-conditioned, ketosis-prone cows. Feed niacin until maximum DMI has been achieved usually within 10 weeks after calving. Do not feed niacin to thin cowsassumedtobecowsbelowa2.0 body condition score (BCS) (Schroeder., 2001)

4. Choline: 28% of absorbed Methionine used for Choline synthesis. Feeding 12gm of Rumen Protected Choline (RPC)/day in Combination with the low Rumen Undegradable Protein (RUP) in Prepartum diet increase Milk Production during the first 56 day of Lactation (prepartum RUP × RPC, $P < 0.05$) (Hartwell *et al*., 2000)

F. Benefits of Buffer, Ionophores in the Diet:

Free-choice Bicarbonate may benefit early lactation or high producing cows and cows under heat stress, but may need to be mixed with salt to limit its intake and should not replace what is provided in the TMR. Sodium or potassium buffers should not be fed to dry cows, because of effects of elevated DCAD on hypocalcemia. Feeding Monensin @ 200 Mg/Day during Prepartum reduce BHBA Production, so prevent Ketosis.

- Maintain pH of Rumen
- Maintain the Microbial Flora of rumen
- Decreases the Incidence of Ruminal Acidosis followed by Lameness

Reasons for Immunosuppression during this Phase includes:

- Oxidative Stress
- NEFA
- Ketones
- Negative Energy Balance
- Calcium Status

G. Role of antioxidant and Trace minerals on Immunity during Transition Phase:

1. **Cobalt (Co)**@ 0.8 to 1.2 mg/kg diet DM.
2. **Zinc (Zn)**:@ 80 mg/kg diet DM.A summary of 11 trials showed that dietary supplementation with zinc methionine increased milk and FCM yields 2.8 and 2.6 lb./cow/day, respectively, on average. Hoof health was improved by dietary supplementation with ZinPro in an Illinois trial and 4-Plex (complexed zinc, manganese, copper and cobalt) in a New York field trial. The cost of supplementing metal amino acid complexes is 2 - 5cents/cow/day. **(**Shaver *et al.*, 2014**)**
3. **Mangenese(Mn):**@ 55 to 75mg/kg diet DM.
4. **Selenium (Se):** @ 0.3 mg/kg diet DM (Socha*et al.*, 2010)
5. **Chromium** (Cr): @ 0.50 mg/kg diet DM Supplement for dairy cattle diets in the form of Chromium Propionate. (FDA, 2009)
6. **Copper** (Cu): Supplementation @ 15-30 mg/kg Diet DM reduced the peak Clinical response during experimental *Escherichia coli* Mastitis.Research in Dairy Cows is limited using Chelated and Complex Trace Minerals.
7. **Vitamin E:** @ 600-800 IU/Day Prepartum Reduced the Incidence of FoetalMortility, Metritis, & Number of days open in Murrah buffaloes. (Panda *et al.*, 2006)
8. **Beta-Carotene:** Supplementation may Enhance Immunity and reduce the Incidence of retention of placenta (ROP) and Metritis.
9. **Probiotics:** Yeast culture additives stimulate fiber digesting bacteria, help maintain rumen environment, pH and promote volatile fatty acid production, thus helping keep cows on feed. Suggested feeding rates vary quite widely at 10 to 115 grams per cow per day depending on their concentration. (Schroeder., 2001)

Conclusion:

Precision feeding practices manage to reduce nutrients/feed intake which leads to less nutrients excreted in feces or urine while maintaining or even improving animal production and the economic viability of an animal operation. Reducing the nutrients in manure lowers airborne emissions. Transition cows experience low immunity & more vulnerable to metabolic & infectious diseases. Precision feeding prevent many disorders and increases production/reproduction performances. Excellent nutrition and feeding management during the transition period helps to maximize the dry matter intake after calving & ultimately leads to higher milk production.

References:

Allen, M.S., B.J. Bradford and M. Oba (2009). Board-invited review: the hepatic oxidation theory of the control of feed intake and its application to ruminates. J. Anim. Sci. 87: 3317-3334.

Drackley,J.K.(1999). Biology of dairy cows during the transition period: the final frontier. J. Dairy Sci. 82:2259-2273.

Hartwell, J.R., M.J. Cecava, S.S. (2000). Donkin Impact of dietary rumen undegradable protein and rumen-protected choline on intake, peripartum liver triacylglyceride, plasma metabolites and milk production in transition dairy cows. J. Dairy Sci., 83 pp. 2907-2917

Hosseinkhani,A., T.J. DeVries, K.L. Proudfoot, R.Valizadeh, M.D. Veira, M.A.G. vonKeyserlingk. (2008). The effects of feed bunk competition on the feed sorting behavior of close-up dry cows.J. Dairy Sci., 91 , pp. 1115-1121

ICAR, (2013). Nutrient requirements of livestock and poultry. Indian Council of Agriculture Research, New Delhi, India.

Krishnamoorthy,U,. (2013). Phase feeding in adult stock of dairy cattle. Compandium on ICAR Sponsored Short Course at NIANP Banguluru,4-13 Sept. (81-82)

Lean.,I and DeGaris.,P.(2010). Transition Cow Management A review for nutritional professionals, veterinarians and farm advisers. Produced by Dairy Australia's Grains2Milk and InCalf programs.

NRC, (1994). Nutrient requirements of poultry. National Research Council, National Academy Press, Washington, D.C., USA.

NRC,(2001). Nutrient Requirement of Dairy Cattle. National Research Council, Washington, D.C.

Panda N, Kaur H and Mohanty TK, (2006). Reproductive performance of dairy buffaloes supplemented with varying levels of vitamin E. Asian-Aust J Anim Sci, 19(1): 19-25

Praveen, S., &Dhaarani, c., (2018). Managemental Approaches of the cow during Transition period. International Journal of Science, Environment ISSN 2278-3687 (O)and Technology, Vol. 7, No 3950 – 954, 2277-663X (P)

Reddy,.D. V., & Krishna., N,.(2009). Precision animal nutrition: A tool for economic and eco-friendly animal production in ruminants. Livestock *Research for Rural Development. 21(3,)*March 2009

Reddy.,V. R., & Bhonsle.,D.T.,(2003). Hand book of Poultry Nutrition. American Soybean Association 168, Kor Bagh New Delhi

Schroeder, J. W.(2001). Feeding and managing the Transition Dairy cows. NDSU Extension Feeding Service, North Dakota State University of Agriculture and Applied Science, and U.S. D.A.

Sharma, Neelesh, Upadhyay, S.R. and Srivastava, A.K.(2009). Bovine ketosis-An overview. Agrovet Buzz, 1(6): 43-47.

Shaver R. D,. Magdalena K,.(2014). Nutritional Management of Dairy Cows During the Transition Period. University of Wisconsin–Extension Department, Wisconsin (U.S.)

Tyagi, N., S. S. Thakur and S. S. Shelke (2010). Effect of bypass fat supplementation on productive and reproductive performance in crossbred cows. Trop. Anim. Health. Prod. 41: 1749-1755.

* * * * *

CHAPTER 3

MANAGEMENT STRATEGIES FOR CONTROL OF ENDEMIC AND EMERGING INFECTIOUS DISEASES IN ANIMALS

Dr Sushovan Roy
Professor, Department of Veterinary Medicine
College of Veterinary Science & AH, Durg, Chhattisgarh

In India and abroad, there are several infectious diseases that severely affect the economy and social system (Chakraborty *et al*., 2014). A 'disease' may be defined as a condition of the living human, animal or plant body or one of its parts that impairs normal physiological functioning and is typically manifested by clinical symptoms and signs. Animal and human diseases are classified in several ways depending on the criteria, such as infectious and non-infectious diseases, contagious and non-contagious diseases, zoonotic and non-zoonotic diseases, and acute and chronic diseases. The infectious diseases are caused by virus, bacteria, mycoplasma, fungi or rickettsia depending on the nature of the etiological agent involved. Among the infectious diseases, viral diseases are most devastating and difficult to control as they usually spread very fast and unlike other infectious diseases have no cost-effective or safe antiviral antibiotics/drugs for the treatment. The infectious diseases are dynamic concerning their epidemiology and etiological agents which is manifested within a host, pathogen and environment continuum involving domestic animals, wildlife and human populations. The complex relationship between these host populations and other environmental factors creates conditions for disease emergence. The spill-over of the new emerging disease may be from 'domestic animals to wild life', 'wildlife to humans' or 'domestic animal to human' or in all categories. The factors driving the emergence of different Emerging infectious diseases (EID) interfaces include global travel, urbanisation and biomedical manipulations for human EIDs; agricultural intensification for domestic animal EIDs; translocation for wildlife EIDs; human encroachment, ex situ contact and ecological manipulation for wildlife–human EIDs; encroachment, new introductions and 'spill-over' and 'spill-back'; and technology and industry for domestic animal–human EIDs.

The term 'emerging disease' is used to refer to changes in the disease dynamics in the population. Emerging infectious diseases (EIDs) are those which have moved recently into a new host or have enhanced incidences or geographic range or are caused by evolving pathogens (Daszak *et al.* 2000). This general definition covers a range of infectious diseases of man and animals which pose a significant threat to both medical and veterinary public health. Among the OIE-listed diseases of viral aetiology, major changes have been experienced in the occurrence of rinderpest, peste-des-petits ruminants (PPR), foot-and-mouth disease (FMD), African swine fever (ASF), lumpy skin disease and Rift Valley fever (RVF). Rinderpest presents a success story from the 1990s to 2011 as a result of FAO, OIE, EU and IAEA (International Atomic Energy Agency) guided and co-ordinated programmes including the Pan African Rinderpest

Campaign (PARC), NPRE and NREP in India (Yadav, 2011), Global Rinderpest Eradication Program (GREP) of the FAO and other national governments where the disease was endemic. These exemplary efforts led to the historic declaration of global rinderpest eradication by the FAO on June 28, 2011.

Endemic diseases usually exist at a stable, if often high prevalence, with low apparent mortality and cause less dramatic outbreaks of disease. Individual farmers may seek to eliminate a particular endemic pathogen, but with a high prevalence of infected herds elsewhere a disease-free status is difficult to maintain. Endemic pathogens are often unnoticed, mitigated or tolerated by farmers. Nonetheless, the presence of endemic pathogens causing a reduction in the performance of infected animals and herds represents a considerable, but often underestimated, drain on farm profitability and reduction in animal welfare (Bennett, 2003).

Therefore, the focus is being given by the National livestock policy on monitoring and control of these infectious and emerging animal diseases viz., FMD, PPR, brucellosis, swine fever, ebola virus etc (NLP, 2013). Most of the times, complete eradication of disease is not economically possible, therefore, in such cases attempts can be made to mitigate the disease or its infections effect on economics. Control of diseases and subsequently eradication requires isolation and quarantine of sick animals as well as animals suspected for disease; strengthening disease monitoring and surveillance, vaccines and vaccination strategies along with other control measures (Thrusfield, 2007).

Chain of infection development

The development of an infection has various components:

- **Agent of disease:** The disease-causing organism, or pathogen, which can take the form of a bacteria, virus, fungus, or parasite.

- **Reservoir:** The species—human, animal, or insect—in which the pathogen naturally resides. Pathogens can live in a reservoir for long periods without emerging to cause an epidemic. Reservoir hosts may not be seriously harmed by the pathogen.

- **Portal of exit:** The path by which a pathogen leaves its reservoir or host. Examples include the respiratory tract, urinary tract, rectum, and cuts or lesions in skin.

- **Mode of transmission:** The way a pathogen spreads from its reservoir host to the susceptible host. This can occur directly, via skin-to-skin contact or sexual relations, or through the spread of droplets from coughing or sneezing. It also can occur indirectly, as when organisms are carried on airborne particles, when intermediate objects such as handkerchiefs or bedding are the vehicle of transmission, or when mosquitoes, ticks, and other vectors carry the pathogen.

- **Portal of entry:** The place a pathogen enters a susceptible host. The mouth and nose are common portals of entry. Others include the skin (for hookworm), mucous membranes (for influenza or syphilis), and blood (for hepatitis B and HIV).
- **Susceptible host:** Some host species can acquire the pathogen but do not naturally carry it, and may be affected or unaffected by it, potentially transmitting it to other species or populations or serving as a dead-end for transmission.
- Importantly, human activities can facilitate the transmission of a pathogen at any of these six places—by, for example, enabling contact between reservoir and host species or inducing genetic selection for virulent strains that are more likely to be pathogenic to humans. Conversely, human intervention around any of the six components can stop the spread of an infectious disease.

THREE ESSENTIAL KEY ELEMENTS SUPPORTING THE CONTROL OF ENDEMIC AND EMERGING INFECTIOUS DISEASES

1. Rapid and confirmatory diagnosis, enhanced monitoring/surveillance and networking of diseases:

In developing countries like India the livestock productivity is decreased to a greater extent due to animal diseases. The correct assessment of livestock health in country is of utmost important in formulating the disease eradication or control programmes. Adequate capability and capacity of diagnostic facility is prime requirement. The test for diagnosis should be accurate and ensure the true positive detection of the diseases. The diagnostic laboratories should have quality control coordinated by reference laboratory. In the process of development of animal disease diagnostics a major thrust has been towards the methods that are rapid and have the provision for a definitive answer in less than 24 h period. In order to achieve rapidity of this kind the methods must fulfil the prerequisites of speed and simplicity; sensitivity as well as specificity; reproducibility and low cost. The prerequisites of sensitivity as well as specificity can be fulfilled by certain conventional immunoassays like indirect immunoperoxidase test (to detect antigens of duck swollen head haemorrhagic disease virus) or dot immunoperoxidase test (to detect Blue tongue virus). Such assays also include improved version of ELISA for typing as well as differentiation of strain of FMD virus as well as fluorescent polarization assay in diagnosing brucellosis in bovines. The pen-side diagnostics in addition like immunochromatographic method on the basis of the principle of lateral flow for diagnosing rabies or the reverse transcriptase loop mediated isothermal amplification (RT-LAMP) to detect 5' Non-Translated Region (NTR) gene of the classical swine fever virus aids to rapid diagnosis. The classical Polymerase Chain Reaction (PCR) based diagnosis has been exploited widely for detecting the nucleic acids in clinical specimen for diagnosis based on laboratory methods. Various versions of PCR like nested-PCR (for sequencing the whole genome of pesti virus); Real-Time PCR (RT-PCR) for differentiating morbilli virus for analysis of insertion sequence of Mycobacterium paratuberculosis) as well as multiplex PCR (in order to differentiate the cluster of various viruses that cause disease in swine) have helped in improving the skills of diagnosticians in veterinary medicine from time to time.

2. Effective vaccines and vaccination strategies: Possible way to control most of the animal diseases including zoonosis is vaccination which play essential role in the control of many diseases. A vaccination strategy alone is not useful unless it is the part of disease control strategy along with other control measures. Use of vaccination along with other control measures will help in eliminating the epidemics of animal diseases. If vaccination is applied then, the factors like role of vaccination, its type, quality, delivery and availability should also be considered. Ideally the herd immunity is obtained after 70-80% of vaccination coverage but some disease like Foot-and-mouth disease requires higher than this. In dairy enterprise many such cost-effective vaccines are available nowadays (Deb et al., 2013). The procedures for delivery systems that include: nanoparticle and liposome; viral vector as well as vaccination that are cell based need to be explored and their application is required for achieving effective as well as protective response of the immune system (Sumi et al., 2012).

3. Appropriate prevention and treatment measures: Animal disease prevention and control requires insights into occurrence of disease. There is thus need for a system for the monitoring as well as surveillance of occurrence of disease. At herd level in health control systems for recording disease can be based on observational results such as at slaughter recording of lesions or data of production such as gain in weight; rate of pregnancy as well as farrowing. Such kind of data even though they are of non-aetiological type) are valuable tools as a basis for evaluating further possible involvement of infectious diseases that are specific in nature. The basic concept of hygiene can be defined as measures taken for preventing sources of pathogens building up and methods that are applied for prevention of exposure to possible target animals. A basic measure to limit the exposure of pathogens excreted to neighbouring animals in a herd is isolating the sick animals. Large amount of infectious doses are excreted by sick animals. For instance calves infected with Salmonella Dublin excrete up to 100 (Lethal dose 25) infectious doses per gram of faeces. Isolation of such kind of animals may well be the threshold preventing an isolated outbreak of salmonellosis in one or a few animals that ends up in an enzootic spread of infection within a herd. It is also recommended not to transport or introduce animals that are sick because transport itself is known to be a factor triggering the exacerbation of a subclinical infection to fulminant status along with associated pathogen excretion. A simple recommendation is therefore isolating new animals for a specific incubation period before their introduction into a herd thereby allowing clinical observation and when required testing for infections specifically. Along with this undertaking specific biosecurity measures is also mandatory. Cooperation at the international level has led to decrease in the risk of introducing epizootic diseases but for endemic diseases this is not the case. This risk is however considerably decreased when live animal importation is replaced by semen as well as embryos (Doherr and Audige, 2001).

The availability of antibiotics that are effective in nature has revolutionized animal health care and has been found to be responsible to enable countless advancement in medical care. Some of the most widely used drugs worldwide are antimicrobial agents but their injudicious uses have led to development of resistant infectious agents. For prescribing antimicrobial therapy therefore it is necessary to diagnose the infection accurately along with the process of understanding the distinguishing features between empiric as well as definitive therapy. Along with this identification of the opportunities for switching to narrow-spectrum as well as cost effective oral agents for the shortest necessary duration; understanding characteristics of drugs that are peculiar to antimicrobial agents (like the pharmacodynamics profile) help in their judicious uses (Spellberg et al., 2008; Leekha et al., 2011). Over a century antibodies have been used in the prevention as well as treatment of infectious diseases like rabies and varicella as well as tetanus and vaccinia. Antibiotics have largely replaced them for the treatment of bacterial infections but they (antibodies) have remained a critical component for treating tetanus and botulism. The process of developing and using monoclonal antibodies in addition may help in defining further protective humoral responses and can lead to new approaches for preventing as well as treating infectious diseases (Keller and Stiehm, 2000).

References

- Chakraborty, S., N. Kumar, K. Dhama, A.K. Verma and R. Tiwari *et al*. (2014). Foot-and-mouth disease, an economically important disease of animals. Adv. Anim. Vet. Sci., 2: 1-18.
- Daszak, P., A.A. Cunningham and A.D. Hyatt. (2000). Emerging infectious diseases of wildlife-Threats to biodiversity and human health. Science, 287: 443-449.
- Deb, R., S. Chakraborty, B. Veeregowda, A.K. Verma, R. Tiwari and K. Dhama. (2013). Monoclonal antibody and its use in the diagnosis of livestock diseases. Adv. Biosci. Biotechnol., 4: 50-62.
- Doherr, M.G. and L. Audige. (2001). Monitoring and surveillance for rare health-related events: A review from the veterinary perspective. Philos. Trans. R. Soc. London B, 356: 1097-1106.
- Keller, M.A. and E.R. Stiehm. (2000). Passive immunity in prevention and treatment of infectious diseases. Clin. Microbiol. Rev., 13: 602-614.
- Leekha, S., C.L. Terrell and R.S. Edson. (2011). General principles of antimicrobial therapy. Mayo Clin. Proc., 86: 156-167.
- NLP (2013). National livestock policy. Department of Animal Husbandry and dairying, Ministry of Agriculture, Government of India.

- Spellberg, B., R. Guidos, D. Gilbert, J. Bradley and H.W. Boucher *et al.* (2008). The epidemic of Antibiotic-resistant infections: A call to action for the medical community from the infectious diseases society of America. Clin. Infect. Dis., 46: 155-164.
- Sumi, V., S.D. Singh, K. Dhama, V. Gowthaman, R. Barathidasan and K. Sukumar. (2012). Isolation and molecular characterization of infectious bronchitis virus from recent outbreaks in broiler flocks reveals emergence of novel strain in India. Trop. Anim. Health Prod., 44: 1791-1795.
- Thrusfield, M. (2007). Veterinary Epidemiology. 3rd Edn., Blackwell Publishing, UK.
- Yadav, M.P. (2011) FAO sponsored final project report on "Laboratory contributions for rinderpest eradication in India" under the Global Rinderpest Eradication Programme (GREP)-(GCP/GLO/302/EC), pp 1–58.

* * * * *

CHAPTER 4

NUTRITIONAL MANAGEMENT OF LIVESTOCK DURING SCARCITY

Dr. Meenu Dubey
Assistant Professor, Department of Animal Nutrition, College of Veterinary Science and A.H., Anjora, Durg

Introduction

Livestock plays a central role in the natural resource-based livelihood of the vast majority of the population especially in developing countries. Livestock are the best insurance against the unpredictable occurrence of nature due to drought, famine and other natural calamities. India is traditionally been vulnerable to natural disasters like floods, droughts, cyclones, earthquakes and landslides due to its unique geo-climatic conditions. Among various natural calamities, flood is the major devastating natural calamity resulting in heavy loss of vegetation. In Indian sub-continent, drought is predominantly characterized by monsoon failure. The major effects of natural disasters are acute shortages of food, feed, fodder and drinking water which adversely affect human and livestock health and nutrition. Severe malnutrition due to natural calamities may depress growth, productive and reproductive performance. Hence, there is a need to have feeding strategies for maintenance of animals to ensure its survival during and after the natural calamity.

Feeding Strategies during Natural Calamities

During natural calamities, feed security for animals should be considered as important as food security for humans, because keeping animals alive ensures families' survival after the occurrence of drought or disaster (Bakshi *et al*., 2018). It is therefore required to have feeding strategies for maintenance of animals to ensure its survival during and after the natural calamity. The following feeding strategies should be followed during scarcity

I. **Feeding of densified complete feed block (CFB)**

This technology can be effectively used as a disaster management strategy in order to save the animals from dying during natural calamities. Complete feed is a system of feeding concentrates and roughages together in blended form. Complete feed block is composed of forage, concentrate and other supplementary nutrients in desired proportions capable to fulfill nutrient requirement of an animal. This system is economical and efficient as it allows inclusion of low cost agro industrial byproducts, locally available crop residues and non-conventional feeds with their efficient utilization. The chaffed untreated or urea treated rice straw can be used as basal roughage supplemented with ingredients like mustard cake, rice bran, molasses and binder, with or without hay. Complete feed supplies readymade, balanced, low cost ration for ruminants for the benefit of landless labourers and small farmers. The blocks can be prepared in the surplus season and can be fed during scarcity and or transported easily to the deficit region for feeding of animals to save heavy loss of livestock.

