ANIMAL HUSBANDRY AND VETERINARY SCIENCE

Malathi. H
Dr. R. L. Meena

BOOKS ARCADE

Animal Husbandry and Veterinary Science

Animal Husbandry and Veterinary Science

Malathi. H
Dr. R. L. Meena

BOOKS ARCADE
KRISHNA NAGAR, DELHI

Animal Husbandry and Veterinary Science

Malathi. H
Dr. R. L. Meena

BOOKS ARCADE

Regd. Office:
F-10/24, East Krishna Nagar, Near Vijay Chowk, Delhi-110051
Ph. No: +91-11-79669196, +91-9899073222
E-mail: info@booksarcade.co.in, booksarcade.pub@gmail.com
Website: www.booksarcade.co.in

Year of Publication 2023

International Standard Book Number-13: 978-81-19199-62-4

CONTENTS

CHAPTER 1
DOUBLING FARMERS' INCOME: ROLE PLAYED BY ANIMAL HUSBANDRY AND VETERINARY SCIENCE

Malathi.H, Assistant Professor
Department of Life Science, School of Sciences, Jain (Deemed to be University), Bangalore, India
Email Id- h.malathi@jainuniversity.ac.in

ABSTRACT:

In India, the cattle industry is crucial to boosting farmers' livelihoods. The Department of Animal Husbandry, Dairy and Fisheries developed a number of plans to boost milk output, improve the quality of native animal breeds, and increase feed and fodder availability. The income of farmers may be quadrupled via a number of programs that are undertaken at the federal and state levels, including the Rashtriya Gokul Mission, the Livestock Health and Disease Control Program, the Dairy Enterprise Development Program, and others. Farmers may also get financial assistance from organizations that support policies, such as the Kisan Credit Card, women's SHGs, farmer's federation, and Non-governmental organization (NGOs). The department of animal husbandry also plays a significant role in educating farmers by holding village-wide vaccination clinics for diseases like FMD, PPR, and HS. It also helps farmers understand best practices for managing their livestock and the advantages of diversifying their animal husbandry operations.

KEYWORDS:

Agriculture, Animal husbandry, Farmers Income, Livestock management, Non-governmental organization (NGOs).

INTRODUCTION

India is an agricultural nation and the majority of people in the nation rely on agriculture as their primary or secondary source of income and employment, whether directly or indirectly. Animal husbandry plays a significant role in our nation's agricultural system. The majority of farmers in our nation use a mixed agricultural system in which animals play a significant role. Animal husbandry emerges as a prospective business to boost farmers' income over time, when land holdings are divided and agricultural output looks to be reaching saturation. In this sense, veterinary science is crucial for the treatment of sick animals, for maintaining the wellbeing and productivity of livestock, and for increasing productivity in livestock. A cherished goal of our Honourable Prime Minister Shri Narendra Modiji to double farmer income has recently acquired traction. There are many ways to accomplish this revenue doubling for farmers. The current discussion aims to provide light on the role that the animal husbandry industry and veterinary science played in the doubling of farmers' income [1]–[3].

Farmers' Earnings from July 2012 to June 2013, the monthly income for farm families was INR 6491, or Rs. 77,888. According to a related NSS survey conducted during the same time period in 2002 and 2003, the average monthly income for agricultural families was INR 2,115. In terms of actual household earnings from 2002–2003 to 2012–2003, this amounts to a CAGR of 3.4%. Real income from crop cultivation, revenue from livestock, income from nonfarm business, and income from salaried/wage work all show a CAGR of 3.7%, 14.3%, -0.1%, and 1.4%, respectively, during the same time period. In comparison to other revenues, the rise of income from livestock was quite strong, and it rose from 4% to 13% of the total income of a farm family.

Increase in Productivity; b) Incentive structure in the form of remunerative prices for some crops and subsidies on farm inputs; c) Public investments in and for agriculture; d) Facilitating Institutions. The past strategy for development of the agriculture sector in India has focused primarily on raising agricultural output and improving food security. The plan made no mention of the need to increase farmers' income and didn't include any specific actions to advance their wellbeing.

The Prime Minister declared that it was his hope that farmers' incomes will quadruple by 2022, when the nation would have achieved 75 years of independence, during a speech at a Kissan Rally in Bareilly, Uttar Pradesh. 100.4 percent yearly growth rate is necessary. Method for Increasing Farm Income Four categories may be used to group the sources of income and production growth: I institutional processes, (ii) technology, (iii) policies, and (iv) development projects, including infrastructure [4], [5]. Mathematical framework for tripling farmers' income: Roadmap and Action Plan

(1) Increased agricultural output (2) Increased livestock production (3) Increased input utilization efficiency (cost saving) Intensification of agricultural production (iv), diversification toward high-value crops (v), farmers' improved price realization (vi), shift of cultivators to non-farm occupations (vii), and

Economics & Animal Husbandry: The total value of the livestock sector's output in 2018–19 was Rs. 11, 59,636. The livestock industry makes up 25.6% of all of agriculture's GDP and adds 4.11% to it.

Increase the farmer's revenue by twofold

Support the wellbeing of farmer’s use of cutting-edge technology that aids in increased output and farmer expansion. The Department of Animal Husbandry, Dairy & Fisheries also develops several programs and Yojnas to support farmer welfare. A good example is ENAM (Electronic: National Agriculture Market). Pradhan Dairy Enterprise Development Program, National Livestock Mission, Mantri Fasal BimaYojna (PMFBY), etc.

Agricultural distress

India is the second-largest agricultural producer in the world. Since the weather, crops, and markets are so unpredictable, farming may be an extremely dangerous enterprise. For small farmers, this uncertainty caused agricultural misery for many.

An increase in farmer suicides

Farmer’s suicide is a highly complicated problem that is often linked to psychological, social, and economic difficulties. Increased production costs, globalization, and financial exploitation, as well as crop failures on an ongoing basis, natural disasters, and a lack of other means of income, are some of the factors that contribute to farmer suicides. Rural kids are less inclined to pursue farming Lack of finance and a bad reputation for farming make young people less interested in and eventually abandon farming. Due to declining agricultural viability and income, young people are giving up on farming. The Indian Ministry of Agriculture and Farmers Welfare has devised two programs, Attracting and Retaining Youth in Agriculture (ARYA) and Rural Entrepreneurship Awareness Development Yojna (READY), to educate rural youth about farming. Concept affecting agricultural prowess: The capacity of farmers is also impacted by the introduction of contemporary technologies such as hybrid seed, crop variety, advanced equipment, water irrigation techniques, fertilizers, pesticides, milking procedures, and skill development programs. Enhance financial situation: By generating new sources of income like dairy farming, poultry farming, animal farming, etc., diversification is

a major technique in improving the financial situation of farmers. Provide farmers information on improving seed quality, restoring soil fertility, and supporting the livestock and agricultural industries in rural areas. Improvements in the economic situation of farmers are made possible by the implementation of livestock policy measures and livestock development programs [6].

Getting rid of poverty: In India, around 21.90% of the population lives in poverty. India's poverty is mostly concentrated in rural agricultural areas, where farm women, men, and children must juggle several sources of income and struggle to obtain essential services like education, healthcare, and water supplies. Improve livelihood: Small-scale farmers, who often have less than 2 hectares of land and rely on family members for labor, face a number of challenges. Different inputs Contract farming and integrated farming assist to improve access to financing and input resources via diversity.

Source of the farmer's income increase

Increasing animal production

Semen straw is in short supply, which is the primary cause of poor A.I. To get to the suitable A.I amount, we need 160 million doses of semen straws in contrast to the 81 million that are already available. Enhancing dairy animal production and efficiency: Management of health, management of nutrition and housing, and avoidance of illnesses of reproduction such anestrous, delayed puberty, and delayed heat. The production of dairy animals is increased through improved genetic material and a variety of breeding techniques.

The creation and spread of technology

Information technology is used in livestock to provide information connected to cattle, such as vaccination alerts that may be sent by mobile service before monsoon.

Diversification

Animals are crucial to the wellbeing of Indian farmers. For agricultural households, crop-livestock diversification is the best means of subsistence. With the help of this system, farmers' incomes are more stable and their food supply more secure. For more than 70 million small and marginal farmers, the livestock industry alone offers an alternate source of income. The production of meat, eggs, wool, and their byproducts is becoming more essential as a means of diversification [7], [8].

Value augmentation

A product is changed and transformed from its initial condition to a more valued one via the process of value addition. Product development may raise the value of items like milk and meat. If local farmers participate in value-adding activities that raise the value of animals, they will also gain.

Livestock industry's function

The livestock industry is a significant portion of India's agricultural sector. Animal husbandry supports the livelihood of two-thirds of rural households, particularly landless and marginal farmers who own between 70 and 75 percent of the livestock population. It is a significant livelihood activity for the majority of farmers, providing agriculture with essential inputs, supplementary income for the household's health and nutrition, employment opportunities, and finally serving as a reliable "bank on hooves" in times of need. It serves as an auxiliary and complementary business. Gross domestic product (GDP) contributions from the livestock industry, which account for 4.11% of national GDP and 25.6% of agriculture's GDP (2012).

Several plans for dairy development

Emphasis of the national dairy development initiative is on establishing and strengthening infrastructure for the production, acquisition, processing, and marketing of high-quality milk. The goal of the dairy entrepreneurship development program is to increase self-employment in the nation's dairy industry. Under the aid of NABARD, this program is being carried out. Phase 1 of the national dairy plan: The scheme's goal is to enhance milk output by breeding and feeding dairy animals more productively in order to keep up with the fast rising demand for milk. A major government initiative called NDP1 is being carried out by the National Dairy Development Board. By 2022, the milk production goal has been maintained at 254 million tonnes.

DISCUSSION

Development of Poultry (DAHD)

Our nation produces 729.21 million chickens. Around 88 billion eggs were produced in 2016–17 (DAHD, Annual Report 2017–18). About 69 eggs are available per person year in 2016–17. By a variety of programs, poultry farming is encouraged in order to improve the socioeconomic situation of the farmers and to produce wholesome food for society. For instance, provide instruction in poultry rearing and a payment of $2,000 to farmers who are interested in raising poultry. Offer farmers with affordable chicken feed as well as additional technical services like immunization, treatment, debeaking, etc. Intensive Poultry Development Block carries out these plans.

Boost the output of dairy animals

India has extremely low milk output per cow (2-4 kg/day) as compared to other nations. Several breeding programs and breeding techniques, such as inbreeding and out-breeding, are used to increase animal output, which may quadruple a farmer's revenue. 2018. Increase in the amount of feed available According to studies, India has a 10% shortage in dry fodder, a 35% deficit in green fodder, and a 33% deficiency in concentrate. Hence, dietary modification, microbial modification, and increased fodder crop output enhanced the availability of fodder. Livestock husbandry is crucial in helping farmers' incomes double. There are many methods to make this a reality.

- The potential of animal husbandry in terms of the use of cutting-edge technology to increase output and revenue in contrast to the oversupplied agricultural producing sector.
- The emergence of a brand-new sector in pet animal care, which aids farmers in breeding and selling pets.
- Extending the network of veterinary schools, universities, and institutions to improve the efficient provision of veterinary services and extension education.
- The federal and state governments have placed more emphasis on the need to protect rural livelihoods via animal husbandry.
- SHG networks that are developing. Operated mostly by women. Primary employment is animal husbandry.
- The intensification of animal husbandry practices.
- Using ICTs for marketing information, faster technology diffusion, etc. The industry of animal husbandry is predicted to increase quickly as a result of this.

- Farmers have a special opportunity to boost their revenue by capitalizing on the rising trends in health concern for organic and Natural livestock products and the resulting demand for such items.
- Another effective method for boosting farm family income quickly is the integrated farming system (IFS).

The country's livestock productivity is relatively poor. The typical milk output for an in-milk buffalo is 4.90 kg and for an in-milk cow is 3.1 kg. According to estimates, the productivity of the in-milk population has increased and the quantity of livestock has increased, which is the main driver of the milk production rise of roughly 37%. This kind of expansion brought on by an increase in animal population is unsustainable. Raising livestock production requires taking significant steps including breeding improvements, improved feed and nutrition, improving animal health, and improving herd composition. The goals listed below are considered for development activities by 2022–2023:

Just 35% of cattle and buffaloes in India have access to artificial insemination (AI). Semen straws are the primary cause of poor artificial insemination rates. To get to a tolerable level of Al, we need 160 million doses of semen straw as opposed to the 81 million that are now available. As of right now, 6 million breedable indigenous cattle, 1.3 million breedable cross-bred cattle, and roughly 4 million breedable buffaloes have never given birth. By 2020, there should be at least 2 million buffaloes, 0.8 million crossbred cattle, and 3 million native cattle with extra calves. By 2020, the age of puberty in buffaloes must be lowered by three to four months. Nowadays, murrah buffaloes are around 33 months old when they reach puberty [9]. Hence, the possible sources of growth include an increase in artificial insemination, better feed (better feeding management/better nutrition), an improvement in herd quality, a shorter calving interval, and a lower age at first calving.

Achieving a higher price realization, effective post-harvest management, competitive value chains, and adoption of related activities may easily account for around one third of the increase in farmers' income. This necessitates extensive market, land-lease, and tree-planting changes on privately owned property. Due to a lack of contemporary resources, including money and expertise, agriculture has suffered. Agriculture has to be liberalized to draw ethical private investments in production and market. Similar to FPOs, FPCs may significantly contribute to the promotion of small farm businesses. In many states, ensuring MSP for agricultural products alone via a competitive market or government involvement would lead to a significant boost in farmers' income. The country can double farmers' incomes by 2022 if the Center, all States, and all UTs work together in harmony and under a single, well-defined plan.

Management of the home and health

Enough space for each animal, avoiding overcrowding of animals, and appropriate In an animal shelter, sufficient ventilation, water management, food management, and cleanliness should be provided. Farmers should contribute to the comfort and welfare of the animal as well as to its management.

Commercial farming

By establishing a helpful institutional mechanism and conducting regulatory and policy framework for contract farming, it is possible to improve the production and marketing of agricultural produce livestock and its products through holistic contract farming. It is also possible to make it easier for the parties involved to develop a system of contract farming that is efficient and mutually beneficial.

A plan for enhancing livestock production

Balanced rationing

Livestock feed is the most important component in the production of livestock, and the main productivity issues are feed scarcity, low nutritional quality of feed, and imbalanced feeding. Feeding dairy animals in a balanced ratio boosts production while lowering feed costs. It also offers dairy producers advice on the ideal amount of dry feed, green feed, and concentrate supplements to provide dairy animals based on their age, breed, weight, and lactation stage. According to study, ration balancing interventions increase the production of cows by around 13.00% and that of buffaloes by 5.50%. With only a 5% increase in milk output (price) and a 5% decrease in feed costs, ration balancing intervention may quadruple the farmers' revenue.

Increase the availability of forage

To reduce the chance of failure, intercropping and mix cropping are often utilized. Low water-requiring, short-duration forages, such cow peas and cluster beans, may be interplanted with long-duration crops, like sorghum and pearl millet. By growing fodder crops as catch crops in between the primary cropping seasons, fodder output may be boosted.

Feed bank

The establishment of fodder banks in regions with a lack of fodder via dairy federations and organizations may assist small farmers in providing for their animals in times of shortage. Fodder banks can also be crucial in times of drought.

An increase in nutritional value

Paddy straw, wheat straw, maize stalk, sugarcane, and bagasse all give a significant amount of dry matter but are low in nutrients owing to their high fiber content. To increase the nutritional content of such feed, procedures including urea treatment, water irrigation, and heat treatment are used. Moreover, this will increase the amount of fodder storage.

Diminution of the herd size

Instead of keeping a high number of underfed animals, farmers need to be made aware of the need to minimize herd size and provide optimal nutrition.

Enhancement tactics

- By holding a camp in communities to encourage local resident’s farmers to use better methods for managing their cattle.
- The growth of local organizations like co-operative societies and SHGs, which provide loans and financial assistance to farmers in times of need.
- Creation of common fodder supplies that lessen the lack of fodder at a time of scarcity
- Appropriate deworming and immunization of animals may lower the risk of infection.

Veterinarian’s part in increasing a farmer's profits income

Provide livestock producers with strategies for managing their animals' housing, health, and nutrition, as well as the avoidance of illnesses with high economic impact. Demonstrating facts for prompt vaccination. Inform the landless and small farmers on livestock policies and programs, the dairy entrepreneurship development program, and the national livestock mission. Impart information about milk's value addition and milk's various products, as well as provide

guidance for export. Inform farmers about the advantages of industry diversification in the animal husbandry sector.

CONCLUSION

By 2022, farmers' actual earnings will have doubled is a difficult job that can only be accomplished by correctly using the relevant tactics. Since farming is a specialized occupation, the government's numerous skill development programs may help individuals become proficient and motivated. Farmers need to be made aware of the prospects for commercialization and diversification, improved technology, infrastructure, markets, insurance, climate change, governmental laws, etc. Farmers needed to become entrepreneurs in order to use innovation and technology to quadruple their revenue.

REFERENCES

[1] P. Bhavyabhanu, A. Pandian, P. Vinothini, and S. Mathanghi, "Analysing the Consumer Preference for Dairy Products in Trivandrum City, India," *Int. J. Sci. Environ. Technol.*, 2017.

[2] P. A. Reshi *et al.*, "A Pilot Study on Horti-Poultry Integrated Farming Model," *Curr. J. Appl. Sci. Technol.*, 2022, doi: 10.9734/cjast/2022/v41i231648.

[3] E. S. Swai, S. Masaaza, and C. J. Daborn, "Evaluation of community animal health delivery systems in Simanjiro, Tanzania," *Livest. Res. Rural Dev.*, 2014.

[4] B. A. Reiling, T. T. Marshall, J. H. Brendemuhl, J. A. McQuagge, and J. E. Umphrey, "Experiential learning in the animal sciences: Development of a multispecies large-animal management and production practicum," *Journal of Animal Science*. 2003. doi: 10.2527/2003.81123202x.

[5] A. T. Niba *et al.*, "Current situation of cavy production in Cameroon: Challenges and opportunities," *Livest. Res. Rural Dev.*, 2012.

[6] O. C. Madubuezi, "The Application of Information and Communications Technology (ICT) in Agriculture," *Int. J. Sci. Eng. Res.*, 2015.

[7] L. Hmar, S. Rahman, and L. Tochhawng, "Ran VulhtuteThian: The Smart Extension Services through Smart Phone in Picturesque Hills of Mizoram," *J. Ext. Syst.*, 2020, doi: 10.48165/jes.2020.36203.

[8] H. Bottermann, "Prevention and monitoring: tasks of the federal states in Germany.," *Int. J. Med. Microbiol.*, 2006, doi: 10.1016/j.ijmm.2006.01.057.

[9] D. O. Montiel, "Keeping goats or going north? Enhancing livelihoods of smallholder goat farmers through brucellosis control in Mexico.," *Keep. goats or going north? Enhancing livelihoods Smallhold. goat farmers through Brucell. Control Mex.*, 2014.

[10] I. Hussain *et al.*, "Impact of Different Crude Protein Levels on Growth of Lambs under Intensive Management System," *Int. J. Adv. Res. Journalwww.journalijar.com Int. J. Adv. Res.*, 2014.

[11] A. Manhique, "Optimisation of Alkali-Fushion Process for Zircon Sands: A Kinetic Study of The Process," *Scientifica (Cairo).*, 2016.

CHAPTER 2
BEST PRACTICES FOR ANIMAL HUSBANDRY TO DOUBLE FARMER INCOME

Renuka Jyothi.S, Assistant Professor
Department of Life Science, School of Sciences, Jain (Deemed to be University), Bangalore, India
Email Id- j.renuka@jainuniversity.ac.in

ABSTRACT:

Proper husbandry techniques enhance the environment for the animals, stop animal stress that causes illness, and generally lessen the need for veterinary assistance. so enabling natural growth and expansion of your goods, stock, and output to fulfill the needs of human consumption. The following key tenets serve as the foundation for the approach to double farmers' income: Realizing increased productivity will result in an increase in overall production across the many agricultural sub-sectors. Lowering/rationalizing the manufacturing cost. Ensuring that agricultural output is valued at fair rates.

KEYWORDS:

Agriculture, Animal Husbandry, Dairy Industry, Infertility, Veterinary.

INTRODUCTION

Good Practice

A good practice is just a procedure or approach that reflects the most efficient means of reaching a certain goal. While it is questionable if there is a single "best" approach because techniques are, of course, continuously growing and being updated some individuals prefer to use the phrase "excellent practice." Hence, another approach to describe a good practice is one that is suggested as a model because it has been shown to function effectively and provide excellent outcomes. Learning from others and using information is the core of recognizing and sharing excellent practices. The main advantage is the presence of well established procedures built on years of expertise. Utilizing ICTs; effectively reaching women and socially excluded groups; connecting farmers to markets; building capacity; decentralizing extension; financing extension; the role of farmer organizations; partnerships and collaboration; addressing nutrition through extension; pluralism and coordination; developing extension policy; and adapting to climate change are examples of good practices in extension and advisory services [1], [2].

Good methods in the dairy industry and in animal husbandry, however, have proven crucial to increased output and productivity. Over the years, despite numerous attempts to encourage scientific practices in the field, there has been a poor response from the farmers. This could be because of significant obstacles like a lack of awareness and resources, the farmers' poor socioeconomic status, the high cost of production, limited market access, etc. Moreover, cooperation amongst different stakeholders is essential for establishing excellent practices in the animal husbandry industry for sustainable means of living. For a sustainable way of life, it is necessary to conduct livestock-based research and extension operations in the field. This book has explored several growth methods for the Karnataka animal husbandry industry and has concentrated on various participatory research and extension activities carried out via various projects by various funding bodies. The following projects and a few other pertinent experiences of the writers provide the foundation for some of the significant actions covered in this article.

Based on water channel flow and socioeconomic circumstances, the project is carried out by the Government of Karnataka's Watershed Development Department, which is funded by the World Bank. Seven project districts in Karnataka are where these initiatives are carried out. The Sujala III project, sponsored by the Karnataka Watershed Development Department and supported by the World Bank, was carried out at the Veterinary College of Bidar from December 2014 to the present. Individual farmers and members of producer groups (such as the Karnataka Milk Federation, private milk societies, etc.), the State Department of AH&VS, the State Department of Agriculture, and others participated in the research [3]–[5].

United Nations Sustainable Development Goals and the Livestock Sector

In response to the ever-increasing needs of the rising population, particularly in emerging nations, the highly dynamic livestock business is evolving quickly. Since site-specific integration of crops with livestock is essential to achieving various SDGs, wise management and eco-intensification of livestock-based systems may help solve the formidable problem of advancing the UN's SDGs as the shown in Figure 1. In particular, good livestock management may achieve SDG #1 (No Poverty) by boosting both small-scale farmers' and commercial farmers' incomes. Livestock is not just a source of food for small landowners in developing nations; they are also a source of renewable energy via draft animals, the use of dung as domestic fuel, and a supply of manure as a crop fertilizer.

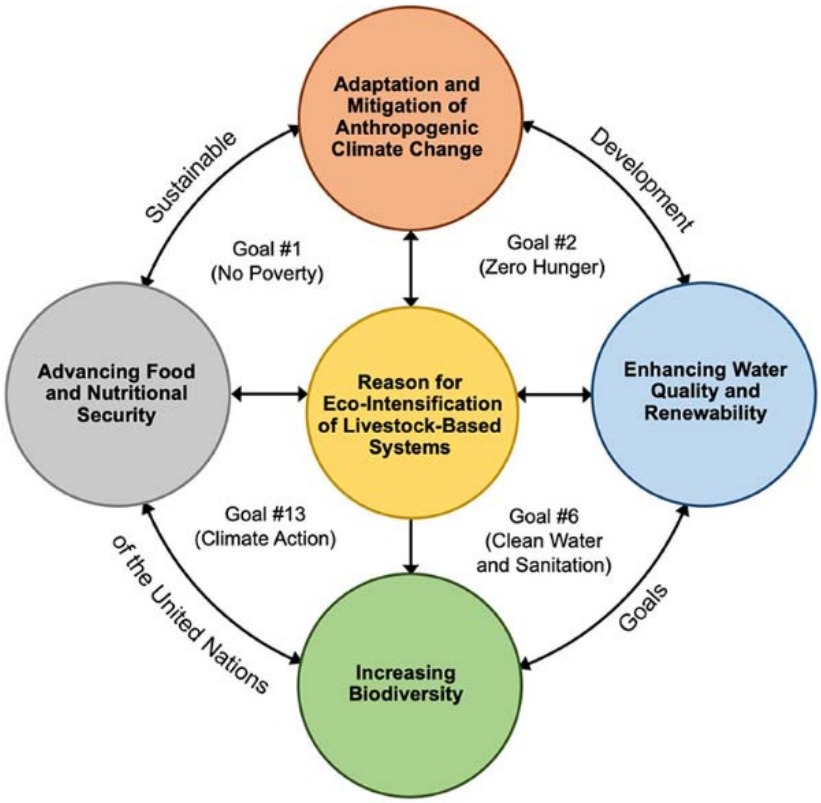


Figure 1: Illustrate the Sustainable intensification of livestock-based systems to promote the SDGs.