II. Feeding of urea molasses mineral blocks (UMMBs)

The urea molasses mineral block (UMMB) is a strategic feed supplement for ruminant animals. It is a blend of energy, protein and minerals in the ration of ruminants to enable animals to survive until pasture conditions improve during natural calamities. The UMMB is a convenient and inexpensive method of providing a range of nutrients to the animals. UMMB can improve the utilization of low quality roughages by satisfying the nutrient requirements of the rumen microorganisms, creating a better environment for the fermentation of fibrous material and increasing production of microbial protein and volatile fatty acids. The blocks can be made from a variety of components depending on their local availability, nutritive value, price, existing facilities for their use and their influence on the quality of blocks. NDDB has developed UMMB with the following composition

Ingredients	**Quantity (%)**
Urea	15
Molasses	45
Mineral mixture	15
Cotton seed cake	10
Salt	8
Calcite powder	4
Sodium bentonite	3
Total	**100**

III. Urea treatment of straws/stovers

Natural fermentation of straws/stovers with urea is one of the attractive ways to improve the nutritive value of poor quality crop residues. The recommended treatment rate is 40 g urea/kg straw with the urea usually being added as a solution in water (4 kg urea/60 l water) which is then sprinkled on the straw. It was observed that more than 85% of the added urea was hydrolyzed by 9th day, thereby eliminating the chances of urea toxicity to animals fed urea treated straw. The method proved to be highly applicable under field conditions. It has universal application in improving the nutritive value of many cereal (wheat, rice, barley, oat) straws, maize stovers, sorghum and pearl millet stalks. The shelf life of the fermented straw is more than one year without any deterioration in the quality. The processed straws/stalks/stovers if used judiciously could save livestock population during natural calamities.

Precaution need to be taken during feeding of urea treated fodder to animals

1. The treated fodder should be kept open before feeding so as to liberate excess ammonia in it.
2. The treated fodder should not be fed to the ruminant animals below 6 months of age.
3. With the urea treated fodder, 4-5 kg green fodder also to be supplied.
4. Ample drinking water should be provided to animals while feeding the urea treated fodder.
5. Treated fodder should be fed as per requirement of animals.
6. The level of urea should not be increased above recommended level to avoid urea toxicity.
7. Supplementation of Sulphur is essential with urea feeding.
8. The treated straw or fodder must be gradually introduced / reduced from ration of animals.

IV. Silage technology for scarcity period

The process is very simple and involves spraying of urea solution uniformly over the straw and storing it for a specific time period. A large amount of fruit left over getting waste every day and causes a great disposal problem. These fruit by products are generally rich source of soluble carbohydrate also contain little amount of protein to facilitate microbial fermentation, so this can be ensiled with paddy straw and poultry droppings. Paddy straw should be chaffed and mixed uniformly with other two components. Such silo should be kept for 4 weeks at least; after that it is ready for feeding of animals.

V. Dry and fallen tree leaves

During scarcity leaves of neem, mango, banyan, pipal, babul, subabul, mahuva, etc. can be used as green fodder. Tree leaves are good source of protein, calcium and carotene (Singh and Chandramoni, 2010). The comparative evaluation of tree leaves (26 species) and grasses (10 species) indicated that tree leaves had significantly higher CP, EE, Ca (Chander Datt *et al.*, 2008b). Complete feed prepared using 50 kg tree leaves, 5 kg groundnut cake, 25 kg vilayati babul pods (*Prosopis julifora* pods), 15 kg molasses, 1kg urea and 2 kg mineral mixture is palatable to animals and it can form a good maintenance ration.

VI. Use of conserved fodders

During drought or floods, there is an acute shortage of feeds and fodders. This gap between demand and supply can be bridged considerably by transporting green, ensiled, dry roughages from surplus regions to deficient areas. Maize, sorghum or bajra green fodders can be harvested and chaffed either manually or by using a tractor fixed with single-row or self-propellant multiple-row harvester. The chaffed fodder is then transferred to the hopper of a semi or fully-automated baling machine for making bales. These bales are highly compact with high density

(450 to 500kg/m^3) and are kept for 42 d ensiling (Bakshi *et al*., 2017a). Fruit and vegetable wastes can also be ensiled with or without wheat or rice straw. Baby corn husk or baby corn fodder are harvested and wilted for few hours in summer and 1-2 days in winter and then chopped and ensiled like conventional fodders. Fresh empty peapods available after shelling peas is an excellent source of nutrient for ruminants. These are mixed with wheat straw in 75% EPPs and 25% straw ratio to obtain 34-35% DM required for making good silage. The baled hay or silage of conventional or non-conventional fodders can be easily transported to the affected region and fed to the animals.

VII. Feeding of low cost hydroponic fodder

The acute shortage of green fodder during drought and other natural calamities can be addressed to a considerable extent by feeding hydroponic fodder. Hydroponic green fodder can be produced by utilizing tap water without soil. A critical assessment of hydroponic fodder production revealed that the low cost hydroponic system can be effectively used during natural calamities (Bakshi *et al*., 2017b). The clean, intact, untreated, viable seeds/grains of high quality are soaked in 0.1-1.5% bleach solution for 30-60 min then washed in tap water again soaked at 23°C in fresh aerated water for 4 to 24 h depending on the hardness of the seed coat. After soaking, the seeds are spread up to one cm depth in plastic or light weight metallic trays with holes to facilitate drainage of the waste water. The recommended seeding rate for production of hydroponic barley, wheat or sorghum fodder is 4-6 kg/m^2 and for maize fodder it is 6.4-7.6 kg/m^2, respectively. The trays are placed in hydroponic racks and seeds are kept moist by spraying fresh tap water at frequent intervals. Hydroponic fodder (20-30 cm grass mat containing roots, spent seeds and green shoots is ready for harvesting within 6-8 days. Amongst different hydroponic fodders, the sprouted barley has the highest forage quality. The hydroponic technology requires only 1-3% space and 2-5% water for irrigation in comparison to that required under traditional fodder production. One kg of un-sprouted seed yields 6-10 kg green forage in 7-8 d.

VIII. Use of unconventional feeds

These feeds help in reducing the deficit of animal feeds as well as to make livestock production more economical and profitable. Some unconventional feed resources e.g. rubber seed cake, niger seed cake, tea waste, mango seed kernel, ambadi cake, tamarind seed powder, mahuva seed cake, mahuva flowers, subabul seeds, sea weeds, rain tree pods, tomato waste, isabgul gala and isabgul lali, neem cake, kusum cake, palm male flower, jowar gluten and jowar cake, banana root bulbs etc. can be used in the ration of livestock (Patil, 2006). Some other examples of unconventional feed are

i. Sugarcane residue

After harvesting the sugar cane, the green tops available as a waste can be used for the feeding of cattle and buffaloes. Sugarcane trash mostly used as fuel for the preparation of jaggery, may also be used to supply part of the roughage requirement after chaffing and enriching with more palatable and nutritious feeds. The by-product of sugarcane *i.e*. sugarcane tops, sugarcane bagasse, molasses can be fed to cattle and buffaloes during scarcity period.

ii. Aquatic plants

Several types of aquatic plants are available in river, pond and other water logging areas may be used for the feeding of farm animals. Although the palatability of most of the aquatic plants is not good but the voluntary intake often exceeds 1 kg dry matter per 100 kg body weight in cattle and buffaloes. Besides supplying protein and energy, they are rich sources of carotenes. So far the common aquatic plants tested for the feeding of farm animals are water hyacinth, aquatic spinach, stalks and leaves of lotus plant (Neumbiull sp.), water chestnut (Trapa natans), hydrilla, pistia and aquatic weeds. They are available readily at most of the places during floods, which can be used in different forms for feeding of animals during scarcity.

iii. Cactus

Cactus is not a conventional feed ingredient but can be used for feeding of animals during scarcity. It contains 3.3% crude protein, 3.8% crude fat and 56% carbohydrate. It also provides water to animals. The thorns should be removed/ burnt before feeding cactus. 8.0 to10.0 kg cactus can be fed daily to an adult along with other roughages.

iv. Paper waste

Paper waste contains about 70% cellulose and hence it helps satisfying the hunger of animals. Ground paper waste (6 kg) supplemented with molasses (4 kg), salt (50g), and mineral mixture (50 g) per day is sufficient to maintain an adult animal. Complete feed containing 30% ground paper waste and other concentrates can be effectively used to maintain the animals during scarcity.

v. Saw dust

During scarcity when nothing is available saw dust can also be fed to animals. Complete feed containing 30% saw dust, 32% maize bran, 31% molasses, 4% urea, 2% salt and 1% mineral mixture can be used as maintenance ration during scarcity.

vi. Addition of Feed Supplement

Use of enzyme mixture in the ration of animals will improve digestibility of available feed and fodder, improves digestive environment in the rumen, improves utilization of feed and fodders, increases availability of nutrients to animal body during scarcity period.

Feeding of bypass protein and bypass fat provides more bioavailable protein and energy to animal body which is required to fulfill the protein and energy demand of animal body while feeding the crop residues to animals during scarcity. Usually the nutritive requirement of the animal can-not be satisfied with feeding of dry fodder or available crop residues to animal. Hence, use of bypass protein and bypass fat will definitely benefit the animal body in terms of maintaining the animal health and production.

vii. Establishment of Feed and Fodder Bank

Keeping in view of flood and drought situations, there is a need to establish feeds and fodder banks at non-affected areas. Ministry of Agriculture and Cooperation has a scheme with the name of Gramin Bhandaran Yojana. Similar programmes may be proposed for feeds and fodder to encourage farmers to contribute in such banks. These banks are necessary to meet the emergency needs of livestock during floods and other natural calamities. Since during natural calamities, priority is to sustain the animals on basic feeding schedule, the co-operative societies, 'Krishi Vigyan Kendras', 'Pashu Palan Kendras' and NGOs should have the banks that contain densified feed blocks, UMMB or green fodder bales so as to ensure the feed security.

The feed ingredients which become unfit for human consumption can be spared for livestock use and stored in feed banks either in silos or stores after testing it for aflatoxin contents, pesticides and drug residues. Grasses from periphery of forest area, wastelands and farmlands may be harvested and stored as hay in briquettes and high density stacks. Crop residues of the major cereals like rice and wheat straws, coarse cereals, legumes, haulms left after removing grains from the crops may be stored in these banks. This programme is used to meet the fodder needs in drought prone areas of arid and semi-arid parts of the country.

Conclusion

The natural calamities cause acute shortage of food, feed and drinking water and play havoc with livestock nutrition and health. Feeding management during disaster has to be given utmost care to prevent starvation. The feeding strategies such as UMMB supplementation to roughages, feeding of complete feed blocks, urea treatment of straws, feeding of dry and fallen tree leaves, hay and other conserved fodder has the capacity to meet the challenge. Unconventional feeds and wastes also have the capacity to mitigate the challenge. Once the situation is under control and feedstuffs availability improves after natural disaster, the affected animals should be given compensatory feeding to re-attain the lost weight and production.

References

Bakshi, M.P.S., Wadhwa, M. and Makkar, H.P.S. 2017a.Utilization of baby corn by-products and waste as livestock feed. *Broadening Horizones* 44: 1-4.

Bakshi, M.P.S., Wadhwa, M. and Makkar, H.P.S. 2017b. Hydroponic fodder production: A critical assessment. *Feedipedia Broadening Horizones* 46: 1-10.

Bakshi, M., Wadhwa, M. and Makkar, H. 2018. Feeding Strategies during Natural Calamities. Indian Journal of Animal Nutrition, 35(1): 1-21. DOI:10.5958/2231-6744.2018.00001.4.

Chander Datt, Datt, M. and Singh, N.P. 2008b. Assessment of fodder quality of leaves of multipurpose trees in subtropical humid climate of India. *Journal of Forest Research*. 19:209-214.

Patil, N.V. 2006. Major nutritional implications and strategies to overcome ill effects of drought in livestock. In: "Feeding of Livestock during Draught and Scarcity-A Short Course" held at Central Arid Zone Research Institute, Jodhpur, India, from 1-10 November, 2006. pp 9-20.

Singh, P and Chandramoni. 2010. Feeding of farm animals during scarcity. Dairy Year Book. pp. 93-95.

* * * * *

CHAPTER 5

ADVANCES IN CONTROL AND MANAGEMENT OF PRODUCTION & DEFICIENCY DISEASES IN DAIRY ANIMALS

S.L.Ali[1], Jasmeet Singh[2] and Rashmi S. Kashyap[3]
1. Head of Department, Deptt. of Veterinary Medicine
2. Assistant Professor, Wildlife Health & Forensic Centre
3. Ph.D. Scholar, Deptt. of Veterinary Medicine
College of Veterinary Science & A.H., Anjora
Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg

Introduction

Elevated concentrations of blood BHB and non-esterified fatty acids (NEFA) as well as decreased concentrations of blood calcium, are characteristic of an unsuccessful transition from late gestation to early lactation and have been associated with an increased risk of many diseases, including infectious diseases, such mastitis and uterine diseases. Elevated concentrations of ketone bodies decrease neutrophil function and are associated with increased oxidative stress. Similarly, hypocalcemia is associated with impaired neutrophil function. Thus, metabolic diseases are risk factors for infectious diseases as they predispose cows to the development of infectious diseases. It is important to highlight that the inadequate adaptation to the increased nutritional demands of the transition period can increase the susceptibility of the dairy cows to infectious diseases.

Management of Hypocalcemia

Nutritional strategies are commonly used to prevent clinical hypocalcemia. The use of anionic salts to create a negative dietary cation–anion difference (DCAD), causes a drop in blood pH that results in low-grade calcium release from the bones into the extracellular fluid in order to balance the excessive concentration of anions in circulation. The mobilized calcium is excreted by the kidneys until parturition, when it is then used to meet the elevated milk calcium demands of lactation. Therefore, the beneficial effects of negative DCAD diets, fed during the dry period for early lactating dairy cows, are explained by an enhanced capacity to mobilize calcium from the bones and the maintenance of parathyroid hormone actions.

The optimum DCAD value for prepartum diets has not been established. A recent meta-analysis indicated that prepartum DCAD does not need to be less than negative 150 mEq/kg of dry matter. It is important to highlight that different anionic salt sources will determine different levels of metabolic acidosis. It has been suggested that sulfate salts have approximately 60% of the blood acidifying activity of chloride salts, suggesting that the addition of chloride salts is more effective in inducing metabolic acidosis than sulfate salts. Different anionic salts also lead to different reductions in dry matter intake, even though the DCAD level in the diet formulation is equal. Because the decrease in DMI is mainly mediated by the metabolic acidosis caused by the feeding of acidogenic diets, monitoring metabolic acidosis when feeding anionic salts during the pre-fresh period is extremely important. The degree of acidification caused by use of anionic salts during the dry period can be determined by measuring individual cow urine pH, with optimal urine pH of dairy cattle consuming anionic salts during the dry period being between 5.5 and 6.2. It is important to reinforce that cows should be consuming anionic salts for at least 2 days before assessing their effect on urine pH.

The strategy of adding anionic salts to the pre-calving diet to improve calcium homeostasis around parturition and prevent milk fever was first described 50 years ago. Since then, many groups have replicated these results using different anionic salts and DCAD targets. Diets with limited calcium concentrations (0.4% of dry matter) have traditionally been used in the formulation of acidogenic prepartum diets. A significant decrease (risk ratio = 0.60) in clinical hypocalcemia, in addition to a 1.1 kg/d increase in milk production by multiparous dairy cows that were fed DCAD diets pre-calving has been reported. When the postpartum DMI increased 1 kg/d, the predicted incidence of clinical hypocalcemia was reduced from 11.7 to 2.8%, and the number of disease events per cow was decreased by 50% when prepartum DCAD was reduced from 200 to 100 mEq/kg. Adding calcium to fully acidified diets improved postpartum uterine health and fertility, highlighting the importance of calcium metabolism for uterine immunity.

Another nutritional strategy that has been investigated to prevent hypocalcemia is the incorporation of compounds capable of biding dietary minerals, including calcium, decreasing the availability of calcium for intestinal absorption. The addition of synthetic zeolite A to non-acidified prepartum diets resulted in improved serum calcium concentrations around parturition and similar postpartum performance, when compared to animals receiving a similar base diet without the addition of calcium binders. However, few peer-reviewed articles have investigated this strategy. Nutritional management of dairy cows during the dry period has been the key to decreasing the incidence of clinical cases of hypocalcemia to levels as low as 1%. Combining the severity and duration of the low blood calcium concentration bouts in early lactation, might represent a better parameter to understand the association of low calcium concentrations in the first few days post-calving and animal health and performance compared to the alternative method of checking blood calcium concentration with a single sample within the first 24 h of calving.

Furthermore, transient subclinical hypocalcemia has been associated with elevated milk production, whereas persistent subclinical hypocalcemia has been associated with decreased milk production, increased risk of early lactation disease and culling, and impaired reproductive performance. Prophylactic use of oral calcium supplementation during early lactation has been proposed as a strategy to overcome calcium deficits during the first few days of lactation, especially for subclinical hypocalcemia cases. Unlike intravenous administration of calcium, oral calcium boluses establish a more sustained elevation of blood calcium concentration without elevating blood calcium concentrations to near cardiotoxic levels. Calcium supplementation immediately after calving has been shown to increase polymorphonuclear leukocyte function. Oral calcium supplementation decreased the risk of one or more health disorders (i.e., retained placenta, displaced abomasum, metritis, and mastitis) by 15% in cows, with low blood calcium concentrations being noted postpartum.

Management of Hypomagnesemia

Animals showing clinical signs require treatment immediately with combined solutions of calcium and Mg, preferably given slowly IV while monitoring the heart. The response to treatment is slower in animals with hypomagnesemic tetany than in animals with hypocalcemia alone, because of the time it takes to restore Mg in the CSF. The animal should not be stimulated during treatment, because this could trigger fatal convulsions. Additional Mg sulfate (200 mL of a 50% solution/cow) can be given SC. After treatment, cows should be left to respond without stimulation and then moved off the tetany-prone pasture, if possible. Animals must be provided with hay treated with 2 oz (60 g) of Mg oxide daily; if this is not done, the condition can recur within 36 hr after initial therapy.

Magnesium must be given daily to animals at risk, because the body has no readily available stores. Daily oral supplements of Mg oxide (60 g to cattle and 10g to sheep) should be given in the danger period. Most Mg salts are unpalatable and must be combined with other palatable ingredients such as molasses, concentrates, or hay. Feeding hay alone may be all that is required to prevent hypomagnesemic tetany in herds in which only old cows (>6 yr) are affected. If slow-release intraruminal Mg devices are administered, the animals also should be provided with hay. Fertilizers containing Mg effectively increase herbage Mg only on certain soil types. Herbage may be dusted with powdered Mg oxide (500 g/cow) or sprayed with a 2%solution of Mg sulfate at intervals of 1–2 wk. If rainfall exceeds 40–50 mm within 2–3 days of dusting, the herbage will require another dusting. Out-wintered stock should be protected from wind and cold and provided with supplementary food. Sheep and cattle should have access to hay, particularly when grazing either green cereal crops or pastures fertilized with potassium or nitrogen (or both).

Management of Energy Imbalances: Hyperketonemia and Fatty Liver

Different nutritional strategies are used to minimize energy deficits and excessive lipid mobilization during early lactation. Excessive energy deficits remain a common issue, however, leading to the occurrence of metabolic diseases. In an effort to decrease economic losses associated with the negative downstream outcomes following elevated concentrations of blood beta-hydroxybutyrate (BHB) during early lactation, a combined testing-and-treating strategy has been suggested. This strategy consists of testing approximately 20 cows, every other week, between 3 and 14 DIM, for blood BHB concentrations, using a cow-side test. Cows with BHB concentrations _1.2 mmol/L are deemed to be positive for hyperketonemia. This categorization does not group dairy cows into subclinical and clinical ketosis, but rather into moderate (BHB between 1.2 mmol/L and 2.9 mmol/L) and severe (BHB=3.0 mmol/L) hyperketonemia cases based only on the blood BHB concentration, independent of other clinical signs associated with ketosis. The frequency of hyperketonemia determines the recommended intervention. A herd prevalence of <15% warrants monitoring. If a 15 to 40% prevalence is detected, all cows should be monitored twice between 3 and 9 DIM and all positive individuals should be treated with 300 mL of propylene glycol for 5 days. If more than 40% prevalence is detected, all cows should be treated with propylene glycol starting at 3 DIM, for 5 days. Hyperketonemic cows treated with propylene glycol are 40% less likely to develop displaced abomasum than their non-treated counterparts. Herds with elevated hyperketonemia prevalence should revise management and nutritional protocols to achieve acceptable prevalence rates, and disease prevalence should be re-assessed after 1 month. Recently, several groups have investigated the use of monthly test-day information, Fourier transform infrared spectrometry, on-farm cow data, and multiple biomarkers of metabolic stress to predict the occurrence of hyperketonemia and other metabolic diseases. These strategies have the potential to identify dairy cows at risk of health disorders postpartum during the dry period and, in some cases, at dry-off. Early identification of individual cows, or groups of cows, that have a higher risk for the development of metabolic diseases postpartum is important for timely intervention to prevent the occurrence of these diseases.

Several other nutritional and management strategies have been tested to treat, prevent or alleviate fatty liver disease with limited success. Increasing the nutrient density of transition diets to increase propionate production in the rumen, as well as supplementing dietary fat to increase the dietary energy density were strategies proposed to prevent fatty liver. Nonetheless, increasing the energy density of prepartum diets had little effect on the liver accumulation of triglycerides after calving. In fact, overfeeding energy to dairy cows during the dry period (150% of energy requirement; 1.62 Mcal of net energy for lactation (NEL)/kg of dry matter (DM)) was associated with greater mobilization of triacylglycerol from adipose tissue, increased concentrations of BHB, and greater concentrations of lipids in the liver during the postpartum period, when compared to dairy cows fed to meet energy requirements (100% of energy requirements; 1.21 Mcal of NEL/kg of DM). Similar results were reported in a recent study that also compared different planes of nutrition (150% versus 100% of energy requirement) during the last 28 days prior to parturition. Taken together, these findings support the use of controlled energy diets to minimize energy deficits postpartum. Feeding controlled-energy diets with adequate physical format, limits the energy intake before parturition to meet energy requirements, while both preventing BCS gain and diminishing the extent of the postpartum energy deficit. The use of controlled-energy diets during the dry period leads to a better transition, a decrease in the occurrence of health problems, and improves dairy cow performance.

Feed additives that decrease adipose tissue lipolysis (e.g., propylene glycol, monensin, chromium, and niacin), enhance hepatic very low-density lipoprotein secretion (e.g., choline and methionine), and alter hepatic fatty acid metabolism (e.g., carnitine and tallow), have been suggested as nutritional strategies to prevent and treat fatty liver. Among the dietary supplements tested, only choline and propylene glycol repeatedly reduced liver triglycerides. Management strategies such as feeding one diet during the entire dry period and shortening the dry period have been proposed, but the current available data are insufficient to assess the effectiveness of such strategies in reducing lipid accumulation in the liver.