Based on the findings of a baseline study done in the project region by KVAFSU, Bidar, production techniques and significant deficiencies in the industry were found. Technical interventions were adopted in conjunction with technical experts, field officials, and the agricultural community to solve the aforementioned key deficiencies.

Techniques Used in the Research

- As the Veterinary College of Bidar undertook the Sujala-III project in this area, the Bidar district was chosen using the purposeful sampling approach.
- The Government of Karnataka (India) designated 14 project villages, and a baseline survey in those villages as well as several meetings and awareness campaigns in those villages set the way for generating knowledge and enthusiasm in various scientific techniques in farmers' fields.
- Throughout the project region, a variety of technical interventions were adopted based on the baseline survey and significant gaps.
- Field day and workshops/awareness programs on identified treatments
- On-farm demonstrations of enriching dry feed and using unorthodox, low-quality feeds
- On-Farm Silage Making Demonstrations Using Silo Bags
- On-Farm Experiments on the Incorporation of Feed and Feed Trees in Horticulture Crops on Bunds of Farm Ponds. (Livestock and gardening)
- Goat feeding tests conducted on farms during the changeover period
- Participatory Study on Subclinical Mastitis Identification and Management
- Creation of fodder nursery (minimum of 5 kinds in 2 guntas each); introduction of rams or bucks; and promotion of sesbania as livestock fodder are all production units.
- Multidisciplinary teams performed educational programs, training sessions, field days, and demonstrations regarding the production of fodder and its significance for the recipients. The study used a before-after research design to determine the effect of these programs in the project communities.
- Before to and during the implementation of the awareness and demonstration program, adoption studies, knowledge tests, and attitude tests concentrating on the scheme's goals were carried out in the project villages.

ESTABLISHMENT OF FODDER NURSERY FOR DAIRY DEVELOPMENT

For the growth of the dairy industry, it is crucial to build a fodder nursery and distribute seeds and root slips to the agricultural community via integrated and participatory extension methods. Following Good Practices Advantages and Effect Trainings, demonstrations, and awareness campaigns

Technical staff/human resources:

Establishment of a fodder nursery and demonstration plot; Access to inputs; Farm literature and videos; Convergence of multi-stakeholder/actor groups; Increase in fodder production and farmers' interest; Horizontal diffusion of fodder production practices; Preference for fodder cultivation; Improved knowledge of dairy farmers; Increased quantity and quality of milk; Increased economic returns; Promotion of an appropriate fodder variety; Silage making by benefit [6], [7].

On-farm demonstrations: Adding nutrients to dry feed and using high-quality novel feeds. In India, crop leftovers are the most common source of animal feed and have enormous potential

as a feed ingredient. In this situation, enrichment using urea is taken into consideration as a feasible solution at the field level to increase the value of such low-quality feedstuffs. While urea-treated straw is more appealing and digestible, this method has drawbacks that prevent it from being efficiently introduced to field settings. Throughout the project villages, this practice is carried out utilizing various wastes, including sugarcane waste, jowar straw, paddy straw, etc.

On-farm demonstrations: Using silo bags to create silage

One of the significant issues farmers confront throughout the summer is a lack of green fodder supply. As a result, silage production utilizing silo bags was started since it offers benefits over traditional silage production.

The more expensive traditional method of preparing silage requires cement containers that are airtight and waterproof. As a result, reusable silage bags of various sizes are inexpensive and may be stored in various locations. There are many silo-bag kinds with capacities ranging from 2 quintals to 10 quintals. Even little holders may use this strategy [8]. In the project communities, farmers have started utilizing silo bags to make silage.

In order to carry out expertise-based interventions in 20 pilot villages across seven districts in the Bundelkhand area of Uttar Pradesh, ICRISAT has chosen and formed a collaboration with the financial backing of the state government of Uttar Pradesh. This project was carried out by the ICRISAT Development Center, ICRISAT, Patancheru from May to June 2017 to the present. The experience presented is from the project villages of that project. Individual farmers, members of various organizations, officials from the state departments of agriculture and AH&VS, BISLD, and non-governmental organizations were all participating in the research [9].

Program Design:

- In May 2017, the pilot sites encompassing about 5000 hectares (hydrological border) in all seven districts were selected with assistance from district administration and employees of the department of agriculture. In each district, a group of two to three villages was chosen to serve as the test site.
- A baseline survey of 1400 farmers from 20 chosen project villages, or around 200 farmers from each district, was conducted. The investigation included the state of, and problems with, agriculture and the care of farm animals.
- Several issues, including anna pratha, the presence of low-yielding dairy animals, poor access to veterinary and breeding services, a lack of production of green fodder, etc., were identified as the critical gaps in the dairy sector of the Bundelkhand region based on the results of the baseline survey.
- To fill the important gaps that were found, the relevant institutions and organizations were found and given assignments as consortium partners in the project.
- With the aid of regional NGOs, ICRISAT attempted to build relationships with the community directly between May 2017 and June 2018. As shown in Table 1, ICRISAT established the coalition of institutions at the national level in the interim.

- Being leaders in the field of animal husbandry, ICAR-IGFRI and BISLD also carried out a preliminary assessment on the project areas' dairy animal population, breedable population, kinds of animals raised, potential for SSS and EPD, state of fodder production, etc.
- Several dairy development interventions, including as SSS, EPD, animal health and infertility camps, capacity building programs, green fodder production, etc., were started by the project partners based on the significant concerns highlighted.
- To determine the effect of these programs in the project villages, a before-after study approach was used in conjunction with participatory research.

Practices connected to technology

- Insemination with sex-sorted semen (SSS) at farmers' doorsteps
- Early pregnancy detection (EPD) on the doorstep of farmers
- Veterinary clinics and infertility clinics
- the generation of green feed
- Construction of rural biogas facilities

Practices relating to Extension

- Information distribution using mobile devices
- The creation of farmer interest organizations
- Farmer publications and videos
- Education and capacity-building initiatives
- Personnel for implementation and supervision

Advantages and Effect

- The consequence or outcomes of the interventions made at the project sites need enough time to prove their value and influence. Nonetheless, an attempt has been made to aggregate these advantages and impacts that have been seen so far in the project areas.
- An increase in female calves being born
- Low-cost early pregnancy detection
- Increased output of green fodder
- Increasing milk output and better financial results
- Making use of animal waste in rural biogas facilities
- Increased dairy producers' interest and knowledge level

CONCLUSION

Integrated extension strategies of consortium partners assisted the project teams in raising knowledge levels and putting the scientific advances being pushed into practice

with relatively little expenditure, notwithstanding the initial lackluster reaction from farmers to the programs. To increase output and productivity, policies must be changed to place more focus on input delivery and ongoing monitoring of extension activities. The author came to the conclusion that the farmers would embrace the excellent practice more readily in the current situation if they had access to key inputs and services, were aware of the practice, etc. Moreover, the farmers must be inspired to implement these treatments and build sustainability via participatory methods long after the initiative is finished. In order to ensure the sustainability of project operations and foster beneficiary participation, the project teams have also placed a strong emphasis on the creation of farmer interest groups. A formal or informal consortium approach between the stakeholders must be maintained for a few more years in such development-based programs, even if farmers now have sufficient information and a favorable attitude toward dairy growth. The integrated and collaborative method, however, may be used on a bigger scale in the long term to support livestock development or any other similar agricultural-based development programs for tripling farmers' income.

REFERENCES

[1] Y. Kogoya, G. D. Lenzun, and E. Wantasen, "Peran penyuluh peternakan dalam peningkatan pendapatan anggota kelompok peternak babi di Kecamatan Tompaso Barat Kabupaten Minahasa," *ZOOTEC*, 2021, doi: 10.35792/zot.41.1.2021.32384.

[2] S. Kunz, H. Hänke, and E. Schlecht, "Income diversification trough animal husbandry for smallholder vanilla farmers in Madagascar," *J. Agric. Rural Dev. Trop. Subtrop.*, 2020, doi: 10.17170/kobra-202004061143.

[3] C. Cevher, B. Altunkaynak, and M. Gürü, "Impacts of covid-19 on agricultural production branches: An investigation of anxiety disorders among farmers," *Sustain.*, 2021, doi: 10.3390/su13095186.

[4] W. Nkomoki, M. Bavorová, and J. Banout, "Factors associated with household food security in Zambia," *Sustain.*, 2019, doi: 10.3390/su11092715.

[5] D. Tekam, N. Sonawane, A. Bhanotra, and M. Sawant, "Doubling of Farmers Income through Animal Husbandry by 2022," *Int. J. Curr. Microbiol. Appl. Sci.*, 2019, doi: 10.20546/ijcmas.2019.802.379.

[6] G. S. Gultom and S. Suharno, "KINERJA USAHA TERNAK SAPI PERAH DI KELURAHAN KEBON PEDES, KOTA BOGOR," *Forum Agribisnis*, 2017, doi: 10.29244/fagb.5.1.47-66.

[7] E. L. Ferreira, R. A. Barros, and P. D. Bevilacqua, "Women working in animal husbandry: A study in the agroecological transition context," *Cienc. Rural*, 2020, doi: 10.1590/0103-8478cr20190149.

[8] K. Sah, P. Karki, R. D. Shrestha, A. Sigdel, A. T. Adesogan, and G. E. Dahl, "MILK Symposium review: Improving control of mastitis in dairy animals in Nepal," *Journal of Dairy Science*. 2020. doi: 10.3168/jds.2020-18314.

[9] Z. Han, C. Han, and C. Yang, "Spatial econometric analysis of environmental total factor productivity of ranimal husbandry and its influencing factors in China during 2001–2017," *Sci. Total Environ.*, 2020, doi: 10.1016/j.scitotenv.2020.137726.

[10] C. E. Meka and H. M. I. Nahak, "Dinamika Survival Petani dan Tantangan De-agrarianisasi," *Ganaya J. Ilmu Sos. dan Hum.*, 2022, doi: 10.37329/ganaya.v5i1.1492.

[11] A. Faraz, M. Younas, C. I. Pastrana, A. Waheed, N. A. Tauqir, and M. S. Nabeel, "Socio-

economic constraints on camel production in Pakistan's extensive pastoral farming," *Pastoralism*, 2021, doi: 10.1186/s13570-020-00183-0.

CHAPTER 3
ADVANCED FEED RESOURCES FOR LIVESTOCK FARM PROFITABILITY

Asha.K, Assistant Professor
Department of Life Science, School of Sciences, Jain (Deemed to be University), Bangalore, India
Email Id- k.asha@jainuniversity.ac.in

ABSTRACT:

The approximately 6% annual growth rate of cattle wealth in India. The greatest protection against the whims of nature, such as drought, starvation, and other natural disasters, is animals for livestock producers. Valuable animal products include milk, wool, egg, meat, etc. The proper use of animal products and byproducts has a direct influence on the nation's economy, environmental pollution, and ability to pay farmers more. Utilizing crop residues, utilizing non-traditional feed sources, adopting crop sequencing, crop rotation, and integrated farming systems with year-round access to lush, green pastures or fodders all contribute significantly to lowering the cost of feeding animals and maintaining environmental safety. The production of valuable products like Panchgavya, Jeevamrit, and Gau-mutra ark as well as the proper and prudent use of various milk products with value addition and animal byproducts of the dairy, meat, and skin industries as well as dung and urine have all received a lot of attention in recent years, which has improved both the socio-economic standing of farmers and the environment.

KEYWORDS:

Agriculture, Animal Products, Animal Husbandry, Dairy Industry, Livestock Farm, Veterinary.

INTRODUCTION

In underdeveloped nations like India, livestock serves as the ATM for the underclass. They increase their herds during prosperous times, and during difficult times, they sell cattle to get money. Especially in the country's arid and semi-arid areas, livestock stabilizes household income. Due to drought, starvation, and other natural disasters, livestock are the greatest protection against nature's whims. The lack of food and shelter poses a hazard to animals that survive severe disasters. In the same way that other agricultural crops are destroyed entirely, so are fodder fields. These animals are agitated and immune-suppressed due to lack of food and shelter, making them more vulnerable to infectious infections. Persistent feed shortages are a significant barrier to animal productivity.

The farmers who raise cattle lack any other means of support and are unable to decrease the number of animals they keep, the majority of which are underproductive. Thus, initiatives must be done to increase output by better using the many alternative feed supplies that are now accessible. Crop leftovers and other low-quality roughages and foraging materials make up the majority of the feed items that are readily accessible. Several other feed sources that are thought to be non-traditional feed sources have been identified and are now being used in animal rations. The non-traditional feed sources could have certain drawbacks, which means they might not taste good, be difficult to digest, or sometimes be poisonous to animals. They may be categorized into a number of groups according on where they came from [1]–[3] .

Millions of people in India, particularly in the arid and semi-arid areas, depend on animal husbandry as a means of subsistence. In India, 44% of the land is used for agricultural agriculture, while more than 69% of the nation's milk is produced by small and marginal

farmers who have less than 2 hectares of land. The productivity of small & marginal farmers in India will determine the country's future food security & sustainable agricultural development.

It offers a lifeline to two-thirds of rural communities, supplying employment to a significant number of young people who lack skills. Contrary to the national average of 14% for all rural families, livestock accounts for 16% of the income of small farm households. Moreover, 8.8% of the population who are mostly landless and unskilled are employed in the cattle industry. The dairy sub-sector has traditionally been significant in the cattle industry. Speaking for the National Dairy Development Board (NDDB), Nanda Kumar said that "Doubling farmers' income by 2022 is unachievable without dairy farming, which has a CAGR of 19.6%." In India, the marginal and small farmers make up 85% of the farming population; they own just 45% of the land but 75% of the cattle.

Dairying is definitely one of the better jobs for someone without land. Also, no one is unmoved by India's admirable position in the world of milk production, which accounts for 18.5% of global output (789 million tons). This was accomplished without assistance from subsidies or other inducements, and its monetary worth exceeds the present combined value of rice and wheat. Management has a vital influence in enhancing lactation efficiency in dairy cows since good and productive animals are always developed rather than bought [4] . Management is the art and science of integrating concepts, resources, tools, procedures, labor, and materials to effectively manufacture and sell a valuable product or service. By implementing scientific managemental interventions, livestock management significantly contributes to increasing farmers' income by lowering feeding costs, mortality, morbidity, age at maturity, age at first calving, and generation intervals, while improving peak yields, growth rates, fertility rates, prolificacy, and other production-related metrics.

DISCUSSION

Management-Related Measures

For a sustainable way of life as well as for the safety and wellbeing of cattle, management is crucial. The management interventions listed below must to be adhered to religiously. The primary management pillars for improving cattle are four.

- Breeding: Permit superior mating.
- Feeding: Offers a diet rich in greens for growth, maintenance, production, and reproduction.
- Weeding, or the culling of unwelcome and ineffective animals.
- Paying attention to: Implementing proper livestock management and general oversight, including housing, care, and sanitation and hygiene upkeep.

Focus should be placed on scientific management of livestock throughout each stage of life to maximize benefits to livestock owners.

Housing Management

To safeguard their cattle from bad weather, theft, improper feeding and raising, etc., livestock owners should construct more affordable, scientific homes. The animal housing should be situated in a region that is relieved. Well-lit, well-ventilated, elevated, with provisions for a fan, a curtain, etc. for the wellbeing of the animals.

Neonatal care and management:

Neonatals determine the future of livestock farms' reproductive and productive capacities as well as those of farmers. "Good animals are grown, not bought," the saying goes. As it is hard to routinely buy high-quality animals, one must grow their own neonates, or calves, in order to have a decent herd. Ineffective management is to blame for India's high neonatal death rate.

Neonatal care starts even before the baby is born. Undernourished and frail calves will be born from cows that are not properly fed. So, the owner of cattle should place appropriate attention on feeding advanced pregnant cows. Neonatals will also need intensive care during and after the delivery. Remove the mucus from the mouth and nose as soon as the baby is born to enable the mother to lick the calf. 10% of the body weight of calves is given as colostrum four to five times daily within 30 to 50 minutes after birth. Provides synthetic colostrum in the event that the mother suffers any injuries. Provide calf starter and milk replacement for the animal's early development. Antibiotic, probiotic, and prebiotic feeding should also be done. Farmers should be urged to get their scheduled vaccinations and deworming's [5], [6] .

Heifer care and management

The greatest foundational stock for a dairy herd are well-developed heifers. Heifers may be raised inside or outdoors, depending on the situation. Offers a maintenance diet; in the event of a breeding season or pregnancy, the livestock owner should provide extra concentrates for healthy conception and delivery. At least 0.5–1.0 kg more concentrates should be provided before to mating season, and 0.5–1.0 kg and 1.0–1.5 kg more concentrates should be provided throughout early and mid-pregnancy, respectively. Advanced pregnancy requires the use of steaming-up and challenge feeding techniques for a successful delivery and healthy calves that provide the most milk.

Caring and management of nursing animals: Farmers should place a strong focus on providing high-quality concentrates enriched with adequate fat and protein, excellent, lush green fodder, and roughage available all year long for their lactating or producing animals. Proper grooming, gentleness in handling, exercise, and consistency in care should all be observed [7].

Care and management of dry animals: The dry season is from the day the cows cease producing milk to the day the next calf is due. A dry interval is required for the udder tissues to heal and regenerate, giving the cow's udder time to relax and return to normal. Three drying techniques are available.

- Sudden milk stoppage
- Completely discontinuing milking
- Developing Livestock
- The owners of cattle should keep their records and the integrity of their genetic material.

Therefore stay away from outrageous cross breeding with subpar stray bulls. This will support keeping animals performing as productively and reproductively as possible. Reduced generation intervals and total milk output from the animals are both significantly impacted by timely and accurate heat detection using artificial intelligence (AI) or natural services. Teasure bull should be used to do the heat detection.

Feeding cattle

Owners of livestock should provide their animals a balanced diet consisting of high-quality

concentrates, roughages, and green grass. Provides chelated mineral combinations, 25 to 30 kg of excellent, luxuriant green fodder, and 4-5 kg of dry fodder combined with concentrates with high grade proteins enhanced with bypass fat and protein. Feeding of nutrigenomic and immunostimulatory herbal products, as well as prebiotics, probiotics, antibiotics, and antioxidants. The digestibility, productivity, and profitability of low-quality roughages should be significantly impacted by urea or NPN treatments. Feeding of UMMB and salt lick play important roles as well.

Green fodder availability

Farmers should develop a plan to ensure that excellent quality, lush green fodder is available all year long. This plan should include appropriate crop rotation, increased cropping intensity, and the planting of annual & perennial legumes alongside cereal fodder. In order to ensure that green fodder is available during the time of shortage, livestock owners should also store green fodder in the form of hay or silage during the month when it is available [8]. Usage of unconventional feed sources: When the harmful alkaloids are removed, using unconventional feed sources or scarce fodder is crucial for the survival of animals during natural disasters and for lowering feeding costs.

Hygiene and Sanitation

To reduce the spread of illness and death on the farm, livestock owners should place a strong focus on maintaining the cleanliness and sanitary conditions of the farm. The owner of cattle should take strict biosecurity measures. Routine health inspections, immunization of animals, and staff. The owners of livestock should place a strong focus on routinely checking the health of both their animals and the workers who care for and raise those animals. The recommended physician or veterinarian should immediately isolate and treat the patient. Animals must get vaccinations on a regular basis to be healthy and produce.

Marketing channel

The formation of a market for animals and livestock products should get proper consideration from the government. Due of the presence of the middleman, the cattle owner makes less money. As milk and other animal products are perishable by nature, having a deep freezer and a transportation facility available is necessary to extend their shelf life.

Animal replacement and culling

Eliminate the farm's less-productive animals. The rearing cost to profit ratio is significantly impacted by the underproductive or underproductive animals. Thus, constant culling and replacement of aged animals is necessary for the livestock owner to make a profit.

Adding value to milk and milk products

Value addition is the process of turning extra milk into sweets and other products like curd, cheese, paneer, butter milk, flavoring milk, kheer, paysam, etc. in order to extend the shelf life of the milk and boost revenue. Since there were no cooling facilities to keep milk cold in a warm area, milk was substituted by other milk products that had a somewhat longer shelf life.

Making use of animal byproducts

A major resource for feeding cattle is represented by animal by-products (ABPs), which include processed animal proteins, animal fats, milk and egg products, and former food items. So, in order to increase farmers' income and improve their socioeconomic condition, frequent awareness campaigns should be organized to raise knowledge of the usage of various animal

byproducts, such as dairy, manure, urine, and meat industry byproducts. There are several benefits to using animal dung as fuel for big livestock and poultry enterprises. Wastes are either cheap or less costly than kerosene, electricity, and the majority of natural gas. Manure may be used as fuel to reduce some of the expenses involved with disposing of it. Manure as a fuel also reduces runoff (non-point source pollution), odor, and other annoyances. The financial performance of the farm business may be enhanced by using animal dung as fuel. The most adaptable method of biomass conversion for an agricultural enterprise is often anaerobic digestion.

It generates biogas, which has an energy value of 60 to 80% more than that of natural gas and a heating value of around 600–800 Btu/cubic foot. The gas may be utilized to drive refrigeration equipment, a boiler or furnace, or to create electricity. In terms of generating power, mechanical energy, and gas for cooking, biogas is among the more significant energy sources. A clean and effective fuel is biogas. Methane (CH4), carbon dioxide (CO2), hydrogen (H2), and hydrogen sulfide are all present in it (H2S). Methane makes over 65% of biogas's composition. The anaerobic digestion method of turning cow manure into bio-energy may help livestock farms cut down on their greenhouse gas emissions. As a result, this method may be extensively used to produce biogas on a huge scale. Moreover, the produced methane may be used for cooking, heating, lighting, and energy production.

A dairy by-product is a product with a commercial use that is created during the production of a primary dairy product, such as paneer, cheese, chhana, buttermilk, or ghee. The main byproducts of the dairy industry include whey, buttermilk, ghee residue, skim milk, and buttermilk. Using dairy byproducts boosts plant productivity, provides vital nutrients for people, and lessens environmental pollution brought on by dairy waste. It is acknowledged that the efficient disposal of dairy waste is a crucial component of a successful dairy sector, as well as one that will improve farmer welfare and environmental health [9].

The main issues with the production and use of dairy by-products in some nations, such as India, are the following: low availability of milk per capita, higher proportion of buffalo milk, poor quality of raw milk, lack of organized product manufacture, inadequate technology, high cost of new technologies, lack of in-house R & D, inadequate infrastructure, lack of indigenous equipment and plants, etc. Prior to opening a by-product factory, it's crucial to take the plant's economics into account. In certain cases, the cost of producing a by-product may be higher than the value of the finished product, making opening a by-product factory unfeasible from an economic standpoint. However the economic viability of these may be increased with advances in science and technology, as well as factory automation.

Skim milk is mostly used in India for standardization or for preservation in spray-dried form. It is only necessary to utilize a very tiny amount of skim milk as a byproduct, most of which is of poor quality. The by-products of whey Whey production has increased proportionally to the enormous growth in the manufacturing of cheese and other coagulated milk products in India. The by-product produced when butter is made is butter milk. It is unknown how much buttermilk is produced in India precisely. Moreover, significant quantities of lassi (sour butter milk) are also produced while making makkhan straight from fermented milk (curd). An estimated 35 million tonnes of butter milk are produced in India each year. In terms of overall chemical makeup, sweet cream buttermilk and skim milk are similar, and they are often combined for spray drying or even product production in dairy factories. On the other hand, Desi butter milk has long been a popular household beverage in India. It is very nutritious and healing. It is also used in the creation of a variety of foods, including kadhi, dhokla, and idli. Also, a number of state dairy federations and private businesses offer 200 ml pouches of salted and spiced butter milk. Butter milk (chhach) is a product that Sumul, a company established in

Surat, sells around the city. In 500ml packets, "Sumul chhach" is available at more than 850 retail locations around Surat.

Energy, both renewable and non-renewable, has a significant impact on a country's capacity to grow. Animal by-products (ABPs), which comprise processed animal proteins, animal fats, milk and egg products, and previous food items, may be a useful source for feeding cattle. So, there are essentially two fundamental ways in which we might boost our cattle owners' income generation.

1. Leftovers from previous harvests and feeding
2. The ideal sources of food
3. Agriculture and industrial byproducts
4. Marine wastes, byproducts, and aquatic vegetation
5. Fruit and vegetable waste

Crop waste and more recent feeds

Unique straws such cotton straw, cotton seed hulls, sunflower heads, sugar cane bagasse, sawdust, wood pulp waste, dried grass and leaves from forests, banana leaves, pineapple waste, maize cobs, and groundnut hulls are used in ruminant diets. Moringa leaves, certain fruit peels, and some flower petals are used in chicken diets.

Important sources for feeds

Trees and shrubs generate green biomass with moderate to high protein and digestible concentrations. Top feed contains between 20 and 40 percent DM and 10 to 15 percent CP on DMB. Also, when tree leaves age, they lose their flavor, digestibility, and nutritional value. In the woods, there are 300-350MT of dried grass and leaves. To assist sheep maintenance and development, they may be added to feed formulations.

Agricultural byproducts of industry

They could account for 30–35% of ruminant feed. These meals' nutritious contents are diminished by impeachable or antinutritional compounds if permissible limits are exceeded, which may have a detrimental impact on reproduction and output. As a result, the proper treatments must be used to get rid of antinutritional reasons. Karanja cakes, neem seed cakes, and cashew bran are used as non-conventional feed sources for animals.

Marine wastes, leftovers, and aquatic vegetation

The industries for fish, prawns, frogs, and shrimp produce a number of by-products. Mostly waste from lobster, fish, frog, and fish, along with shark liver and squill leftovers. Water plants include Hydrilla, Salvinia, Myriophyllum, Pantaogeton, Ceratophyllum, Nymphaea, and Ipomoea quatica, to name a few. They are very succulent and have a moisture level of 92–94%. On DMB, the algae has modest levels of CF (5-8%), EE (6-8%), and CP (30-70%). Algal protein is metabolized by sheep at a rate of 54% and 72%, respectively. On DMB, water hyacinth provides cattle with 2.84, 24.95, and 44.69% DCP, SE, and TDN, respectively.

Discarded produce and food waste

Fruit and vegetable processing, packing, distribution, and consumption result in around 1.81, 6.53, 32.0, and 15.0 million tonnes of fruit and vegetable wastes (FVW) being created in India annually. Animals who are nursing may consume fresh banana leaf up to 15% of the time

without it having an impact on their milk supply. It may also be administered after ensiling with wheat straw or broiler litter (40:60). (75:25). Cows that are nursing may ingest banana peels at concentrations of 15% to 30% without experiencing any detrimental effects on flavor or performance. When fed to maturing pigs at levels up to 20% of the diet or to rabbits at levels up to 30% of the diet, dried, ripe banana peels had no adverse effects. Dried citrus pulp is used as a grain substitute in concentrate mixes because to its high net energy (NE) value (1.66-1.76 Mcal/kg DM) for nursing dairy cows. It may take the place of up to 20% of the concentrate in the diets of dairy cattle.

Without up to a 30% reduction in nursing ewes' nutritional intake or utilization, milk production, composition, palatability, or output. When citrus pulp is ensiled in a 70:30 ratio with wheat or rice straw, excellent silage is created. The concentrate mixture may include up to 50% mango seed kernels. By soaking or boiling mango seed kernels in water, tannins and cyanide may be removed. Thereafter, the kernels can be added to broiler diets at a rate of 5–10%. Mango peels may be fed fresh, dried, or dried and fed, ensiled with wheat or rice straw, or fed. Due of their high sugar content, they are highly tasty (13.2 percent). In ruminant diets, the roughage included in cereals and the waste from pineapple juice may be totally and partly replaced, respectively. Ensiled pineapple waste may replace up to 50% of the roughage in the overall mixed diet for dairy cattle when combined with straw. Fresh baby corn husk, which is what's left behind after the cob is cut off for human use, may be given either raw, after wilting, or when coupled with cereal straw. They are more palatable and delicious than conventional maize feed, in comparison.

Fresh cauliflower and cabbage leaves with their stems still attached are a great source of soluble carbohydrates, proteins, macro- and micronutrients, and dry matter. They won't harm the cattle's taste, ability to absorb nutrients, health, or performance when fed to them either directly or after drying or ensiling with cereal straws. Beta-carotene and vitamin C are both abundant in fresh carrots, which also include 88 percent water, 10 percent crude protein (CP), and up to 60 percent carbohydrates, mostly sucrose. The range of 4 to 8 percent dry carrot diet given to laying hens significantly improved yolk color without impacting egg output. Cull potatoes, which contain a significant amount of starch (60–70%), may be fed in their raw form to dairy cows that are nursing up to 15-20 kg per day without causing any harm to their health. Ensiling chopped foraged potato tubers is another option. Up to 6 kg of boiled potatoes per day may be fed to sows for breeding and fattening. In chicken diets, up to 40% of the boiled potatoes may be used. In dried tomato pomace, there is a lot of lycopene (TP). In nursing animals, dry TP may replace up to 35% of the concentrate combination without negatively impacting milk production. In adult buffaloes, dried TP can completely replace concentrate mixture without negatively impacting nutrient absorption[10], [11]. It should only be given to the diets of broilers and layers up to a maximum of 5% and 10%, respectively. It may be included in the diet of rabbits up to a maximum of 30%.

REFERENCES

[1] L. Molossi, A. K. Hoshide, L. M. Pedrosa, A. S. de Oliveira, and D. C. de Abreu, “Improve pasture or feed grain? Greenhouse gas emissions, profitability, and resource use for nelore beef cattle in Brazil’s cerrado and amazon biomes,” *Animals*, 2020, doi: 10.3390/ani10081386.

[2] S. Balhara, R. P. Singh, and A. P. Ruhil, “Data mining and decision support systems for efficient dairy production,” *Veterinary World*. 2021. doi: 10.14202/vetworld.2021. 1258-1262.

[3] L. W. Bell, A. D. Moore, and J. A. Kirkegaard, "Evolution in crop-livestock integration systems that improve farm productivity and environmental performance in Australia," *Eur. J. Agron.*, 2014, doi: 10.1016/j.eja.2013.04.007.

[4] J. M. Wilkinson and M. R. F. Lee, "Review: Use of human-edible animal feeds by ruminant livestock," *Animal*. 2018. doi: 10.1017/S175173111700218X.

[5] M. Monjardino, D. Revell, and D. J. Pannell, "The potential contribution of forage shrubs to economic returns and environmental management in Australian dryland agricultural systems," *Agric. Syst.*, 2010, doi: 10.1016/j.agsy.2009.12.007.

[6] S. Homann-Kee Tui *et al.*, "Economic trade-offs of biomass use in crop-livestock systems: Exploring more sustainable options in semi-arid Zimbabwe," *Agric. Syst.*, 2015, doi: 10.1016/j.agsy.2014.06.009.

[7] J. Cortez-Arriola, W. A. H. Rossing, R. D. A. Massiotti, J. M. S. Scholberg, J. C. J. Groot, and P. Tittonell, "Leverages for on-farm innovation from farm typologies? An illustration for family-based dairy farms in north-west Michoacán, Mexico," *Agric. Syst.*, 2015, doi: 10.1016/j.agsy.2014.12.005.

[8] B. R. Thompson, D. R. Stevens, A. C. Bywater, J. M. Rendel, and N. R. Cox, "Impacts of animal genetic gain on the profitability of three different grassland farming systems producing red meat," *Agric. Syst.*, 2015, doi: 10.1016/j.agsy.2015.09.006.

[9] J. Cortez-Arriola *et al.*, "Resource use efficiency and farm productivity gaps of smallholder dairy farming in North-west Michoacán, Mexico," *Agric. Syst.*, 2014, doi: 10.1016/j.agsy.2013.11.001.

[10] A. Notenbaert *et al.*, "Towards environmentally sound intensification pathways for dairy development in the Tanga region of Tanzania," *Reg. Environ. Chang.*, 2020, doi: 10.1007/s10113-020-01723-5.

[11] H. Asgedom and E. Kebreab, "Beneficial management practices and mitigation of greenhouse gas emissions in the agriculture of the Canadian Prairie: A review," *Agronomy for Sustainable Development*. 2011. doi: 10.1007/s13593-011-0016-2

CHAPTER 4
BIOTECHNOLOGICAL ARRANGEMENTS IN ANIMAL HUSBANDRY TO INCREASE FARMER PROFIT

Uzma Noor Shah, Assistant Professor
Department of Life Science, School of Sciences, Jain (Deemed to be University), Bangalore, India
Email Id- ns.uzma@jainuniversity.ac.in

ABSTRACT:

The livestock farming sector is strategically important and has a significant potential to enhance the agriculture sector. A significant portion of the world's population receives their protein intake from the cattle agricultural sector. Not only serving as a source of food, but also making a significant contribution to global agricultural development. With the supply of organic fertilizers that are beneficial to the environment, the livestock industry helps to meet some of the demands of the agricultural sector. The agriculture industry's connection with the livestock farming sector is a mutually beneficial arrangement. A farm in a specific location that integrates plants and animals is essentially an agricultural system defined by a tight link between plant and livestock components. The bio-mass waste products from the agricultural sector may be utilized as composting starter material or as a source of animal feed. The livestock and agricultural sectors may both grow significantly economically as a result of the merging of these two industries. It has been shown in Indonesia that the idea of integrating the livestock and agricultural sectors would raise the community's quality of life and economic standing.

KEYWORDS:

Agriculture, Animal Husbandry, Environment, Livestock Industry, Animal Products, Veterinary.

INTRODUCTION

The foundation of each nation's economy is its agriculture. This backbone's major pillar is agriculture. Farmers nourish the human race by producing the food we consume. In India's economy, livestock farming is a significant subsector of agriculture. It is a business that supports agricultural agriculture. Together with supplementing income in the rural sector, it improves the health and nutrition of the families. The cattle business is essential to boosting the country's economy and raising the quality of life for the populace. The agricultural economy benefits greatly from the cattle industry. In addition to providing wholesome food, it also significantly boosts employment in the rural sector, especially for landless, small, and marginal farmers. The livestock industry in India accounts for around one-fourth of the country's agricultural GDP, 4.11% of the total GDP, and 8.8% of all employment. According to the 20th Livestock Census, India has 304 million cattle, 74 million sheep, 149 million goats, 9 million piglets, and 852 million chickens. According to 2019–20, India produces 198.4 million tonnes of milk annually, as well as 114.38 billion eggs, 36.74 million kilograms of wool, and 8.6 million tonnes of meat [1]–[3].

In order to reduce rural poverty in India, increasing agricultural productivity with an emphasis on animal production, disease prevention, and dairy development is a crucial step. Regrettably, farmers are having a very difficult time keeping up with the high demand for agricultural produce. These difficulties include a lack of connected infrastructure, an increase in the need for animal proteins, food spoilage, and illnesses. The main reason for low productivity is poor animal health, and developments in this area might help farmers avoid paying approximately Rs. 20,000 in direct expenditures each year. In the field of applied biology, biotechnology,

biological systems or creatures are used to create goods that are beneficial to society. Tools from biotechnology aid in enhancing the health and wellbeing of animals.

Enhancing cattle production in the process. Using biotechnology, meat, milk, and eggs are improved. It could improve our capacity to identify, manage, and prevent illnesses. For the creation of pharmacological, agricultural, or industrial goods, the science employs methods to modify the animal genome. The application of cutting-edge genetic engineering methods in particular offers considerable potential for improving animal health, which may therefore aid increase farmer revenue and the whole economy. By increasing the ability to produce animals and through methodical management, animal biotechnology has the potential to improve farmers' wellbeing. Biotechnology has considerable promise for prospective transformation in the veterinary area of treatment and major improvement in the identification of animal illnesses, in addition to aiding in the reduction of poverty and hunger [4], [5].

The alteration of an animal's DNA for the creation of medicinal, agricultural, or industrial goods is a significant application of animal biotechnology. One might comprehend how a live animal's genetic composition affects its growth and development by looking at the gene interactions inside the organism. Genomic information about cattle enables farmers to make breeding and animal selection choices that maximize production and profitability. Food quality may be improved by introducing desired features via new genes into agricultural cattle.

There is a need for advanced methods for the genetic improvement of cattle due to the expanding global population and the rising demand for the supply of livestock products. More efficient animal products must be produced through livestock agriculture. Regarding this, methods like artificial insemination, embryo transfer, animal cloning, and marker-assisted selection that support animal breeding programs would result in superior genetic productivity improvement and develop desired healthy livestock, allowing to produce healthier offspring and thereby improving animal production. Cloning and transgenesis may also aid in the development of biofactories. Also, the creation of animals that have been genetically engineered would increase productivity by adding advantageous features [6].

The biotechnology-based vaccines of the next generation are endowed with a number of benefits, including stability, non-infectiousness, uniformity in antigen synthesis, and affordability in manufacturing. Veterinary vaccinations developed by biotechnology might be used to reduce infectious illnesses, boost production by altering hormonal or immune functioning of the system, immune castration, etc. Correct diagnosis is necessary for timely illness management. Moreover, the development of monoclonal antibodies (mAbs), nucleotide sequencing, and methods like polymerase chain reaction, among others, has helped to manage a number of illnesses. Recombinant DNA technology aids in the production of certain reagents that are helpful in the diagnosis of diseases, vaccination sero-monitoring, and the distinction between vaccinated and diseased animals. Safer meals for human customers would arise from improved animal health conditions brought on by immunizations and diagnostic procedures. The construction of transgenic animals, the development of animal models for disease research, the manufacturing of certain cell lines, and the treatment of genetic illnesses are all made possible by the use of contemporary genetic engineering techniques like CRISPR/Cas9.

The potential for the biosensor technology to change cattle management in India is yet untapped. Artificial intelligence and biosensors are being developed to track pregnant hormones, health, and milk quality in real-time. By identifying unwell animals and intelligently recommending methods to restore their health, sensor and data technologies have the potential to significantly improve monitoring and managing livestock as well as their productivity and welfare. The use of cutting-edge methods might have a significant positive impact on decision-

making that will increase the production of animals. The expanding idea of Precision Livestock Farming (PLF) automates livestock farming using biosensor engineering concepts, enabling farmers to quickly identify problems with specific animals while keeping an eye on huge populations of animals for welfare and health. Examples include keeping an eye on cattle behavior, listening for vocalizations like screams in pigs, keeping an eye on coughs to spot respiratory illnesses, and spotting pregnancy in cows by tracking changes in body temperature. PLF technology may aid farmers in keeping an eye on contagious illnesses. The use of PLF technology will eventually enhance animal welfare and health, hence lowering concerns about food safety.

Additionally, the use of biotechnology for the creation of improved feeds with increased nutrient digestibility, silage inoculants, amino acid supplementation, mycotoxin diagnosis, removal of toxins and anti-nutritional factors by the enzymatic treatment, inclusion of probiotics, prebiotics, hormones, and disease-specific antibodies, as well as for the development of improved feeds with inclusion of probiotics and prebiotics to promote gut growth and health, could promote increased livestock productivity. Nevertheless, a key barrier to fully using biotechnology is the need for substantial upfront expenditures, which is difficult for manufacturers to provide. Societal issues also often obstruct the adoption of new technologies. During the last several decades, ethical issues have proliferated all over the globe, which have stifled the use of biotechnology and genetically modified animals on actual farms.

DISCUSSION

Probiotics may be used as a biodegradation during the fermentation process to boost the nutritional value of straw. The protein quality of the fermented straw is virtually identical to that of elephant grass. The fermented straw has to be kept as soon as possible in a dry location to preserve its quality. The ability of straw to be used as animal feed may expedite the effort that farmers must do to get ready to locate grass. In fact, the study's findings indicate that supplementing agricultural straw waste with urea and microorganisms may increase animal output. Straw is a byproduct of rice plantations. Fresh straw waste from rice fields will be produced per hectare at a rate of 12–15 tonnes every season. Moreover, manure that has through the fermentation process will provide 5-8 tons/ha, which may be utilized to satisfy the yearly feed requirements of 2-3 cows [7], [8].

The fermentation of straw makes excellent use of bacteria to enhance the quality of the straw. As compared to unfermented rice straw, the nutritional content of rice straw that has been fermented with a Starbio starter up to 0.06% of its weight often exhibits an improvement in quality. After a reduction in crude fiber content, the fermentation process may raise the crude protein content of rice straw from 4.23% to 8.14%. Our findings suggest that Starbio starter is a proteolytic microbe capable of producing the enzymes needed to convert proteins into simple peptides by breaking them down into polypeptides. By using a microbial starter, it was possible to lower the cell wall composition of rice straw from 73.41% to 66.14%. During the fermentation process, the linkages between the lignocellulose and hemicellulose in rice straw will be broken. The lignocellulose linkages are broken down by the action of lignolytic microorganisms in the microbial starter, allowing cellulose and lignin to be liberated from these bonds by the activity of the lignase enzyme. One indication that these bacteria are functioning well is the drop in cellulose and lignin levels that occurs during fermentation. The physical barrier of lignin molecules in straw may prevent plant tissue enzymes from being digested. Furthermore, lignin and hemicellulose have a strong bond. The reduction in cell wall composition suggests that the cellulose cell walls have begun to break down, making the feed easier for cattle to digest. The outcomes of the fermentation might boost the straw's nutritional value. Cattle that are fed supplementary feed such straw and probiotics are able to offer a live

weight growth of 0.56-0.68 kg/head/day greater than the control, demonstrating how dramatically the rise in live weight of livestock may increase.

Bran is one sort of trash created during the processing of rice. A layer of aleurone with a trace amount of endosperm, pericarp, pigment, and germ make up this bran. As bran may be generated in quantities up to 8 to 10% of the weight of milled rice, it is widely available. As much as 88.30% of rice bran's dry constituents are composed of crude fiber (15.30%), ash (9.90%), crude protein (10.10%), crude fat (4.90%), and 48.10% BETN. Bran is a readily accessible and highly efficient source of carbohydrates that enhances the quality of rice straw fermentation [38]. Feeding pregnant cows of local cattle rice bran and Bioplas probiotics may raise body weight by approximately 0.5 kg/head/day and birth weight by around 10.5 kg when compared to the control 8.9 kg. The amount of feed consumed has gone up by roughly 5.2 kg. In addition, cows given bioplas bran and probiotics were able to reestrus 62 days after giving birth, which was a significant difference from controls who took roughly 85 days [9].

Breeders anticipate using the usage of solid waste (manure) and liquid waste (urine) in cow production as organic fertilizer as a source of extra revenue. Moreover, it may increase the fertility of land used for agriculture. In comparison to conventional technology, which increased farmers' revenue by IDR 22,903,200, the technology for integrating livestock with rice plants was able to do so by IDR 34,488,800. According to the R/C ratio study findings, the value was 6, greater than the conventional pattern's R/C ratio of 4, making it possible for farmers to grow. By choosing limited land in rural regions, rice farming that is linked with cattle is an efficient and effective farming for increasing the agricultural revenue of the people. When producing rice on a large scale with 5 hectares of plant area and 20 head of cattle, integrating cattle and rice may enhance farmers' revenue by 70%.

The population of domestic cattle will grow as more cattle are developed utilizing the RLIS approach in various prospective regions. The outcome is predicted to be able to be self-sufficient in meat. This initiative attempts to preserve the diversity of regional cattle populations as very important genetic material. It also aims to cut down on the imports of meat, which have been difficult to stop because of the enormous domestic demand for meat. The capacity to enhance the performance of other farmer groups in terms of purchasing and selling livestock results in another advantageous effect. The straw is only used for animal feed demands, with a pattern of growing rice three times per year and being a technically irrigated area. At 25 kg per day per head for seed cows and 31 kg per day per head for fattened cows, straw is provided at such a high rate for animal feed. The RLIS pattern implementation was hampered by a number of issues, including: (1) a poor group functioning mechanism; (2) a collective pen utilization that is far from optimal, resulting in a low level of pen facility utilization; and (3) a mentoring and coaching process that is ineffective due to the position of the cattle, which cannot be kept in a single collective pen. The current cattle will thereafter be dispersed in accordance with the breeders' residence positions. Another problem is that it still takes a long time to go from the compost facility to the fields. On the other hand, group farmers have not yet become used to using manure. In order to use the available manure, this needs socializing.

The ICM program and the RLIS program were both started at the same time. Moreover, in order to promote agricultural extension, the adoption of rice-livestock technologies, and government aid channels, the development of the RLIS must be carried out via a farmer group method. The use of potential plant waste as a source of animal feed, the use of livestock dung as manure, the creation of new employment in rural regions, and an increase in community involvement are all benefits of the rice-livestock integration pattern. The poor functioning of farmer groups, the unsatisfactory use of collective cages, the ineffectiveness of mentoring and

coaching due to the dispersed location of livestock, the lack of widespread adoption of manure use among rice farmers, and the lack of discernible progress in the implementation of RLIS are all barriers to SIPT realizing food security. Future RLIS advancements should concentrate on production hubs in order to be widespread and have a major influence on population increase and livestock output. To reduce transportation costs and achieve zero waste and a well-integrated agricultural system, the processing of animal manure is conducted near to the site where rice is planted [10].

In a situation of synergy, rice-livestock integration technology may boost farmers' supplementary revenue. Input for farming has been used as efficiently as possible. Straw and feed, both of which have commercial worth, were combined with the process of producing rice in order to fatten cattle. With the recycling process, biogas is produced from cow dung. Plants are fertilized with worms and organic fertilizers, while fish ponds are fertilized with cattle manure. In addition to the primary rice products, paddy fields also provide straw and bran that may be utilized as animal feed. In this instance, all waste, including that from animals and plants, has additional value and does not harm the ecosystem.

An essential method for achieving environmentally responsible farming, farmer welfare, and the well-being of rural communities is the RLIS in the agricultural sector. RLIS is one of the government's initiatives to achieve food sovereignty, which has evolved into everyone in Indonesia having the right to acquire food that is suitable for survival, abundant, and freely available. RLIS is based on the idea of zero waste farming, which makes optimal use of local resources including rice bran, straw, and manure from animals. Straw has a lot of promise as an agricultural by-product (by-product), but it hasn't been utilized as cattle feed for cattle. By probiotic fermentation, straw's nutritional content may be raised to a level that is almost equal to that of elephant grass. Composting technology is a different approach to resolving environmental issues that may alleviate significant issues in rice fields. The integration of cattle and rice farming is a productive and efficient farming method for raising the agricultural income of rural residents with limited land ownership.

CONCLUSION

In conclusion, there is unquestionably a need for new procedures to enhance productivity due to the expanding global population and the exponentially rising demand for animal products. Our comprehension of the nature of genetic information and its possibilities has been greatly aided up to now by genetic engineering and biotechnology. To enable truly sustainable uses in the future, this field of study has to be pursued more actively. To produce vaccinations and other veterinary goods, it is necessary to harness the potential of biotechnology to increase livestock output. Also, the choice of animals most suited to a certain production setting will be accessible. This research would help end world hunger and satisfy future needs by fostering confidence and dispelling fears related to the use of biotechnology. From a biosafety standpoint, it is also essential to create an appropriate regulatory framework for the safe use of these technologies.

REFERENCES

[1] S. Neethirajan, “The role of sensors, big data and machine learning in modern animal farming,” *Sensing and Bio-Sensing Research*. 2020. doi: 10.1016/j.sbsr.2020.100367.

[2] A. Balkrishna *et al.*, “Agricultural mobile apps used in india: Current status and gap analysis,” *Agric. Sci. Dig.*, 2021, doi: 10.18805/ag.D-5140.

[3] S. Rusdiana and C. Talib, “Kebijakan Pemerintah Mendukung Peningkatan Usaha Sapi

Potong Di Peternak," *SOCA J. Sos. Ekon. Pertan.*, 2019, doi: 10.24843/soca. 2019.v13.i03.p08.

[4] A. Ishak *et al.*, "The Role of Social Capital in Developing Smallholders' Beef Cattle in Bengkulu," *Sodality J. Sosiol. Pedesaan*, 2021, doi: 10.22500/8202034481.

[5] S. S. Hayer, J. A. R. Staduto, and D. Darr, "Vertical coordination in the Brazilian milk supply chain: The case of 3B Agro LTDA," *Int. Food Agribus. Manag. Rev.*, 2019, doi: 10.22434/IFAMR2018.0080.

[6] K. Jadhav, K. S. Sharma, S. Katoch, V. Sharma, and B. G. Mane, "Probiotics in Broiler Poultry Feeds: A Review," *J. Anim. Nutr. Physiol.*, 2015.

[7] S. Melanie, K. Benedikt, M. W. Pfaffl, and R. Irmgard, "The potential of circulating extracellular small RNAs (smexRNA) in veterinary diagnostics-Identifying biomarker signatures by multivariate data analysis," *Biomol. Detect. Quantif.*, 2015, doi: 10.1016/j.bdq.2015.08.001.

[8] G. M. Dallago *et al.*, "Keeping dairy cows for longer: A critical literature review on dairy cow longevity in high milk-producing countries," *Animals*. 2021. doi: 10.3390/ani11030808.

[9] M. Shahjahan and F. H. Bhuiyan, "Socio-economic condition and indigenous poultry production scenario in a selected cluster area of Bangladesh," *Asian Australas. J. Biosci. Biotechnol*, 2016.