Management of PPH

Parenteral phosphorus supplementation and periodic hematological evaluation can be valuable in conforming diagnosis, assessing prognosis and success of treatment in case post-parturient hemoglobinuria. Seven days of parenteral phosphorus supplementation and supportive therapy significantly improves the clinical condition (temperament, food intake and urine color) in case of post-parturient hemoglobinuria. Supplementation of acid inorganic phosphorous can be successfully used for the therapeutic management of PPH in a cross bred dairy animals. An alternate treatment of PPH in dairy cattle and buffaloes is whole blood transfusion, sodium acid phosphate IV and administration of Di-calcium phosphate orally. Treatment of PPH in buffaloes by IV infusion of copper glycinate and oral administration of di-calcium phosphate has yielded good results. Treatment with sodium acid phosphate along with ascorbic acid was found to be highly effective as compared to sodium acid phosphate alone. Treatment with buffered phosphorous preparation showed early recovery about (2 - 3 days) minimum dose and without reaction. After the blood transfusion, fluid therapy is necessary as both supportive therapy and to reduce the danger of hemoglobinuric nephrosis. Supportive therapy is also an important thing for treatment of PPH which comprises of Thiamin hydrochloride 30 mg, Pyrinidone hydrochloride 13.75 mg and Cyanocobalamin 50 mg), 10 ml, IM, once a day for 5 days, Dexamethasone 40mg IM, once a day for 3 days, Calcium borogluconate together with Magnesium and Phosphorous in organic combination and Dextrose (Mifex), 300 ml slow IV and reset subcutaneously, Nicinamide, Folic acid, Vit. B12 and B6 Glycinated iron copper and cobalt, vitamin E.

The prevention of post-parturient hemoglobinuria particularly during late gestation and early lactation comprises mainly of adequate intake of phosphorus. Most researchers observed that the etiology of PPH is still unresolved, so this problem can be multifactorial. The control and prevention of this disorder include using of phosphorous and other mineral and vitamin supplementation. While the serum inorganic phosphorous is below 5 g/100ml, supplementing a source of phosphorous in ration or in water is recommended. When a large number of dairy cattle are to be affected with phosphorous deficiency, it is maybe comfortable to administer a water soluble salt of phosphorous in drinking water. An optimal intake of other minerals and Vitamins (Particularly Ca, Zn, Cu, Iodine, Mn and Mg; Vit D, E, and etc.) should be recommended by supplementing diet. Monthly parenteral administration of Vitamin D (Vit.AD3E 10 ml for adult cattle and buffaloes). Parenteral administration of Vitamin D can increase the absorption of both phosphorous and calcium from the small intestine. Removing the intake of cruciferous plants, Lucerne, berseem and sugar beets from the ration of pregnant and dairy cattle and buffaloes. The suitable control of PPH affected animals is ensuring adequate intake of dietary phosphorous and copper. After copper supplementation of animals in copper deficient areas, a decrease in the occurrence of the PPH is reported.

Management of Selenium and Vitamin E deficiency

Selenium requirement for dairy cows is 300μg/kg DM (dry matter) while selenium requirement for calves is 100 μg/kg DM per day. Dietary selenium consumption is also influenced by Vitamin E. The amount of selenium is increased when a diet low in vitamin E is consumed which is necessary for the prevention of certain anomalies. In adult cattle, NRC recommends 15 to 60 international units (IU) of Vitamin E as the daily nutritional need while the daily requirements for nursing calves are 40–60 IU. However, vitamin E and selenium are involved in similar functions. Therefore, Vitamin E deficiency could be partially compensated by an adequate intake of Selenium and vice versa.

In animals, selenium deficiencies can be corrected by giving injections, dietary supplements, salt licks and drenches. The concentration of selenium in tissue, serum, and whole blood was found to be to higher by the administration of organic selenium such as selenium methionine than by the administration of equivalent doses of selenite. Vitamin E status and species of host determines the level of dietary selenium needed to prevent deficiency. Assuming normal vitamin E status of the animal, concentrations of 0.04 - 0.1 mg/kg (dry weight) of selenium in feedstuffs are generally adequate for most animals with a range of 0.15-0.20 mg/kg for poultry and 0.03-0.05 mg/kg for ruminants and pigs. The international standard for Se requirements for cattle is 0.1 to 0.8 mg/kg dry matter. However there is a variation with the recommended level for cattle in different parts of the world. The concentration of 0.1 mg/kg of selenium and 10-20mg/kg DM of Vitamin E in feedstuffs is required to maintain immunity status in sheep. 3mg of selenium as sodium selenite along with 150 IU alpha-tocopherol acetate mixture @20mg/lb body weight through the intramuscular route has also been recommended. Tocopherol acetate can be given up to 300 to 2000mg/day in calf, 100 to 500mg/day in lamb, 500mg/day in pig, and 30 to 100mg/day in dog.

Management of Vitamin A deficiency

Preformed vitamin A itself does not occur in plant products, but its precursors, carotenes, do occur in several forms. These compounds (carotenoids) are commonly referred to as provitamin A, because the body can transform them into· the active vitamin. Affected sheep and cattle should be injected with Vitamin A at a rate of 400 IU/Kg. Treatment should be administered in consultation with your veterinarian. Ongoing supplementation methods are discussed below. Response to treatment is generally rapid, however animals that are showing signs of eye damage may not recover and suffer permanent blindness. Calves and lambs that are born with deformities due to deficiency during foetal development cannot be treated with Vitamin A. Their survival will depend on the level of damage and their ability to function. Fresh green pasture is the best source of carotenoids for conversion to Vitamin A. Preserved forages such as silage and hay also contain carotenoids; however these are destroyed over time, so feeds that have been stored for long periods will have lost much of their carotenoid content. Cereal grains such as wheat and barley are very low in carotenoids. In addition, diets that are high in grain inhibit the conversion of carotenoids to vitamin A in the small intestine.

Management of Vitamin D deficiency

Since more and more cows are being raised indoors with no exposure to direct sunlight vitamin D deficiency is becoming a cause for concern. The cows were not exposed to direct sunlight and the content of vitamin D3 measured in total mixed ration was <400 IU/kg dry matter, which is too low, even though it was supplemented with mineral and vitamin mixture, calculated to meet NRC (2001) recommendation (30 IU/kg of body weight in feed). This finding suggests that more attention should be paid to vitamin D supplementation in dairy cattle. Deficiency is even more likely to occur in hilly regions especially in the winter months. Vitamin D can be supplemented in two ways: feed additives and parenterally. Only cholecalciferol is administered parenterally to food producing animals. There is currently only one registered vitamin D supplement in the EU for cattle and this is cholecalciferol, although calcidiol is a registered supplement elsewhere. Cholecalciferol can be mixed with cattle feed in a form of a powder with a maximal dose of 4000 IU/kg of complete ration with 12% moisture content. It can also be added to milk replacers for calves. Cholecalciferol can also be given by intramuscular and subcutaneous routes at the recommended dose of 500 to 2000 IU/kg body weight in cattle, sheep, horses, pigs, rabbits and chickens. However, in dairy cows this practice can increase risk of milk fever if employed at the end of pregnancy. A special UV light emitting UV light with a wavelength between 250 and 400 nm used for irradiating cows has showed that 25-OHD levels could be raised in blood as well as in milk with UV light exposure. Of course, vitamin D synthesis could also be stimulated by exposing cow to natural sunlight.

Management of Copper deficiency

Copper is presenting in and essential for the activity of numerous enzymes, cofactors and reactive protein. Cu also plays an important role in the immune system. Cu is necessary for production of melanin pigment and interaction of copper and estrogen are also observed. Cu and Zn have a correlation with reproductive hormones especially progesterone and estradiol as for as reproduction is concern copper is one of the important mineral. Copper deficiency has been associated with delayed or depressed estrus, early embryonic death and resorption of the embryo, increased chances of retained placenta and necrosis of placenta, low fertility associated with delayed or depressed estrus decreased conception rates and anestrus.

Copper treatment is reported to improve conception rate as the copper treated cow require 1 service and the untreated cow require 1.15 services per conception. The following mineral ratios may be helpful in maintaining Cu levels in blood: Zn: Cu 4:1, Cu: Mo 6:1 and Fe: Cu 40:1. Amino acid chelates of Cu, Mn and Zn have been reported to reduce services per conception significantly in dairy cows. The normal body requirement of Cu in dairy cattle is 10 ppm but additional supplementation of copper is essential for quality semen production.

Management of Zinc deficiency

Zinc plays a major role in the immune system and certain reproductive hormones. This mineral has a significant role in the repair and maintenance of the uterine lining following parturition, speeding return to normal reproductive function and early return of postpartum estrus. Zn deficiency has been associated with abortion, fetal mummification, lower birth weight and prolonged labour as Zn plays important role in uterine lining. Zinc deficiency associated with delayed puberty and lower conception rates, failure of implantation reduction in litter size. Animal deficient with Zn have lower concentrations of FSH and LH chiefly in males. The recommended dietary content of Zn for dairy cattle is typically between 18 and 73 ppm depending upon the stage of lifecycle and dry matter intake. Cu, Cd, Ca and Fe reduce Zn absorption and interfere with its metabolism. Requirement of Zn in diet of dairy cows is 40ppm. Crossbred bulls improved semen supplemented with Zn showed a better response in improving sperm per ejaculate, mass motility and semen fertility test like bovine cervical mucus penetration. Zinc supplementation has also increased ejaculate volume, sperm concentration, percent live and percent motility in bull.

Management of Cobalt deficiency

Cobalt is essential for proper vitamin B12 synthesis. Maintaining adequate vitamin B12 status benefits both the dam and offspring. Reduced fertility and sub-optimal conditioning of the offspring are noted in a cobalt deficiency. Insufficient level of cobalt in the diet has been correlated with increased early calf mortality. Cobalt deficiency leads to delayed uterine involution, irregular estrous cycle and decreased conception rate. A cobalt deficiency ultimately resulted in vitamin B12 deficiency. Manganese, Zinc, iodine and monensin may reduce cobalt deficiency. Dietary requirement for a lactating cow is 0.11ppm of the ration of dry matter intake.

Management of Iron deficiency

Iron is essential for the synthesis of hemoglobin and myoglobin and various other enzymes that help in formation of ATP through electron transport chain. It helps in transport of oxygen to tissues, maintenance of various oxidative enzyme systems. Deficiency is rare in adult animals due to its abundance in feed stuffs. But in cases where deficiencies are there, reproductive health is deteriorated due anemia, reduced appetite and poor body condition. Chances are there that deficient animal will become a repeat breeder and will require increased number of services per conception and may abort occasionally.

Additional management practices

Improving cow comfort during the transition period has a remarkable impact on dry matter intake and, in turn, improves the welfare, health, and performance of dairy cows during early lactation. Aspects such as proper stocking density, sufficient bunk space, access to water, correct stall designs, comfortable and sanitary bedding material, heat abatement systems, and frequent and adequately delivered feed should not be overlooked. Future studies to establish physiological limits considering the specific best management conditions, will potentially yield data that can be beneficial in detecting health problems during early lactation in dairy cows. The importance of adequate feeding strategies has been highlighted several times in this review. In order to accomplish these goals, comprehensive total mixed ration (TMR) audits, when feeding TMRs, should be performed on a regular basis to determine if the feed delivered to the cows on a daily basis is in accordance with the recommended diet for each particular group of cows.

Bibliography

- Barros, C.S.L. (2016). Fígado, vias biliares e pâncreas exocrine. *In:* Santos R.L., Alessi A.C. (Eds), Patologia Veterinária. 2nd edn. Editora Roca, Rio de Janeiro. pp 181-266.

- Cejna, V. and Chladek G. (2005): The importance of monitoring changes in milk fat to milk protein ratio in Holstein cows during lactation. *Journal of Central Europe Agriculture.* **6**: 539-546.
- EMEA/MRL (1998). Committee for veterinary medicinal products, vitamin D, summary report. EMEA/MRL/366/98 (1998) The European Agency for the Evaluation of Medicinal Products, Veterinary Medicines Evaluation Unit Available at https://www.ema.europa.eu/en/documents/mrl-report/vitamind-summary-report-committee-veterinary-medicinal-products_en.pdf accessed on 18. 10. 2019
- Hodnik, J.J., Jezek, J. and Staric, J. (2020). A review of vitamin D and its importance to the health of dairy cattle. Journal of Dairy Research. 87(S1): 84–87.
- Houe, H, Ostergaard, S., Thilsing-Hansen, T., Jorgensen, R.J., Larsen, T. and Sorensen, J.T. (2000*)*. Milk fever and subclinical hypocalcaemia: An evaluation of parameters on incidence risk, diagnosis, risk factors and biological effects as input for a decision support system for disease control. *Acta Veterinaria Scandinavica*. **42:**1-29.
- Hutjens, M.F. and Aalseth, E.P. (2005). Caring for transition cows. Hoards dairyman Books. Illustrated. *SR Journal of Agriculture and Veterinary Science,***1**:71-73.
- Oetzel, G.R. (2004): Monitoring and testing dairy herds for metabolic disease. *Veterinary Clinics of North America: Food Animal Practice.* **20:** 651-674.
- Radostits, O., Gay, C., Hinchcliff, K. and Constable, P. (2006). Veterinary Medicine . A textbook of the diseases of cattle, horses, sheep, pigs and goats. 10th edn. Saunders Ltd., Philadelphia.
- Voyvoda, H. and Erdogan, H. (2010). Use of a hand-held meter for detecting subclinical ketosis in dairy cows. *Research Veterinary Science.* **89:** 344-351.
- Zhang, Z., Bi, M., Yang, J., Yao, H., Liu, Z. and Xu, S. (2017). Effect of Phosphorus deficiency on erythrocytic morphology and function in cows. *Journal of Veterinary Science.* **18:** 333-340.

* * * * *

CHAPTER 6

ADVANCES IN IMPROVING REPRODUCTIVE EFFICIENCY IN LIVESTOCK UNDER FIELD CONDITIONS

R.P. Tiwari and G. K. Mishra
Department of Veterinary Gynaecology and Obstetrics,
College of Veterinary Science and A. H., Anjora, DSVCKV, Durg, Chhattisgarh

Introduction: India is very rich in livestock wealth with 529.7 million livestock out of which bovine population alone is 304.77 million. They together contribute nearly 29.7% of the total value of agriculture GDP and accounts for about 4.07% of the total GDP. We have a very large population of low and unproductive bovines to thrive on scarce resources. Among the several causes, compromised reproduction efficiency is one of the major bottlenecks in achieving high individual animal productivity. The majority of the world's estimated 1.3 billion poor people live in developing countries where they depend directly or indirectly on livestock for their livelihood support (FAO, 2009). Globally in the developing countries, livestock contributes about 40 percent to the agricultural GDP and constitutes about 30 percent of the agricultural GDP (World Bank, 2009).

Livestock is an integral part of India's agricultural economy also and plays a multifaceted role in providing livelihood support to the rural population. In rural India over 20% families are landless and about 80% of the land holders belong to the category of small and marginal farmers; for them, livestock is the main source of livelihood. Livestock sector plays very important role in country's agricultural economy, contributing to about 30% of the GDP of agriculture and allied sector and is one of the fastest growing agricultural subsectors. Milk production accounts for 5.86% of the GDP while the total contribution from Animal Husbandry is 9.33%. Livestock is therefore, highly livelihood intensive particularly in arid and semi arid areas. We all know that the overall growth rate in livestock sector is steady and is around 4-5% and the same has been achieved despite the fact that investment in this sector was not substantial. The progress in this sector results in balanced development of the rural economy particularly in reducing the poverty amongst the weaker sections. Livestock sector also acts as best insurance for farmers against vagaries of weather like flood, draught etc.

Constraints of livestock development in India: Livestock production systems in India are mostly based on traditional knowledge. Low livestock productivity and profitability, coupled with land degradation, global warming, erosion of animal and plant genetic resources, livestock mediated environmental pollution, severe water shortages and the threat of emerging infectious diseases pose several new challenges to sustainable animal production. Therefore, meeting the increasing demand for animal products while protecting the environment is the major challenge today. Under the above circumstances, rural economy can be enhanced by:

- Improvement in genetic constitution of livestock
- Increased availability of feed and fodder
- Improvement in health care
- Providing better extension services and coordination among developmental agencies
- Absence of suitable policies and involvement of small farmers

Role of Reproductive Biotechnology in Livestock Improvement: Biotechnology will provide new and unprecedented opportunities to improve the productivity of animals through growth, carcass quality and reproduction, improve nutrition and feed utilization, improve quality and safety of food, improved health and welfare of animals and reduced waste through more efficient utilization of resources. Based on the progress in scientific knowledge of biotechnologies have been developed and introduced into animal breeding such as artificial insemination (AI), Use of sexed semen, in-vitro fertility assay, oestrus synchronization, timed AI, multiple ovulation and embryo transfer (MOET), in vitro embryo production (IVEP), cryo-preservation of gametes and embryos, cloning by nuclear transfer and use of stem cells.

Reproductive Technologies

Artificial Insemination: Artificial insemination (AI) allows the rapid genetic improvement of a breed through the use of superior sires (Mishra *et al*., 2007). The development and application of artificial insemination (AI) - a powerful and successful example of reproduction biotechnology - has revolutionized the breeding of cattle, particularly dairy cattle. With the introduction of frozen semen, application of A.I. has increased manifolds. Different part of India indicates different rate of success of A.I. as 40.71 per cent in Karnataka (Radhakrishna *et al*., 1983), 30.90 to 42.20 per cent in Harayana (Kaul *et al*., 1979), 35.50 per cent in Assam (Kalita, 2008) and 45.03 per cent in West Bengal (Roy. 1974). However, overall conception rate through A.I. remains to be on 20 per cent in India (Misra, 2005). A number of factors such as type of animal inseminated, quality of semen, life of semen, skill of inseminator and error in frozen semen handling influence the rate of success of A.I. in the field. (Alder, 1964, Lysak, 1965; Howalder *et al*., 1997 and Kalita, 2008). Out of 122.5 million breedable cattle and buffaloes (92 million to be bred every year keeping calving interval to be 16 months), at present only 17 million animals can be covered with AI (50 million AI @ 3 services per conception). This very poor AI coverage (< 19%) and conception (~ 30-35%) following AI does affect reproduction rates and has direct economic implications on the Indian dairy industry, which needs to be addressed on priority. Recent attempt to improve fertility include development of new technologies leading to higher fertility, particularly timed artificial insemination needs to be used as a routine reproductive management practice.

Fixed-Time Artificial Insemination (FTAI) / Modified Target Breeding: The AI in bovine has been widely pursued and successfully used in breeding programs around the world. The failure to detect estrus is one of the main factors that impair reproductive development in artificially inseminated herds. In cattle, "Ovsynch" method has demonstrated efficient synchronization of ovulation and production of satisfactory pregnancy rates in the inseminated herd, without the need of estrus detection. Liang *et al.* (2007) reported GnRH+PGF2α+GnRH is the most effective combination for buffalo estrus synchronization and it resulted a synchronous rate of 88.46%. Qin *et al.* (2008) reported that the synchronous estrus rate reached 91.7% when GnRH+PG+GnRH were adopted for buffalo estrus synchronization. Modified target breeding system improves the target breeding program by using GnRH. It involves the insemination of cows detected in heat after synchronization programmed timed insemination of those cows not observed in heat. The protocol developed for use in dairy cows that have resumed estrous cycles involves the sequential injection of GnRH, prostaglandin and GnRH at defined intervals (on day 0, 7 and 9) and treated cows being inseminated at fixed timed.

Day 0	**Day 7**	**Day 9**	**Day 9, 10, 11**
GnRH	$PGF_2\alpha$	GnRH	AI at observed estrus or at fixed time

Some other program like presynch, heat synch, cosynch and select synch can also be used for estrus synchrony.

Embryo Transfer Technology (ETT): ETT helps in the dissemination of best germplasm of both male and female whereas artificial insemination (AI) disseminates only male genotype (Mishra *et al*., 2010). This technology has potential to multiply the elite animals at faster rate. Impact of ETT can be further increased by the use of embryo transfer associated techniques such as embryo sexing, cloning, transgenesis, stem cell technology, singly or in combination. The ETT can also be used for the genetic evaluation of of bull using sibling testing, especially in progeny testing programmes (PTP). Other applications of ETT include conservation and preservation of the indigenous/endangered breeds, economic transport of livestock across the globe, salvage of reproductive function and research in reproductive biology.

Multiple Ovulation and Embryo Transfer (MOET): MOET can increase the genetic gain per year than was possible through AI alone by shortening the generation interval from birth to reproductive age by obtaining and transferring the embryos from prepubertal animals. MOET also increases the selection intensity through increased number of progenies per animal per year. MOET have already been recognized as proven technologies for rapid genetic improvement of livestock in developed countries.

MOET involves in super ovulation of elite donor females, breeding with superior sires, collection of embryos and then transfers of the embryos to surrogate mothers. The main disadvantages of MOET are highly variable success rate, higher incidence of embryonic death and higher occurrence of dystocia (Van Wagtendonk-deleeuw *et al*., 2000).

Semen and Embryo Sexing: Predetermination of the sex of offspring would inevitably lead to selective multiplication of the desired sex. It is presumed that known sex of embryos produced for use in ET programs can more effectively help to manage producer resources, because it would enable to produce more heifer calves per ET, which is the main goal of the dairy entrepreneur. The offspring of desired sex have already been produced employing flow sorting for sexing of both fresh and frozen-thawed semen in several species like cattle, goat, pigs and sheep (Seidel et al. 1999; Parrilla et al. 2004; Grossfeld et al. 2005; De Graaf et al. 2007). In case of buffalo, birth of the first buffalo calves produced by the combined use of AI and sexed semen has been reported by Presicce et al. (2005). Predetermination of sex of preimplantation embryo, has an important application in domestic species for livestock management and breeding. Sex of embryo is generally controlled by Y-chromosome. An embryo which inherits a Y-chromosome develops into male and which is lacking Y-chromosome develops into female. Male is first choice for meat industry and also in artificial Insemination programmes for production of semen. Female is the choice for diary industry. This preselectionn of female has got immense importance in favour of females in case of endangered species. There are several non invasive (H-Y antigen detection and Measurement of X-linked enzyme activity) and invasive methods (Karyotyping, Y-specific DNA probe and Polymerase Chain Reaction) available for determination of sex in embryos.

Ovum Pick-Up (OPU): OPU is an alternative way to super ovulation and embryo flushing. Ovum pick up involves ultrasound guided trans-vaginal recovery of oocyte from live animals (cows/buffaloes). Oocyte may also be recovered from ovaries collected from slaughterhouse. After recovery, oocytes are evaluated, matured, fertilized and cultured in vitro. Production of embryos through OPU and subsequent embryo cryopreservation has resulted the transport of genetics throughout the world and thus globalization of breeding programmes. OPU technology can applied to produce embryos and calves from the high genetics cows that do not respond to superstimulation with hormone as port of MOET that have blocked oviducts or to produce offsprings from pregnant and juvenile animals (Devaraj and Manjunatha, 2007).

In Vitro Embryo Production: Generation of embryos through sequential steps of in vitro maturation (IVM) of oocytes, in vitro fertilization (IVF) and in vitro culture (IVC) of embryos, is referred as in-vitro embryo production (IVEP). Oocytes may be aspirated from live cows / buffaloes using ultrasound guided trans-vaginal technique, popularly called as ovum pick-up (OPU). IVEP is considered to be more economic and efficient technique to produce embryos in bulk to meet the demand of elite animal production as well as newer reproductive technology research. The 30-40% donor animals not responding to superovulation treatment and animals infertile due to pathological conditions of the uterus and oviduct (and not for genetic reasons) can also be used for OPU-IVEP. All the genetically normal bovine females above 2 months of age, including the pregnant (<3 months), are eligible to become oocyte donors.