[10] A. W. Stott *et al.*, "Interactions between profit and welfare on extensive sheep farms," *Anim. Welf.*, 2012, doi: 10.7120/096272812X13345905673683.

[11] M. S. Faskhutdinova, N. B. Larionova, and R. A. Latypov, "Digitalization In Agricultural Enterprises," *Sci. Rev. Theory Pract.*, 2021, doi: 10.35679/2226-0226-2021-11-4-1053-1062.

CHAPTER 5
REPRODUCTIVE TECHNIQUES FOR IMPROVED PRODUCTION FROM LIVESTOCK

Padmapriya.G, Assistant Professor
Department of Chemistry, School of Sciences, Jain (Deemed to be University), Bangalore, India
Email Id- g.padmapriya@jainuniversity.ac.in

ABSTRACT:

For the eight billion people that inhabit the earth, livestock is a significant source of food. If we are to achieve global food security, countries throughout the world must collaborate to use reproductive technology to fulfill the ever-increasing need for food. A healthy, well-balanced diet for people must include foods from animal sources since they provide a necessary supply of energy, minerals, vitamins, and protein (including certain amino acids not often present in plant-based diets).

KEYWORDS:

Agriculture, Animal Husbandry, Environment, Embryo Transfer, Livestock Industry, Reproductive, Veterinary.

INTRODUCTION

The livestock industry is one of the nation's fastest-growing sectors and a significant source of revenue for dairy farmers. The secret to expansion is productivity, and animal output depends heavily on reproduction. In the cattle sector, failure to reproduce may result in significant financial loss. Since cows do not become pregnant during a specific mating season, infertility caused by low conception rates and high embryonic death rates continues to be a significant issue. To accomplish this, a number of reproductive technologies have been used. Estrus Synchronization, artificial insemination, Multiple Ovulation and Embryo Transfer (MOET), embryo transfer, cloning, transgenesis, cryopreservation, in vitro fertilization, sexing of semen and embryos, and stem cell technology are examples of assisted reproductive technologies that have been developed to address reproductive issues. These methods are used to shorten generation gaps in farm animals and enhance the number of offspring from chosen females. Also, these technologies have been utilized to protect native breeds and have shown to be effective weapons against the spread of vertically transmitted illnesses [1]–[3].

Synchronization of Estrus

Estrus synchronization is a different tactic for getting around the crucial issue of estrus detection. Estrus synchronization is the practice of employing hormonal treatments to put female animals into the heat state of those that are experiencing preovulatory follicular activity. This enhances the likelihood of estrous detection and aids in timely insemination to increase the rate of conception.

Estrus synchronization's function

- To do away with the necessity for labor-intensive estrus identification in large herds.
- It is necessary in order to use embryo transfer technologies.
- Comes to a close in a brief but intense period of AI (timed AI).
- Produces a calf crop that is aged more consistently.

- Boost the number of animals born, their fertility, and milk production

Artificial insemination (AI)

The earliest generation of ART, which has been around for more than 200 years, is artificial insemination. Semen is artificially deposited into a woman's vagina using this procedure. During the last 60 years, AI with fresh or frozen semen has been the most prolific and effective reproductive method used in animal husbandry. Genetic enhancement projects in wealthy nations were significantly impacted by the application of AI, by 1.0 to 1.5%. Rates of genetic progress each year in dairy cattle. By increasing the employment of exceptional guys, disseminating genetically superior germplasm, speeding up genetic selection, introducing new germplasm by importing semen rather than live animals, and so on, AI technology lowers the expense of international transportation. Usage of frozen sperm even after the donor has passed away lowers the chance of sexually transmitted illnesses spreading. If semen is treated in accordance with established health standards, this will also aid in enhancing biosecurity and lowering the potential for disease transfer from farm to farm. Nowadays, every year artificial insemination is performed on more than 100 million cattle, 40 million pigs, 3.3 million sheep, and 0.5 million goats globally. According to NABARD's impact study report, the total conception rate rose from 20% to 35%. Due to poor management and technical expertise of AI providers, the conception rate in AI programs in poorer nations is relatively low, and as a result, the anticipated impact in terms of animal development has not yet been reached [4], [5].

DISCUSSION

Super ovulation/Multiple Ovulation and Embryo Transfer (MOET):

A cow typically only develops one egg during each oestrus cycle, and the pregnancy lasts 40 weeks. A cow typically gives birth to just 2 or 3 calves throughout her lifetime. As a result, the pace at which a specific attractive cow may be utilized to enhance the genetic status of a herd is gradual in the absence of intervention. MOET programs may result in more selection pressure and shorter generation times, which would improve genetic gains. A genetically superior mother produces many offspring via multiple ovulation and embryo transfer (MOET). Nevertheless, if sound production methods (such as management, nutrition, and husbandry) are in place, ET and AI may be extremely helpful. The unpredictability and lack of predictability in the response of follicular development and embryo generation after a superovulatory therapy is one of the limitations associated with MOET technique.

Nonetheless, the expense of labor and hormone therapy treatments is a major factor in the high cost of MOET programs. These factors suggest that exceptional cattle farmers will continue to employ MOET more often. Since it forgoes super ovulation and AI treatments, the use of transvaginal, ultrasound-guided follicular puncture for oocyte retrieval, also known as ovum-pick-up (OPU), may make MOET more effective. Up to 1,000 oocytes can be collected from a heifer or cow per year, and after in vitro embryo production, up to 300 in vitro produced embryos can be obtained per year [6], [7] . Breeding farm in Himachal Pradesh recently saw the birth of two male calves called Gaurav (2010) and Saurabh (2011) as well as two female calves named Ganga and Jamuna in 2012. World's first Mithun calf ever to be produced via embryo transfer technique occurred at the National Research Center (2012).

Cryopreserved gametes and embryos

Due to the limited fertile life of mammalian oocytes and the benefits of frozen semen for the dairy industry, preservation of unfertilized oocytes would provide a readily accessible supply,

allowing the studies to be conducted at a suitable time and potentially being of practical significance. Oocyte preservation lowers the dangers of disease transmission, the cost and risk of transporting live animals, and it also offers insurance against natural calamities. The preservation of endangered species' oocytes protects them from extinction.

IVF: In-vitro fertilization

In the rabbit, the first IVF procedure was followed by the birth of offspring. Unfertilized eggs are now fertilized in a lab, cultured for a few days, and then re-fertilized. This process continues until the undeveloped eggs have become early embryos. Once in the recipient cow, which has regular oestrous cycles, they are transferred. Technologies for producing embryos in vitro not only aid in the creation of animals with high genetic merit but also serve as a great supply of embryos for embryo sexing, cloning, nuclear transfer, and transgenesis. With IVF, we may examine an embryo's potential for development, including the distribution of cytogenetic problems, epigenetic changes, and changes in gene expression. Despite ongoing attempts to increase the effectiveness of bovine in vitro embryo production (IVP), only 30% to 40% of blastocyst development from oocytes have been achieved following in vitro maturation, fertilization, and embryo culture. Transgenic bulls were made easier to breed using embryos created in vitro. Transgene transmission rates between bulls ranged from 3% to 54%. Unfortunately, IVEP's actual use is constrained by high manufacturing costs and its dismal overall performance in real-world settings.

Sexing of embryos and sperm

Predicting the gender of the child would result in more males or females, which would aid in the selection of people with the best genetic make-up for the advancement of the next generation. The presence or lack of components typically found on the Y chromosome affects how sexually differentiated an embryo is. Chromosomal study of embryos, immunological identification of embryonic H-Y antigen, and use of Y-specific probes are a few of the sexing procedures. iv) Loop-Mediated Isothermal Amplification (LAMP) reaction-based fluorescence in situ hybridization (iv) quick sexing technique for bovine pre-implantation embryos. Another method involves separating semen into male and female sperm one at a time using a staining approach and laser beam detection with the use of typical flow cytometry equipment. The unique sequences on the bovine Y-chromosome are shared by buffalo, Indian zebu, and Taurus cattle. Hence, the sex of buffalo or Indian zebu cow embryos may be shown by the use of primers that are unique to the bovine Y chromosome. Early in the embryonic stage, sexes may be determined with the use of a DNA probe.

A number of animal species, including cattle, goats, pigs, and sheep, have successfully generated offspring of predetermined sex utilizing fresh and frozen-thawed spermatozoa in recent breakthroughs in semen sexing employing fluorescence activated cell sorters (FACS). The most effective way to distinguish X from Y spermatozoa on a wide scale is via the sex sorting process using flow cytometry. Semen sex sorting improvements have made it possible to use this technology in industrial settings. Despite major advancements in sex-sorting sperm in cattle using flow cytometry, rates of pregnancy per artificial insemination (P/AI) and in vivo embryo development are lower than those with non-sexsorted sperm. With the exception of China, there have been no field reports of embryo or sperm sexing in any of the emerging nations. The majority of heifer research indicates that the conception rate after artificial insemination (AI) upon estrous detection with sex-sorted sperm is approximately 70% to 90% (according to the farms handling) from the conception obtained after the use of conventional semen, despite the literature's greater variability on the pregnancy outcomes of cattle inseminated with sex-sorted sperm [7], [8].

Cloning:

The process of creating a whole creature from a single cell obtained from the original organism and in a genetically identical way is known as animal cloning. This implies that the cloned animal is a perfect replica of its parent in every regard since it has the same DNA. It may be used to preserve endangered species and to spread them. Animals with certain qualities may be chosen and multiplied via the use of somatic cell cloning. A cultivated adult somatic cell containing an enucleated oocyte was used to create the first animal to be acquired by somatic cloning, a sheep named Dolly (Willmut et al., 1997). Since then, SCNT has been used to clone cattle, goats, pigs, and horses with success. The most popular method for creating genetically modified cattle is microinjection of DNA into the pronuclei of newly fertilized eggs. Introducing a novel method.

Transgenesis

In contrast to spontaneous mutation, an animal that has undergone intentional genome change is referred to as a transgenic animal. The first example was "super mice" in the 1980s. The human protein tPA, which is used to treat blood clots, was produced by these mice. Recombinant DNA methods are used to introduce previously undiscovered traits (i.e., genes) into creatures, including humans. Both breeding and biomedical applications are possible for transgenic farm animals.

Transgenic mice demonstrate that people have enhanced quantitative and qualitative qualities as well as illness resistance. Such examples are live sheep that produce more wool and have integrated keratin-IGF-I genes, as well as sheep and goats that have antitrombin III and antitripsin in their milk. The development of transgenic cows with mastitis resistance was a significant accomplishment. Studies on xenotransplants involve domestic transgenic pigs. Environmentally friendly transgenic people are being created by scientists to study different physiological systems in farm animals and people.

Stem cell science

The ability of stem cells to regenerate themselves by mitotic cell division for endless in vitro proliferation in an undifferentiated, pluripotent state is what distinguishes them from other types of cells. From the in vitro creation of embryoid bodies through the in vivo differentiation into somatic and germ cell lineage, embryonic stem cells have the ability to differentiate into any specialized cell type both in vitro and in vivo.

Stem cells have a wide range of uses, including as a model for developmental biology, in gene therapy, organ transplantation, the creation of chimeras, drug discovery, and regenerative medicine. the use of embryonic stem cell technologies in big animal models to investigate tissue-specific differentiation and cell treatment for diverse tissues and organs. It is simple to adapt the successful transplant of spermatogonial stem cells (SSCs) from testicular tissue utilized in goat and pig to cattle. Elite genetics might be more extensively distributed by transferring SSCs from superior bulls into inferior bulls and then allowing natural selection to take its course. In locations where artificial insemination is not feasible, this approach may provide an option for the use of exceptional sires in the cattle sector [9], [10].

CONCLUSION

The group of reproductive and genetic technologies discussed here offers a method for achieving the sustainable production of foods derived from animals. In order for livestock producers to provide animal-sourced foods, which are such an essential part of a healthy, well-balanced human diet, they must use climate-smart livestock production techniques.

REFERENCES

[1] J. M. Morrell and I. Mayer, "Reproduction biotechnologies in germplasm banking of livestock species: A review," *Zygote*, 2017, doi: 10.1017/S0967199417000442.

[2] J. A. H. Gifford and C. A. Gifford, "Role of reproductive biotechnologies in enhancing food security and sustainability," *Anim. Front.*, 2013, doi: 10.2527/af.2013-0019.

[3] A. Svitáková, J. Schmidová, P. Pešek, and A. Novotná, "Recent developments in cattle, pig, sheep and horse breeding - a review," *Acta Vet. Brno*, 2014, doi: 10.2754/avb201483040327.

[4] M. B. Wheeler, "Production of transgenic livestock: promise fulfilled.," *Journal of animal science*. 2003. doi: 10.2527/2003.81suppl_332x.

[5] C. A. Ramírez-Restrepo and T. N. Barry, "Alternative temperate forages containing secondary compounds for improving sustainable productivity in grazing ruminants," *Animal Feed Science and Technology*. 2005. doi: 10.1016/j.anifeedsci.2005.01.015.

[6] M. B. Wheeler, E. Monaco, M. Bionaz, and T. Tanaka, "The role of existing and emerging biotechnologies for livestock production: Toward holism," *Acta Sci. Vet.*, 2010.

[7] H. P. S. Makkar, "A review of the use of isotopic and nuclear techniques in animal production," *Anim. Feed Sci. Technol.*, 2008, doi: 10.1016/j.anifeedsci.2007.03.002.

[8] E. Adell, F. Estellés, A. G. Torres, and M. Cambra-López, "Morphology, chemical composition, and bacterial concentration of airborne particulate matter in rabbit farms," *World Rabbit Sci.*, 2012, doi: 10.4995/wrs.2012.1211.

[9] K. Raje, S. Ojha, C. Rawat, A. Mishra, V. K. Munde, and S. K. Chaudhary, "Impact of supplementation of mineral nano particles on growth performance and health status of animals: A review," *~ 1690 ~ J. Entomol. Zool. Stud.*, 2018.

[10] C. Wrenzycki, "In vitro production of (farm) animal embryos," in *Animal Biotechnology 1: Reproductive Biotechnologies*, 2018. doi: 10.1007/978-3-319-92327-7_12.

[11] J. O. Daramola, M. O. Abioja, and O. M. Onagbesan, "Heat stress impact on livestock production," in *Environmental Stress and Amelioration in Livestock Production*, 2013. doi: 10.1007/978-3-642-29205-7_3.

CHAPTER 6
USE OF MOBILE APPS TO TRANSFER TECHNOLOGY IN ANIMAL HUSBANDRY

Suhas Ballal, Assistant Professor
Department of Chemistry, School of Sciences, Jain (Deemed to be University), Bangalore, India
Email Id- b.suhas@jainuniversity.ac.in

ABSTRACT:

Smartphone applications are prospective digital tools that may be successfully used to quickly spread Animal Husbandry knowledge to a large number of farmers. With the provision of accurate information, improved input and farm management, simple marketing, connections with government agencies for policy assistance to farmers, etc., they may be utilized to increase farm revenue and productivity. There are obstacles, too, including low smart phone adoption in rural India, erratic internet access, poor digital literacy among farmers, and a dearth of agricultural information available in regional languages, among others.

KEYWORDS:

Agriculture, Animal Husbandry, Livestock, Management, Socio-economic Development.

INTRODUCTION

The livestock industry provides roughly 4.2 percent to the socioeconomic development of rural families and plays a variety of roles in that development. To the country's Gross Domestic GDP and 25.6% to its Agricultural Gross Domestic Product. According to empirical evidence, livestock are a crucial part of the animal husbandry system, providing a large segment of the rural population with a second source of income and nutritional security, particularly the poor and disadvantaged households. In comparison to land, the distribution of cattle to impoverished households as a liquid asset is more equitable. Nevertheless, the recent rise in the livestock industry indicates that the production system has to be reoriented in order to increase efficiency and foster quality awareness in order to fulfill the growing demand for livestock-based goods on both local and international markets [1]–[3]. According to het farmers are seeking for numerous information sources not only to carry out their production and marketing activities successfully but also to guarantee that the customers get safe and high-quality goods.

Information transfer to cattle using ICT

Sector may greatly enhance the effectiveness of decision-making in the system for raising livestock. Mobile phone usage has increased among ICTs, which is altering the way that agriculture communicates. Several services and applications have emerged as a consequence of the adoption of mobile phones. More and more mobile applications are available that provide users access to information about the animal husbandry industry and related fields. A mobile application is software that runs on a mobile phone or tablet computer that allows users to access certain information, conduct financial transactions, send messages, and more. The program (app) is downloaded from a wireless network from an online shop (for free or for a fee), and it may need a live connection to run properly. The key benefits of mobile applications for farmers are simple information access on their mobile devices. For simple access, the data is kept on the mobile device itself. During the COVID-19 epidemic, the potential for mobile applications to provide EAS (Extension and Advisory service) is enormous. As a result, farmers will be able to handle their cattle independently in emergency circumstances [4], [5].

For the benefit of farmers and other stakeholders, the Government of India has established a variety of web- and mobile-based apps for the free distribution of information on animal husbandry-related activities. NGOs, the corporate sector, and veterinary institutes have all produced applications these applications are improving information sharing between stakeholders and conveying information from livestock research and extension to farmers and other stakeholders. For farmers, the documentation of these mobile applications and the evaluation of their features and content are of utmost significance since it will help them choose the best app for obtaining trustworthy information for raising livestock depending on their specific needs. Also, this will help mobile app developers create new applications or improve and enhance their current mobile apps.

These websites are readily accessible to farmers through smart phones. They may get information on current market pricing and several crop-related details over the internet, which might be of greater use to them. Even in isolated locations throughout the world, most farmers have cell phones. Even without internet connectivity, they may get specialized agricultural guidance by SMS and voice message. These timely, low-cost tips help farmers improve their methods in order to boost agricultural profitability. Moreover, mobile applications aid the public and commercial sectors in monitoring inventories of emergency input stockpiles in government storage facilities or allocating subsidies to farmers. In the interest of the general welfare, it promoted more data exchange between the corporate and governmental sectors. In a country like India, where the agricultural population speaks a variety of languages, regionally appropriate smartphone applications providing information on soil, climate, nutrient management, and input pricing might be very useful.

Due to the youth farmer generations' heavy reliance on mobile devices, information may be easily shared through digital apps. The ability to accomplish anything one wants is the main advantage of information technology. It allows for creativity. It allows for productivity. It enables individuals to learn things they previously didn't believe they were capable of learning, so in a way, it's all about potential. The spread of science and technology across human activity is accomplished via the process of technology transfer. Mobile apps are digital tools that may be efficiently used to quickly transmit information about animal husbandry to a big number of farmers located all over the world. With the provision of accurate information, improved input and farm management, simple marketing, connections with governmental organizations for policy assistance to farmers, and other methods, these apps may be utilized to increase farmers' revenue and productivity. There are obstacles, too, including low smart phone adoption in rural India, erratic internet access, poor digital literacy, and a dearth of local language resources for farmers that provide knowledge on animal husbandry.

However, the current situation is that since the government of India launched the Unified Payments Interface (UPI), people have begun using their mobile devices for online payments. Today, we can observe that the general public uses UPI-based online payment apps on their mobile devices, and demonetization has also played a significant role in the use of the online payment apps. While the Covid-19 epidemic has had a negative influence on society, it has accelerated the spread of technology by at least 5 years compared to what would have been the average rate. Nowadays, we can observe that practically all institutions, small and large, schools and colleges use the web platform for both academic work and daily operations. Work from home culture is gaining traction in our nation as well. The value of digital tools was carefully considered during the COVID-19 pandemic to meet the need for everyday to emergency usage items. After considering everything, we can conclude that, in comparison to recent years, India's low smart phone adoption rate is not a major issue now [6]. Technology may spread more quickly because to modern digital technologies like blogs, websites, social

media, mobile applications, and the internet, among others. With the purpose of maximizing profits and reducing losses, farmers equip themselves with this focused, real-time knowledge using digital instruments. Farmers now have complete market access without the need of middlemen because to the advent of internet marketing platforms. Farmers now have simple access to these sites through their smartphones. They may get information about current market pricing and several details about animal husbandry that can be utilized to secure earnings or benefits via the internet. For the benefit of farmers, a variety of innovative digital tools, such as mobile applications, have been created to improve animal husbandry-related information, transfer effectiveness, and substantially affect animal husbandry-related business. Understanding and enhancing value chains connected to animal husbandry may be facilitated by the use of digital technologies. Via audio-visual services, digital technologies provide simple access and adoption chances to introduce new technology to rural communities. Food security for expanding populations has significantly improved as a result of using technology across the value chain. The following are the main benefits of mobile app use in the animal husbandry business.

Offers notifications through text and video messaging services. Access to data on management, nutrition, and other topics that have a direct impact on agricultural decision-making. By giving information on the pricing, quality, and quantity of agricultural commodities arriving at various marketplaces around the nation, market intelligence is provided. Mobile applications provide online administration of fisheries, cattle, poultry, and other resources. Providing comments from farmers and other stakeholders in many agricultural areas. With the use of mobile applications, information about significant machines and equipment is readily available. Through mobile applications, the government may provide inputs and provide subsidies to farmers, among other things. It may be used to farming using sensors, managing irrigation systems in big fields, identifying various soil kinds, etc. By collecting information, evaluating it, and making sensible recommendations for various companies, it makes successful farm management possible [7], [8].

DISCUSSION

India's Mobile App Use Challenges

Mobile app operation demands trained personnel, and digital literacy is a must. Making local language applications is challenging due to the country's linguistic diversity. The text must be translated at various stages, which might lower its quality and decrease acceptance within the agricultural community. The use of mobile applications requires a faster internet connection. Internet connection and speed are often a big problem in rural areas, which has an impact on mobile application services. Farmers lack the knowledge and skills necessary to effectively utilize mobile applications. Farmers may not be able to pay for services offered via these applications since a lot of mobile apps charge for their usage. A major difficulty is the low acceptance and usage of mobile applications by farmers, and the government must promote digital literacy to address it.

Advantages of Using Mobile Apps Related To Animal Husbandry

The advantages of mobile phones are their accessibility, widespread ownership, voice communication, and quick and easy service delivery. These factors have led to a worldwide boom in the usage of mobile applications, which has been made possible by the development of mobile networks, the expansion of mobile phone functionality, and the decline in price of mobile devices. Various governmental and commercial sector groups have created smartphone applications for farmers that are relevant to animal husbandry. Supporting farmers who raise animals by providing text and video communications services. Nationwide convenience and

door-to-door delivery service. Updates the farmer on transactions and money transfers, including instant messaging. Farmers may get a better understanding of the breeds of animals that are suited to their location, and they can use this information to boost their revenue and the production of their animals [9].

There are smartphone apps that provide information about raising livestock, managing it, and helping to avoid infections. Farmers may educate themselves on enhancing the value of foods with an animal origin. Mobile apps provide online administration of fisheries, livestock, and poultry, among other things. It offers the ability for farmers and other stakeholders to submit input. Information about various animal husbandry machinery and equipment is readily available. Apps for mobile devices may be used to provide government services like input distribution and the direct account transfer of different subsidies. Quick and simple access to a wealth of information by category in real time. It aids in more effective marketing and storage of items connected to animal husbandry for use in distant markets.

Use of Mobile Applications in India Has Its Problems

Most of the time, farmers lack the knowledge and skills needed to effectively utilize mobile applications. Low digital literacy is required to use and benefit from the apps that are offered. Developing mobile applications in every local language is made more challenging by the country's linguistic diversity. Bad translation might further degrade the content's quality and farmers' willingness to accept it. Despite the fact that high-quality smartphones are now reasonably priced, a fast internet connection is also necessary for the proper operation of mobile applications. Rural regions continue to have poor coverage and slow internet. Despite the fact that most smartphone applications are free, a handful do charge a price, and since farmers often have low incomes, they may not be able to buy these services.

Despite a rise in smartphone ownership, farmers in certain regions of the nation are less likely to accept and utilize mobile applications, which presents a significant barrier that calls for more efforts to improve digital literacy. Low data accuracy in applications, unequal internet access, and a lack of content that meets local needs are sometimes significant obstacles to the straightforward adaption of mobile apps. In contrast to other industries like health and sports, animal husbandry has less applications. We must depend on growing digital literacy efforts to get beyond all of these obstacles so that the accessible mobile apps may be utilized as a way of turning natural resources into usable resources via technological interventions. We may also take advantage of these improvements in animal husbandry by using mobile applications that enable farmers greatly enhance their revenue [10].

CONCLUSION

Mobile applications have the ability to improve animal husbandry, the social sectors, and a range of other businesses that are connected to it in terms of competence, output, competitiveness, and increasing production and productivity. Through facilitating access to information and information sharing, all of these are made feasible. The distribution of information in the animal husbandry and associated industries is greatly aided by mobile phones. We can simply communicate with many of farmers and provide them with the essential information all at once in a systematic manner so that they may gain knowledge and take useful activities.