Transgenic Animals: A transgenic animal is an animal in which foreign DNA has been incorporated into its original DNA and the transfer of the gene responsible for the desired productive trait into the embryo through micromanipulation. There are several methods for the introductions of transgene in fertilize oocytes/embryos. Recently a new concept for transgenesis explored in spermatozoa as a recombinant vector in which transfection male germ cells in vitro followed by transfers to a recipient's seminiferous tubules (Celebi *et al*., 2002). This technology holds much promise, but requires further development in the same field.

Gene Mapping: Genome analysis in farm animals has provided new insights into the molecular structure of genes as well as new knowledge on their regulation and expression. Knowledge of major genes on the molecular level allows application of gene transfer and marker assisted selection in farm animals for quantitative target traits (Bujarbaruah, 2012). Future developments in gene mapping for cattle as a means of identifying the genetic loci responsible for genetic variation in traits of economic importance i.e. identifying quantitative trait loci (QTL) that can be used in selection programmes. To manipulate commercially important genes with limited success are now made change as progress in gene mapping and identifying QTLs (Bulfield, 1994).

Estrus Detection and Artificial Insemination: Proper heat detection is a key factor for successful management of dairy herd. Generally heat detection in the organized farm is done either manually by visual inspection twice in a day i.e. morning and evening or by parading androgenised female or vasectomised male/ teaser. Estrus detection rate in absence of bull is less than 50% whereas in presence of bull, it is up to 70 – 80%. The correct knowledge of timing of estrum onset is one the main loophole if animal comes in heat during odd hours. In case of large herds the chances to miss the heat is more common. Missing one estrous cycle will put extra burden over the productive capacity by 21 days (ranged from 18 to 24 days) thereby extra delay in production potential. There are different methods for improving estrus detection viz, proper identification of animals, proper adequate light in animal shed, frequent and regular observation of cows (daily 3 times) and use of certain estrus detection aids. Correct timing for deposition of semen is the one of the important and foremost criteria to have maximum pregnancies having maximum conception rate up to 80-90%. Proper time of AI should be during standing estrus so that AI should be done from mid of the estrus to end of the estrus in cows. Recently to achieve higher results through AI, the "AM – PM rule" is normally practised/formulated for cattle. Cows detected in estrus in the morning 'AM' are to be inseminated 'PM'; cattle observed in heat 'PM' are to be inseminated the following morning. To cover anovulation and delayed ovulations, multiple inseminations are sometimes advocated for improving pregnancy. Double inseminations at the interval of 6 to12 hours in animal exhibiting prolonged estrus are the basis of positive outcome.

Estrus Synchronization: Synchronization of estrus is defined as methods by which group of randomly cyclic females brought to heat at predefined period of time subject to artificial manipulation. Synchronization of estrus in a group of females allows one to predict the time of estrus with reasonable accuracy. Progesterone and synthetic progestagens are known to suppress estrus and ovulation. Recent studies indicate that progestagens act via a mechanism of negative feed back on LH secretion, probably via a reduction in LH pulse frequency. Similarly, prostaglandin can be used for estrous synchronization. When exogenous prostaglandin is used in animals with a susceptible CL (Day 6 to 17 of cycle), the plasma progesterone level rapidly declines to < 1 ng/ml with in 24 hours. Estrus is usually exhibited within 36 to 72 hours. A single injection of PGF2 alpha should result in 50 to 65% of cycling animals. A second injection given 11 days later, result in synchronized estrus in 90% of animals. Synchronization of estrus is found to be better after second PG injection that after first. This may be because of synchronization of follicular development before the second injection.

Pregnancy Diagnosis (PD): Pregnancy rate is a good overall measure of reproductive performance. An accurate and early PD is essential to a successful breeding program for the management of infertility. Confirmation of pregnancy at an earliest day depends upon the ability of practitioner and method of pregnancy diagnosis. As a management, non pregnant animals after mating or insemination can be identified so that production time loss may be reduced. It can be divided into three phases

35-50 day post service (early) pregnancy diagnosis: A major goal in early confirmatory pregnancy diagnosis in cattle is to identify non-pregnant cows as early as possible to allow for rapid insemination in reducing the inter-calving period. With the advent of ultrasonographic scanning and hormonal assay have additional advantage over the conventional method of pregnancy diagnosis as a back bone of dairy industry.

120 days post service (mid) pregnancy diagnosis: This is very crucial period in reproductive framework as differential diagnosis from other forms of infertility like pyometra, fetal mummification, fetal maceration, mucometra/hydrometra and tumours to rule out varying degree of genital non specific infections.

6-7 months (before drying off) pregnancy diagnosis: This is not routine practice but this type of pregnancy diagnosis is newer concept in dairy to know the any accidental losses and precautionary measures are very good healthy option for dairy owners.

Infertility and their Management: Infertility is one of the greatest threats to dairy industry resulting direct and indirect impact on production potential of individual dairy animal thereby ultimate heavy economic loss of particular herd. Practically delayed puberty, gestational accidents, postpartum complications and ovarian inactivity are the major forms to hamper fertility rate under agro-climatic conditions of the country.

Delayed puberty: Timely onset of the puberty optimized the reproductive efficiency of female animals resulting into higher fertility index. Delayed puberty and sexual maturity may be mainly due to low plain of nutrition, exposure to stress and inbreeding trends. Delayed puberty accounts economic disadvantages through decreased lifetime reproductive performance. Delayed first estrus contributes reduced reproductive efficiency thereby leads to a period of adolescent infertility.

Gestational accidents: Diseases and accidents of gestation believe to the major silent forms of infertility as it generally goes unnoticed. It includes early embryonic loss, unseen expulsion of embryos or fetuses (abortions), fetal death, fetal mummification and maceration.

Embryonic loss: Embryonic mortality is one of the major causes of the reproductive failure. Early embryonic mortality occurs between fertilization and day 24 of gestation resulting in repeat breeding whereas the late embryonic mortality considered between day 25 to 45 day resulting into irregular or prolonged estrous cycle and thereby decreasing lifetime performance. Luteal insufficiency, physiological as well as thermal stress and incompatibility between spermatozoa/ egg or between zygote and mother may lead to embryonic loss.

Abortion: Economically, abortions are of great importance to the dairy owner, because of the fetus loss (future breeding stock), production loss (milk production), a prolonged period of uterine disease and infertility and chances to spread of infection of other animals (if threatens infectious abortions).

Fetal death, fetal mummification and maceration: Fetal death in animals after conception prolongs the estrus cycle results into infertility. Aseptic form of fetal death (mummification) and septic condition (maceration) generally goes undiagnosed and confused with pregnancy resulting into infertility. On the other hand if spontaneous abortion occurs, the heavy economical burden to be imposed on the dairy farmers by reproductive disruption.

Postpartum Complications: The causes are many and can be complex.

Endometritis - Metritis - Pyometra complex: Specific or non specific infections cause the infertility due to the alterations of uterine environment. Varying degree of inflammation of various layers of uterus by damage of physical barriers and failure of natural defense mechanism may lead to the infection of genital tract. Physical damage of barriers is either due to damage of vulva which impairs the sphincter like barrier, aspiration of air, ballooning of vagina and vaginitis or damage of cervix predisposing factor for uterine infections. Progesterone dominance state of genital organs is more prone to infection. Endometritis is the inflammation of the endometrium, whereas metritis involves the entire thickness of the uterus. Pyometra is the accumulation of purulent exudates within the uterus. Postpartum uterine infections occur commonly sequelae to trauma, retention of fetal membranes leads to the establishment of infection. Unhygienic breeding during wrong time and site are the major cause of endometritis. Low grade uterine infection (endometritis) changed to moderate (metritis) and severe infection with pus (pyometra) temporary reduces fertility of the animals as one of the most complex disease to a large extent.

Ovulatory disturbances: Ovulatory failure and cyst formation are mostly related to high prolactin secretion associated with high yielders which suppress the release of luteinizing hormone (LH) resulting ovulatory defects. The incidence of delayed ovulation is 12-20% and 10-12% in cattle and buffalo, respectively. However, the incidence of anovulation ranges from 2 to 13% in cyclic and repeat breeder cows and buffaloes.

Ovarian acyclicity: Resumption of ovarian cyclicity after parturition is a critical component in attaining a higher fertility in dairy animals. Up to 50 per cent of modern dairy cows have abnormal estrous cycles postpartum resulting in increased calving to first insemination interval and decreased conception rates (Garnsworthy *et al.*, 2009). Production loss coupled with negative energy balance during lactation reduces functional competence of ovarian follicle responsive towards pulsatile LH stimulation resulting into delayed ovulation.

Repeat breeding: Repeat breeding is a syndrome in which female animal fail to conceive after 3-4 attempts by fertile bull or artificial insemination at normal or nearly normal estrous cycle. It is one of the poorly understood defined reproductive challenging and discoursing problems related to dairy animals. Fertilization failure or early embryonic death (EED) are the primary cause of repeat breeding that results from the hostile uterine environment produced by the invading microorganism during the critical period of pre-implantation stage. Mild ascending specific and non specific clinical and sub-clinical genital infections found to be closely associated with post-parturient form of repeat breeding.

Reproductive Management: Management is a very important factor to optimize reproductive efficiency. Nearly 70% of breeding problem arises due to improper manage mental practices and nutritional deficiencies of the animals. Management includes

Nutritional management: The interrelationship between nutrition and reproduction are amongst the most important and probably the least understood, of the factors that control the reproductive performance. Healthy nutrition is responsible for optimum fertility of the animals. The level of energy intake is more important for normal reproductive function. Low level of energy intake in adult animals causes failure of follicle to develop on maturity and follicular atresia along with a loss of sexual desire and anestrus. Similarly, quality and quantity of protein is important for reproductive functions. Present concept of chelated form of micro-minerals (manganese, cobalt, copper, iron, iodine and zinc) and macro-minerals availability is helpful to optimize reproductive functions. Vitamin A deficiency adversely affects reproduction and characterized by changes in the epithelial tissues such as keratinization and degeneration of placenta, fetal death, abortion, dystocia, retained placenta and septic metritis ultimately forms the basis of nutritional infertility. Vitamin E and selenium deficiency play a major role in higher incidence of metritis, ROP and cystic ovaries. Now a days area specific soil testing facilities are available and accordingly mineral mixture can be prepared and fed to the animals. Therefore improving and managing nutrition aspect in fertility management should be first choice rather than treatment.

Calving Interval: The calving interval (or index) is the sum of two components, the interval from the last calving date to the date of conception (a) and the length of gestation (b). Thus:

CI =a+ b.

Therefore:

CI = 85 days+ 280 clays= 365 clays.

The calving-conception interval (CCI) is calculated by counting the number of days from calving to the service that resulted in pregnancy (effective service); this is usually the last recorded service date. The CCI is a useful measurement of fertility but requires a positive diagnosis of pregnancy to be made. It is influenced by two factors: how soon after calving the cows are re-bred and how readily they become pregnant when they have been served. The CCI can be expressed thus:

Mean CCI = c + d,

where c is the mean calving to first se1vice interval and d is the mean first service to conception inter- val. The latter interval is due to the fact that on aver- age it will take 20 days after the first service for the cow to conceive or, put another way, approximately one oestrus interval will elapse, as the average cow will require approximately two services before preg- nancy is achieved. Therefore:

Mean CCI = 65 clays + 20 days = 85 days

Parameters to evaluate the reproductive efficiency

Index	**Target level**	**Interference level**
Mean calving to first service interval (days)	65	70
Mean calving to conception interval (days)	85	95
Mean interval of first service to conception (days)	20	25
Overall pregnancy rate (%)	58	50
First service conception rate (%)	60	50
Cows served that conceive (%)	95	90

Conclusions: Fertility over past few decades is of serious concern in the dairy industry. Fertility in dairy cows decreased over the past few decades as milk production per cow has increased. One of the greatest challenges for reproductive biologist, nutritionist and geneticist is to gain an understanding of the underlying biology that leads to low fertility and develop strategies to improve the fertility. Several approaches have been employed to augment fertility in infertile animals or to reduce the magnitude of high-production associated decline in fertility. Reproductive management is a multi-facet arrangement related to breeding as well as targeted nutritional aspects. Breeding can be started within three months after parturition to achieve the goal of one calf per year for economic and profitable dairy farming. Proper deworming schedule should be done to control the worm infestations to maintain regular cyclic reproductive health of the animals. A small investment in periodic deworming, vaccination, mineral supplementation with a well balanced diet with energy, protein, minerals and vitamin can bring greater gains in dairying. This helps in increased conception rate, healthy pregnancy, safe parturition, low incidence of infections and a healthy calf. So six "R" management concept i.e. right nutrition, right estrus detection, right A.I., right pregnancy diagnosis, right postpartum management and right semen (good quality) is the reproductive wheel in reproductive management of dairy animals.

References: References will be provided on request.

* * * * *

CHAPTER 7

ADVANCES IN DIAGNOSIS, THERAPEUTIC MANAGEMENT AND CONTROL OF HAEMOPROTOZOAN DISEASES IN LIVESTOCK

Dr S.K. Maiti
Professor and Head,
Department of Teaching Veterinary Clinical Complex
College of Veterinary Science and Animal Husbandry,
Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Anjora, Durg- 491001 (C.G.)

Abstract

Haemoprotozoan diseases are a great economic constraint to livestock production in terms of morbidity and mortality worldwide. Diagnosis of haemo-protozoan infection is a key to control these diseases. Routine diagnosis of haemo-protozoan infection has been largely based on clinical findings and identifying/ demonstrating the causative protozoa/ richettsia in the blood smear by parasitological techniques. Conventional techniques like microscopical and serological viz CFT, ELISA though provide definite clues about the parasitic infection in general, but these tests have also limitations. In this direction, the recently introduced molecular diagnostic techniques show highest specificity but their application is restricted to curricular research and advanced parasitological laboratory of research institutes. The use of DNA hybridization probes, although developed several years ago, could not find space in regular diagnostic laboratories and has now been superseded by polymerase chain reaction. The ability of PCR to detect parasite in blood, tissue or ticks with high level of sensitivity and specificity even in very mild and early infection and there is no use of radioactive elements are basic advantages of PCR. However, more accurate identification of a PCR product may require the use of specific nucleic acid probes. Further these techniques can also be exploited to identify subspecies also. However, recombinant antigens based ELISAs may be used for routine diagnosis in the field. Effective therapeutic approach for haemoprotozoan diseases includes specific treatment against particular haemoprotozoan parasite and supportive treatment based on pathophysiological changes in the affected animal. Control of these diseases aims to reduce incidence through an integrated approach like chemotherapy, chemoprophylaxis, vector control and vaccination for tropical theileriosis.

Key words: Babesiosis, tropical theileriosis , trypanosomsis, Anaplasmosis, ELISA, PCR

Introduction:

In today's scenario, livestock rearing has become complementary and supplementary business to agriculture.to achieve the goal of optimum or maximum production from livestock, it is mandatory to maintain healthy livestock by good management practices providing balanced diet and protection from diseases/conditions and systemic illness. Globally tick borne diseases (TBD) are major constraints on the profitable livestock production and productivity. Among all TBD, haemoprotozoan diseases especially babesiosis, tropical theileriosis, trypanosomosis and anaplasmosis are considered as great impediment to health and productive performance of cattle. These haemoprotozoan diseases have got a serious economic impact due to obvious reason of death, decreased productivity, lower working efficiency and cost of treatment and control measures. In India, annual economic loss to the livestock industry due to tropical theileriosis, babesiosis and trypanosomosis has been estimated to the tune of Rs 8426 crore, Rs 4000 crore and Rs 4474 core respectively (Bock *et al* ,2004; Kumar et al,2017,; Narladkar, 2018) .

So, the most important tick borne haemoprotozoan diseases are *Trypanosomosis caused* by *T. evansi, Tropical Theileriosis* caused by *Theileria annulata, Babesiosis caused by Babesia bovis, Babesia bigemina, Babesia ovis* etc, and anaplasmosis caused by *Anaplasma marginale, Anaplasma centrale*.

In India, babesiosisis one of the most commonly prevalent haemoprotozoan infection of different species of livestock in general and cattle and buffalo in particular (Saravanan *et al*., 2013). The *Babesia* sp is transmitted to the susceptible animal by one host tick *Boophilus microplus*. Transovarial route is the major mode of transmission within the tick. The infected female adult tick can spread the disease up to 32 generations. Important clinical findings in acute form of babesiosis are moderate to high fever, inappetence, depression, polypnoea, reduced milk yield in lactating animals, dark red to brown colour urine, reluctance to move and anaemia followed by jaundice .

Trypanosomiasis is another important haemoprotozoan infection of horses, camels, donkeys, cattle, buffaloes, wild animals and dogs (Tewari *et al*., 2013). The disease is commonly known as Surra in all animals except camels and in camel, the disease is known as Tibersa. Tabanidae flies (Horse flies and Deer flies) are the vectors, responsible for the spreading of the disease. Buffaloes may act as reservoirs for trypanosomiasis (Jaiswal *et al*., 2015). The disease occurs in all age groups of animals. The incidence of infection is more common during 1.5 to 2 months after rain, because more availability of rain water lodged breeding areas for disease spreading vectors. When the animals are under stress due to long transportation, hard work, overcrowding, malnutrition, inclement weather and other concurrent infections, the infection flare up and turns into active clinical form of infection. The acute form of the disease in bovine is manifested as high fever, lachrymation, corneal opacity, reduced milk yield, nervous signs and mortality often happens within 24 hours of onset of clinical signs. Chronic Surra is characterized by weight loss with loss of reproductive performance (Radostits *et al.*, 2007). In addition to economic losses, the disease also causes immune suppression in precious animals.

In India, the tropical theileriosis is one of the major hurdles in genetic improvement programme of Indian taurus cattle breed. *T. annulata*, is transmitted mainly by *Hyalomma anatolicum anatolicum* tick. The immature phase of tick usually feed on the animals, and nymphs and larvae can obtain the disease by feeding on the infected animal and transmit the disease to other animals following moulting, adults or nymphs while feeding on other animals. The incidence of disease has been found to be higher during late spring and early summer season (Vahora *et al*., 2012) due to availability of ticks on the host, which carries the organism. Other predisposing factors favouring the occurrence of disease are stress, adverse climate, concurrent disease, transportation and vaccination. The most commonly observed clinical signs in tropical theileriosis include fever, anorexia/inappetence, lymph node enlargement in more than 80% cases, anaemia , lacrymation in more than 50% cases.

The epizootiology of anaplasmosis is complicated by the life-long carrier state which occurs in animals that have recovered from the clinical disease. Spread from infected animal to healthy animal occurs mainly by insect vectors followed by arthropod tick vectors of which *Boophilus* sp has major significance in tropical and subtropical regions. In most cases, disease is sub acute, especially in young animals. However important clinical signs are intermittent fever, inappetence, gradual loss of body condition, anaemia.

Reduction in the losses due to tick borne haemoprotozoan diseases requires rapid, reliable and highly sensitive diagnostics tests, which can also serve to monitor the effectiveness of therapeutic and prophylactic measures.

The common conventional methods to diagnosing haemoprotozoan diseases are history, clinical signs, blood/tissue smears examination, post-mortem lesions and conventional serology. But they lack sensitivity, specificity, involvement of expertise, labour intensiveness etc, and cannot fulfil complete requirements. Sero-diagnosis cannot differentiate between current and past infection as animal may already have cleared pathogen, but remain seropositive. Nucleic acid-based diagnostics, particularly a wide range of DNA based techniques have been developed and validated for identification, characterization and pathogenic studies of various haemoprotozoan parasites. The polymerase chain reaction-based assay (PCR) allows identification of parasite at levels far below the detection limit of commonly used parasitological techniques. Control approaches for these diseases include chemotherapy, chemoprophylaxis, vector control and vaccines.

Conventional Diagnosis Techniques

Parasitological techniques (Blood smear examination)

The microscopic techniques for diagnosis of haemoprotozoan diseases are still considered as "gold standard" technique. Babesiosis is diagnosed by examination of blood or organ smears stained with Romanowsky stain. The direct method involves identifying the parasite in the stained blood smears; however, this technique shows a low sensitivity in subclinical and chronic phase of the infection (Terkawi*et al*., 2011). Blood film examination requires very much expertise to differentiate between *Babesia* species from one or more animal species which look similar under stained preparation. Quantitative buffy coat (QBC), an acridine orange based improved technique which concentrates and stains parasitized blood in one step may be of value in low parasitemia.

In case of tropical theileriosis, microscopic examination of stained blood smear shows piroplasms alone or along with schizonts and *Theileria* schizonts in the lymph node aspiration smears. It is also quite difficult, to demonstrate parasites in carrier animals as the numbers of parasites in such animals fall below detectable levels soon after the acute stages of the disease (de Waal, 2012).

In case of Trypanosomiasis, conventional parasitological techniques (CPT) followed in India include wet blood film, stained thin and thick blood smears. Demonstration of trypanosomes in blood is the only true gold standard and the most commonly adopted diagnostic technique used in the laboratory. The giemsa-stained thin blood smears have a low sensitivity equivalent to 10^5 trypanosomes per ml. More than 50 to 80 % of the infections are cryptic and undetectable by direct microscopy. So, CPT cannot be relied upon for diagnosis and chemotherapy. The diagnostic capability could be significantly improved by adopting simple low-cost alternative, the Haematocrit Centrifugation Technique (HCT) that has sensitivity equivalent to 85 trypanosomes/ml (Reid *et al*. 2001). Furthermore, the sensitivity of parasite detection can be enhanced by using buffy coat. The miniature anion-exchange centrifugation technique is considered as more sensitive method for detecting trypanosomes in the blood (Reid *et al*. 2001). Mouse inoculation (MI) test using buffy coat is accepted as the most sensitive method to detect trypanosomosis in subclinical infection.

The most commonly used method for diagnosis of *Anaplasma* infection in clinical case is the microscopic examination of Giemsa-stained thin blood smears but disadvantages are to detect parasite in low parasitemia in carrier cattle and difficulty to differentiate *Anaplasma* from other structures. Sub inoculation of *A. marginale* infected erythrocytes into susceptible splenectomized calves has been considered as the 'gold standard' for detection of such cattle, but it is not practical for routine testing.

Indirect Diagnostic Methods:

In subclinical cases, when degree of parasitaemia is very low, in those cases indirect diagnostic methods i.e serological tests which either detect antibodies or antigens are used. Among the various serological tests, most important tests are complement fixation test (CFT), indirect fluorescent antibody technique (IFAT) and enzyme-linked immunosorbent assay (ELISA).

CFT: CFT has been used for diagnosis of *Babesia*, *Theileria*, *Toxoplasma*, and *Trypanosoma*, infection in the past. Based on this test, a commercial kit (COFEB Kit) has been developed by NRCE for diagnosis of equine piroplasmosis (Sengupta, 2001).

IFAT: Indirect fluorescent antibody technique has been used for the diagnosis of parasites like *Babesia* sp, *Trypanosoma* sp and *Theileria*sp. IFA test is one of the OIE recommended test for the diagnosis of theileriosis and Trypanosomiosis.

ELISA: Now ELISA is being used most frequently for detecting parasite-specific antibodies, antigens and immune complexes (Kachani*et al*., 1992). On the other hand, ELISA based on piroplasm antigen has also been used for diagnosis of *Theileria* spp. in sheep in experimental cases but it showed cross reaction with *B. ovis* (Gao *et al*., 2002). An advance in serological diagnosis was achieved with the development of a competitive ELISA applying the TaSP antigen and using a monoclonal antibody (1C7) that was found to bind to TaSP antigen (Renneker *et al*., 2008). ELISA is widely used as the basis for epidemiological surveys and for evaluation of vaccination programme. Antigen based ELISA are useful in detection of current infections, while antibody-based ELISA and CATT (Card agglutination trypanosomal test) are useful for sero-epidemiology of cattle, buffalo and camels (Salih *et al*., 2015).

Nucleic Acid-Based Techniques

Molecular nucleic acid-based diagnostic techniques have been proved to be sensitive, easy to use, can analyze large number of samples and can detect the parasites directly in clinical and environmental samples without culture (Dey and Singh, 2009). The first introduced diagnostics was nucleic acid hybridization technique, however, in the recent years, PCR and allied techniques along with genomic sequencing have superseded it. Various molecular diagnostic techniques that have been developed for diagnosis of haemoparasites include conventional PCR, PCR-Restriction Fragment Length Polymorphism, multiplex-PCR, real-time PCR, reverse transcriptase PCR, PCR-ELISA, micro-arrays, loop mediated isothermal amplification (LAMP), etc (Kaur *et al*., 2012).

Treatment, Prevention and Control:

Chemotherapy

Effective therapeutic management of haemoprotozoan diseases mainly depend on specific chemotherapy and supportive treatment. Currently available drugs for treatment of trypanosomosis in India are diminazene aceturate (berenil), quinapyramine sulphate and chloride (curative and/ or preventive), isometamedium chloride (both curative and preventive) and cymelarsan (for curative treatment of camels), Diminazene aceturate is the most widely used drug in ruminants followed by isometamedium chloride and quinapyramine. It's use in horses and dogs is limited due to poor efficacy and tolerance. Diminazene aceturate and isometamedium chloride constitute an 'sanative pair 'that means once resistance develops to one of the drugs, another drug can be used to control the infection. Melarosomine dihydrochloride (cymelarsan) is the latest trypanocide used to control infection at a dose rate of 0.25, 0.25-0.5, 0.5, 0.75 mg/kg bwt in camel, horse, cattle and buffalo respectively. Joshi and Singh (2000) in their study on comparative evaluation of suramin, quinapyramine, diminazene and isometamedium against clinical *T. evansi* infection in buffaloes indicated that therapeutically all the four drugs were effective. Recently Hota *et al* (2019) also reported that quinapyramine, and isometamedium were equally effective in the treatment of clinical *T. evansi* infection in cattle.

A study has shown that simultaneous administration of Difluoromethylornithine (DFMO), newly introduced human trypanocide by IV and single dose of diminazene (7mg/kg bwt) achieved higher chemotherapeutic level and there was no relapse. Antioxidant (tochopherol and se , ascorbic acid) supplementation following diminazene injection showed superiority over diminazene alone in reversing pathological condition caused by trypanosome infection (Eghianruwa and Olayinka,2018).

For chemotherapy of babesiosis, three babesiacides viz.quinuronium sulphate, amicarbalide isothionate and diminazene acuturate were available in most European countries, whereas only diminazene is available in India. It works rapidly against *B. bovis, B. bigemina* at a dose rate of 3.5 to 7 mg/kg bwt.

Parvaquone and Buparvaquone, are the two important chemotherapeutic agents for tropical theileriosis. Buparvaquone, a second-generation hydroxynaphthoquinone related to parvaquone, is more effective in the treatment natural infections of *T. annulate* in cattle and buffalo. The attenuated schizont vaccine of *T.* annulate under the trade name of "Raksha Vac-T" is meant for prevention of tropical theileriosis caused in cross bred and exotic cattle. Immunized cattle remain immune for 3 years and require revaccination in every 3 years when maintained in tick free condition. The prophylactic use of Raksha vac –T and chemotherapy with buparvaquone could be the most promising way to control tropical theileriosis.

All *Anaplasma spp* infection in cattle in early stage can be treated with tetracycline at a dose rate of 6-10 mg/bwt. However chronic infection can be treated with long acting Oxytetracycline at a dose of 20 mg/kg body weight at least two injections at 7 days intervals. Imidocarb is highly effective against *A.marginale* infection at a dose of 1.5 mg/kg bwt. Presently there are two commercially available vaccine for anaplasmosis in United States. Anaplaz is first vaccine for anaplasmosis produced for cattle in USA. Very Recently Plazvax vaccine is in market. Both are killed vaccines, two injections at 4-6 wk apart with annual booster are recommended.

The control measure for TBDs has been focused on the diagnosis and treatment of the disease and development of a suitable prophylaxis system for protection against the disease. Besides, prompt diagnosis and treatment of diseased animal, for control of diseases the main emphasis should be focused towards control of tick vectors and chemoprophylaxix wherever possible.

Control of ticks

The four classes of chemical acaricides which are the mainstay for tick control programme in India are organophosphates, pyrethroids, formamidines and macrocyclic lactones. Organophosphates and pyrethroids have been widely used all over the country. Presently formamidines like amitraz and macrocylic lactones like ivermectin are in use due to the inefficiency of OP and SP acaricides to control tick infestations. The potential problem associated with use of acaricides is the environmental contamination and the contamination of milk and meat products with chemical residues. Globally, there have been frequent reports of acaricide resistance in ticks. Cases of *R. (B.) microplus* developing resistance to organophosphates and synthetic pyrethroids are well-documented. Till now, acaricide resistance in India was not well-documented even though possibility of widespread resistance was reported in a FAO questionnaire survey. The development of resistance against OP and SP acaricides has resulted use of formamidines (amitraz) and macrocyclic lactones (ivermectin) by the farmers.

Tick vaccine

As vector control through chemicals has many drawbacks and so development of vaccine against vector is considered as one of the important options. Vaccination is a cost-effective, environment friendly that allows control of several VBDs by targeting their common vectors. Two recombinant vaccines (GavacTM and TickGARDPLUS) against *R. (B.) microplus* are available commercially (Willadsen, 2008).

Phytoacaricides

To address the problems associated with the application of chemical acaricides, focus has been directed towards the development of herbal acaricides (Phyto acaricides) which are safe for animal use and there will be less chance of development of resistance to herbal formulations. The advantages of Phyto acaricides lie in their rapid degradation and lack of persistence and bioaccumulation in the environment, which have been the major problems in synthetic chemical use. Acaricidal activity of essential oils from leaves and flowers of *Ageratum houstonianum*, *Origanum onites*and *O. minutiflorum*against *R. (B.) annulatus* and *R. turanicus* have been reported by Cetin *et al.*, 2009. Recently, IVRI and NBRI, Lucknow have developed an ecofriendly herbal acaricides to control ticks and mite infesting livestock and pets.

Conclusion:

Confirmatory diagnosis of etiological agent is the most important key to control haemoprotozoan diseases. Though microscopical detection techniques are cheapest for diagnosis of haemoprotozoan diseases but the methods lack sensitivity and specificity. Immunological diagnosis provides quick and better results than routine methods. Serological tests are commonly used for diagnosis of haemoprozoan diseases by detecting circulating antibodies. But many times, particularly in carrier cases though parasites persist, test may give negative result. Sometime, parasites are not present but test gives positive result in recovery cases. Therefore, traditional test have been replaced by molecular techniques. Nucleic acid based diagnostic tests are very sensitive and specific. Various types of PCR are useful for species specific diagnosis and even, study of molecular epidemiology of parasites. These diagnostic tools would help in detecting carrier animals in endemic area. So, an integrated approach for control of haemoprotozoan diseases should be based on early diagnosis by advanced diagnostic techniques, treatment of sick animals by efficient chemotherapeutic agent, identification of endemic area, application of chemoprophylactics, vector control and vaccination against tropical theileriosis.

References:

Cetin, H., Cilek, J.E., Aydin, L. and Yanikoglu, A. (2009) Acaricidal effects of the essential oil of *Origanum minutiflorum* (Lamiaceae) against *Rhipicephalus truancies* (Acari: Ixodidae). *Vet Parasitol.* 160 (3–4): 359–61.

de Waal, T. (2012). Advances in diagnosis of protozoan diseases. *Vet. Parasitol*. 189:65-74.

Dey, A. and Singh, S. (2009). Progress of science from microscopy to microarrays (Part 1): Diagnosis of parasitic diseases. *J. Lab. Phys*. 1: 2-6.

Eghianruwa, K.I and Olayinka,A Oridupa (2018).Chemotherapeutic control of trypanosomosis – a review of past measure , current status and future trends .Veterinarski Ariv. 88(2):245-270.

Gao, Y.L., Yin, H., Luo, J.X., Ouyang, W.Q., Boa, H.M., Guan, G.Q., Zhang, Q.C., Lu, W.S. and Ma, L.M. (2002). Development of enzyme-linked immunosorbent assay for the diagnosis of *Theileria*sp. infection in sheep. *Parasitol. Res*. 88:s8-s10.

Hota Abhisek, Maiti, S.K, Ghosh, R,C and Mukherjee .K., (2019) Therapeutic efficacy of isometamidium chloride in trypanosomiasis affected cattle J. Entomol Zoolol Studies . 7(3) : 1622-1626.

Hota Abhisek, Maiti, S.K, and Ghosh, R,C (2019) Therapeutic efficacy of quinapyramine compounds in T *evansi* affected cattle .*Pharma Innovation* . 8(9) : 467-471.

Jaiswal, A.K., Vikrant, S., Neha and Verma, A.K. (2015) Insight into Trypanosomiasis in Animals: Various Approaches for its Diagnosis, Treatment and Control: A Review. *Asian J. Anim.* Sci. 9: 172-186.

Joshi, S.S. and Singh,B.(2000).Evaluation of therapeutic and chemoprophylactic efficacy of certain drugs against clinical surra in buffaloes. Indian Vet J.77: 895-897.

Kachani, M., Oliver, R.A., Brown, C.G.D., Ouhelli, H. and Spooner, R.L. (1992). Common and stage-specific antigens of *Theileria annulata*. *Vet. Immunol. Immunopathol.*34:221-234.

Kaur, P., Sharma, A., Singla, L.D. and Juyal, P.D. (2012). Molecular detection of anaplasmosis and babesiosis by duplex PCR in cattle. *Crop Improv.* 1395-1396.

Kumar, V., Kaur, P., Wadhawan, V.M., Pal, H., Sharma, H. and Kumar, P. (2015) Theileriosis in cattle: prevalence and seasonal incidence in Jalandhar district of Punjab (India). *International J. Recent Scientific Res* .6: 2998-2999.

Radostits, O.M., Gay, C.C., Hinchcliff, K.W. and Constable, P.D. (2007) Veterinary Medicine. Text book of the diseases of cattle, sheep, pig and goats, 10th Edn. Saunders Elsevier publication, Philadelphia, USA. pp: 1537-1538.

Reid S.A., Husein A. and Copeman, D.B. (2001) Evaluation and improvement of parasitological tests for *Trypanosoma evansi* infection. *Vet. Parasitol*. 102: 291-297.

Renneker, S., Kullmann, B., Gerber, S., Dobschanski, J., Bakheit, M.A., Geysen, D., Sheils, B., Tait, A., Ahmed, J.S. and Seitzer, U. (2008) Development of a Competitive ELISA for Detection of *Theileria annulata* Infection. *Transbound. Emerg. Dis*, 55: 249-256.

Salih, D.A., Hussein, A.M.E. and Singla, L.D. (2015) Diagnostic approaches for tick-borne haemoparasitic diseases in livestock. *J. Vet. Med. Anim. Health*, 7:45-56.

Saravanan, B.C., Das, S., Siju, S.J., Tewari, A.K., Sankar, M., Kataktalware, M.A. and Ramesha, K.P. (2013) *Babesia bigemina* infection in yak (Poephagusgrunniens L.): molecular detection and characterization. *Vet. Parasitol.* 194: 58-64.

Sengupta, P.P. (2001). Complement fixation test based COFEB- kit for the diagnosis of *Babesia equi* infection in equines. Patent application No. 36/DEL/2001, dt. 19.01.2001). Patent related to COFEB kit (56/DEL/2004)

Sharma, A., Singla, L.D., Tuli, A., Kaur, P., Batth, B.K., Javed, M. andJuyal, P.D. (2013). Molecular prevalence of *Babesia bigemina* and *Trypanosoma evansi* in dairy animals from Punjab, India by duplex PCR: A step forward to detection and management of concurrent latent infections. *Biomed Res. Int.* Article ID 893862:8 p

Terkawi, M.A., Thekisoe, O.M., Katsande, C., Latiff, A.A., Mans, B.J., Matthee, O., Mkize, N., Mabogoane, N., Marais, F., Yokoyama, N., Xuan, X. and Igarashi, I. (2011). Serological survey of *Babesia bovis* and *Babesia bigemina* in cattle in South Africa. *Vet. Parasitol.*182:337-342.

Tewari, A.K., Saravanan, B.C., Sudan, V., Maharana, B.R. and Sudhakar, N,R, (2013) Trypanosomosis caused by *T. evansi*: An insight. Livestock Management Product *Technology and Health* pp: 409411.

Willadsen, P. (2008) Anti-tick vaccines. In: Bowman AS, Nuttall Patricia A, editors. *Ticks: Biology, disease and control.* Cambridge: Cambridge University Press; p. 424–46.

* * * * *

CHAPTER 8

NUTRIONAL INTERVENTION IN DAIRY CATTLE DURING TRANSITION PERIOD

Dr Kiran Kumari[1] and Dr. M. K. Gendley [2]

1. Assistant Professor, Instructional Livestock Farm Complex Department,
2. Associate Professor, Department of Animal Nutrition

College of Veterinary Science and A.H., Anjora, Durg

Introduction

The three weeks before and the three weeks after calving is an important and weak period for the dairy cow. Cow metabolism during this period needs to increase dramatically, and how she copes with this high-energy transition period will impact how well she performs during the rest of the lactation cycle. This is why having a good transition cow management program is crucial for a successful dairy operation. The transition cow period is critical period to health, production and fertility. An optimal transition program can increase milk yield by 273 - 682kg /cow/lactation. Dairy managers should focus on this critical 50-70 days' period.

Goals of feeding are to help in involution of mammary gland, provide added nutrients to meet needs of the conceptus (fetus), adjust BCS, if needed, stimulate the cow immunity, stimulate rumen microflora and rumen papillae, minimize metabolic disorders, reduce udder edema especially in heifers etc.

Transition cow biology and management has become a focal point for research in nutrition and physiology during the past 15 yr. First, it was recognized that many of the metabolic disorders afflicting cows during the peri- parturient period are interrelated in their occurrence and are related to the diet fed during the prepartum period (Curtis et al., 1985). Although the strategy for prevention of milk fever was to feed a prepartum diet low in Ca at that time, Ca content of the prepartum diet was not related to the occurrence of milk. Despite the prodigious output of research on the nutrition and physiology of transition cows, the transition period remains a problematic area on many dairy farms, and metabolic disorders continue to occur at economically important rates on commercial dairy farms (Burhans et al., 2003).

Estimates of the demand for glucose, AA, fatty acids, and net energy by the gravid uterus at 250 d of gestation and the lactating mammary gland at 4 d postpartum indicate approximately a tripling of demand for glucose, a doubling of demand for AA, and approximately a fivefold increase in demand for fatty acids during this time frame.

Nutritional metabolism during transition period and its management

Glucose metabolism

The primary homoeothermic adaptation of glucose metabolism to lactation is the concurrent **increase in hepatic gluconeogenesis** and decrease in oxidation of glucose by peripheral tissues to direct glucose to the mammary gland for lactose synthesis. The maximal calculated contribution of propionate to net glucose release by liver ranged from approximately 50 to 60% during the transition period; that for lactate ranged from 15 to 20%; and that for glycerol ranged from 2 to 4%. Excess protein or asynchronous supply of ruminal N relative to carbohydrate supply may increase the ammonia load on the animal, and thereby affect the capacity of a triglyceride-laden liver to synthesize glucose.It has been proposed that dietary fat may help to decrease concentrations of NEFA and help to prevent occurrence of ketosis (Kronfeld, 1982).

Calcium metabolism

Calcium pools are under strict homeostatic control, whereas the P pool is less regulated.

- Calcitonin is secreted by the thyroid gland in response to elevated serum Ca and results in increased bone mineral deposition, decreased intestinal absorption, and increased urinary Ca excretion.
- A diet containing containing 1.54 to 1.62 Mcal/kg of NEL be fed during the last 3 wk preceding approximately 1.25 Mcal/kg of NE_L be fed from dry off until approximately 21 d before calving, and that a diet parturition.
- Calcium mobilization in support of lactation can be facilitated effectively by lowering the DCAD (Dietary Cataion Anion Difference) of the diet fed during the prepartum period.

Carbohydrate formulation of the prepartum diet

- The high NFC diet should contain 1.59 Mcal/kg of NE_L, 40% NFC, and 28% starch; the high non forage fiber sources diet contain 1.54 Mcal/kg of NE_L, 34% NFC, and 18% starch.
- Propylene glycol is a glucogenic precursor that has been used for many years as an oral drench in the treatment of ketosis.
- Available studies consistently demonstrate decreased concentrations of NEFA in plasma and usually demonstrate decreased concentrations of BHBA in plasma in response to propylene glycol administered as an oral drench.
- Incorporation of propylene glycol into the TMR did not affect concentrations of NEFA and BHBA in plasma.

Supplementation of fat in transition diets

- This fat can provide energy for peripheral tissues and the mammary gland indicating that added fat fed to cows during the prepartum period does not decrease plasma NEFA concentrations.

- Recent evidence suggests that supplying specific nutrients to dairy cows during the transition period may increase rates of NEFA disposal, with resulting effects on performance.
- Choline is a quasi-vitamin that has a variety of functions in mammalian metabolism. Most of the potential application of choline within transition cow nutrition has focused on its role in lipid metabolism because phosphatidylcholine is required for synthesis and release of VLDL by liver.
- Linoleic and linolenic acids are considered to be essential in many species. Linolenic acid is a precursor to both docosahexaenoic and eicosapentaenoic acids—collectively, these fatty acids may have roles important for the secretion of apolipoprotein B100 and also for VLDL particle stability

Supplementation of Amino acids in transition diets

- Methionine and Lys are frequently considered to be the 2 most limiting AA for synthesis of milk and milk protein
- These 2 AA also have potential roles in mitochondrial B-oxidation of fatty acids (carnitine biosynthesis) in liver and export of triglycerides as VLDL.

Table 1. Daily feed requirement of a pregnant animal

S.No.	**Feed stuff**	**Quantity (Kg)**
1	Green Fodder	15-20kg
2	Dry Fodder	4-5kg
3	Compound cattle feed	2-3kg
4	Oil cake	1kg
5	Mineral mixture	50g
6	Salt	30g

Three periods of nutrient requirement

Period 1 (Challenge Period):

- Cow is challenged to produce more milk by increasing concentrates in diet until milk production no longer increases.
- Start 2 weeks before expected date: increase 0.5 kg concentrate/ day
- Increased 300-400 g daily until cow is consuming 500-1000 g conc. for every 100 kg b.wt.
- After calving, concentrate should be increased by 500 g/day (first 2 weeks of lactation) until cow achieves peak yield in 2^{nd} month of lactation (free choice basis).

Period 2 (Mid and late lactation period):

- Cow should be fed well balanced ration of good quality fodder & concentrate acc. to milk yield & fat % of milk.

Period 3 (Dry Phase):

- Milking halted: about 45 to 50 days before calving.
- Dry off a cow by: withdraw all grain, reduce water supply (several days before start of dry period)
- Changes in mammary gland: influence mammary cell proliferation and mammary function.
- Pregnancy allowances: 1-2 kg/day
- Heifers & young cows: 2-2.5 kg/day.

Table 2: Nutrient composition and feed formulation of concentrate mixture for transition periods

Sr.No.	Ingredients	Quantity for 100 kg	CP%	TDN%
1.	Maize	30	10	78
2.	GNC	5	40	75
3.	Soybean	5	41.6	75
4.	Green gram chuni	10	18.8	56.2
5.	RP	5	12	78.5
6.	Wheat bran	40	14	65
7.	Lime stone	2	-	-
8.	Mineral Mixture	1	-	-
9.	Salt	2	-	-
	Total	100	14.76	66.27

Conclusions

Overall, nutritional management schemes for dry cows to minimize overfeeding during the early dry period and to increase energy supply to dairy cows during the late prepartum period should be the efficient management strategy to deal the transitional period implications.

References

Burhans, W. S., A. W. Bell, R. Nadeau, and J. R. Knapp. 2003. Factors associated with transition cow ketosis incidence in selected New England herds. J. Dairy Sci. 86(Suppl. 1):247. (Abstr.)

Curtis, C. R., H. N. Erb, C. H. Sniffen, R. D. Smith, and D. S. Kronfeld. 1985. Path analysis of dry period nutrition, postpartum metabolic and reproductive disorders, and mastitis in Holstein cows. J. Dairy Sci. 68:2347–2360.

Kronfeld, D. S. 1982. Major metabolic determinants of milk volume, mammary efficiency, and spontaneous ketosis in dairy cows. J. Dairy Sci. 65:2204–2212.

* * * * *

CHAPTER 9

APPROACHES FOR DIAGNOSTIC AND THERAPEUTIC MANAGEMENT OF PRIMARY RUMINAL DISORDERS IN DAIRY ANIMALS

Dr. H. K. Ratre
Assistant Professor, T.V.C.C.
College of Veterinary Science & A.H., Anjora, (DSVCKV Durg)

Evaluation of forestomach motility is an integral part of the clinical examination and differentiation of forestomach abnormilities in to primary and secondary causes and its essential for diagnsosis and accurate therapty. Application of the knowlefge of the physiology of normal reticulorumen motility can improve the diagnosis, prognoisis and therapy for the disease of the forestomach.

Rumen Overload or Metabolic Acidosis

Rumen Overload in feedlot cattle has gained attention because of its economic impact. Economics of feedlot beef production dictate that cattle must gain weight at their maximum potential rate; this involves getting them quickly onto a full feed of a diet containing a high concentration of grain. Economics also favour processing of grain by available methods to increase the digestibility of starch. All of these factors set the stage for grain overload in feedlot cattle [1, 2]. In fact, digestive disorders, including ruminal acidosis, are second only to respiratory diseases in depressing animal performance and production efficiency [3]. However, there is still a lack of data from the field and,moreover, of uniformity in definition, and clinical diagnosis terminology varies and different descriptions of the disease are made [4]. Therefore, it appears to be useful to review the literature on this topic. This paper provides an overview of research of this digestive disease in beef cattle, with different preventive measures and nutritional alternatives.