REFERENCES

[1] P. Palvia, N. Baqir, and H. Nemati, “ICT for socio-economic development: A citizens’ perspective,” *Inf. Manag.*, 2018, doi: 10.1016/j.im.2017.05.003.

[2] D. Wang, T. Zhou, F. Lan, and M. Wang, "ICT and socio-economic development: Evidence from a spatial panel data analysis in China," *Telecomm. Policy*, 2021, doi: 10.1016/j.telpol.2021.102173.

[3] M. U. Niaz, "Socio-Economic development and sustainable development goals: a roadmap from vulnerability to sustainability through financial inclusion," *Econ. Res. Istraz.* , 2022, doi: 10.1080/1331677X.2021.1989319.

[4] K. Papageorgiou, P. K. Singh, E. Papageorgiou, H. Chudasama, D. Bochtis, and G. Stamoulis, "Fuzzy cognitive map-based sustainable socio-economic development planning for rural communities," *Sustain.*, 2020, doi: 10.3390/su12010305.

[5] A. M. Migdad, "CSR practices of Palestinian Islamic banks: contribution to socio-economic development," *ISRA Int. J. Islam. Financ.*, 2017, doi: 10.1108/IJIF-06-2017-0001.

[6] S. Kryshtanovych, B. Kindzer, M. Goryn, A. Kravchenko, and S. Frunza, "Management of socio-economic development of tourism enterprises," *Bus. Theory Pract.*, 2020, doi: 10.3846/btp.2020.12162.

[7] C. Yin, W. Zhao, F. Cherubini, and P. Pereira, "Integrate ecosystem services into socio-economic development to enhance achievement of sustainable development goals in the post-pandemic era," *Geogr. Sustain.*, 2021, doi: 10.1016/j.geosus.2021.03.002.

[8] N. Milenkovic, J. Vukmirovic, M. Bulajic, and Z. Radojicic, "A multivariate approach in measuring socio-economic development of MENA countries," *Econ. Model.*, 2014, doi: 10.1016/j.econmod.2014.02.011.

[9] M. K. Dash, C. Singh, G. Panda, and D. Sharma, "ICT for sustainability and socio-economic development in fishery: a bibliometric analysis and future research agenda," *Environ. Dev. Sustain.*, 2022, doi: 10.1007/s10668-022-02131-x.

[10] Z. Chojnicki, "Socio-economic development and its axiological aspects," *Quaest. Geogr.*, 2010, doi: 10.2478/v10117-010-0010-9.

[11] K. Wang *et al.*, "Understanding the impacts of climate change and socio-economic development through food-energy-water nexus: A case study of mekong river delta," *Resour. Conserv. Recycl.*, 2021, doi: 10.1016/j.resconrec.2020.105390.

CHAPTER 7
ANIMAL HUSBANDRY ENTREPRENEURSHIP: A TOOL FOR DOUBLING FARMERS' INCOME

Roopashree, Assistant Professor
Department of Chemistry, School of Sciences, Jain (Deemed to be University), Bangalore, India
Email Id- r.roopashree@jainuniversity.ac.in

ABSTRACT:

In addition to providing a source of high-quality food that boosts nutritional status, farm animals also give other resources including manure for fertilizer, on-farm electricity, and other byproducts, as well as economic diversity and risk sharing. By giving domestic animals the right nutrition, housing, and disease protection, animal husbandry aids in the appropriate management of animals. Several farmers are given jobs as a result, raising their level of life. Cross-breeding aids in the development of animal breeds with high reproductive rates.

KEYWORDS:

Animal Husbandry, Animal Health, Domestic Animals, Entrepreneurship, Natural Resources**.**

INTRODUCTION

It is undoubtedly an extremely difficult challenge to double farmers' income. The majority of the farmers we're discussing are marginal, tiny, and landless laborers who are less wealthy, dispersed, unorganized, and have limited access to knowledge and production methods, among other disadvantages. Positively, young people are very eager to become involved in animal husbandry (AH), particularly in light of the COVID scenario. To do this assignment in this situation, a comprehensive strategy is required. An entrepreneurial mindset is crucial for ensuring the coherence of all the parties engaged in reaching this aim. Let's attempt to comprehend the whole of entrepreneurship from two perspectives, one from the standpoint of development and two from the perspective of farmers [1], [2].

Understanding entrepreneurship from the standpoint of development. It is preferable that we take into account the well-known rural development (RD) model suggested by Katar Singh. Under the headings of natural resources, institutions and organizations, technology, capital, and human resources, he tackles the problem of RD. Only if these five RD elements are addressed together with effective stakeholder coordination can the problem of entrepreneurship in animal husbandry be solved. Let's have a quick discussion on these points.

Resources from nature

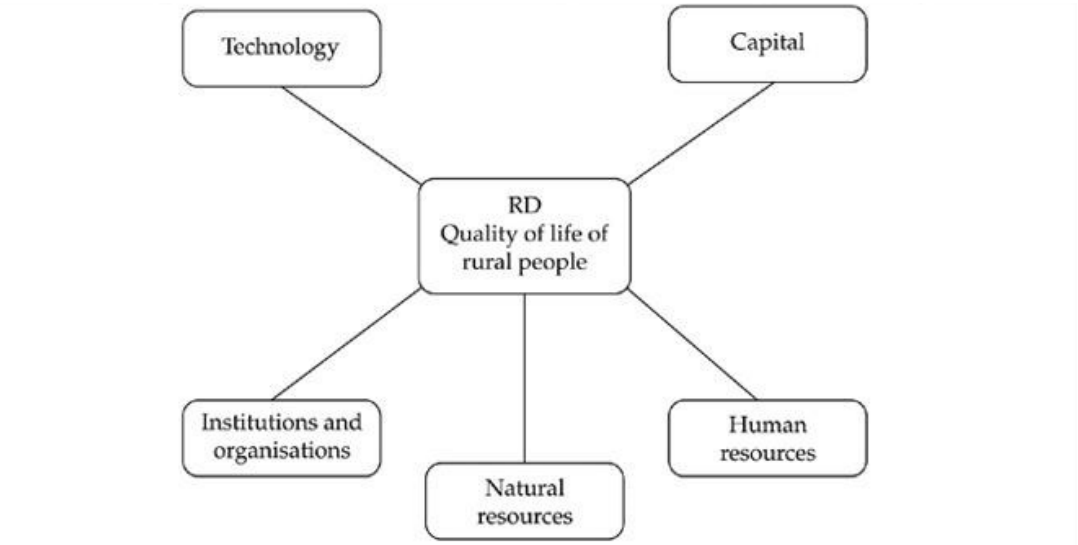
Natural resources, such as land, water, plant genetics, and animal genetics, are the fundamental components that a farmer may tamper with. The domestic animals, feed and fodder, water, conservation and preservation of the same, as well as different methods of raising and maintaining the same's maximum output, are the key concerns of the livestock farmer, as shown in Figure 1. The supply of high-quality breeding stock, including dairy animals, small ruminants, pigs, and poultry, is a problem. The male offspring of crossbred cows continue to be an issue. Similarly, there is a severe lack of feed and fodder nationwide [3], [4].

Institutions and businesses

These are the social structures responsible for coordinating the processes of growth. Department of Animal Husbandry & Veterinary Services in connection to AH, Milk. The main actors are cooperatives, a few NGOs, business corporations, etc. Although though government

agencies are responsible for providing animal health care, their ability to effectively serve the population is hampered by a lack of manpower and inadequate funds. Similar to this, cooperatives handle the marketing of milk. Their market share is limited nonetheless. Moreover, the functionality exists. Little ruminants, backyard chickens, and piggies are ignored. The chicken industry is a part of the private sector.

Figure 1: Illustrate the RD quality of life of rural People.



- **Technology:** It is essential to use technologies that are appropriate for the different types of farmers. The current trend is toward automation. Universities of Agriculture and Veterinary Medicine, as well as research institutes, are unable to meet these demands. The resulting set of techniques and technology lacks efficient transmission channels. The majority of technology creation and transfer institutions lack effective coordination.

- **Capital:** One of the key elements in the growth of entrepreneurship is capital. Farmers in need have difficulty getting funding in a timely manner. It is necessary to channel loans and subsidies properly so that the correct recipient receives them [5].

- **Human resources:** One of the key components of RD is human resource development. That holds true for the production process in agriculture. The entrepreneur is the one who coordinates all the other production components, including land, labor, and money. It seems sense to linger on the subject a bit longer in this setting. The farmer's philosophy on farming and cattle becomes crucial. The issue is whether it's a livelihood strategy or an entrepreneurial one. That would often work out to be a means of support.

A person's capacity to get the fundamental essentials of life food, water, shelter, and clothing is referred to as their means of subsistence. Consequently, a livelihood is defined as all activities involved in obtaining food, water, housing, clothes, and other essentials for both individual and family survival. The strategy would be to safeguard the livelihood, which is susceptible to numerous natural disasters, in the majority of the agricultural community. And induced shocks, such as price changes, droughts, and floods. In terms of manufacturing, a lot of people want to be safe.

DISCUSSION

An entrepreneurial approach, however, requires a thorough comprehension of the manufacturing process, measured investment, manufacture of what the people desire, and attentive marketing and sales of those products to generate profits. It takes this strategy to encourage entrepreneurship in the rural community. The agricultural community has to be inspired, educated, organized, and led to discover and utilize the market potential and generate money in light of the changing social demands. Here, numerous institutions and organizations have a role in encouraging farmers to be entrepreneurial [5], [6]. Looking closely at the graph below shows that more income and a higher standard of living are produced by a modest overlap of entrepreneurial and lifestyle approaches. So, a comprehensive examination of the whole range of growth aspects in the livestock industry offers prospects for a business owner to establish a company. Social entrepreneurship may fill the void wherever there is social concern, as shown Figure 2.

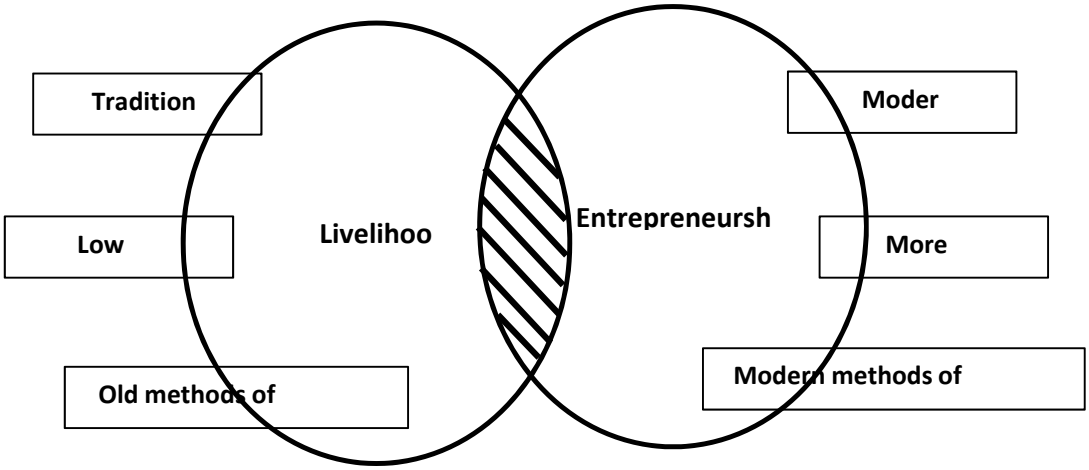


Figure 2: Livelihood Vs Entrepreneurship.

Considering entrepreneurship from a farmer's viewpoint:

The whole topic of entrepreneurial opportunities may be seen from a farmer's point of view as a three-step process: input, process, and output. There are opportunities for entrepreneurs at every level of the industrial process. An entrepreneur may develop a business concept and establish a company by carefully analyzing the manufacturing process, its needs, its production restrictions, the way its products are processed and distributed, and social changes and expectations [7], [8]. It is believed that there is never a shortage of business possibilities. Every issue a client has presents a business opportunity.

Lower the price of production

- By implementing preventative health care procedures including vaccinations, deworming, maintaining cleanliness in sheds, etc. to lower the incidence of illness.
- By reducing the cost of production, utilize cheaper and more efficient inputs, lessen the amount of feed, and raise the amount of high-quality fodders.
- By lowering the cost of transportation—by batching deliveries, house sales, etc.
- By lowering advertising costs - by fostering consumer loyalty, word-of-mouth advertising, etc.

- By lowering the overhead costs, such as by using the right amount of labor, animals, space, water, etc.
- By using direct sales to clients to cut down on the number of middlemen.
- Boost the product's worth to increase earnings

CONCLUSION

By enhancing the items' worth, maintaining their quality, dividing up the consumer base, and looking into the possibility of exporting. The list above is only illustrative. Farmers are able to adapt their services as a result of societal developments. This is the diligent character of a businessperson who recognizes possibilities and seizes them. This is a list that serves as an example of the many entrepreneurial possibilities that have been generated by social change and taken advantage of by various businesses.

REFERENCES

[1] D. Debnath and S. C. Babu, "What does it take to stabilise India's sugar market?," *Economic and Political Weekly*. 2018.

[2] N. Soni, P. Patil, K. C. Meena, A. Haldar, D. K. Patidar, and R. Tiwari, "Evaluation of Different Coloured Varieties of Grapes under Nontraditional Area of Malwa Plateau: A Thin Line Tool for Doubling the Farmer Income," *Int. J. Curr. Microbiol. Appl. Sci.*, 2019, doi: 10.20546/ijcmas.2019.803.234.

[3] P. Singh *et al.*, "Integration of sugarcane production technologies for enhanced cane and sugar productivity targeting to increase farmers' income: strategies and prospects," *3 Biotech*. 2019. doi: 10.1007/s13205-019-1568-0.

[4] J. K. Sundaray, P. N. Ananth, N. K. Barik, P. R. Sahoo, P. P. Pal, and A. K. Dash, "Institutional perspective for doubling fish farmers' income: A case study," *Indian J. Fish.*, 2020, doi: 10.21077/ijf.2019.67.2.79563-14.

[5] I. H. Eririogu, E. D. Mevayekuku, R. N. Echebiri, A. Atama, P. C. Amanze, and U. M. Olumba, "Income Diversification and Sustainable Land Management Practices among Rural Cassava-based Farmers in Imo State," *J. Agric. Ecol. Res. Int.*, 2019, doi: 10.9734/jaeri/2019/v18i330061.

[6] S. B. R. Lakshmi, P. Patra, and K. C. Gummagolmath, "Impact of Doubling Farmers' Income on Area, Production and Productivity of Pulses in India," *Curr. J. Appl. Sci. Technol.*, 2020, doi: 10.9734/cjast/2020/v39i2830939.

[7] V. B. Mor, H. Parmar, and S. Patel, "Riverbed farming : means of livelihood," *Int. J. Chem. Stud.*, 2018.

[8] R. A. Rather *et al.*, "The Assessment of Morphological Diversity of Colchicum luteum L., an Economically Important Threatened Medicinal Plant of Kashmir Himalaya," *Sustain.*, 2022, doi: 10.3390/su14031327.

[9] Y. Waarts and K. Zwart, "Investing in sustainable palm oil production. Ex-ante impact assessment of investments in a palm oil mill in Palembang, Indonesia," *LEI Memo. 13-038*, 2013.

[10] M. A. S. Tabieh, J. Suliman, and A. Al-Horani, "Pricing mechanism as a tool for water policy using a linear programming model," *Aust. J. Basic Appl. Sci.*, 2010.

CHAPTER 8
VETERINARY DIAGNOSTIC LABORATORIES USED TO IMPROVE LIVESTOCK PRODUCTION

Swarupa.V, Assistant Professor
Department of Chemistry, School of Sciences, Jain (Deemed to be University), Bangalore, India
Email Id- v.swarupa@jainuniversity.ac.in

ABSTRACT:

The possibility for the introduction of animal diseases is increased by globalization in the agriculture industry. Trade growth increases the potential for cross-border animal disease transmission. With border screening procedures and testing for transboundary animal diseases, many nations are essentially shielded from significant outbreaks of animal illness (TADs). Given that the sector producing animal products accounts for around half of agricultural revenue, the potential economic impact of the introduction of a serious animal illness is obvious.

KEYWORDS:

Agriculture, Animal Products, Livestock Production, Productivity, Veterinary**.**

INTRODUCTION

A disastrous epidemic of an animal illness would have a significant negative effect on farmers, the supply chain, and gross agricultural revenue. India has a loss of 20,000 crores as a result of the harmful effects of cattle illnesses. A negative impact from disease on the cattle production system causes a domino effect of poor output, low income, and subsistence living. Animal illnesses in cattle may have complicated impacts that often go much beyond the immediate effects on the producers who are afflicted. Numerous negative effects are caused by these diseases, including decreased productivity in the livestock industry (production losses, treatment costs, market disruptions), loss of income from animal resource-based industries (energy, transportation, tourism), increased costs for prevention or control (production costs, public expenditure), and suboptimal use of production potential (animal species, genetics, livestock practices) [1]–[3].

Mobile is developing as the Flat World platform for distribution and monetization since it is a low cost technology with high speed self-service and the quickest growth. Digital driven marketing ideas have a ton of potential. It may be based on ICT or a smartphone. As knowledge equals production, digital led deliverables are necessary for knowledge, production, and marketing. Startups with the necessary breakthroughs are needed to enhance output and productivity using a market-led approach. Success in the agricultural industry relies on the convergence or integration of several industries like dairying, cattle, fisheries, etc. With the fusion of several industries, Kerala Veterinary and Animal Sciences University created a revolutionary scheme called Startup Village to encourage the production of healthy foods in Kole lands. Production of organic/safe-to-eat goods using ICT deliverables would aid in promoting employment and sustainability in agriculture at a time when food safety concerns are spreading throughout the nation. When necessary, the university's E Vetconnect and advising contact centers provide the right information and services. In order to incubate and accelerate ideas with the right deliverables, students must consider suitable innovation based on their concepts. Agribusiness startups have several opportunities as demand rises [4], [5].

Both statistically and qualitatively, there is an increase in the demand for animal-sourced foods (ASF). The milk and meat industries have expanded at an average rate of roughly 6% during

the last five years. In order to boost its GDP from its present level of US $ 3 trillion to US $ 5 trillion by the year 2025, the Indian government is currently focusing on cattle. By 2025, private dairy units' processing capacity will have doubled thanks to funding from the "Make in Rural India Initiative," which will also expand their reach into untapped markets and improve milk quality at milk collecting points. In addition, the Indian government is taking steps to increase meat and egg output via backyard poultry and small ruminants since those industries are growing at rates of more than 5 and 10%, respectively. Through the promotion of micro and small businesses in the livestock sector in rural India, the Prime Minister of India's recently announced policy on decentralized food production and processing systems offers a great opportunity for creating jobs in rural India and improving the lives of farmers who own livestock [5], [6]. In order to encourage entrepreneurship in the rural livestock sector and create jobs while doubling farmer income, this article is intended to share knowledge and technologies in milk, meat, and egg production and processing, as well as improve the efficiency of livestock production systems. This will also help India's economy grow to US $ 5 trillion by 2025.

Almost 1.32 billion people live in India, the second-most populated nation in the world, together with 512 million animals and over 1 billion birds in a richly diverse environment covering 3.3 million square kilometers. There is enormous pressure on this interdependent system of people, animals, and the environment to expand livestock output in order to meet the demands of a rising human population in our modern economy. In India, the poultry and dairy industries have grown significantly over the last two decades. Organized commercial farmers, cooperatives, and organizations have mostly been responsible for this rise. The provision of veterinary goods and services by private businesses and governmental regulations is highly supported by this expansion in the organized and commercial animal production industry. Such assistance is beneficial for increasing production efficiency in the organized sector and providing a large population with animal products (milk, meat, and eggs).

The agricultural community suffers severe financial losses as a result of highly infectious livestock illnesses such foot and mouth disease (FMD), hemorrhagic septicemia (HS), mastitis, peste des petits ruminants (PPR), and surra in cloven-footed domestic animals. They also hold the top spot among livestock illnesses as a result of their vast host range, variety of immunological types, short immunity duration, economic losses, and effects on productivity and output of animals [7], [8]. The yearly economic loss at the farm level in India as a result of various diseases such as brucellosis and peste-despetits ruminants (PPR) was estimated to be US$ 3.4 billion annually and hemorrhagic septicemia (HS) to be roughly US$ 6.6 million. A significant amount of government resources must be allocated for disease control and eradication efforts. The cattle industry and the products it produces provide significant prospects for agricultural growth, poverty reduction, increases in food security, and better nutrition for people. Also, the sector can increase the effective use of natural resources and empower rural adolescents and women.

Meat, milk, eggs, and other animal products, including fish and other seafoods, are crucial, although being often ignored, in ensuring food security for a number of reasons. First, a moderate intake of foods derived from animals is crucial for achieving a nutritionally balanced diet because animal products are a significant source of high-quality, balanced, and highly bioavailable protein as well as numerous essential micronutrients, such as iron, zinc, and vitamins B-12 and A, many of which are deficient in a significant portion of the world's population.

- Second, the demand for animal products will very certainly continue to rise sharply since they are valued as high-quality meals.

- Finally, farm animals are essential to a sustainable agricultural system, particularly for smallholder farmers, who make up the majority of farmers worldwide.
- In addition to providing a source of high-quality food that boosts nutritional status, farm animals also give other resources including manure for fertilizer, on-farm electricity, and other byproducts, as well as economic diversity and risk sharing.
- Fourth, ruminants, including cattle, sheep, goats, and buffalo, effectively transform grassland forages into high-quality animal products. Grazing also helps to maintain the health and biodiversity of grasslands.
- Don't forget to go here to place an order for nutritious, traceable meat (ram included) from a livestock that is suitable for slaughter in the interim.

Veterinary diagnostic laboratories (VDLs) are significant service organizations that provide crucial diagnostic testing for a broad range of domestic and wild animal species. Every monitoring or control program must include laboratory diagnosis since it supports the elimination of diseases at the national level. In addition to diagnosing clinical diseases, state labs and veterinary teaching hospitals also conduct testing for export and surveillance programs. To ensure the validity of test findings, several national and state labs are creating.

Quality assurance programs

National veterinary services are available in many nations across the globe to handle diverse requirements for protecting animal health and ensuring the safety of food. The veterinary diagnostic facilities, such as HSADL, Bhopal in India, are an essential component of this organization. To ascertain the presence or introduction of a disease, monitoring and diagnosis of clinical instances of animal illness are required, and laboratory testing is an essential component of these surveillance programs.

Thus, veterinary diagnostic labs serve as the foundation for disease control initiatives run by a nation's veterinary services. The effective completion of laboratory studies depends significantly on the collection of samples and specimens, their preservation, and their physical conditions during transportation to the laboratory. Many general factors that apply to all specimen types include:

- Expired containers should not be used to collect or transport specimens.
- Label must include all relevant data that is requested on the test request form.
- Enough number of specimens to execute the test in accordance with the specifications (to avoid QNS -quantity not sufficient)
- For the proper preservation of the specimen, use the container/tube specified in the test criteria.
- Fasten the lids of specimen containers to prevent leaks and/or possible contamination of the samples.
- The test requirement specifies the temperature at which the specimen must be kept.

BLOOD SCREENING

Complete blood count (CBC)/blood smear analysis A blood sample is a very trustworthy indicator of the animal's health condition and may show qualitative and quantitative damage to the organ system or the particular organ. Early evaluation of these factors with little intrusion

into the animal's body will aid in early and accurate illness diagnosis, reducing the cost of protracted therapies and reducing the animal's unproductive sick days.

FAECAL EXAMINATION

One of the major threats to restricting animal output is internal parasitism. Internal parasites fight for the host animal's gastro intestinal tract's nutritional supply. Even when the host animal consumes appropriate or sometimes too much feed, which worsens condition, this restricts the nourishment it needs to maintain and be productive. Feed loss, a poor recovery, or even death may result from untreated or delayed conditions. Regular checking of animals for internal parasites by microscopic inspection of fecal samples helps to avert this financial loss. Optimal production levels and improved herd health are promised by appropriate management practices [9].

CONCLUSION

This is a scientific examination of urine to primarily examine the health of the kidneys and urinary system, but it may also uncover issues in other systems that are obstructing the animal's production and general well-being. With urine analysis, some bacteria and parasites (kidney worms) may be precisely identified, reducing treatment costs, increasing treatment effectiveness, and supporting economic production levels. The following are other clinical or postmortem samples that are crucial for illness diagnosis, successful therapy, and understanding the pathophysiology of diseases to create precise treatment protocols: The samples of choice, the preservatives used in their transportation to laboratories, and the corresponding tests to be carried out to reach a confirmatory diagnosis and start the effective treatment, ensuring that the animal suffers from illness for the least amount of time possible and maximizing their productivity.

REFERENCES

[1] M. A. Kucuker, B. Demirel, and T. T. Onay, “Enhanced biogas production from chicken manure via enzymatic pretreatment,” *J. Mater. Cycles Waste Manag.*, 2020, doi: 10.1007/s10163-020-01039-w.