Ruminal acidosis is frequently defined as a decrease in the ruminal pH. But the question is whether this condition is a disease or not. So, many researchers recognized that acidosis is not one disease, but rather a continuum of degrees of ruminal acidity, because nonphysiological accumulation of organic acids and consequent reduction in pH below the normalhave a significant impact onmicrobial activity, rumen function, and animal productivity and health [5]. Accordingly, it may be better to define ruminal acidosis as a fermentation disorder in the rumen characterized by a lower than normal ruminal pH, but reflecting an imbalance between microbial production, microbial utilization, and ruminal absorption of volatile fatty acids (VFA) [6]. Some 30% to 50%of the acid in the rumen is neutralized by salivary buffers or bound to ammonia generated from urea entering across the ruminal wall. A smaller quantity passes on into the lower gastrointestinal tract [7, 8].However, even the most conservative estimates leave a significant proportion of about 30–50% of the acid that is ruminally produced and that has to be absorbed by the ruminal wall, and one of the most important reasons for the appearance of ruminal acidosis would be a decrease in the absorptive capacity of the rumen which is thus unable to maintain a stable pH. Absorption of VFA, by removing unionized acid and by the exchange of ionized VFA for bicarbonate during the absorption process, aids in maintaining pH near neutrality. Consequently, a reduced rate of VFAabsorption causes ruminal pH to drop for two reasons: ruminal VFA accumulate and bicarbonate input from the blood stream is decreased [1]. The severity of acidosis allows us to classify ruminal acidosis considering different factors, among others, like ruminal pH threshold, predominant acid (VFA or lactic), and ruminal population bacteria, in two forms: acute and sub-acute acidosis.

In a brief summary, and starting with clinical signs, in acute forms symptoms will appear in the animal, more or less noticeable, and will be absent in a subacute form. Taking into account ruminal parameters, ruminal pH will be low in acute form, and this fact will imply an important difference in bacterial species, with gram negative bacteria appearing, with lactate consumers bacteria, and high amount of VFA. Meanwhile, in an acute form, we will find gram positive ,bacteria, with lactate producer bacteria, like *Streptococcus bovis* or even, in ruminal pH below than 4.8, *Lactobacillus* spp. In this severe form, with pH next to isoelectric point of lactic acid (around 3.8), we will find metabolic acidosis, with a decrease in blood pH and blood bicarbonate, increasingthe amount of serum lactate and decreasing the presence of lactate in the rumen. In conclusion, we can define *acute ruminal acidosis* as a metabolic status defined by a decrease in blood pH, parallel to blood bicarbonate decrease, which is caused by a D-lactic ruminal overproduction.

An important difference between both molecules gives reference to its particular metabolization and elimination. So, L-lactate is quickly metabolized in the liver, by *L-lactic dehydrogenase* (EC 1.1.1.27), to pyruvate, which will be turned into glucose through the gluconeogenesis. In relation to Dlactate, this molecule is metabolized by *D-α-hydroxy acid dehydrogenase* (EC 1.1.99.6) and by *D-lactate dehydrogenase* (EC 1.1.1.28); the latter is able to convert pyruvate to Dlactate. Another important difference between them is their renal excretion capacity, higher for L-lactate, at least at the beginning, although both enantiomers share the same zone for renal excretion. When serum value of D-lactate is increased, it will increase their excretion ratio, exchanging with L-lactate [8].

In cows, lactic acidosis has been related to different diseases in young calves (suckling calves or growing calves) and in mature cows. In the latter, acid is produced in rumen or in gastrointestinal system, like humans, because they contain the same transporter, called *proton-dependent monocarboxylate*; members of the SLC16Afamily are proton-linked transporters that play a crucial role in cellular metabolism. These isoforms differ in terms of tissue distribution, substrate specifics, and affinities with only four isoforms (MCT1-4) characterized as proton-dependent monocarboxylate transporters, being the most important for D-lactate two isoforms (MCT-1 and MCT-2), especially isoform 1, from intestine to the bloodstream, allowing the acid metabolization in the cytosol of the liver or heart cells. Some similar processes with high levels of D-lactate have been described in other animals, like cats with pancreatic failure, kids (floppy kid syndrome), or lambs (drunken lamb syndrome) and even humans (shortbowel syndrome, colorectal cancer).

There are three main groups of reasons that, isolated from combining, can produce ruminal acidosis.

In the last year, new focus has been directed towards the feeding behaviour, due to the fact that dry matter intake determines the acid production, and the chewing activity determines the buffer capacity, and both, together, determine the ruminal pH. But it is important to remark that susceptibility to suffer from this problem is individual, so animals in the same barn will not necessarily suffer from the same probability of developing this problem, possibly related to hierarchy or dominance patterns. Calsamiglia et al. [9] coined the name of *concentrate syndrome* for this problem because this process is related to two different facts: (i) decrease in ruminal pH and (ii) changes in the ruminal microbiota population and both are responsible for the process, in a combined way. This point of view is very interesting in order to apply some preventive measures, as we will see later.

An interesting fact was pointed out in other studies [10] talking about nutritional synchrony, which presumes that the diet is the major determinant of the quantity and quality of nutrients supplied to the rumen microbial population and to the animal. In reality, multiple ruminal and endogenous pools determine nutrient availability to the rumen and animal.

Factors like immune status, damage to tissue function, and the animal's own metabolic fluctuations may alter response to the diet. The risk for acidosis is not equal for all animals, and, presumably, it is related to the combined effects of level of feed intake, eating rate, sorting of feed, salivation rate, the inherent ruminalmicrobial population, previous exposure to acidosis, rate of passage of feed from the rumen, and other aspects of physiology and behavior [11].

After the consumption of a high grain diet, nonstructural carbohydrates will arrive to the rumen (physiological process), promoting their fermentation by amylolytic bacteria, producing pyruvate and finally volatile fatty acids (VFA), dissociating, and producing a drop in ruminal pH. This drop implies that many gram (−) bacteria disappear, including lactate-consuming bacteria, like *Megasphaera elsdenii* and *Selenomonas ruminantium* (convert lactate to pyruvate), because they are sensitive to pH. Conversely, there is an increase in the population of some gram (+) bacteria, especially Streptococcus bovis, known as a lactate-producing bacteria; thereby promoting a second ruminal bacterial population change, due to a new drop in ruminal pH, derived from increase in L-lactic acid, which is a very potent acid (10 times stronger than VFA), and this property contributes further to the decline in ruminal pH, growing only bacterial pH resistance, like *Lactobacilli* spp., great lactate producer bacteria, especially for D-lactate, which will conduct a new drop of ruminal pH, up to 3.8, an isoelectric point for this acid, and, in this moment, acid will be undissociated, crossing the ruminal wall to the bloodstream and provoking a metabolic acidosis.

Clinical Findings

The onset of the clinical signs associated with ruminal acidosis will depend on the clinical form, varying from sudden death in peracute course to a light feed depression in subacute way. It is normal to talk about the relationship between ruminal acidosis and ruminal hypotony or even atony, producing this last one by some different, and not excluded, mechanism.

(1) Direct action of the VFA is one of the most important mechanisms to consider, since chemical receptors in the epithelium send a feedback signal to the brain to reduce ruminal motility. When VFA contacts with them, signal will be sent to the central nervous system, promoting ruminal atony [7].

(2) Another mechanism to promote the rumen hypomotility is related to the increase in the osmolality in the ruminal content, produced by the accumulation of organic acids and glucose increasing the osmotic pressure inside the rumen, which implies a water flux from the bloodstream across the rumen wall, sometimes producing a *hydrorumen*.

As a consequence of *hydrorumen*, animal will show a decrease in packed cellular volume, with haemoconcentration and sometimes polyuria, with the animal feeling dehydrated. Taking into account an abnormal composition of the ruminal juice, animal may show diarrhea, which will complicate the hydroelectrolytic balance of the animal. Considering that the structure and consistency of the faeces depend on rumination, activity of the ruminal flora and ruminal passage, the animal will show some changes in colour, odour, pH, and consistency, and even whole cereal grains may be present. The impaired ruminal function in terms of rumination, bacterial breakdown, and passage leads to the alteration in faecal aspects [4, 12].

(3) The third mechanism involved in this hypomotility is the role of the different vasoactive substances, such as histamine, tyramine, and tryptamine, which are produced in the rumen by decarboxylation of histidine, tyrosine, and tryptophan, respectively. Bacterial endotoxins have been related to the decrease in rumen motility although the exact mechanism remains unclear [4, 12].

The growth of ruminal epithelium has been shown to be directly linked to the nonstructural carbohydrates presence in the tissue. Propionic and butyric acid are promoting the growth of the ruminal papillae, thus providing a higher absorption fromthe rumen by themucosa, but, in a lowruminal pH, with excessive amount of VFA, will lead to a parakeratosis of the ruminal epithelium, and this parakeratosis will lead to rumenitis, particularly the presence of microabscesses within the ruminal mucosa, favouring to incorporate with the bloodstream of the different ruminal bacteria, especially among others, with *Fusobacterium necrophorum* and *Arcanobacterium pyogenes*, colonizing the liver tissue and from there spreading to other organs like kidneys, heart, and lungs [13, 14] and promoting the *parakeratosis-rumenitis liver abscesses complex* [13]. One important complication is that, as a consequence of the ruminal mucosae destruction, many anaerobic bacteria will be able to cross the ruminal wall, incorporating with the bloodstream and favouring infections like pneumonia, pyelonephritis, and typical endocarditis.

Another symptom is that the animal would develop polioencephalomalacia, produced by a B1 vitamin or thiamine deficit. The bacteria in the rumen normally create this vitamin, so cattle do not normally need it in feed. So, thiamine inadequacy can be caused by decreased production by rumen microbes or factors that interfere with the action of thiamineIt is important to point out that many of the neurologic signs are not promoted by thiamine deficit, because the serum D-lactic acid increase allows it to cross the blood-brain barrier by monocarboxylate protons transporters. The majority of neurological disturbances (i.e., ataxia and depressed menace, palpebral, and tactile reflexes) are related to D-lactate accumulation in cerebrospinal fluids rather than in blood [15]. One clinical sign regularly mentioned to be associated with ruminal acidosis is laminitis [4], or *pododermatitis aseptica diffusa*, which is an aseptic inflammation of the dermal layers inside the foot. Finally, as a consequence of the metabolic acidosis, animal could show symptoms like hyperventilation and signs derived from compensatory hyperkalemia. Note that hyperkalemia could develop from itself ventricular fibrillation or cardiac arrest, producing the death of the animal in some circumstances.

Blood analysis will show a leukocytosis with neutrophilia, derived from stress, and anemia and decrease in the packed cell volume, due to ruminal ulcers and hyporexia. In acid-base parameters, blood pH, base excess, and bicarbonate will be low, with an increase in anion gap, because lactate will act as an unmeasurable anion, decreasing measurable anion, in this case bicarbonate, in order to guarantee the electroneutrality principle.

More ruminal interesting parameters could be physical characteristics like colour (white), smell (acid, not aromatic), and consistency. From a microbiological point of view , in acidosis we will find an increased gram-positive ,bacteria population, as they are resistant to a low pH environment; whereas the population of gram-negative bacteria is decreased or absent. The lactate-producing bacteria *Streptococcus bovis* increases in acute ruminal acidosis,while lactateutilizing species decrease.With a decrease in lactate-utilizing bacteria, lactate accumulates in the rumen during acute lactic acidosis.This will contribute further to a decreased or complete defaunation of ciliated protozoa in a low ruminal pH environment; and if we execute the methylene blue reduction test (also called methylene blue decolourisation test), we will see a decrease in the time necessary to convert the blue color to white colour, as an index of redox potential (remember, in acidosis, redox potential could be increased at the beginning of the process).

TREATMENT AND PREVENTION

Individual cattle can be treated successfully, although the chances of success depend on the severity of the case [18], based on controlling changes associated with systemic acidosis and dehydration (we will apply fluid therapy, avoiding lactate enrichment fluids, such as Ringer lactate), and trying to correct complications, trying to restabilize ruminal functions. In the herd, the most important thing to do is to anticipate the ruminal acidosis, and in order to do that the Reference Advisory Group on Fermentative Acidosis of Ruminants (RAGFAR) [18] have proposed some indirect indicators of ruminal acidosis in feedlot cattle; among others are

i. Decline in pen feed consumption of more than 10% for two or more consecutive days, causing a weight loss,
ii. a pen incidence of bubbly scours of more than 3% on any given pen inspection,
iii. evidence of laminitis in any *Bos taurus* cattle andmore than 3% of *Bos indicus* cattle,
iv. A decrease in chewing activity (less than 50% of the calf rest time), due to a decrease in neutral detergent fiber.

But prevention is the most important tool to avoid acidosis appearing. In order to do that, we would keep the ruminal pH in physiologic ranges, increasing the neutral detergent fiber and decreasing concentrate intake and, in a second place, trying to keep ruminal microbiota, which will allow controlling the fermentative process. There are three strategies for the prevention of the high-concentrate syndrome [9]: (1) proper diet balancing and feeding management,

(2) control of ruminal pH, and (3) control of the fermentation process.

Feeding Management Strategies: Feeding management includes changes to diet composition, increasing fiber content, and applying feed additives [7]. Applying diet changes includes giving the animals a proper balanced diet, increasing the FND to stimulate the chewing activity, and increasing particle size and length of the component, which will in turn increase salivation production and ruminal pH [19].

Supplementation with Ruminal Buffers. Another measure could be to incorporate buffers, like sodium and potassium bicarbonate, or alkalinizing agents (sodium and potassium carbonate, magnesium oxide) in the diet, with different objectives, because buffers will be able to neutralize ruminal pH changes; meanwhile the second ones will increase the ruminal pH. They have a direct effect on rumen fluid pH through chemical changes in the rumen because they neutralize acidity through H+ sequestration and increase buffering capacity of ruminal fluid, but some experiences have suggested that the potential benefits of controlling ruminal pH with buffers and alkalizers are limited, and they cannot prevent ruminal acidosis alone. This is consistent with the hypothesis that part of the effects observed is pH independent and should be resolved using alternative feeding strategies [20].

Probiotics. Direct-fed microbials (DFM), or probiotics, are live, naturally occurring bacterial supplements that have been used to improve digestive function of livestock. Feeding bacterial DFM is based on the concept of providing positive postrumen effects on the animal by improving the population of beneficial gutmicroflora, being able to alter rumen fermentation in order to reduce the risk of ruminal acidosis [25].The main objective is to stimulate the growing of *Megasphaera elsdenii* (a gram-negative and large coccus which is probably the most important ruminal organism with regard to lactic acid fermentation and Yeast (*Saccharomyces cerevisiae*, dried or live-active dry-) and fungi (*Aspergillus oryzae*) have been proposed as alternative to bacterialmicrobials, with differentmode of action. In general, . Fungal DFM have been extensively used in ruminants for improving performance and normalizing rumen fermentation, increasing the ruminal bacterial activity and preventing the lactic acid production [25–28].

Ruminal Tympany or Frothy Bloat

Bloat is an overdistention of the rumenoreticulum with the gases of fermentation, either in the form of persistent foam mixed with the ruminal contents, called primary or frothy bloat, or in the form of free gas separated from the ingesta, called secondary or free-gas bloat. It is predominantly a disorder of cattle but may also be seen in sheep. The susceptibility of individual cattle to bloat varies and is genetically determined. Death rates as high as 20% are recorded in cattle grazing bloat-prone pasture, and in pastoral areas, the annual mortality rate from bloat in dairy cows may approach 1%. There is also economic loss from depressed milk production in nonfatal cases and from suboptimal use of bloat-prone pastures. Bloat can be a significant cause of mortality in feedlot cattle.

Bloat is a common cause of sudden death. Cattle not observed closely, such as pastured and feedlot cattle and dry dairy cattle usually are found dead. In lactating dairy cattle, which are observed regularly, bloat commonly begins within 1 hr after being turned onto a bloat-producing pasture. Bloat may develop on the first day after being placed on the pasture but more commonly develops on the second or third day.

In primary pasture bloat, the rumen becomes obviously distended suddenly, and the left flank may be so distended that the contour of the paralumbar fossa protrudes above the vertebral column; the entire abdomen is enlarged. As the bloat progresses, the skin over the left flank becomes progressively more taut and, in severe cases, cannot be "tented." Dyspnea and grunting are marked and are accompanied by mouth breathing, protrusion of the tongue, extension of the head, and frequent urination. Rumen motility does not decrease until bloat is severe. If the tympany continues to worsen, the animal will collapse and die. Death may occur within 1 hr after grazing began but is more common ~3–4 hr after onset of clinical signs. In a group of affected cattle, there are usually several with clinical bloat and some with mild to moderate abdominal distention. In secondary bloat, the excess gas is usually free on top of the solid and fluid ruminal contents, although frothy bloat may be seen in vagal indigestion when there is increased ruminal activity. Secondary bloat is seen sporadically. There is tympanic resonance over the dorsal abdomen left of the midline. Free gas produces a higher pitched ping on percussion than frothy bloat. The distention of the rumen can be detected on rectal examination. In free-gas bloat, the passage of a stomach tube or trocarization releases large quantities of gas and alleviates distention.

Diagnosis

Usually, the clinical diagnosis of frothy bloat is obvious. The causes of secondary bloat must be ascertained by clinical examination to determine the cause of the failure of eructation.

Treatment:

In life-threatening cases, an emergency rumenotomy may be necessary; it is accompanied by an explosive release of ruminal contents and, thus, marked relief for the cow. Recovery is usually uneventful, with only occasional minor complications.

A trocar and cannula may be used for emergency relief, although the standard-sized instrument is not large enough to allow the viscous, stable foam in peracute cases to escape quickly enough. A larger bore instrument (2.5 cm in diameter) is necessary, but an incision through the skin must be made before it can be inserted through the muscle layers and into the rumen. If the cannula fails to reduce the bloat and the animal's life is threatened, an emergency rumenotomy should be performed. If the cannula provides some relief, an antifoaming agent can be administered through the cannula, which can remain in place until the animal has returned to normal, usually within several hours.

When the animal's life is not immediately threatened, passing a stomach tube of the largest bore possible is recommended. A few attempts should be made to clear the tube by blowing and moving it back and forth in an attempt to find large pockets of rumen gas that can be released. In frothy bloat, it may be impossible to reduce the pressure with the tube, and an antifoaming agent should be administered while the tube is in place. If the bloat is not relieved quickly by the antifoaming agent, the animal must be observed carefully for the next hour to determine whether the treatment has been successful or whether an alternative therapy is necessary.

A variety of antifoaming agents are effective, including vegetable oils (eg, peanut, corn, soybean) and mineral oils (paraffins), at doses of 250–500 mL. Dioctyl sodium sulfosuccinate, a surfactant, is commonly incorporated into one of the above oils and sold as a proprietary antibloat remedy, which is effective if administered early. Poloxalene (25–50 g, PO) is effective in treating legume bloat but not feedlot bloat. Placement of a rumen fistula provides short-term relief for cases of free-gas bloat associated with external obstruction of the esophagus.

Refertences:

[1] F. N. Owens, D. S. Secrist, W. J. Hill, and D. R. Gill, “Acidosis in cattle: a review,” *Journal of Animal Science*, vol 76, no. 1, pp. 275–286, 1998.

[2] O. M. Radostits, C. C. Gay, D. C. Blood, and K.W. Hinchcliff, *VeterinaryMedicine: A Textbook of the Diseases of Cattle, Sheep, Pig, Goats and Horses*, Elsevier Saunders, New York, NY, USA,2006.

[3] T. G. Nagaraja, M. L. Galyean, and N. A. Cole, “Nutrition and disease,” *Veterinary Clinics of North America: Food Animal Practice*, vol. 14, no. 2, pp. 257–277, 1998.

[4] J. L. Kleen, G. A. Hooijer, J. Rehage, and J. P. T.M. Noordhuizen, Subacute ruminal acidosis (SARA): a review,” *Journal of VeterinaryMedicineA: Physiology Pathology Clinical Medicine*, vol. 50, no. 8, pp. 406–414, 2003.

[5] T. G. Nagaraja andK.F.Lechtenberg, “Acidosis in feedlot cattle,” *Veterinary Clinics of North America—Food AnimalPractice*, vol. 23, no. 2, pp. 333–350, 2007.

[6] C. Castillo, J.Hernandez,V. Pereira, and J. L. Benedito, “Update about nutritional strategies in feedlot for preventing ruminal acidosis,” in *Advances in Zoology Research*, O. P. Jenkins, Ed., vol. 4, pp. 1–84, Nova Science Publishers, New York, NY, USA, 2012.

[7] L. A. Gonz´alez, X.Manteca, S. Calsamiglia, K. S. Schwartzkopf- Genswein, and A. Ferret, “Ruminal acidosis in feedlot cattle: Interplay between feed ingredients, rumen function and feeding behavior (a review),” *Animal Feed Science and Technology*, vol. 172, no. 1-2, pp. 66–79, 2012.

[8] J. E.Nocek, “Bovine acidosis: implications on laminitis,” *Journal of Dairy Science*, vol. 80, no. 5, pp. 1005–1028, 1997.

[9] S. Calsamiglia, M. Blanch, A. Ferret, and D. Moya, “Is subacute ruminal acidosis a pH related problem? Causes and tools for its control,” *Animal Feed Science and Technology*, vol. 172, no. 1- 2, pp. 42–50, 2012.

[10] M. B. Hall and G. B. Huntington, “Nutrient synchrony: sound in theory, elusive in practice”, *Journal of Animal Science*, vol. 86, no. 14, pp. E287–E292, 2008.

[11] K. Beauchamin and G. Penner, “New developments in understanding ruminal acidosis in dairy cows,” in *Proceedings of the 18th Tri-State Dairy Nutrition Conference*, pp. 6–17, Ohio State University, Columbus,Ohio, USA, 2009.

[12] J. Kleen, *Prevalence of subacute ruminal acidosis in Dutch dairy herds - a field study [Ph.D. thesis]*, Klinik f¨ur Rinder der Tier¨ arztlichen Hochschule, Hannover, Germany, 2004.

[13] T. G.Nagaraja, “Liver abscesses in beef cattle-potential for dairy monitoring?” in *Proceedings of the 33rd Annual Convention of the American Associations of Bovine Practice*, pp. 65–68, Rapid City, SD, USA, 2000.

[14] K. V. Norlund, E. F. Garret, and G. R. Oetzel, “Herd-based ruminocentesis-a clinical approach to the diagnosis of subacute rumen acidosis,” *The Compendium X*, vol. 17, pp. 48–56, 1995.

[15] S. Abeysekara, J. M. Naylor, A.Wassef, U. Isak, and G. A. Zello, “D-Lactic acid-induced neurotoxicity in a calf model,” *American Journal of Physiology—Endocrinology and Metabolism*, Vol.293, no. 2, pp. E558–E565, 2007.