[2] M. Abera, A. Tolera, A. Nurfeta, and D. Geleti, “PRODUCTION, UTILIZATION AND CONSTRAINTS OF DESHO GRASS (Pennisetum glaucifolium) AS LIVESTOCK FEED IN ETHIOPIA,” *Online J. Anim. Feed Res.*, 2021, doi: 10.51227/OJAFR.2021.29.

[3] C. Miranda, A. S. Soares, A. C. Coelho, H. Trindade, and C. A. Teixeira, “Environmental implications of stored cattle slurry treatment with sulphuric acid and biochar: A life cycle assessment approach,” *Environ. Res.*, 2021, doi: 10.1016/j.envres.2020.110640.

[4] H. S. Mudau, H. K. Mokoboki, K. E. Ravhuhali, and Z. Mkhize, “Nutrients profile of 52 browse species found in semi-arid areas of south africa for livestock production: Effect of harvesting site,” *Plants*, 2021, doi: 10.3390/plants10102127.

[5] C. Long, “Transgenic livestock for agriculture and biomedical applications,” *BMC Proc.*, 2014, doi: 10.1186/1753-6561-8-s4-o29.

[6] R. Romar, H. Funahashi, and P. Coy, “In vitro fertilization in pigs: New molecules and protocols to consider in the forthcoming years,” *Theriogenology*, 2016, doi: 10.1016/j.theriogenology.2015.07.017.

[7] M. Syauqi Nazmi, R. Abu Dardak, R. Abdul Rani, and M. Rashid Rabu, "Benchmarking Indonesia for the Development of the Grain Corn Industry in Malaysia," *FFTC Agric. Policy Platf.*, 2021.

[8] H. Saleh, M. Elhenawee, E. M. Hussien, N. Ahmed, and A. E. Ibrahim, "Validation of HPLC-UV Multi-Residue Method for the Simultaneous Determination of Tetracycline, Oxytetracycline, Spiramycin and Neospiramycin in Raw Milk," *Food Anal. Methods*, 2021, doi: 10.1007/s12161-020-01838-9.

[9] S. Djordjevic, V. Mandic, N. Djordjevic, and B. Pavlovic, "Bacterial inoculant effect on quality of alfalfa silage and haylage," *Biotechnol. Anim. Husb.*, 2019, doi: 10.2298/bah1901085d.

[10] Guido Rychen *et al.*, "Safety and efficacy of Lactobacillus plantarum DSM 29024 as a silage additive for all animal species," *EFSA J.*, 2017, doi: 10.2903/j.efsa.2017.4675.

CHAPTER 9
RECENT TRENDS IN ANIMAL HUSBANDRY

Malathi.H, Assistant Professor
Department of Life Science, School of Sciences, Jain (Deemed to be University), Bangalore, India
Email Id- h.malathi@jainuniversity.ac.in

Abstract:

Globally, the cattle industry is quite dynamic. It is changing in emerging nations as a result of the quickly rising demand for animal products. Although many production processes are becoming more efficient and environmentally sustainable, the market for cattle products is stagnant in affluent nations. The demand for livestock products has historically changed as a result of changes in human population, wealth, and urbanization. The production response in various livestock systems has been correlated with advances in science and technology as well as increases in the number of animals. Competition for natural resources, notably land and water, rivalry between food and feed, and the need to function in a carbon-constrained economy will all have an increasing impact on productivity in the future. The potential for increased output, increased efficiency, and genetic advances will continue to be influenced by advancements in breeding, nutrition, and animal health. Regulations governing the environment, animal welfare, and carbon emissions are projected to have an increasing impact on livestock production. Future demand for cattle products may be significantly tempered by socioeconomic variables including worries about human health and shifting sociocultural norms. Regarding how these forces will manifest themselves in various parts of the globe during the next decades, there is a great deal of ambiguity.

KEYWORDS:

Animal Husbandry, Animal Products, Genetic Change, Livestock Products, Socioeconomic.

INTRODUCTION

Our farmers' basic occupation has always been caring for their livestock. The initial purpose was to provide for the families' basic requirements, including food and other necessities. It ultimately took on a commercial shape. Nowadays, animal husbandry is regarded as an economic industry. It is carried out as a business, an organization, and a kind of employment. The worldwide market has increased the number of possibilities available, making animal husbandry a lucrative industry. Several educated children are now also entering this industry. Consumers govern the contemporary market, which includes the market for cattle and animal products. Urban markets, globalization, liberalization, shifting consumer habits, scarcity of water and land, climate change, the desire for alternative energy sources like biofuels, and the emergence of new diseases are all influencing the expansion of agriculture.

Consumer demands and preferences must be prioritized in all choices if one wants to boost profitability. In line with this, the animal husbandry industry is not an exception. The demands of customers and market trends should not only be taken into consideration while producing cattle; it is also a need. So, it would be better for farmers if they planned the production of their animals in accordance with market demands [1]–[3]. Farmers must also be transparent about the costs of their products, their marketing plans, and their production processes. Accuracy in agriculture is required. The following concepts need to be considered in this circumstance.

Livestock systems make up 30% of the planet's ice-free terrestrial surface area and constitute a huge global asset worth at least $1.4 trillion. Long market chains that employ at least 1.3 billion people worldwide and directly assist 600 million impoverished smallholder farmers in

developing countries are being established in the livestock industry. Maintaining livestock is a crucial risk reduction approach for communities who are at risk, because animals are crucial fertilizer and traction sources for smallholder systems' crop growth. Worldwide, consumption of livestock products makes up 17% of calories consumed and 33% of protein consumed, however there are significant disparities between wealthy and poor nations [4].

Livestock systems affect the use of natural resources, public health, social fairness, and economic development in both favorable and unfavorable ways. Livestock is now one of the agricultural subsectors in emerging nations that is expanding at the quickest rate. It already accounts for 33% of the agricultural GDP and is growing significantly. The demand for animal products, which is rising quickly due to population expansion, urbanization, and rising affluence in emerging nations, is what's fueling this rise. Between emerging and established nations, there is a contradiction in the world's cattle industry. Between 1980 and 2002, the amount of meat produced in the developing world increased by three times, from 45 to 134 million tons. The main drivers of this growth poultry and pigs were centered in nations that saw fast economic expansion, especially in East Asia. On the other hand, although being at high levels, output and consumption of animal products are now only rising slowly or stagnant in industrialized nations. Yet, 53% of the agricultural GDP in developed nations is accounted for by the production and sale of cattle. Given that the majority of demand is currently satisfied by domestic production and is expected to do so for the foreseeable future, the combination of rising demand in developing nations and stagnant demand in industrialized nations represents a significant opportunity for livestock keepers in these nations. Agricultural output has to be raised, but it must be done in a manner that benefits the less fortunate and has a minimal negative effect on the environment [5].

This essay aims to provide a concise overview of the current situation of livestock production systems internationally in connection to recent developments and a quick evaluation of the likelihood that these patterns will persist going forward. The main factors that have contributed to historical gains in livestock output are discussed in section 2, along with the status of intensive and extended production systems in developed and emerging countries. Part 3 lists the scientific and technological developments that have led to historical improvements in livestock output and highlights untapped potential in areas like livestock nutrition, disease control, and genetics. The rivalry for land and water, climate change, the influence of socio-cultural drives, and ethical concerns are just a few of the variables that might alter both the production and consumption of animal products in the future. (The competition for resources and climate change are only briefly discussed; other assessments go into more detail.) The section finishes with a short consideration of three relatively arbitrary "wildcards" that might significantly alter future patterns in animal production and consumption: fake meat, nanotechnology, and growing public apprehension about new technologies. The report continues (5) with a synopsis of the future development of livestock production systems and some of the major uncertainties [6]–[8].

Utility

The capacity of a product or service to fill a need is known as utility. The value of anything is determined by its utility. A product couldn't be valuable by itself. It will become more valuable if it is put to use. For example, we could have enough water to drink at home. Nonetheless, the benefit of water is more obvious when one is outside and really thirsty but unable to get water than when one is at home. Similar to this, a farmer's livestock production must be beneficial. In course, most cattle products will be beneficial. To boost sales and profits, the product must be made more usable.

There are three methods for doing this:

Time Utility

This is the value connected to a certain product at a particular time. For instance, keeping milk on hand could be handy in the future. Yet, it is vital to brew tea for guests when they come, but there is no milk in the home. Milk will then be much more beneficial. This may be achieved by using milk that has been UTHT packed (Eg. Good Life Milk produced by Nandin, KMF, Karnataka). Several farmers are having success selling lights (Diyas) made from cow dung during the Deepavali season.

Location Utility

This relates to a product's usefulness in a certain area. For instance, cooked eggs could be conveniently available in frequently visited places. Nonetheless, the need for boiled eggs could become more apparent when on a trip or tour where it might be challenging to obtain good food. Similar to this, setting up booths at gatherings like festivals, fairs, and shows may help sell specific livestock products more effectively. These areas must be used by farmers to increase the market for their products.

Form Utility is the utility connected to a certain product in a particular form. Animal products tend to be hefty and perishable in nature. To increase the effectiveness of transportation, their bulkiness might be decreased. For instance, making condensed milk from ordinary milk. To make them less perishable, they may be transformed into different forms. Creating milk powder from milk is one example. Producers need to be aware of the time, place, and form-related market needs for animals and livestock products. They need to correctly plan their production if they want to optimize their profit. Profitability may be impacted by a variety of market variables in addition to utility. Among them, these are a handful.

Opportunities for Export

- Opportunities for organic animal husbandry; a growing customer concern for both the health and the quality of their products.
- In view of the existing demand and competitive price for the products, manufacturing will be increased.
- Using peak demand during certain seasons, holidays, and events will increase demand and price for cattle farmers.

Producing on its own is not enough. The concert should go as planned. Advertising must be done as planned. Precision farming is the name for it. Precision farming requires the use of cutting-edge tools and techniques, market research, and marketing. The management of cattle utilizing a variety of computerized technology is known as precision livestock farming (PLF). Automating animal monitoring is required to improve the health, welfare, reproduction, and productivity of animals as well as their impact on the environment.

Dairy farming as the use of technology to evaluate physiological, behavioral, and production factors on individual animals in order to improve management practices and farm performance. A precision dairy farming system, which increases productivity and revenues, enables dairy farmers to make decisions that are more timely and well-informed. Pedometers, automatic temperature recorders, milk conductivity indicators, automatic estrus detection monitors, daily body weight measurements, daily milk production records, milk component monitoring (such as fat, protein, and SCC), and other Precision Dairy Farming technologies are currently being used by dairy farmers. The maximization of each animal's potential, the early detection of

ailments, and the use of preventive health measures to lower the need for medication are, according to him, the three main objectives of precision livestock farming. It is believed that using precision livestock farming technologies would increase output while lowering costs, improving product quality, reducing harmful environmental consequences, and improving animal welfare.

By using this technology, farms may be able to produce more food while resolving impending socio-ethical, environmental, and animal care issues. More clarity is needed to identify the (financial and non-financial) benefits of deploying certain technologies at the agricultural system level, to lessen farmers' investment uncertainty, and to guide technical advancement.

Several farms and organizations in India have started embracing precision cattle farming. The National Livestock Identification System (NLIS), which uses RFID tags, the Information Network for Animal Productivity & Health (INAPH) of the NDDB, the BAIF Development Research Foundation, and RFID-based identification and farm management solutions are some examples in this respect.

Precision farming will be done on many levels.

- Production with accuracy
- Processing, storing, and transporting information precisely
- Marketing with precision.

Accuracy in Production

This may be achieved by choosing the best animals for the farm, adhering to scientific feeding, breeding, medical, and other management procedures. A veterinarian is also needed for advice and intervention in this. For instance, it should materialize if a cow has to give birth to one calf per year. The 15 liter wet average is what ought to happen.

Accurate processing, storage, and delivery

To do this, the appropriate infrastructural facilities, including as processing plants, cold storage, and transport vehicles, are needed. These amenities may be available on an individual, group, or mass scale.

Marketing with precision

Finally, a livestock farm's success rests heavily on how its goods are marketed. Packaging for products should be attractive and practical. They need to be sold quickly and at a profit. For instance, dung would cost around Rs. 0.25/Kg if supplied fresh and unprocessed. The price per kilogram of the same dung would range from Rs. 1 to 4 if it were made into dry dung powder, dung cake, or lamp (Diya). Also, its packaging need to be functional and appealing [9].

DISCUSSION

Evolution of livestock systems and trends in livestock production (a) the rising demand for livestock-related goods. The anticipated global population in 2050 is 9.15 billion, with a range of 7.96 to 10.46 billion. The majority of the growth is anticipated to occur in emerging nations. By the late 2040s, East Asia's population growth will be negative (FAO 2010). In contrast, the population of Sub-Saharan Africa (SSA) will continue to rise at a rate of 1.2% annually. Even if the global population stops expanding at some point in the current century, rapid population growth may still be a significant obstacle to improving food security in certain nations. Urbanization is a significant role in influencing food demand. According to the UNFPA, as of

the end of 2008, more people lived in cities than in rural regions, with urbanization rates ranging from less than 30% in South Asia to close to 80% in industrialized nations and Latin America. Urbanization will see extraordinary increase over the next decades, especially in Africa and Asia. Urbanization often drives improvements in infrastructure, particularly cold chains, allowing for more trading of perishable items. This has a significant influence on patterns of food consumption in general and on demand for cattle products in particular. Income growth is the third factor influencing the rise in demand for animal products. The yearly growth rate of the world's per capita income was 2.1% between 1950 and 2000. When income increases, so rise spending on livestock-related goods. Future economic growth is anticipated to persist, often at rates between 1.0 and 3.1 percent (van Vuuren et al. 2009). It is anticipated that industrialized country growth would be slower than that of emerging nation economies.

The trends in meat and milk consumption as a consequence in both emerging and developed nations, together with projections for 2015–2050. In particular across locations, differences in the intake of animal products are substantially bigger than those in the overall amount of food available. In sub-Saharan Africa and South Asia, the food demand for animal products will almost quadruple, rising from around 200 kcal per person per day in 2000 to over 400 kcal per person per day in 2050. Contrarily, levels of consumption will scarcely change in the majority of OECD nations where people currently consume a lot of animal products (1 000 kcal or more per person per day), but they will rise to OECD levels in South America and the former Soviet Union.

Globalized diets are increasingly being catered for in the agriculture producing sector. As urban customers want more processed goods, the role of agriculture will rise over the next several decades. Retailing via supermarkets is rising at 20% per year in nations like China, India, and Vietnam.

The output reaction

During the 1960s, the world's livestock output has significantly expanded. In contrast to the roughly 10-fold rise in chicken meat output over the same period due to both productivity and animal population growth, beef production has more than doubled. From the early 1960s to the mid-2000s, carcass weights climbed by roughly 30% for poultry and beef cattle and by about 20% for pigs (FAO 2010). Camel and sheep carcass weight gains per head throughout this time span are substantially smaller, just around 5%. Cow milk output per animal has increased by around 30%, about equal to gains in chicken egg production per animal during the same time period.

Science and technology in livestock as a force for change

Genetics and breeding

The rise in production of livestock products seen in recent decades has historically been mostly attributed to domestication and the use of traditional livestock breeding procedures. At the same time, there have been significant changes in the makeup of cattle products. Future changes are expected to be addressed more by innovative approaches if previous changes in demand for livestock products have been handled by a mix of traditional strategies, such as breed replacement, cross-breeding, and within-breed selection.

The most suited breed or breed cross may be determined using the standard methods of selection among breeds or crossings, but further improvement can only be achieved by selection within the population. In commercial production, cross-breeding is common and uses the complementary traits of many breeds or strains as well as heterosis or hybrid vigor. Farm

animal breed selection often results in genetic alterations between 1% and 3% every year in reference to the mean of the single or multiple qualities of interest. Such rates of change have been realized in practice over the past few decades in breeding programs for pigs and chickens in several nations, as well as for dairy cattle in nations like the USA, Canada, and New Zealand. This has largely been made possible by the actions of breeding companies. In national populations of beef cattle and sheep, rates of genetic change are often far lower than what is theoretically achievable. The majority of nations have widely distributed ruminant breeding, making sector-wide development difficult.

Most species in developed countries have experienced higher rates of genetic change in recent decades for a variety of reasons, including the increased use of technologies like artificial insemination, more focused selection on measurable traits like milk yield, and more effective statistical methods for determining an animal's genetic merit. Dairy cattle have made less progress than poultry and pigs, especially in affluent nations and in certain emerging nations with highly industrialized production methods. Part of this has been accomplished via the common practice of breed substitution, which often results in the dominance of a small number of highly specialized breeds and allows for the possibility of narrowly focusing genetic selection aims.

While wealthy nations have seen the majority of the benefits, emerging nations have many potential to boost productivity. Due in part to a lack of the necessary infrastructure, within-breed selection has not been used very often (such as performance recording and genetic evaluation schemes). Breed replacement or crossing may boost output quickly, but new breeds and crosses must be suitable for the environment and work with production systems that could be characterized by resource limitations and other restrictions. Dairy cows from high-performing temperate breeds may not be suitable for all developing-country conditions. For instance, heat stress and energy shortages make the use of Friesian cattle on smallholdings along the coast of Kenya untenable, in part due to poor cow replacement rates. The utilization of European breeds crossed with regional Zebus that are well acclimated to the environment has considerably greater potential.

The goals of many breeding programs are evolving along with the tools and methods of breeding. Although there is little evidence of direct genetic limits to selection for yield, if selection is too narrowly focused there may be undesirable associated responses. For instance, in dairy cattle, there is now a lot of evidence of unfavorable genetic changes in fertility, disease incidence, and overall stress sensitivity in addition to genetic gains in some production traits, despite better nutrition and general management. Trade-offs between breeding for better resource efficiency, ripple effects on fertility and other qualities, and environmental repercussions like methane emission are anticipated to become more significant. In order to unravel these complexity, whole-system and life-cycle analyses also known as "cradle-to-grave" analyses that evaluate the complete spectrum of pertinent costs and benefits will become more and more crucial.

In the next decades, new molecular genetics methods may have profound effects on cattle and livestock productivity. But, whether new or conventional technologies are utilized, maintaining access to animal genetic resources is ultimately what matters. The preservation of farm animal genetic resources will be essential in helping livestock adapt to climate change and the changes that may occur in these systems, such as shifts in disease prevalence and severity, in developing countries if livestock are to continue to contribute to improving livelihoods and meeting market demands. The shrinking animal genetic resource base in many intensive livestock production systems in industrialized nations highlights the necessity to preserve a wide variety of genetic resources in order to offer genetic insurance against future difficulties and shocks.

Implementing institutional and legislative frameworks that support the in situ preservation of traditional breeds and their sustainable usage is necessary, and a better knowledge of how livestock populations, breeds, and genes fit into the physical, biological, and economic environment is also required.

CONCLUSION

Farmers are able to manage their output in proportion to demand and market conditions in this manner. Maintain the farm with accuracy. Hence, increasing farmer revenue would assist them tremendously, tripling their income. Future trends in livestock breeding will continue to place an emphasis on traits other than output and productivity, such as product quality, improved animal welfare, disease resistance, and reduced environmental impact. Future developments are anticipated to be significantly influenced by the molecular genetics technologies. For instance, DNA-based testing for genes or markers influencing features that are now difficult to detect, such meat quality and disease resistance, would be very helpful. Another example is the production of transgenic cattle for food; although theoretically conceivable, the technologies related to livestock are still in the early stages of development compared to the technologies related to plants. Such strategies might significantly alter animal productivity when combined with novel dissemination approaches like cloning. There are now complete genomic maps for chickens and cattle, which pave the path for future developments in evolutionary biology, animal breeding, and disease-modeling animals. Given that genomic selection enables selection decisions to be based on genomic breeding values, which can ultimately be calculated from genetic marker information alone, rather than from pedigree and phenotypic information, it should be possible to at least double the rate of genetic gain in the dairy industry. Although while genomic selection has its difficulties, it will probably transform animal breeding.

REFERENCES

[1] C. Tisdell, "Socioeconomic causes of loss of animal genetic diversity: Analysis and assessment," *Ecol. Econ.*, 2003, doi: 10.1016/S0921-8009(03)00091-0.

[2] G. Caja, A. Castro-Costa, and C. H. Knight, "Engineering to support wellbeing of dairy animals," *Journal of Dairy Research*. 2016. doi: 10.1017/S0022029916000261.

[3] S. Ganguly, *Recent Research Trends in Veterinary Sciences and Animal Husbandry*. 2018. doi: 10.22271/ed.book04.

[4] *Recent Research Trends in Veterinary Sciences and Animal Husbandry*. 2022. doi: 10.22271/ed.book.1503.

[5] *Recent Research Trends in Veterinary Sciences and Animal Husbandry*. 2021. doi: 10.22271/ed.book.1268.

[6] E. C. Y. Lee and J. M. Devlin, "Knowledge of pet-related zoonotic diseases and pet care in Hong Kong, a heavily crowded urban setting," *Vet. Med. Sci.*, 2022, doi: 10.1002/vms3.656.

[7] L. Miao, R. Fraser, Z. Sun, D. Sneath, B. He, and X. Cui, "Climate impact on vegetation and animal husbandry on the Mongolian plateau: a comparative analysis," *Nat. Hazards*, 2016, doi: 10.1007/s11069-015-1992-3.

[8] E. Stampa, C. Schipmann-Schwarze, and U. Hamm, "Consumer perceptions, preferences, and behavior regarding pasture-raised livestock products: A review," *Food Quality and Preference*. 2020. doi: 10.1016/j.foodqual.2020.103872.

[9] A. Grant, C. G. Gay, and H. S. Lillehoj, "Bacillus spp. as direct-fed microbial antibiotic alternatives to enhance growth, immunity, and gut health in poultry," *Avian Pathology*. 2018. doi: 10.1080/03079457.2018.1464117.

[10] S. Shi, T. Shen, Y. Liu, L. Chen, C. Wang, and C. Liao, "Porcine Myeloid Antimicrobial Peptides: A Review of the Activity and Latest Advances," *Frontiers in Veterinary Science*. 2021. doi: 10.3389/fvets.2021.664139.

[11] W. Anzai *et al.*, "Quantifying the 60-Year Contribution of Japanese Zoos and Aquariums to Peer-Reviewed Scientific Research," *Animals*, 2022, doi: 10.3390/ani12050598.

[12] K. Y. Loo *et al.*, "Incidence of antibiotic resistance in Vibrio spp," *Reviews in Aquaculture*. 2020. doi: 10.1111/raq.12460.

CHAPTER 10
SUCCESSFUL MANAGEMENT METHODS TO DOUBLE FARMER'S INCOME

Renuka Jyothi.S, Assistant Professor
Department of Life Science, School of Sciences, Jain (Deemed to be University), Bangalore, India
Email Id- j.renuka@jainuniversity.ac.in

ABSTRACT:

Raising agricultural production and enhancing food security have been the two main goals of previous agricultural sector development strategies in India. Overall, there has been a 45% rise in food output per person, making India not just a net food exporting nation but also food self-sufficient overall.

KEYWORDS:

Agriculture, Animal Products, Livestock Production, Productivity, Veterinary.

INTRODUCTION

Livestock management is a skill that doesn't need a lot of work and entails providing systematic care for cattle at various stages of development. Any domesticated animal species that produce milk or meat for human consumption are referred to as livestock. Foods made from domesticated animals include chicken, beef, pig, meat, eggs, and milk. These dietary items are very nutrient-dense and fatty and protein-rich. Three different kinds of agricultural techniques are now used. There are three different agricultural systems: intensive, semi-extensive, and extensive. The majority is reliant on a complex system of child upbringing. While some are using an intensive fact-growing system. Most of these are cows, pigs, or poultry, which are often raised outside, typically in high densities. The use of current raising techniques will determine if a farmer's revenue doubles. The introduction of new technology opens the door to better returns. Hence, in order to utilize the new technology, farmers or business owners need to be interested in doing so. Also, they must accept the risk of making larger investments in new technology. The following 4 Livestock Management Pillars may be used to categorize the new technologies that are now available [1]–[3].

- Artificial intelligence-based breeding technologies
- Innovations in the production of fodder and feeding procedures
- Advances in disease and weed control technologies
- Technology-based methods (welfare, housing)

Artificial intelligence-based breeding technologies

The generation of offspring is the fundamental goal of breeding. It entails forcing females to make ova while also collecting and storing males' semen. Therefore, for a successful conception, the female should be mated during oestrus. An ancient technique for introducing artificially stored semen into an animal's female reproductive system is artificial insemination. for an effective conception. Although being utilized on cattle and buffalo, this technique only has a success rate of 40–50% for a variety of reasons. When cows are conceived, farmers lose a lot of time. The inability to recognize them when they are in heat and the indiscriminate use of medications to treat repeat breeder cows may be to blame for this. While artificial intelligence (AI) is a well-established technology, it only applies to the cattle and buffalo species.

The plan included no mention of the need to increase farmers' incomes or of any specific actions that would directly advance their wellbeing. Overall, the income of farmers has remained low, as seen by the prevalence of poverty among farm families. Agrarian distress first emerged in the nation throughout the 1990s and became extremely acute in certain years due to low levels of absolute income as well as a widening income gap between farmers and non-agricultural workers. Between 1995 and 2004, the nation also saw a high rise in the number of farmer suicides, with losses from farming, shocks to farm revenue, and poor farm income all being significant contributors.

Apart from having a negative impact on interest in farming and farm investments, the poor and extremely variable farm income is driving an increasing number of cultivators, especially those who are younger in age, out of the industry. The future of agriculture in the nation might be seriously harmed by this [4]. It is clear that a farmer's income from farming is essential to alleviate agricultural distress and advance farmer wellbeing. In light of this, it is crucial to achieve the aim of doubling farmers' income by 2022–2023 in order to improve farmer welfare, lessen agrarian misery, and achieve income parity between farmers and those in non–agricultural professions.

Precalving Age Reduction Measures

The ideal foundation stock for the dairy is well-grown heifers. Many variables affect development, which in turn affects the early age at first calving. They may be divided into two categories: internal (genetic) and external (non-genetic) influences. Dairyman has control over the outside variables. It covers the animal's surroundings, food, shelter, care, and administration. Its capacity to reach adolescence and start its first conception depends on the weight of the calf at birth and its pace of weight increase over time. Calving interval is the time gap between two calvings. Normally all dairy farmers must getone calf a year. This is a measurement of reproductive efficiency.

Elements of the calving period

The calving interval is composed of two parts:

(1) **The time between conception and calving:** This spans the period after delivery and before the start of the next pregnancy. This interval, which serves as the primary determinant of the calving interval, is the one that is often altered in an effort to reach the desired calving interval.

(2) **The time of gestation:** The cow typically reaches this age between 280 and 285 days; variations are often brought on by genetic effects from both the mother and the sire. Just a little amount may be cut short by inducing parturition artificially.

The time between conception and calving should not exceed 80 to 85 days in order to obtain a 365-day calving interval. The calving to first service period and the first service to conception interval are often separated into two halves for the purpose of tracking reproductive success on a farm. The length of time between calving and the first service relies on three factors: (1) the resumption of ovarian cycles after calving, (2) the appearance and detection of oestrus, and (3) the herdsperson's anticipated start date of services, if later than.The capacity to conceive and sustain pregnancy after a specific service and the persistence of ovarian cycles and the accurate identification of oestrus in cows that do not conceive following first services are both necessary conditions for the first service to conception interval. The timing of calving is influenced by a variety of environmental and genotypic variables that impact the cows. The fertility of the semen utilized for a specific insemination and the efficiency of the insemination method both

affect the likelihood of conception. Hence, if oestrus detection were to get greater attention such that 80% of oestrous episodes were identified, the average time between calving and conception would drop to around 82 days, which is near to the 365-day requirement. Interval between calves. In practice, it could be difficult to pinpoint the causes of extended calving intervals [5], [6].

Pregnancy expectancy: Calving rates won't approach 100% even under perfect circumstances, with 100% of "regular" cows and 100% of oestrus detection efficiency. Just 60–70% of cow inseminations, at best, result in the birth of a calf, and the bulk of failures happen before the second trimester of pregnancy. This is caused in part by infertility, which affects most species, and in part by embryonic or fetal mortality. In test circumstances,

While the number may be lower under typical farm settings, cows' fertilization rates, as determined by testing of ova and embryos after slaughter or surgery, have been estimated to be more than 90%. Yet, it seems that a significant amount of reproductive failure is due to embryonic or fetal mortality [7]. The "ideal" 365-day calving interval is difficult to accomplish even in the absence of special reproductive issues. Clearly, all of this does not imply that calving rates will never reach 100%. It is obvious that for approximately 50% of services to fail, there must be a particular reason or causes. It is probable that there are many contributing factors, including interactions between genetics, environment, and management. Because of the decreasing fertility of dairy cows, this topic is now quite contentious.

Innovations in the production of fodder and feeding techniques

- In any sort of animal husbandry, feed accounts for around 80% of total expenses. Hence, farmers must use all available techniques to make the most use of the feed supplies.
- Using resources that are close by may significantly reduce the expense of buying feed and fodder.
- By roughages, we mean the green and dry grain that a farmer uses to feed his animals.
- The term "concentrate" refers to a balanced ration that contains elements for high-protein and energy-dense feed.
- For agricultural animals, roughage and concentrates are often supplied in a 60:40 ratio.

Concentrates are widely accessible and come with a variety of price options. Typically, 60% of the ingredients in concentrates are carbohydrate sources like maize, jowar, ragi, etc. 20% of brans, including wheat bran, rice bran, Polish, etc., are offered for bulk production and simple ingested food digestion. Proteins are included in 15–18% of the oil seed cake, which also has 2% of a mineral combination and 1% of salt. To suit the needs of milking cows, this ration typically contains 16% crude proteins. It is quite fortunate that Type 1 and Type 2 feeds in the form of such rations are now being sold by milk cooperative groups. The brand names Nandini Gold (Type-1, 18% CP) and Type-2 (Nandini Bypass feed, 21% CP) have been developed by Nandini. Farmers are required to buy these feeds and give them to their cows [8], [9]. It is sufficient to feed non-pregnant dairy cows a maintenance diet of 2.5 kg of concentrates and roughly 15-20 kg of green forage each day. For dry pregnant cows, 3.5 kg of maintenance feed concentrates per day are permissible, as well as 20–25 kg of green feed.

For each 2.5 kg of milk produced, recent calves may be given a concentrate combination of 1 kilogram, as well as an extra 1 kg of concentrates for maintenance. In addition, 30-35 kg of green fodder must also be provided. After collecting the seeds, the plant material is picked

using sickles to produce straw bales. That takes a lot of work and time, however. The majority of the fodder can now be harvested from the ground and rolled into 30 kilogram bales thanks to the availability of tractor mounted baling devices. These bales may be easily kept together for many years. There are a variety of agricultural chores that may use tractor-mounted equipment, such seed drilling. There are many types of fodder harvesters that may be attached on tractors, including front, side, and rear mounting.

Making silage is simple when using high-moisture crops like Napier and maize fodder. Nowadays, silage may be made in smaller amounts, such as 1 tonne or less, and is conveniently processed, transported, and sold thanks to the availability of compact, handy sacks. Cutting of feed: Farmers often supply uncut feed to livestock. As animals prefer bigger stems and leaves over thinner ones, they cannot consume all feed. Usually, the stem is left over. Cutting can easily prevent this. This has the advantages of providing enough of room for storage in the manger and evenly mixing all the feed. There are many different styles and sizes of these choppers. Also, the government offers incentives for the purchase of such equipment.

ONE CALF A YEAR GOAL FOR CALF CARE AND MANAGEMENT

The dairy herd's future is in the calf. Every year, it is important to replace 20% of the cows with recently calved heifer cows in order to maintain production efficiency. The most challenging task on a dairy farm is raising calves. This requires a significant degree of managerial talent, application, and ongoing focus. Nine months of pregnancy result in a healthy birth for the calf. The length of gestation varies depending on the breed of cow. The gestation time of Jersey and HF cows is shorter (290 days) than that of indigenous cows, whereas that of buffaloes is longer (310 days). The gestation period lasts between 279 and 287 days. The average breed would typically live for 283 days. Unlike to cows bearing heifer calves, bull calves often have a somewhat longer gestation period.

NOURISHING CALVES

After-birth feeding of calves: The productivity and lifespan of newborn calves are significantly impacted by their nutrition and care. Colostrum must be given to the infant as soon as it is born in order to guarantee that it develops a sufficient defense system before it can make its own antibodies. Furthermore acting as a laxative, colostrum aids in the removal of meconium from the calf's digestive system. It is a wonderful source of energy, protein, and vitamins and minerals. It has 5–15 times as much vitamin A as regular milk and 3–5 times as much protein. The calf should be started on high-quality green fodder and concentrates at two weeks of age. This encourages the rumen to develop and function correctly.

Typical calf starter mixtures should include readily digested, high-quality, low-fibre feed. It should have a TDN of between 70 and 75 percent and include 22% crude protein. Calf starter should only be made using high-quality components that are devoid of harmful adulterants. The rumen is considerably established about 3 months of age, and microbial digestion occurs there. For normal development, a palatable diet consisting of 13–14% CP and 60–62% TDN is necessary. The animals may be 12% CP starting at six months old, and 58–60%TDN is needed at this stage.

Feeding Starter Calf

For usage in situations where whole milk is scarce, calf starters have emerged. 20 percent DCP and 70 percent TDN make up the perfect calf beginning. It consists of a blend of grains, proteins, vitamins, minerals, and antibiotics. A decent calf starter should be sufficiently palatable, high in energy, and include around 18–20% protein and less than 7% fiber. 50 to 100

grams of calf starter should be given every two to three days beginning in the second week. Since a calf's rumen has not yet grown, the regular concentrate given to cows includes urea, which cannot be digested by a calf.

Feeding soya milk supplement

Soy milk is provided to the calves at a concentration of 50% in whole milk. Overnight soaking of 1 kilogram of soy beans is required to make this. This is ground with a mixer grinder the next morning. With a ratio of 1:8 litres of water, the produced batter paste is diluted. From 15 days after birth until 3 months old, it receives 3 liters of food every day. It has been shown that this soy milk is a fantastic source of protein (45%), which is essential for the calves' healthy growth and development. Bulk soy beans are bought and stored. Moreover, it may be utilized to strengthen the health of heifers and weak calves. By doing this, we can improve immunity and get closer to calf mortality zero.

CALF MORTALITY: REASONS FOR AND PREVENTIONS

Worldwide, the neonatal calf mortality rate ranges from 8.7 to 64 percent (Arif 2012). According to observations, 30–35% of calves died on various Indian farms (Thomas et al., 2012). According to statistics, 84% of all infant deaths occur in the first month of life and the third week of life is especially high. The period of a calf's life from birth to age 21 is referred to as the crucial phase. If the calf survives this time, it may be able to maintain its health for the rest of its life.

There are infectious and non-infectious causes of calf death. Pneumonia and diarrhea brought on by bacteria, viruses, or protozoa are examples of infectious causes. The Dystocia, inappropriate colostrum feeding, low birth weight, and inadequate care techniques are the main non-infectious reasons. Scours and pneumonia are two other major factors in calf death [10].

Dystocia or a difficult calving might be the main causes of this. Low birth weights decrease survivorship, which has a considerable impact on death for calves. Key factors of the decreased calf survival rate include elements that weaken the calf's resistance to sickness and capacity to cope with environmental stress. It is clear from this that all management techniques that improve calf vigor and immunological function while decreasing calving issues have the potential to lower early calf mortality.

CONCLUSION

In conclusion, records are crucial because they allow the farmer to (2) respond based on the information provided by the records and (3) monitor the reproductive success of the herd and the individual cows. The recording of all oestrus episodes, including other indicators like bleeding, to anticipate roughly when predicted oestrus will occur and identify problem cows, as well as the recording of all issues as a tool for culling choices, are two unique and significant applications of records. All of these elements support sound management techniques that double farmer revenue.

REFERENCES

[1] E. Banowati, D. R. Indriyanti, I. Anisykurlillah, H. H. Pratikto, and Y. Sari, “Increasing the competency of cassava farmers as a revitalization efforts of tapioca industries for food private realization,” *Int. J. GEOMATE*, 2020, doi: 10.21660/2020.72.ICGEO17.

[2] G. Danso-Abbeam, K. N. Addai, and D. Ehiakpor, “Willingness to Pay for Farm Insurance by Smallholder Cocoa Farmers in Ghana,” *J. Soc. Sci. Policy Implic.*, 2014.

[3] E. D. Okoffo, E. K. Denkyirah, D. T. Adu, and B. Y. Fosu-Mensah, "A double-hurdle model estimation of cocoa farmers' willingness to pay for crop insurance in Ghana," *Springerplus*, 2016, doi: 10.1186/s40064-016-2561-2.

[4] S. Simatupang, I. Marpaung, S. Tobing, K. E. Ramija, and N. Juita, "Assessment of cultivation technology package to increase production of red chili in Karo," in *IOP Conference Series: Earth and Environmental Science*, 2021. doi: 10.1088/1755-1315/807/4/042022.

[5] M. Christina Sarkol, L. Kurniawati, and S. Perwita, "Analisis Efisiensi Pemasaran Tempe (Studi Kasus di Sentra Produksi Tempe Sanan, Kelurahan Purwantoro, Kecamatan Blimbing, Kota Malang)," *J. BisTek Pertan. Agribisnis dan Teknol. Has. Pertan.*, 2019, doi: 10.37832/bistek.v6i01.10.

[6] L. O. Olarinde and O. A. Oladunni, "Enhancing Smallholder Farmers Income and Food Security through Agricultural Research and Development in West Africa : Impact of the," *Int. Conf. African Assoc. Agric. Econ.*, 2013.

[7] T. P. Barakoti, "Identification of Suitable Planting Method for Potato + Maize Intercropping System in the Hill of Eastern Nepal," *Nepal Agric. Res. J.*, 2014, doi: 10.3126/narj.v8i0.11604.

[8] Y. D. Li *et al.*, "[Model construction and application for nitrogen nutrition monitoring and diagnosis in double-cropping rice of Jiangxi Province, China]," *Yingyong Shengtai Xuebao*, 2020.

[9] A. Wariwo and A. Seyoum, "Determinants of farmers ' willingness to pay for blue Nile River Protection : The Case of Gilgel Abay River," *African J. Agric. Econ. Rural Dev. ISSN*, 2020.

[10] Y. Li *et al.*, "Regulation of nitrogen fertilizer based on portable apparatus for crop growth monitoring and diagnosis in Jiangxi double cropping rice," *Nongye Gongcheng Xuebao/Transactions Chinese Soc. Agric. Eng.*, 2019, doi: 10.11975/j.issn.1002-6819.2019.02.013.

[11] J. T. DORGE, G. G. JOSHI, and D. J. SANAP, "Employment and income pattern of different farming systems in Western Maharashtra," *Int. Res. J. Agric. Econ. Stat.*, 2015, doi: 10.15740/has/irjaes/6.2/356-363.

CHAPTER 11
LIVESTOCK FARMING SECTOR'S HELP FOR THE GLOBAL AGRICULTURAL SECTOR

Dr. Asha Rajiv, Professor
Department of Physics and Electronics, School of Sciences, Jain (Deemed to be University), Bangalore, India
Email Id- asha.rajiv@jainuniversity.ac.in

ABSTRACT:

The main concerns that affect the social, economic, environmental, and resource-based sustainability of individual farms are those that affect the farm families. Economic, environmental, ecological, sociological, and cultural factors for smaller towns and bigger regions are all part of the sustainability of the whole agricultural and food system, from farm producers to final consumers. In addition to serving as vital food sources for the American diet, animals and their products are also significant sources of revenue for small-scale farmers in more than 80% of the states. There is rivalry for and cooperation in the use of the fundamental resources of land, air, labor, technology, water, energy, capital, and management in agroecosystems of farms. It is ideal to have a stable biotic ecosystem or equilibrium between plants and animals. Systems of agriculture based on livestock may play a significant part in addressing environmental issues such decreased soil fertility, soil erosion, and water pollution. Animals are an economically valuable component of livestock-crop systems.

KEYWORDS:

Agriculture, Animal Husbandry, Livestock, Medicine, Soil Fertility.

INTRODUCTION

One of the Asian nations with a sizable population that depend on agriculture for their livelihood is Indonesia. This is a result of the region's unique natural features, which primarily include vast tracts of land, a high level of biodiversity, and a tropical temperature. The sun's beams may shine all year long in this tropical environment. According to from 2019, Indonesia has a total population of 268.074.600. 33,400,000 persons, or around 12.45% of the total population, are farmers in Indonesia. According to these statistics, up to 8% of farmers are under the age of 39, while the remainder are older. Naturally, the demand for animal food intake (meat) will rise along with the population. The community's growing need for meat will directly correlate with the pace at which that need is growing. Regrettably, attempts to expand domestic beef output have not kept up with the pace of demand. Nowadays, there are still shortages of national beef available throughout the nation. As a result, more imported beef is required. Around 35% of the overall national demand for beef has been satisfied by imports, according to the statistics. Even if it hasn't been able to satisfy all of the demands of the Indonesian people, there is still a good amount of meat available in the nation. Livestock also have the capability to generate milk, which is just as vital as their ability to provide meat. The dairy farming industry is the source of this potential [1]–[3] .

One of the most significant and strategically essential subsectors is livestock. This portion is especially important in the process of supplying the community with the protein-rich foods they require. Indonesia's need for food produced by cattle is growing. The average daily intake of animal protein among Indonesians is still just 4 g per person. Demand for animal products has a rather strong income elasticity. While this is going on, less beef is being consumed than is required. This circumstance presents both an opportunity and a difficulty for would-be

breeders and business owners in the cattle sector. The livestock sub-position sector's as a supplier is very important in the endeavour to supply the demands of animal protein for the whole population. Meat, milk, and eggs provide the demand for animal protein. Overall, the demand for domestic meat has not been able to be met. Thus, attempts to import beef remain an option. The country's population's demands for milk and egg products are still well met. It is important to properly prepare any changes to cattle governance. The production of cattle is anticipated to rise as long as their requirements are met and management is improved. The idea of integrating the cattle business and the agriculture sector may be used to further this endeavour.

From ancient times, the idea of an integrated farming system (IFS) has been practiced. The symbiotic interaction between the agricultural and cattle industries defines this idea. In theory, this approach will make it possible to implement a sustainable farming system. The integrated agricultural system has been abandoned after the conclusion of World War II, according to the history of agriculture. Monocultures and specialized agricultural methods have advanced significantly at this point. Full support has been given to this system, particularly in light of the unchecked use of chemical fertilizers, the use of herbicides to manage weeds, and the use of pesticides and fungicides to control pests and plant diseases. Traditional farming practices have been supplanted by the use of modern agricultural technologies [4].

The productivity and yields of agricultural companies have generally increased greatly as a result of these changes in agricultural practice patterns. However, over time, this method does not demonstrate a sustained effort and results in a decline in the quality of the land, an uptick in the process of land and water pollution, and the creation of specific insect and plant disease variations. Indonesia's population, which mostly depends on agriculture, has used the majority of the country's natural resources to suit their demands. An essential need and prerequisite for the continuation of human existence are agricultural goods. The term "agricultural products" refers to goods produced by the agricultural sector as a whole, plantations, livestock, and fisheries.

Including animals in rice plantations

One of the most significant crops in the history of human civilisation is rice (Oryza sativa L). About 1500 BC, when people moved from mainland Asia to Indonesia, rice is supposed to have originated in India or Indochina. Asia is home to several nations that grow rice, including China (28% of global output). India (21%) and Indonesia (9) came next. Yet, only a tiny part (between 5% and 6% of the total global output) of rice is exchanged between nations. Thailand exports a significant amount of rice (26% of all rice exported globally). Vietnam (15%) and the United States (11%), respectively, came next. Together with Bangladesh (4%), Brazil (3%), and Indonesia (14% of the world's traded rice), these nations all import rice [5], [6].

One of the basic meals for the majority of people in various Asian nations, including Indonesia, is rice. During many centuries, people have used rice as a staple diet. Nowadays, the Asian occupied nations produce and eat over 90% of the world's rice. This is unquestionably an indication that human attempts to boost rice output are insecure. One of the causes is the continued 1.3% annual growth of the world's population. The world's population is predicted to reach 8.3 billion people in 2025. Based on statistics, there were 237.56 million people living in Indonesia as of 2010. In order to achieve these demands, 33.06 million tons of rice are needed annually, assuming 139 kg per person. The government set a goal for rice production of 68.59 million tons of milled dry rice (MDR), which is equal to 38.57 million tons of rice, in response to the population growth that brought the total to 241 million in 2011. Compared to the goal of rice production in 2010, this number grew by 2.1 million tons of MDR, or 3.2%.

The commodity of meat is significant in addition to rice. The growth of the livestock subsector has produced noticeable effects during the last ten years, particularly in terms of its contribution to GDP (GDP). Meat, eggs, and milk consumption as a whole grew by 7.6%, 5.22%, and 0.92%, respectively. The growth in output, notably of beef, whose population has even reduced to 4.1%/year [8,] has not kept pace with the rise in demand. A portion of the meat required to satisfy domestic demand must be imported. The demand for beef in 2014 relates to an increase in meat intake per person from 2.2 kg/year in 2013 to 2.36 kg/year in 2014. Nevertheless, only 58,280 tons, or 9.8% of the 34,970 tons, or 175,407 head, of feeder cattle are used to meet beef consumption from imported goods, while 23,100 tons of meat are consumed. A cow population of 19.7 million heads is required to meet local meat demands in 2014, and 17.6 million beef cattle must be available, which is more than the population of beef cattle in 2013 of 16.8 million tons [7], [8].

While the initiative for beef self-sufficiency was started in 2005 and was supposed to be completed in 2010, it hasn't. As a result, the administration has set new goals for itself, which it eventually attained in 2014. If everyone is committed to creating a domestic beef cow industry, the idea of beef self-sufficiency is undoubtedly feasible. Development of beef cattle with a comparative and competitive advantage in both domestic and international markets should take use of market potential and supporting resources. Indonesia's cattle population may increase since the industry has a lot of potential. This is shown by the expansion of the cattle fattening industry in many areas and the OFPU Program, which was established in 2011. A number of cows are provided to the farmer groups, who subsequently turn the cow excrement into compost. There are farmer groups who are able to turn producing cow dung and urine into their primary source of income, with the side business of fattening animals. Although the cost of purchasing feed is just IDR 7000/head/day, the selling of cow dung and pee generates a revenue of IDR 22,000/head/day. At OFPU, the cost of compost per kilogram varies from IDR 600 to 750.

The rice-livestock integration system (RLIS) is now ingrained in Indonesian agricultural culture. This technique effectively makes use of nearby resources, such as animal waste and byproducts like straw and bran. The primary feature of RLIS is the connection between plants and animals. For instance, rice crop residue (straw) is utilized as animal feed, and vice versa, livestock manure may be used as organic fertilizer to satisfy plant nutritional needs. As a result, the ICM evaluation program for rice paddy was launched concurrently with the RLIS assessment program. One of the primary components that the ICM advises using is organic material. To boost rice yields, enhance the physical and chemical characteristics of the soil, and reduce the usage of inorganic fertilizers, organic fertilizers are required. In certain rice fields, excessive nitrogen consumption and ongoing P fertilizer application might upset the soil's delicate balance of nutrients. The current low levels of organic matter in Indonesia's agricultural land demonstrate the necessity for efforts to double the organic matter content of the soil in order to return the soil to its natural state of health. Claimed that compared to not using organic fertilizers, rice output might be increased by 0.9 tons per hectare.

Farmers may profit from the RLIS by using cow dung and agricultural byproducts like straw and bran. The best way to use waste from animal manure has not always been done. It may be sold to generate extra cash or utilized as organic fertilizer to improve soil fertility. In order to lower the cost of supplying feed, it is possible to utilize the existing agricultural waste as a source of high-quality feed. Feeding issues may be resolved using the RLIS pattern. With the conversion of agricultural waste into feed with high nutritional value, this pattern may increase food security and satisfy the demands of cattle. RLIS is a broad approach to achieving food sovereignty, independence, and security.

DISCUSSION

Since gaining its independence, Indonesia has not been able to produce enough food to fulfill its own requirements. As a result, importing a variety of meals must be an alternative. One way to lower the rate of food imports is via the food sovereignty initiative. By putting an emphasis on production for the fulfillment and sustainability of local food and local markets through the provision of agricultural production inputs that utilize local wisdom and are environmentally friendly, the food sovereignty program is able to reverse the concept of modernization into things that are back to basic or back to nature. One thing that has to be understood is that self-reliance and self-sufficiency are the fundamental ideas and issues that occur in the food production process. Of course, an economic democracy is required in order to attain self-sufficiency in food production. The government must implement redistribution measures. By allocating capital to the agricultural sector fairly, special parties like the government must safeguard the lives and income of the populace. The food production program's issues must depend on initiatives to engage the majority of small-scale food producers. It gives access to resources including land, water, seeds, and animals to underserved areas of the food production industry.