[16] G. N. Gozho, D. O. Krause, and J. C. Plaizier, “Ruminal lipopolysaccharide concentration and inflammatory response during grain-induced subacute ruminai acidosis in dairy cows,” *Journal of Dairy Science*, vol. 90, no. 2, pp. 856–866, 2007.

[17] T. Duffield, J. C. Plaizier, A. Fairfield et al., “Comparison of techniques for measurement of rumen pH in lactating dairy cows,” *Journal of Dairy Science*, vol. 87, no. 1, pp. 59–66, 2004.

[18] Reference Advisory Group on Fermentative Acidosis of Ruminants (RAGFAR), *Ruminal Acidosis— Aetiopathogenesis, Prevention and Treatment*, Australian Veterinary Association, Sydney, Australia, 2007

[19] M. L. Galyean and P. J. Defoor, “Effects of roughage source and level on intake by feedlot cattle”. *Journal of Animal Science*, vol. 81, no. 14, supplement 1, pp. E8–E16, 2003.

[20] S. Calsamiglia, M. Blanch, A. Ferret, and D. Moya, “Is subacute ruminal acidosis a pH related problem? Causes and tools for its control,” *Animal Feed Science and Technology*, vol. 172, no. 1- 2, pp. 42–50, 2012.

[21] C. Castillo, J. L. Benedito, J. M´endez et al., “Organic acids as a substitute for monensin in diets for beef cattle,” *Animal Feed Science and Technology*, vol. 115, no. 1-2, pp. 101–116, 2004.

[22] S. A. Martin and M. N. Streeter, “Effect of malate on in vitro mixed ruminal microorganism fermentation,” *Journal of Animal Science*, vol. 73, no. 7, pp. 2141–2145, 1995.

[23] S. Rochfort, A. J. Parker, and F. R. Dunshea, “Plant bioactives for ruminant health and productivity,” *Phytochemistry*, vol. 69, no. 2, pp. 299–322, 2008.

[24] S. R. Hashemi and H. Davoodi, “Herbal plants and their derivatives as growth and health promoters in animal nutrition,” *Veterinary Research Communications*, vol. 35, no. 3, pp. 169-180, 2011.

[25] M. R. Mc Daniel, *The effects of dosing feedlot cattle with* Megasphaera elsdenii *strain NCIMB 41125 prior to the introduction of a grain-rich diet [M.S. thesis of Science]*, Kansas State University, Manhattan, Kan, USA, 2009.

[26] J. K. Seo, S.-W. Kim, M. H. Kim, S.D.Upadhaya, D. K. Kam, andJ. K. Ha, “Direct-fed microbials for ruminant animals,” *Asian- Australasian Journal of Animal Sciences*, vol. 23, no. 12, pp. 1657- 1667, 2010.

[27] A. Campbell, *Optimizing the adaptation rate of feedlot steers doses withMegasphera elsdenii NCIMB 41125 and fed high starch diets [M.S. thesis]*, Kansas StateUniversity, 2010.

[28] M. Desnoyers, S. Giger-Reverdin, G. Bertin, C. Duvaux-Ponter, and D. Sauvant, "Meta-analysis of the influence of *Saccharomyces cerevisiae* supplementation on ruminal parameters and milk production of ruminants," *Journal of Dairy Science*, vol. 92, no. 4, pp. 1620–1632, 2009.

[29] H. S. Gill, Q. Shu, and R. A. Leng, "Immunization with *Streptococcus bovis* protects against lactic acidosis in sheep," *Vaccine*, vol. 18, no. 23, pp. 2541–2548, 2000.

* * * * *

CHAPTER 10

APPROACHES FOR THERAPEUTIC MANAGEMENT OF COMMON SURGICAL AFFECTIONS IN ANIMALS UNDER FIELD CONDITIONS

Prof. (Dr) S.K. Tiwari
Dean, College of Veterinary Science and A.H., Anjora
Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg (C.G.)

Considerable improvements have been recorded in the Agriculture and allied sector in last decade. The 78 per cent of the total rural households are farmer. A majority of the rural households possesses one or another species of livestock. Livestock is an important source of livelihood for the marginal and landless poor farmers. Livestock sector contributes approximately about 35 per cent to the value of agricultural sector output. The cattle and buffaloes suffers from many surgical ailments such as Urolithiasis, Upward fixation of Patella, Bloat due to plastic menace, Horn cancer, Dystocia, Hernia, Rectal prolapse and Tumours *etc* which requires surgical intervention. The surgery significantly reduced the mortality rate and improves the productivity in animals in such cases.

The most common surgical affections in large animals are as follows-

1. Urolithiasis 2. Upward fixation of Patella 3. Recurrent bloat due to ingestion of plastic and foreign bodies 4. Horn Cancer 5. Dystocia necessitating Caesarean Section 6. Hernia 7. Rectal Prolapse. These surgical ailments are discussed in brief along with their treatment and future strategies to prevent/minimize the chances of occurrence of these affections.

Urolithiasis

Urolithiasis is a general term referring to the cause and effects of stones anywhere in the urinary tract. The term urolith is derived from Greek word *Uro* means urine and *lith* means stone. Urinary calculi are organized aggregations of crystals embedded in an organic matrix. Urinary calculi form in both castrated and uncastrated males and also in females but obstructive urolithiasis is primarily a problem of castrated males. The survey done under ICAR adhoc project on Urolithiases (2005-2008) in Department of Surgery and Radiology, College of Veterinary Science & A.H. Anjora, Durg reported that the prevalence of obstructive urolithiasis in Cattle and Buffaloes was the highest in Raipur District followed by Durg and Rajnandgaon districts. Non-descript cattle and buffaloes were more commonly affected than descript breeds. Common site of lodgement of uroliths in cattle and buffalo is distal sigmoid flexure of the penis and in sheep/goat is urethral process or vermiform appendages. It is a fatal disease, if treatment is not provided in time and leads to sever economic loss to the farmers.

Factors which interact to form the calculi:-

Too early castration in small and large ruminants may predispose to urolith formation as it affects the normal development of urethra due to lack of testosterone. Feeding of animals with paddy straw which is rich in oxalate and responsible for oxalate calculi, consumption of hard water or low intake of water and mineral imbalance especially with calcium and phosphorus may lead to calculi formation. Urine pH influences crystal precipitation and calculi formation.

Common sites:

- Distal to sigmoid flexure
- Between ischial arch and sigmoid flexure
- Bladder neck
- Glans penis
- Terminal urethra (camels, sheep)

Clinical sign:

A clinical sign of retention of urine is complete block after 24 hours followed by rupture of urinary bladder after 72 hours.

History:

- Complete or partial retention of urine, prior treatment, painful and futile attempts by animal to urinate.
- Bladder rupture (cystorrhexis), constant pain (nephroliths) and death in 4-5 days.
- Dry muzzle, sunken anaemic eyes, salivation, rough coat, turgid skin, anorexia, suspended rumination, dry and mucous coated dung balls, variable dehydration.
- If bladder intact, can be felt on rectal palpation.

Surgical procedure: 1. Post scrotal Urethrotomy 2. Ischial Urethrotomy 3. Cystotomy

Horn Cancer

Horn cancer is malignant in nature and originates from the squamous cell lining of the core at the base of the horn. It is the most common condition affecting mostly bullocks, less in cows and rarely in bulls. The condition is more prevalent in working bullocks and very less in buffaloes. The disease is restricted to adult cattle between 5 to 10 years of age. The tumour is seen more commonly in long horned, white coat breeds of cattle. The exact etiology of horn cancer is not known clearly but the following conditions are considered to be predispose the animal for born cancer *viz.*, trauma-mechanical injury to the horn, use of rope or leather stirring used as gall, application of paints like coal tar used for making horn black may lead to this condition. Reproductive hormonal imbalance may play an important role and castrated bullocks are more prone for this condition. The animal suffers from constant shaking of head, rubbing of the horn on some hard object and striking with limbs. In advanced stages, tilting of the horn to one side. The exposed growth looks typically like a cauliflower and bleeds easily and profusely.

Thus, horn cancer is generally squamous cell carcinoma. Mostly found in working bullocks. It is commonly found in old age bullocks. Genetic factor like long horned & white colured horn are predisposing factors for horn cancer. Common aetiology of horn cancer is trauma, chronic irritation by worms & flies, paint application, solar radiation, reproductive hormonal imbalance and viral infections. Main clinical signs are constant shaking of head, pain, foul smelling discharge from nostrils, tilting of horn and exposed growth looks like cauliflower & bleed.

Treatment-Amputation of horn by flap method

Ruminal Impaction

Ruminal impaction develops due to ingestion of polythin bags, plastics, ropes, gunny bags or leather pieces that make large tight balls inside the rumen caused by churning movements. The condition is commonly encountered in cattle and buffaloes. Besides, ingestion of poor quality roughage also leads to this. Animal show the symptoms of recurrent tympani, retarded or suspended rumination, anorexia, listlessness and reduced mild yield.

Rumenotomy- It is surgical opening of the rumen by making the incision on the wall of rumen. Rumenotomy is a routine procedure for treating many diseases in ruminants.

Indications:

a) Persistent ruminal impaction
b) Frothy Bloat
c) Foreign bodies lodged in rumen and reticulum
d) Traumatic reticulitis
e) Atony of omasum and abomasums
f) Reticular abscess
g) Exploratory rumenotomy for diagnosis of intraruminal diseases other than foreign bodies
h) Ingestion of toxic plants
i) Diaphragmatic hernia

Site of incision

The site of incision is

- Left mid flank vertical incision.
- In case of traumatic reticulitis in large size animal the site of incision is parallel to last rib.
- The site of incision is usually equidistant from tubercoxae and the last rib beginning 5 cm ventral to the lumbar transverse process.

Anatomical considerations

Rumen occupies almost left half of the abdominal cavity from 7th or 8th inter-costal space to the pelvic inlet and extend over the medial plane to the right side ventrally.

The rumen is marked on its parietal (left) and visceral (right) surface by longitudinal, anterior and posterior grooves. These grooves divide the rumen into dorsal and ventral sacs, anterior and posterior blind sacs. The rumen is generally opened for rumenotomy through dorsal sac of rumen.

Premedication and anaesthesia

The rumenotomy operation is performed in standing position. The desensitization of flank area with animal in standing position can be achieved by:

1. Inverted 'L' block
2. Field block
3. Paravertebral anaesthesia

In most of the animals Paravertebral anaesthesia is used and for this T13, L1 and L2 nerves are blocked.

Although usually local anaesthesia of the flank and paravertebral block is sufficient for rumenotomy, however in non-cooperative animals tranquilization may be required.

Techniques:

- Stay suture technique
- Weingarth ring technique
- Rumen skin clamp fixation technique
- McLintock's sheet and ring fixator

Dystocia necessitating Caesarean Section

The term dystocia comes from Greek word means **difficult birth**. When the first, or especially the second stage of parturition is markedly prolonged, becomes difficult or impossible for the dam without artificial aid, the condition is termed as dystocia. It develop due to fetal deformity (*viz.* fetal monster, double headed fetus, twins, hydrocephalus of fetus, large sized fetus), fetal mal-presentation or posture, emphysematous fetus, fetal maceration, irreducible uterine torsion, uterine rupture, non or incomplete dilatation of cervical os, deformities of maternal pelvic girdle relative or absolute narrowness of pelvic canal (immaturity of dam, traumatic pelvic deformity) and double head foetus.

Cesarean section of Cow

C-section: Delivery of fetus at parturition by laparohysterotomy. Latin word '*caeso matris utera'*, means 'cutting of mothers uterus'. Greek mythology as *Apollo* delivers *Asclepius* from the abdomen of his mother. Romans claim the term in memorializing the birth of Julius.

Indications- Physical immaturity of the mother, Failure of the uterine cervix fully to dilate, Irreducible uterine torsion, Preparturient recumbency, Acute reticuloperitonitis or pericarditis, *Shistosoma reflexus*, Gross oversize of the fetus, Pregnancy toxaemia, Gross swelling of the vagina and vulva, Irreducible mal-presentation, Hydroallantois, hydrammnios, Mummified foetus and others diseases and complications.

Position of the cow and operative site

- Left paralumbar or Upper left flank approaches
- Upper right flank laparotomy
- Ventral midline approach or paramedian approach
- Ventro-lateral oblique approach

Anaesthesia

- Local infiltration using 2% lignocaine hydrochloride-60 to 90 ml along with mild sedation using xylazine-(0.075-0.1mg/kg body weight)
- Local infiltration using 2% lignocaine hydrochloride-60 to 90 ml along with epidural anaesthesia.

Surgical site

Abdominal cavity is exposed after removing skin, subcutaneous tissue, fascia, external abdominis, internal abdominis, transverse abdominis, rectus abdominis and peritoneum. Foetus is carefully removed from uterus after incising the uterine wall. Precaution should be taken not to over tear the uterine mucosa. Technical assistance should be provided to remove the foetus carefully without contaminating the uterine content into the abdominal cavity. Extra amniotic membranes should be removed as much as possible.

Uterine suturing- Uterus can be sutured by combination of simple continuous followed by cushing. It can also be sutured by cushing followed by lembert. Holding the muscle layers should be done. Suturing of muscle layers should be done. Muscle layers should be sutured using no 2 chromic cat gut in a simple continuous manner. Adequate tension should be maintained during suturing. Then, suturing of sub cutaneous Layer is followed. Sub cutaneous layer should be sutured using no 1 or no 2 chromic catgut. At last suturing of skin is done. Skin suturing should be done by using nylon or silk through cruciate mattress or horizontal mattress.

Upward fixation of patella

The condition is commonly bilateral, sometime unilateral. In Chhattisgarh state most male bovine suffers from this and animal shows jerky flexion during movement or drags the affected limb with flexed pastern and the affected limbs are brought forward with a jerky on every step. These signs disappear after a few steps but reappear after prolong rest. Due to constant dragging, the toes are worn out and blood oozes out in some cases. Animal keeps the limb extended during progression, raise the hind quarters on the affected side and move by swinging the limb outward and forward. As a result the working capacity of the animal is significantly reduced which adversely affects the agricultural activities undertaken by marginal or landless farmers?

Treatment-medial patellar desmotomy

Hernia

Umbilical Hernia

Umbilical hernia occurs frequently in bovine calves and comparatively more frequent in females than in males. Umbilical hernia is usually congenital; however acquired hernia also occurs few weeks after birth. The hernia contents are usually loops of intestine or omentum Hernia occur due imperfect closure of the umbilicus, hypoplasia of abdominal muscle, excusive straining due to diarrhoea or constipation etc.

Ventral hernia/lateral abdominal hernia

The most commonly occurs in cattle. Protrusion of abdominal organs through a tear in the abdominal wall is termed as ventral or lateral abdominal hernia. More precisely, when the hernia is ventral to the stifle skin fold, it is termed as ventral hernia while hernia appeared on flank region is termed as lateral hernia. This hernia develops due to external violence-kick, blows, horn thrusts due to butting by cattle, falling on blunt objects etc., abdominal distension due to pregnancy or excessive staining during parturition, tympany etc. Treatment herniorrhaphy and hernioplasty.

Rectal Prolapse

The most common surgical condition involving the rectum in cattle and buffaloes is rectal prolapse. Rectal prolapse is commonly seen in young and heavily parasite-infested animals of any age or sex. The predisposing factors for rectal prolapse includes diarrhoea, tenesmus or increased intra-abdominal pressure due to bloat, rectal inflammation, act of parturition, excessive coughing, colitis and cystitis and straining caused by rectal polyps, neoplasia, foreign bodies, constipation, perineal hernia, congenital defects and prostatic disease. Prompt treatment is essential to prevent extensive necrosis of the prolapsed mass.

Strategies for Control of Surgical Affections

1. Feeding of urea treated paddy straw along with green fodder to the animals and availability of clean drinking water shall significantly reduce the chances of urolithiasis in ruminants. This is because these untreated straw are very rich source of oxalates leading to formation of calculi of calcium, magnesium and ammonium oxalates.
2. The early castration might be one of the predisposing factors responsible for causation of urolithiasis in cattle and buffaloes. Therefore castration of animals should not be done before one year of age to minimize the chances of urolithiasis.
3. Availability of good pasture land for grazing shall minimize the chances of foreign body syndrome including bloat. Use of plastic should be discouraged.
4. Animal husbandry practices like debudding etc. should be strictly reinforced so that the affection like horn cancer, abdominal hernia can be minimized.
5. Proper selection of semen for a cow according to the size of the cow shall minimize the chances of dystocia due to oversize of the foetus which requires caesarean section to save the life of the animal.
6. Feeding of balanced diet along with proper ratio of calcium and phosphorus (2:1) in the ration of cattle and buffaloes shall also reduce the chances of stone formation, upward fixation of patella and other deficiency diseases.
7. Selective use of crossbreeding and effective use of upgrading programme should be under taken to minimize the incidence of foetal monsters and congenital anomalies like dermoid atresia ani, umbilical hernia, agenesis of abdomen, athelia etc.
8. Farmers should be advised to take the help of local veterinarian during parturition, during sickness of animal and for prophylactic vaccination of animals against diseases.

References:

Athar, H. Mohindroo, J., Singh, Kiranjeet and Singh Tarunbir (2010). Clinical, haemato-biochemical, radiographic and ultrasonographic findings in bovine with rumen impaction. *Intas Polivet*, 11(II): 180-83.

Gahlot, T.K., Bishnoi, P., Jhirwal, S.K., Sarkar Palecha, Purohit, S., Arunkumar, Rajpurohit, G., Parashar, M.C. and Kajoria, P. (2005). Peculiar rumen impaction in cattle of Bikaner. Pre-proceedings of the First Round Table conference on rumenology, 282-87.

Gautam, D., Raghuvanshi, P.D.S., Singh, Deepa and Balamurugan, B. (2017). Common surgical affections in field condition and their management. Advance training on ultrasonography for diagnosis and management of infertility in farm animals, (March 23-29, 2017); ICAR-National Organic Farming Research Institute Tadong, Gangtok, 84-89.

Peshin, P.K., Singh, J. and Tyagi, R.P.S. (2017). General surgical consideration and fluid therapy. In: ruminant surgery 2nd Edn. C.B.S. publishers & distributors, New Delhi, 44-88.

Radotits, O.M., Blood, D.C. and Gay, C.C. (1995). Diseases of the bladder, ureters and urethra. In: Veterinary Medicine; A textbook of the diseases of cattle, sheep, pigs, goats and horses. *ELBS with Bailliere Tindall, London*, 448-55.

Raghuvanshi, P.D.S. (2014). Restoration of livestock traits: study of different clinical conditions and their surgical resolution in Surguja, Chhattisgarh. *Buffalo Bulletin,* 33(1): 68-77.

Raghuvanshi, P.D.S., Maiti, S.K. and Dixit, Aditi A.(2013). Surgical resolution of indigestible forgein body (hair ball) syndrome in Cattle. *Indian Vet. J*. 91(03), 86-87.

Sharma, S.N. and Singh, J. (2017). The urinary system. In: ruminant surgery 2nd Edn. C.B.S. publishers & distributors, New Delhi, 378-95p.

* * * * *

CHAPTER 11

ADVANCES IN THERAPEUTIC AND MANAGEMENT PRACTICES FOR COMMON GYNAECOLOGICAL DISORDERS IN LIVESTOCK

M.K. Awasthi
Veterinary Gynaecology & Obstetrics Department
College of Veterinary Science & Animal Husbandry
Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalay, Anjora, Durg (C.G.)

Abstract

Postpartum fertility is one of the important factors of economic importance in dairy enterprises. The major infertility problems affecting the reproductive performance of dairy animals include postpartum anestrus and repeat breeding. Prolonged postpartum anestrus is the major reproductive concern of economic losses especially to the buffalo breeders. The repeat breeding is another menace causing great economic losses to the cow breeders. Both these infertility problems result in increase in the costs of herd management and rearing by increment of expenses on unsuccessful frequent artificial insemination (AI), extended length of the days open as well as culling and replacement of those animals that can't conceive. This presentation focuses on advance therapeutic measures to alleviate the anestrus and repeat breeding in dairy animals.

ANESTRUS

Anestrus is a functional disorder of reproductive cycle in cows and buffalos, which is characterized by absence of overt signs of estrus resulting in extended calving interval thus leading to great economic loss to livestock enterprise. Incidence of anestrus is more in buffalo than in cattle, and problem is severe during summer. Anestrus is a multi-factorial problem but its occurrence signals the inadequate nutrition, environmental stress, uterine pathology and improper management practices. Expression of estrus is also influenced by seasonal changes, stress and aging. In heifers, it poses a herd problem possibly due to low plane of nutrition, stress of seasonal transition or extremes of climatic conditions. Expression of overt signs of estrus is greatly affected by heat stress in buffaloes.

In comparison to cows, buffaloes have lesser number of pre-antral and antral follicles, smaller sized pre-ovulatory follicle and greater tendency of follicular atresia (Baruselli *et al.*, 1997) which might be responsible for high incidence of anestrus in buffaloes.

Diagnosis of Anestrus

History: Based on the information viz., failure of expression of the overt signs of estrus by the animals after attaining puberty or 60–90 days post-partum; symptoms of estrus displayed, which subsequently ceased and revert in to anestrus. Such cases are diagnosed when presented for pregnancy diagnosis.

Per Rectal Examination: Pregnancy is a major cause of anestrus and therefore, must be ruled out by careful examination of genitalia. Twice per rectal examination at 10 days interval reveals ovaries are smooth, small and inactive with the absence of corpus luteum in true anestrus cows and buffaloes (Agarwal *et al.*, 2004), however, follicles may develop up to pre-maturation stage and get atretic (Ghuman *et al.*, 2010b). Occasionally persistent luteal cyst may be encountered, which is another cause of anestrus in high yielding dairy animals and is mostly observed in buffaloes.

Ultrasonography: Different stages of follicular growth and type of anestrus can easily be detected by ultrasonography. Twice trans-rectal ultrasound scanning of anestrus animals at 12 days interval revealed 45% inactive ovaries (true anestrus), 55% silent ovulation or missing heat (Rahman *et al.*, 2012). It can also differentiate between persistent follicle and persistent CL.

Therapeutic Management: In order to ensure effective treatment, the health and nutritional status of the animals must be in good conditions. Besides deworming, supplementation of vitamins, minerals and antioxidants in feed are useful to improve health status of the animals. Reduced suckling stimulus may also help to stimulate estrus. Anestrus can be treated according to their cause, however; there is no single therapeutic measure to correct it.

Various therapeutic agents including hormonal and non–hormonal compounds have been used extensively for the restoration of cyclicity in anestrus cows and buffalo by several workers with varying degree of success (Kumar *et al*., 2005).

Hormonal Treatments

Progesterone Based Treatment: Exogenous administration of progesterone mimics the luteal phase of the estrous cycle. To be effective, abrupt decrease in progesterone level is required at the end of treatment to stimulate the normal follicular phase. Intra-vaginal progesterone releasing devices such as PRID (progesterone–releasing intra-vaginal device), CIDR (controlled internal drug release) and CueMate; and Ear implants (Crestar and Synchromate–B) are effective in restoration of cyclicity in anestrus animals (Azawi *et al*., 2012). Upon withdrawal, onset of estrus and ovulation occurs within 2–8 days after the end of treatment. To improve the response, the intra-vaginal devices or ear implants are generally used for 7 to 9 days, combined with other hormones (prostaglandins, GnRH, PMSG/eCG and estradiol) towards the end of progesterone treatment and estrus induction rate has been reported between 80 and 100% by most of the workers (Azawi *et al*., 2012).

Gonadotropic Releasing Hormone (GnRH) Based Treatment: Ovsynch protocol or GPG regimen (GnRH–PG–GnRH), developed by Pursley *et al.* (1995) to synchronize ovulations in dairy cows has been widely used to treat anestrus cows and buffaloes and promising results have been obtained. Under this protocol first injection of GnRH (at day 0) induces ovulation, if dominant follicle is present and if not, luteinizes with emergence of new follicular wave 1 to 2 days later, $PGF_2\alpha$ injection given on day 7 regresses the CL formed in response to first injection of GnRH and second GnRH injection on day 9 induces ovulation of new dominant follicle subsequently. Treated animals are inseminated within 16–20 hours of second GnRH injection.

Gonadotrophins Based Treatment: Equine chorionic gonadotrophin (eCG/PMSG) is strong stimulator of ovarian activity because of its predominant FSH like activity. Single intramuscular injection in low doses either alone or in combinations with other hormone(s) has been used successfully to treat anestrus cows and buffaloes (Kumar, 2012). However, breeding of treated cows should be avoided at induced estrus for fear of superovulation. Such animals are bred at subsequent estrus.

Insulin Based Treatment: Use of insulin for induction of estrus in animals either alone or in combination is a fairly recent development and results are very encouraging. The recommended dose is 0.25 IU/kg body weight subcutaneously for 3-5 days. Use of GnRH or eCG pretreated with insulin has shown promising results for management of anestrus cows (Shukla *et al.*, 2005) and buffaloes (Kumar, 2012). Single I/M injection of eCG combined with S/C injections of insulin was found successful for treatment of true anestrus buffaloes under field conditions (Kumar, 2012).

Anti-Prolactin Based Treatment: Plasma level of prolactin is increased in anestrus buffaloes and plasma concentration of melatonin is low during summer. Melatonin is known to suppress prolactin secretion and it stimulates both GnRH and gonadotrophin secretion in buffaloes. Estrus and ovulation was induced in all treated anestrus buffalo heifers during summer using melatonin implants (Ghuman *et al.*, 2010a).

REPEAT BREEDING

Repeat breeding (RB) refers to a dairy animal, which fails to conceive from three or more regularly spaced services in the absence of detectable abnormalities in reproductive system. The incidence of RB in the buffalo is lower (8.68% vs 18.79%) compared to cows (Purohit, 2008). Jersey and Holstein crossbred cows are mostly affected in our country and among them, cows at their 4^{th} or 5^{th} calving are more vulnerable.

Etiology: An insight of various research works revealed that failure of fertilization and early embryonic mortality are the two principal causes of RB (Purohit, 2008). The rate of fertilization is about 80-90% in bovines, strongly suggesting that higher early embryonic mortality is the major cause of conception failure (Noakes *et al*., 2001). The cause of RB may lie within the cow or the bull or a combination of these two (Perej-Marin *et al.*, 2012).

A. Failure of fertilization

Failure of fertilization accounts for a low proportion (10%–20%) of total pregnancy losses during the first 21 days post-insemination (Diskin and Morris, 2008). The cause of fertilization failure can be associated with AI carried out at wrong timings. Ovulatory disturbances resulting in fertilization failures are commonly encountered in crossbred and exotic breeds of cow but less frequent in the buffaloes (Purohit, 2014). The occurrence of prolonged estrus and presence of supra-basal progesterone at estrus is a phenomenon that occurs repeatedly in consecutive cycles, and leads to repeated conception failure in dairy cattle (Singh *et al.*, 2008). Many RB buffaloes at insemination had plasma progesterone profiles greater than 1 ng/ml suggesting that buffaloes were inseminated at the wrong time. A problem with buffalo AI is the poor estrus expression and lack of efficient means to detect estrus.

B. Early Embryonic Mortality: The embryos, derived from normal cows failed to survive in uterus of RB cows, while embryos derived from RB cows had normal survival rates in normal cows (Almedia *et al*., 1984). Hence, the problem of RB lies primarily in uterine environment. Two main reasons of an impaired uterine environment are low grade bacterial infection leading to degeneration of endometrium and luteal deficiency resulting in repeat breeding.

Endometritis: In many RB cows, mild and persistent infections in reproductive tract are commonly observed, rendering uterine environment unsuitable for embryonic development and implantation. Moreover, these mild level infections are not easily recognizable as the clinical signs are very subtle. Sub-clinical endometritis is characterized by inflammation of the uterus, without any clinical signs of endometritis (Sheldon *et al.*, 2009). Zygotes exposed to bacterial toxins are less likely to develop to the blastocyst stage. Early embryonic mortality occurs in cows mostly at around sixth day of pregnancy and further losses at around day 17-19 post-service. These timings are associated, firstly with hatching of morula from zona pellucida; and secondly with failure of maternal recognition of pregnancy (Diskin and Morris, 2008) and accounts for 45% of pregnancy losses during this time.

The predisposing factors for low grade endometritis in dairy animals include abnormal calvings including dystocia, retention of fetal membrane, twinning, abortion, still birth etc. The affected animals develop chronic mild endometritis despite onset of postpartum estrus.

Luteal Deficiencey: One of the reasons of early embryonic death is low progesterone production, possibly due to poor luteinization of ovarian follicle after ovulation and/or aberration in corpus luteum function (Willard *et al*., 2003). Conception failure is coincident with less than normal concentrations of progesterone with suboptimal functioning of corpus luteum (Bedi *et al.*, 2006). A recent study reported that total luteal cells and progesterone content per corpus luteum during the mid luteal stage in the buffalo is less than in cattle suggesting inherent luteal deficiency in buffalo (Baithalu *et al.*, 2013). Lower luteal progesterone at day 5 appears to be crucial in initiating embryonic deaths.

Diagnostic approaches

Diagnosing the cause of pregnancy failures in individual animals is often extremely difficult under field conditions and evaluations are usually restricted to history of case, gyneaco-clinical examination of the genital tract and physiological functioning of the ovaries. However, use of trans-rectal ultrasonography has been suggested to improve the diagnostic skills.

Evaluating genital health: Visual examination of cervico-vaginal mucus is the first diagnostic method of finding infection in the genital tract of cows. White side test is a simple and useful method for detection of mild genital infection (Raja *et al.*, 2012). Ultrasonographic diagnostic features of endometritis include increased endometrial thickness and increased intra-luminal uterine fluid accumulation (Tandle and Purohit, 2013); however, in order to obtain high precision operators need sufficient experience.

Evaluating ovarian function: Timely ovulation in relation to insemination and formation and functioning of the corpus luteum are two major ovarian events associated with outcome of AI. Transrectal palpation findings of these events lack accuracy and therefore, trans-rectal ultrasonography may be used as diagnostic tool to monitor ovulation and corpus luteum formation in cows and buffaloes (Neglia *et al*., 2015). Plasma progesterone profiles have been used in many studies to evaluate corpus luteum function and higher progesterone profiles during mid luteal phase suggest proper corpus luteum function (Mondal *et al*., 2007).

Therapeutic measures

In RB cows with endometritis, infusion of 300-400 ml of isotonic saline into the uterus claimed to have advantage of good cellular response. Infusion of ozone into the uterus is a new treatment option in uterine infections. Antiseptics do not create the issue of milk residues; but many are irritants. Iodine preparations like polyvinyl pyrrolidone (Povidone®) were used for the treatment of uterine infections in dairy animals, but recently it has been reported that the irritant nature of iodine preparations potentially damages the endometrium and reduced the conception rate in forthcoming estrus. Therefore, use of intrauterine infusion of broad spectrum antibiotics has become treatment of choice for RB cows suspected to have an infectious etiology.

Repeat Breeding due to Low Grade Endometritis

Antibiotic therapy: For clinical and subclinical endometritis, many commercial preparations are available but ceftiofur sodium @ 2.2mg/kg has gained popularity in recent times and is frequently recommended. Third and fourth generation cephalosporins have shown efficacy against most uterine pathogens at low minimum inhibitory concentration values (Sheldon *et al.*, 2004). In case of apparent endometritis, intrauterine antibiotic therapy is advocated for 3 to 5 days beginning from estrus without insemination and breeding is carried out at next estrus with single intrauterine antibiotic therapy 12-24 hrs post-insemination. In absence of apparent infection, post-insemination infusion of cephalexin 4 gm and ceftriaxone 2 gm given 24 h post AI resulted in improvement in conception rate in RB buffaloes (Sharma *et al.*, 2008). It has been suggested to combine the antibiotic with an imidazole derivative (metronidazole or tinidazole) to take care of anaerobic microbes and protozoa that might be present (Singh *et al.*, 2013).

Uterine Immunomodulator: As an alternative therapy, intrauterine application of *E. coli* Lipopolysaccharide @ 100 µg dissolved in 30 ml phosphate buffer saline (PBS), Oyster glycogen @500 mg in 30 ml PBS, autologus plasma @ 30 ml as uterine defense stimulator have been tried with successful results (Devraj *et al*., 2006).

Prostaglandin: For suspected low grade endometritis, $PGF_2\alpha$ can be a choice of treatment in cycling animals, administered at 11-13 days apart (Savalia *et. al*., 2013). $PGF_2\alpha$ causes luteolysis and induce the estrus within 3-5 days and, unless the discharge is abnormal the animal can be inseminated with or without post-insemination intrauterine antibiotic therapy. Improved pregnancy rate have been reported in repeat breeder cows and buffaloes by using $PGF_2\alpha$ during mid-cycle (Parmar *et al*., 2015).

Repeat Breeding due to Ovulatory disturbance

Administration of GnRH at Insemination: Administration of GnRH analogues at the time of insemination has been shown to improve the conception rate in RB cows in large scale trials. Treatment with GnRH as 'holding injection' at the time of AI is aimed to ensure timely ovulation and luteinization that would favour embryonic survival in RB cows (Mehrotra *et al*., 2015).

Repeat Breeding due to luteal deficiency

Administration of GnRH during early and / or mid-luteal phase: An approach for treatment of luteal deficiency has been to administer GnRH during early (Day 5) or mid-luteal phase (days 10 to 12) of the estrous cycle, which results either in ovulation or luteinization of dominant follicle of first follicular wave. Administration of GnRH on day 5 post AI induced ovulation of a first wave dominant follicle, which successfully increased concentrations of progesterone during mid luteal phase in lactating dairy cows (Beltran and Vasconcelos, 2008). GnRH treatment on day 12 post-insemination improved the conception rate at first and second insemination in buffaloes (Mandal *et al*., 2004). Similarly, Pandey *et al*. (2013) reported that both GnRH and hCG administration on day 12 post-ovulation leads to accessory CL formation, improves luteal profile and consequently increases conception rate in buffaloes.

Double insemination at 12 hrs interval and double injection of GnRH analogue (10 µg); first at 6 hrs before AI and second on day 12 post-insemination considerably improved pregnancy rate in RB crossbred cows with prolonged estrus than in animals with single GnRH treatment at 6 hrs before AI (Dadarwal *et al*., 2007).

Recently, RB has been treated successfully using combination of CIDR and Ovsynch protocol (Mellado *et al*., 2012). RB cows received a CIDR device and 100 μg of GnRH on day 0; CIDR was removed on day 7 and $PGF_2\alpha$ was administered concurrently. Estradiol benzoate (EB, 1 mg) was injected on day 8 and GnRH on day 9; cows were inseminated 16-20 h later. An acceptable proportion of animals got conceived using this protocol.

Improving the Timing and Technique of Insemination

Proper storage, thawing and post-thaw handling of semen, correct insemination technique and appropriate with respect to estrus status are mandatory in achieving high success rate with AI (Purohit *et al*., 2003). Higher conception rate was obtained when buffaloes were inseminated 11-14 hrs or 15-18 hrs after the onset of estrus (Srivastava *et al*., 1998). Due to a longer window of ovulation in buffaloes it has been suggested that buffaloes should be inseminated twice at 12 hrs intervals, with the first insemination being performed 8-12 h after estrus onset (Agarwal and Tomer, 1998). Provision of regular training to the personnel involved in AI activity can result in improvement of conception rates to artificial insemination.

References

Agarwal SK, Shanker U, Ansari MR (2004). Laboratory manual on Animal Gynaecology. Indian Veterinary Research Institute, Izatnagar, India.

Agarwal, S.K., Tomer, O.S. (1998). Reproductive disorders and their therapeutic management. In: Reproductive Technologies in Buffalo. Indian Veterinary Research Institute, Izatnagar, India 50–65.

Almedia, A.P., Ayalon, N., Faingold, S. and Lewis, I. (1984). In *Arthur's Veterinary Reproduction and Obstetrics.* 8th Edn., Harcourt (India) Pvt. Ltd., New Delhi, p. 462.

Azawi OI, Ali MD, Oday SA, Salih A, Al–Hadad AS, Mouayad SJ, Abdul Hussien AS (2012). Comparative efficacy of different CIDR protocols for the treatment of postpartum anestrous in Iraqi buffaloes. Vet. World. **5** (4): 201- 205.

Baruselli PS, Mucciolo RG, Visintin JA, Viana WG, Arruda RP, Madureira EH, Oliveira CA, Molero–Filho JR (1997). Ovarian follicular dynamics during the estrous cycle in buffalo (Bubalus bubalis). Theriogenol. 47: 1531 – 1547.

Baithalu, R.K., Singh, S.K., Gupta, C., Raja, A.K., Saxena, A., Kumar, Y., et al. (2013). Cellular and functional characterization of buffalo (Bubalus bubalis) corpus luteum during the estrous cycle and pregnancy. *Anim Reprod Sci.*, 140: 138-146.

Bedi, M., Singh J., Gandotra, V.K., Dadarwal, D. and Dhaliwal, G. S. (2006). Incidence of repeat breeding, variation of fertile estrus until respect of season and duration of estrus and progesterone profile of repeat breeding crossbred cows and fertility. *Indian J. Anim. Sci.*, **77** (5): 355-58.

Beltran, M.P. and Vasconcelos, J.L.M. (2008). Conception rate in Holstein cows treated with GnRH or hCG on the fifth day post artificial insemination during summer. *Arq. Bras. Med. Vet. Zootec.*, 60 (3): 580-586.

Dadarwal, D., Honparkhe, M., Singh, J. Cheede, G. S. and Kumar, A . (2007). Efficacy of double injection buserelin improving pregnancy rates oestrus repeat breeding crossbred cattle. *Indian J. Anim. Sci*., 77 (7): 544-548.

Devraj, M., Sachdev, A., Honnappa, T.G. and Krishnaswamy, A. (2006). Efficacy of certain immunomodulators in treatment of endometritis in cross-bred cows. *Proceed. XXII Annual Convention of ISSAR and National Symposium on "Innovative technologies for Fertility Enhancement in Livestock"* held at College of Veterinary Science and Animal Husbandry, Mhow (M.P.), 10th to 12th November 2006, pp. 115-116.

Diskin, M.G. and Morris, D.G. (2008). Embryonic and early foetal losses in cattle and other ruminants. *Reprod Domest Anim.*, 43: 260-267.

El–Wishy AB (2007). The postpartum buffalo II. Acyclicity and anestrus. Anim. Reprod. Sci. 97: 216 – 236.

Forde N, Beltman ME, Lonergan P, Diskin M, Roche JF, Crowe MA (2011). Oestrous cycles in Bos taurus cattle. Anim. Reprod. Sci. 124: 163 – 169.

Ghuman, S.P., Singh, J., Honparkhe, M., Dadarwal, D., Dhaliwal, G.S. and Jain, A.K. (2010a). Induction of ovulation of ovulatory size non–ovulatory follicles and initiation of ovarian cyclicity in summer anoestrous buffalo heifers (Bubalus bubalis) using melatonin implants. *Reprod. Domest. Anim.*, 45(4): 600–607.

Ghuman SPS, Singh J, Honparkhe M, Dadarwal D, Dhliwal GS, Singh ST (2010b). Fate of dominant follicle in summer anestrus buffaloes. Indian J. Anim. Reprod. 31(2): 7-10.

Kumar, P.R. (2012). Incidence of anestrus in buffaloes and its therapeutic management using PMSG and Insulin. M.V.Sc. Thesis, MPPCVV, Jabalpur.

Kumar S, Misra AK, Singh M (2005). Induction of oestrus in post-partum anestrus cows with Creastar, GnRH and hCG. Indian J. Anim. Sci. 75: 22 – 24.

Mandal, D.D., Srivastava, S.K. and Kumar, P. (2004). Effect of day of GnRH administration on conception rate in buffaloes. *Indian J. Anim. Sci.*, 74 (12): 1189-1191.

Mehrotra, S., Chaudhari, R.K. and Narayanan K. (2015). Improvement of fertility using buserelin acetate in repeat breeding cattle. *Indian J. Anim. Reprod.*, 36 (1): 50-52.

Mellado, M.., Zuñiga, A., Veliz, F.G., de Santiago, A., Garcia, J.E. J. and Mellado, J.E. (2012). Factors influencing pregnancy per artificial insemination in repeat-breeder cows induced to ovulate with a CIDR-based protocol. *Anim. Reprod. Sci.,* 134*:* 105-111.

Mondal, S., Prakash, B.S. and Palta, P. (2007). Endocrine aspects of estrous cycle in buffaloes (Bubalus bubalis): An overview. *Asian-Austr J Anim Sci.*, 20:124-131.

Noakes, D.E., Parkinson, T.J. and England, G.C.W. (2001). *Arthur's Veterinary Reproduction and Obstetrics.* 8th Edn., Harcourt (India) Pvt. Ltd., New Delhi, pp. 451-464.

Neglia, G., Restucci, B., Russo, M., Vecchio, D., Gasparrini, B., Prandi, A., et al (2015). Early development and function of the corpus luteum and relationship to pregnancy in buffalo. *Theriogenology*, 83: 959-967.

Pandey, A.K., Ghuman, S.P.S., Dhaliwal, G.S., Kumar, A. and Agarwal, S.K. (2013). Impact of buserelin acetate or hCG administration on day 12 post-ovulation on subsequent luteal profile and conception rate in buffalo (*Bubalus bubalis*). ***Anim. Reprod. Sci*.**, 136 (4): 260-267.

Perez-Marin, C.C., Moreno, L.M. and Calero, G.V. (2012). Clinical approach to the repeat breeder cow syndrome. In: Perez-Marin CC, editor. A birds eye view of vet medicine. In Tech Open, p. 337-362.

Parmar, C.P., Patel, D.M., Hadiya, K.K., Dhami, A.J., Buhecha K.V. and Sarvaiya, N.P. (2015). Fertility and plasma progesterone profile in repeat breeding cows and buffaloes in ovsynch and mid-cycle PGF2α treatment protocols. *Indian J. Anim. Reprod.*, 36 (2) *:* 29-32.

Purohit, G.N. (2008). Recent developments in the diagnosis and therapy of repeat breeding cows and buffaloes. CAB Reviews Perspectives in Agriculture Veterinary Science Nutrition and Natural resources; 3 (62):1-33.

Purohit, G.N. (2014). Ovarian and oviductal pathologies in the buffalo: occurrence, diagnosis and therapeutic approaches. *Asian Pac. J. Reprod.*, 3: 156-168.

Purohit, G.N., Duggal, G.P., Dadarwal, D., et al. (2003). Reproductive biotechnologies for improvement of buffalo: The current status. *Asian Austr J Anim Sci*., 16:1071-1086.

Pursley, J.R., Mee, M.O. and Wiltbank, M.C. (1995).Synchronization of Ovulation in Dairy Cows using PGF2alpha and GnRH. *Theriogenology*, 44: 915-923.

Rahman MS, Shohag AS, Kamal MM, Parveen N, Shamsuddin M (2012). Application of Ultrasonography to Investigate Postpartum Anestrus in Water Buffaloes. Reprod Dev Biol 36(2): 103 – 108.

Raja, S., Devanathan T.G., Kulasekar, K., Pazhanivel, N. and Balachandran, C. (2012). White side test and endometrial biopsy for diagnosis of Endometritis in repeat breeding cows. *Indian J. Anim. Reprod.* 33 (1) : 56-58.

Savalia, K.K., Dhami, A.J. and Patel, K.R., (2013). Influence of controlled breeding techniques on fertility and plasma macro-minerals profile in conceiving and non-conceiving anestrus and repeat breeding buffaloes. *Indian J. Field Vets.*, 9:28-35.

Sharma, H.C., Dhami, A.J., Sharma, S.K., Sarvariya, N.P. and Kavani, F.S. (2008). Assessment of estrus detection and insemination efficiency of AI workers in buffaloes through plasma progesterone profile under field conditions. *Indian J Anim Sci*, 78: 706-709.

Sheldon, I.M., Bushnell, M., Montgomery, J., et al. (2004).Minimum inhibitory concentrations of some antimicrobial drugs against bacteria causing uterine infection in cattle. *Vet. Rec*., 155:383–387.

Sheldon, I.M., Price, S.B., Cronin, J., Gilbert, R.O, and Gadsby, J.E. (2009). Mechanisms of infertility associated with clinical and subclinical endometritis in high producing dairy cattle. *Reprod. Dom. Anim.,* 44: 1-9.

Shukla, S.N., Agarwal, S.K., Shanker, U., Varshney, V.P. and Majumdar, A.C. (2005). Ovarian function and restoration of fertility using insulin in acyclic dairy cattle. *Indian J. Anim. Sci.* ,75: 1135 – 1139.

Singh, M., Chaudhari, B.K., Singh, J.K., Singh, A.K. and Maurya, P.K. (2013). Effects of thermal load on buffalo reproductive performance during summer season. *J. Biol. Sci.*, 1(1): 1 – 8.

Singh N., Nanda A.S. and Singh J. (2008). Assessment of factors affecting conception rate in cross-bred cows following AI under field conditions. *Indian J. Anim. Reprod.*,29: 211-215.

Srivastava, S.K., Sahni, K.L. and Mohan, G. (1998). Time of insemination and conception rate in cows and buffaloes under field conditions. *Indian J Anim Sci.*, 68:129-130.

Tandle, M.K. and Purohit, G.N. (2013) Genital tract affections in the buffalo. In: Purohit GN, editor. *Bubaline Theriogenology*. Ithaca NY: International Veterinary Information Service. http://ivis.org/advances/purohit/chap24/chapter.asp?LA=1.

Willard, S., Gandy, S., Bowers, S., Graves, K., Elias, A. and Whisnant, C. (2003). The effects of GnRH administration post-insemination on serum concentrations of progesterone and pregnancy rates in dairy cattle exposed to mild summer heat stress. *Theriogenology*, 59: 1799-810.

* * * * *

EDITION
2021

SAU - Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg, Chhattisgarh

National Institute of Agricultural Extension Management (MANAGE), Hyderabad