It is well known that Indonesia has unbeatable (comparative and competitive) advantages when it comes to establishing food independence and sovereignty. Of course, this potential has been characterized by a number of factors, including: (1) Indonesia's equator-bound location, tropical climate, and exceptionally high sunlight intensity; (2) the availability of land and water, which means that it is not a limiting factor and is therefore quite alarming; (3) the availability of living natural resources along with a diversity of local foods; (4) advancements in food production technology, including those that have decentralized production. Strong food security is always necessary for initiatives promoting food sovereignty and self-sufficiency. This covers the availability, accessibility, stability of prices, consumption, quality, and safety of food. The government must work to safeguard its farmers in order to achieve food sovereignty. Moreover, the government constantly urges farmers to be prepared to take on food giants. Of course, farmers will suffer as a result of this. A governmental subsidies scheme by preserving commerce and giving enough subsidies to farmers must be adopted. The government must set aside a sufficient budget for subsidies. Budget for food assistance must represent a higher proportion of (GDP). Using local resources that are backed by agriculture-based companies, soft credit programs, and rural infrastructure development is a potential alternative option for achieving food independence and sovereignty. A market for primary agricultural produce and new employment in rural regions are projected to result from this.

From their various functions, it is clear that the livestock business is integrated with the agricultural sector, particularly rice. By producing energy, animals (in this case, cattle) play an important part in the production of rice, processing the soil. Due to the use of very intense chemical fertilizers, livestock waste produced as manure during the soil processing process will breakdown so that it may nourish the hardened soil. He determined that an adult cow can create 8 to 10 kilogram of manure per day, which can be converted into 4-5 kg of compost daily. Urine, a liquid waste product of cattle, is collected during livestock disposal. After processing with additional chemicals that are later placed, the mixture is then kept in a plastic drum. With the use of leaf spraying methods, liquid fertilizer made from pee may be utilized to fertilize rice plants. Consumer demand for organic fertilizers made from excrement and pee is high, but supply is still relatively constrained [9].

The presence and function of animal waste has not entirely replaced the position of chemical fertilizers, but at the very least, organic fertilizers from livestock manure may make up for the lack of certain nutrient components in chemical fertilizers. The average daily gain (ADG) of

0.89 kg/head/day may be increased by the cattle culture management system when it is used rigorously while taking animal health, feed (concentrate and fermented rice straw), and collective cage management into account. The farmer method's 0.29 kg/head/day limit. It was able to manufacture ADG from 0.29 to 0.89 kg/day as a consequence of an increase in ADG of about 0.6 kg/head/day (67.42%). Nevertheless, how can cattle eat rice straw as agricultural waste that has not been exploited to its full potential? This is another reason why fattening cattle is not only about reaching high ADG values. Naturally, this will be able to lower the costs of production for farmers while also being more ecologically friendly.

At least 70% of the productivity of cattle is determined by environmental conditions, while the remaining 30% is regulated by genetic factors. One of the environmental elements that has the highest impact on productivity is feed (up to 60%). Based on this, it may be concluded that even if animals have excellent genetic potential, production will be challenging to accomplish in the absence of high-quality and readily accessible feed. The presence of agricultural waste in the form of rice straw demonstrates the significant function and contribution that the rice plant industry makes to the management of cow feed (whether or not fermented). Yet, it goes without saying that cattle cannot properly digest rice straw that has not gone through a fermentation process. The high lignin and hemicellulose content of the waste straw is to blame for this.

The removal of lignin and improvement of cellulose digestibility are the goals of the biodegradation process of the lignin compounds in straw, which will improve the quality of straw as animal feed. lignin degrades more quickly than cellulose in isolates with high degradation efficiency. Compared to grass, which has a protein level of around 9%, processed agricultural waste (a byproduct) has 12% more protein. Since processed feed includes molasses and pikuten, it has a superior taste (commercial minerals).

Straw made from trash rice plants has to be used as effectively as possible. The nutrients in the straw will be diminished by the burning process. It is exceedingly difficult for soil particles to bind straw that has been kept in the ground without fermentation. Thus, extra consideration must be given to this waste in order to raise the level of quality. Straw may be processed into compost in one of two ways: 1) piled and turned, or 2) stacked with ventilation but not rotated. Using a decomposer in the form of microbes may speed up the breakdown process.

An animal feed additive called probion product may be utilized directly as a concentrate feed combination to raise the caliber of rice straw via fermentation. The product from Probion is a collection of ruminant-derived microorganisms that have been supplemented with crucial nutrients for microbial development. Crumbs, a dark brown hue, and a temperature that is already steady (40–50°C) are all signs of mature compost. The resulting compost weighs around 500 kg, has a C-organic quality of >12%, a C/N ratio of 15–25%, a moisture content of 40–50%, and has a light brown-black hue [10].

Although having a lot of promise, rice straw has not been used to its full potential as cow feed. The fact that there is a lot of crude fiber present but very little digestible protein is one of the challenges. Straw cannot possibly provide the nutritional content required by cattle throughout the production process whether used directly or as a single feed. One of the initiatives to realize an integrated system of rice plants and livestock is the use of rice plant straw waste as animal feed.

Probiotics may be used as a biodegradation during the fermentation process to boost the nutritional value of straw. The protein quality of the fermented straw is virtually identical to that of elephant grass. The fermented straw has to be kept as soon as possible in a dry location to preserve its quality. The ability of straw to be used as animal feed may expedite the effort

that farmers must do to get ready to locate grass. In fact, the study's findings indicate that supplementing agricultural straw waste with urea and microorganisms might increase animal output. Straw is a byproduct of rice plantations. Fresh straw waste from rice fields will be produced per hectare at a rate of 12–15 tonnes every season. Moreover, waste that has through the fermentation process will provide 5-8 tons/ha, which may be utilized to supply 2-3 cows with the feed they require each year.

The fermentation of straw makes excellent use of bacteria to enhance the quality of the straw. As compared to unfermented rice straw, the nutritional content of rice straw that has been fermented with a Starbio starter up to 0.06% of its weight often exhibits an improvement in quality. After a reduction in crude fiber content, the fermentation process may raise the crude protein content of rice straw from 4.23% to 8.14%. Our findings suggest that Starbio starter is a proteolytic microbe capable of producing the enzymes needed to convert proteins into simple peptides by breaking them down into polypeptides. By using a microbial starter, it was possible to lower the cell wall composition of rice straw from 73.41% to 66.14%. During the fermentation process, the linkages between the lignocellulose and hemicellulose in rice straw will be broken. The lignocellulose linkages are broken down by the action of lignolytic microorganisms in the microbial starter, allowing cellulose and lignin to be liberated from these bonds by the activity of the lignase enzyme. One indication that these bacteria are functioning well is the drop in cellulose and lignin levels that occurs during fermentation. The physical barrier of lignin molecules in straw may prevent plant tissue enzymes from being digested. Furthermore, lignin and hemicellulose have a strong bond. The reduction in cell wall composition suggests that the cellulose cell walls have begun to break down, making the feed easier for cattle to digest. The outcomes of the fermentation might boost the straw's nutritional value. Cattle that are fed supplementary feed such straw and probiotics are able to offer a live weight growth of 0.56-0.68 kg/head/day greater than the control, demonstrating how dramatically the rise in live weight of livestock may increase.

Bran is one sort of trash created during the processing of rice. The aleurone layer with a little amount of the endosperm, pericarp, pigment, and germ make up this bran. As bran may be generated in quantities up to 8 to 10% of the weight of milled rice, it is widely available. As much as 88.30% of rice bran's dry constituents are composed of crude fiber (15.30%), ash (9.90%), crude protein (10.10%), crude fat (4.90%), and 48.10% BETN. Bran is a readily accessible and highly efficient source of carbohydrates that enhances the quality of rice straw fermentation [38]. Feeding pregnant cows of local cattle rice bran and Bioplas probiotics may raise body weight by approximately 0.5 kg/head/day and birth weight by around 10.5 kg when compared to the control 8.9 kg. The amount of feed consumed has gone up by roughly 5.2 kg. In addition, cows given bioplas bran and probiotics were able to reestrus 62 days after giving birth, which was a significant difference from controls who took roughly 85 days.

Breeders anticipate using the usage of solid waste (manure) and liquid waste (urine) in cow production as organic fertilizer as a source of extra revenue. Moreover, it may increase the fertility of land used for agriculture. In comparison to conventional technology, which increased farmers' revenue by IDR 22,903,200, the technology for integrating livestock with rice plants was able to do so by IDR 34,488,800. According to the R/C ratio study findings, the value was 6, greater than the conventional pattern's R/C ratio of 4, making it possible for farmers to grow. By choosing limited land in rural regions, rice farming that is linked with cattle is an efficient and effective farming for increasing the agricultural revenue of the people. When producing rice on a large scale with 5 hectares of plant area and 20 head of cattle, integrating cattle and rice may enhance farmers' revenue by 70%. The population of domestic cattle will grow as more cattle are developed utilizing the RLIS approach in various prospective

regions. The end outcome is anticipated to be able to produce enough meat on its own. This initiative attempts to preserve the diversity of regional cattle populations as very important genetic material. It also aims to cut down on the imports of meat, which have been difficult to stop because of the enormous domestic demand for meat. The capacity to enhance the performance of other farmer groups in terms of purchasing and selling livestock results in another advantageous effect. The straw is only used for animal feed demands, with a pattern of growing rice three times per year and being a technically irrigated area. At 25 kg per day per head for seed cows and 31 kg per day per head for fattened cows, straw is provided at such a high rate for animal feed. The RLIS pattern implementation was hampered by a number of issues, including: (1) a poor group functioning mechanism; (2) a collective pen utilization that is far from optimal, resulting in a low level of pen facility utilization; and (3) a mentoring and coaching process that is ineffective due to the position of the cattle, which cannot be kept in a single collective pen. The current cattle will thereafter be dispersed in accordance with the breeders' residence positions. Another problem is that it still takes a long time to go from the compost facility to the fields. On the other hand, group farmers have not yet become used to using manure. In order to use the available manure, this needs socializing.

The ICM program and the RLIS program were both started at the same time. Moreover, in order to promote agricultural extension, the adoption of rice-livestock technologies, and government aid channels, the development of the RLIS must be carried out via a farmer group method. The use of potential plant waste as a source of animal feed, the use of livestock dung as manure, the creation of new employment in rural regions, and an increase in community involvement are all benefits of the rice-livestock integration pattern. The poor functioning of farmer groups, the unsatisfactory use of collective cages, the ineffectiveness of mentoring and coaching due to the dispersed location of livestock, the lack of widespread adoption of manure use among rice farmers, and the lack of discernible progress in the implementation of RLIS are all barriers to SIPT realizing food security. Future RLIS advancements should concentrate on production hubs in order to be widespread and have a major influence on population increase and livestock output. To reduce transportation costs and achieve zero waste and a well-integrated agricultural system, the processing of animal manure is conducted near to the site where rice is planted.

In a situation of synergy, rice-livestock integration technology may boost farmers' supplementary revenue. Input for farming has been used as efficiently as possible. Straw and feed, both of which have commercial worth, were combined with the process of producing rice in order to fatten cattle. With the recycling process, biogas is produced from cow dung. Plants are fertilized with worms and organic fertilizers, while fish ponds are fertilized with cattle manure. In addition to the primary rice products, paddy fields also provide straw and bran that may be utilized as animal feed. In this instance, all waste, including that from both plants and animals, has additional value and does not harm the ecosystem.

Combining ruminants with cassava plants

One of the key components of the agricultural development program is the livestock development program, and the role that farmers and breeders play in this development will be crucial to its success. The primary difficulty confronting the livestock industry today is how to develop livestock products that are highly competitive in terms of quality, quantity, diversity, and price in order to satisfy these expectations. This may be achieved by maximizing the usage of local feed to satisfy the demands of both home and international markets. In Indonesia, there is still a lot of potential and accessible land for the growth of agricultural sectors. Nonetheless, due to the growing demand for both agricultural and non-agricultural land usage, this calls for care. Of course, the fact that there is competition in land usage has an influence.

According to statistics, Indonesia produces 24 million tons of cassava, which is second only to Nigeria in terms of global output (52.4 million tons). With a yield of 20 tons per hectare and a harvest area of around 1.2 million hectares, Indonesia produced 24 million tons of cassava in 2011. With this yield, cassava overtakes rice as the second-largest crop produced (65 million tons). The evolution of cassava growth over the last ten years reveals that although output has grown with a growth rate of 2.62% /year, the area of cassava plants has remained mostly stable and even started to fall in 2012 (0.56%/year). This is brought on by higher production, which has an increase with a 3.97% average annual growth rate.

The cassava plant is a root tuber plant that, depending on the kind and variation, has an elongated form with a center line of approximately 2-3 cm and a length of 50–80 cm. The plant is made up of several different components, including tubers, branches, roots, flowers, and leaves. Cassava's tuber may be utilized as an alternate source of feed for animals. Cassava tubers have a more comprehensive nutritional profile than grass and legumes, which are often utilized as animal feed in rural areas. Farmers of cassava may gain from the integration pattern amongst ruminants (cattle, buffalo, goats, and sheep). Also, in order to reduce unoccupied land, connections of reciprocity with breeders may be possible. Cassava plants may be grown on bare terrain, making it possible for cattle to graze there as well. It should be noted, nevertheless, that the cassava plant has a number of disadvantages as well.

The presence of harmful substances, such as cyanide acid, in cassava plants is one of the drawbacks (HCN). Its usage in poultry is restricted due to the presence of this chemical. Cassava plants have two different kinds of cyanogenic glycosides, which are harmful derivatives of secondary metabolites found in plants. The cyanogenic glycosides in concern are modest quantities of lotaustralin and linamarin (methyl linamarin). Whereas lotaustralin is hydrolyzed slowly to cyanohydrin and glucose, linamarin hydrolyzes quickly to glucose and acetone cyanohydrin. Acetone cyanohydrin breaks down into acetone and hydrogen cyanide in neutral circumstances. Methionine is not readily available in cassava due to the presence of this cyanide acid. Heating may be used to eliminate the cyanide acid compounds that are present. Cassava plants are quite bulky, particularly their leaves, which makes them ineffective for transportation. Many farmers are reluctant to grow cassava because it uses nutrients inefficiently.

Cassava plants may be used in the best way possible as ruminant feed. One of these is using a paradigm for integrating the cultivation of ruminant animals with cassava plants (cattle, buffalo, goats and sheep). This paradigm is based on the idea that animals would seek out sources of food. Some actions that may be done are as follows: (1) The cassava crop is surrounded by a livestock farm. In order to expand ruminant farms close or around the region where cassava is planted, efforts are made to employ cassava plants as feed. This action is one technique to benefit from cassava plants, particularly the discarded leaves and tubers. The implementation of this technique involves rearing animals close to cassava gardens, which are then provided with cassava plant products such leaves, rejected tubers, and tuber skin. This approach is particularly advantageous since it allows for the use of bovine dung as organic fertilizer throughout the growing of cassava plants, maintaining the soil's fertility. For instance, 1.2 tons/ha of cassava leaf output is expected to be sufficient to feed 14 small ruminants (goats/sheep) or the equivalent of 2 cows or buffaloes throughout the time of fattening. The tuber portion may be used to make chips or tapioca goods. Skin and tuber waste from the processing of cassava may be combined with other materials to make animal feed. (2) Animals are positioned everywhere around the tapioca and chip facility.

Tens of tons of cassava are converted each day into tapioca or chips. Moreover, the skin and tuber leftover from the manufacturing process may be combined with other substances to make

animal feed. Businesses may create a cattle enterprise on the property near the tapioca mill. The business will have a fantastic potential to boost animal output in order to satisfy the Indonesian population's need for meat. In order to maximize the utilization of cassava plants, it is believed that an integrated farm system that combines the cultivation of ruminant and non-ruminant livestock is more beneficial. Raising cattle close to the plantation is one action that may be taken to achieve this aim. Non-ruminant livestock (poultry, pigs, and horses) may be prioritized to use dried cassava and its leaves as a source of protein and energy thanks to this integrated agricultural system. In the meanwhile, the discarded bark, leaves, and cassava are utilized as a source of feed for ruminants (cattle, buffalo, goats and sheep). Since there are so many farmers and breeders working in this industry, the method of integrating livestock into the primary cassava plantation company has a lot of potential and potential.

If a farmer uses this earnings to fund their primary operations, one can argue that it is wrong. If a farmer's operation is combined with the business of raising ruminants or non-ruminants, the value of his earnings will undoubtedly rise. Efforts to ensure national food security and the growth of bioenergy (biofuel) may result in competition in land usage in the future, which has to be addressed right now. It is necessary to increase production (intensification), particularly on current land, increase the size of the land area, and create more advanced technical breakthroughs. Hence, it is suitable and effective to utilize idle land for the creation of an integrated system of plantations, agricultural, and animals. This is an endeavor to address Indonesia's issues with food security. By increasing food production, this integration may both meet the goal food demands of the Indonesian people and improve community welfare.

CONCLUTION

The practice of integrating cattle and plants; sometimes known as integrated agriculture. In this concept, agricultural and livestock-related activities are combined. Since agricultural waste is utilized as animal feed and livestock waste as fertilizer for crops, this approach is sometimes referred to as a waste-free farming system. To promote a rise in the effectiveness of farm income, the connection between animals and plants must be complimentary, supporting, and mutually beneficial.

REFERENCES

[1] N. M. Hashem *et al.*, “Agro-livestock farming system sustainability during the covid-19 era: A cross-sectional study on the role of information and communication technologies,” *Sustain.*, 2021, doi: 10.3390/su13126521.

[2] K. Jantke, M. J. Hartmann, L. Rasche, B. Blanz, and U. A. Schneider, “Agricultural greenhouse gas emissions: Knowledge and positions of German farmers,” *Land*, 2020, doi: 10.3390/LAND9050130.

[3] N. B. Jadeja and A. Worrich, “From gut to mud: dissemination of antimicrobial resistance between animal and agricultural niches,” *Environmental Microbiology*. 2022. doi: 10.1111/1462-2920.15927.

[4] R. Lal, “Integrating Animal Husbandry With Crops and Trees,” *Frontiers in Sustainable Food Systems*. 2020. doi: 10.3389/fsufs.2020.00113.

[5] M. Odintsov Vaintrub, H. Levit, M. Chincarini, I. Fusaro, M. Giammarco, and G. Vignola, “Review: Precision livestock farming, automats and new technologies: possible applications in extensive dairy sheep farming,” *Animal*. 2021. doi: 10.1016/j.animal.2020.100143.

[6] L. A. Zadgaonkar, V. Darwai, and S. A. Mandavgane, "The circular agricultural system is more sustainable: emergy analysis," *Clean Technol. Environ. Policy*, 2022, doi: 10.1007/s10098-021-02245-2.

[7] P. Barbieri, S. Pellerin, V. Seufert, L. Smith, N. Ramankutty, and T. Nesme, "Global option space for organic agriculture is delimited by nitrogen availability," *Nat. Food*, 2021, doi: 10.1038/s43016-021-00276-y.

[8] H. Carrão, G. Naumann, and P. Barbosa, "Mapping global patterns of drought risk: An empirical framework based on sub-national estimates of hazard, exposure and vulnerability," *Glob. Environ. Chang.*, 2016, doi: 10.1016/j.gloenvcha.2016.04.012.

[9] N. Boke Olén *et al.*, "Effects of farm type on food production, landscape openness, grassland biodiversity, and greenhouse gas emissions in mixed agricultural-forestry regions," *Agric. Syst.*, 2021, doi: 10.1016/j.agsy.2021.103071.

[10] H. Panchasara, N. H. Samrat, and N. Islam, "Greenhouse gas emissions trends and mitigation measures in australian agriculture sector—a review," *Agriculture (Switzerland)*. 2021. doi: 10.3390/agriculture11020085.

[11] M. E. Fernandez-Gimenez, E. Oteros-Rozas, and F. Ravera, "Spanish women pastoralists' pathways into livestock management: Motivations, challenges and learning," *J. Rural Stud.*, 2021, doi: 10.1016/j.jrurstud.2021.08.019.

CHAPTER 12
AN OVERVIEW ON VACCINES AND VACCINATIONS

Renuka Jyothi.S, Assistant Professor
Department of Life Science, School of Sciences, Jain (Deemed to be University), Bangalore, India
Email Id- j.renuka@jainuniversity.ac.in

ABSTRACT:

Most vaccines are given by needle injection, although some may also be taken by mouth or sprayed into the nose. The process of administering a vaccine to the body in order to generate protection against a particular illness. Vaccines aid in the quicker and more efficient defense against illnesses by the immune system. A vaccination activates your immune system, aiding your body in warding off and remembering the pathogen so it can fight it if it ever invades again.

KEYWORDS:

Agriculture, Animal Husbandry, Animal husbandry, Immune System, Vaccine, vaccination.

INTRODUCTION

BENEFITS OF IMMUNOLOGY

The reduction in the number of animals becoming sick and dying from illnesses is the main advantage of immunization. When a lot of animals are immunized, this "herd effect" benefits both the immunized animals, who are less likely to get the illness for which they have been immunized, and the whole population of animals as a whole, who are less likely to be exposed to it. This is important for public health as well because, in the absence of domestic animal immunization, rabies poses a serious risk to human health in the United States. The main goals of vaccination are to immunize as many people as possible in the population at risk, to immunize each person only as often as is absolutely necessary, and to immunize only against agents to which the animal has a realistic risk of exposure and subsequent development of serious illness [1]–[3].

PROTECTIVE IMMUNITY IS TRANSFERRED BY VACCINATION

An animal's immune system is deliberately exposed to something that causes sickness via vaccination. Immunization is the intended outcome; vaccination is the act. The majority of vaccinations used in veterinary medicine defend against viruses, while some also protect against certain germs or poisons. After receiving a vaccination, an animal's immune system detects the foreign proteins and develops a defense against them. The production of antibodies, which are proteins that bind to the pathogen and cause its elimination, is a component of that response (humoral immunity). The animal's body produces cells that will eradicate the infection as a further aspect of that reaction (cellular immunity). When the animal is exposed to the pathogen again, memory cells in certain of those cells may produce a quicker and more potent response. This indicates that vaccinated animals are substantially less likely to get sick because they have a memory cell reserve and can react swiftly to any natural exposure to the virus.

VACCINE TYPES

Veterinarians have access to three different vaccination kinds. Vaccines that have been killed, often known as inactivated vaccinations, include complete, inactivated viruses or bacteria.

Killed vaccines require the use of an adjuvant, which may be linked to vaccine reactions, and may not produce a long-lasting immune response, necessitating their administration more frequently in order to be effective. They are also more stable for handling and storage and cannot cause disease in the animal. When a killed vaccination is administered for the first time, it primes the immune system but does not cause an immunological reaction; the animal needs a booster shot or to be naturally exposed for an immune reaction to take place. MLV vaccines, also known as attenuated vaccinations, contain intact viruses that are not yet dead but have been altered so they can no longer spread illness. Although the MLV vaccination contains a living, capable of replication bacterium, sometimes infected animals may develop illnesses. These vaccinations often elicit a considerably more potent and durable immunological response. They need to be used cautiously since they sometimes result in illness in animals that have received vaccinations; for instance, several MLV vaccines cannot be administered to animals who are pregnant because they may result in abortion. Immunosuppressed animals should not be given these vaccinations without caution. Recombinant or subunit vaccines elicit an immune response by using fragments of germs or viruses. Vaccinated animals cannot get these diseases, although sometimes an appropriate immune response is not produced. Recombinant vaccinations are projected to become the standard in the future as recombinant technology advances. All animals in a particular species get the same dosage of vaccine since an animal's reaction to immunization is independent of the "dose" of vaccine delivered [4].

SERIES OF VACCINATIONS

The manufacturer specifies the earliest age at which vaccinations may be administered and the need for booster shots. Newborn animals that were breastfed by their dam on the first day of birth will have antibodies in their general circulation from her first milk (colostrum), which was absorbed via their GI tract (passive immunity). These antibodies will prevent vaccinations from working, and often we are unable to predict when these antibodies' concentrations will drop. The time of an animal's own immune system functioning varies for young animals as well (active immunity). As a result, young animals often undergo a series of vaccinations, with the manufacturer defining the timing of boosters. Some vaccinations are boostered when initially administered to adult animals, while others are not; always follow the instructions for usage on the vaccine package. Booster vaccinations are given to older animals in order to strengthen their immune response and prepare them for disease challenges. The kind of vaccination used (killed versus MLV, for example) and the features of the organism itself affect when booster shots should be given. The manufacturer offers recommendations for the best times to provide immunization boosters. What if the animal, whether young or old, is past time for a vaccination? No research examining the immunological response in animals given vaccinations with too extended booster intervals have been reported. Veterinarians must use common sense and their immunological expertise (or in the case of rabies, they must follow the law). The American Animal Hospital Association and American Association of Feline Practitioners have guidelines to address this issue for dogs and cats.

ASPECTS OF VACCINATION REGULATION

How many antigens should be included at once for immunization against illness is a subject of much debate. Others claim that since the immune system is designed to be replicative, even a small number of B cells responding to an antigen will result in the generation of more B cells and a rapid increase in antibody concentrations. Others believe that the body can only react to a certain number of assaults at once due to the limited amount of B cells and T cells that are accessible. The animal (or human) is exposed to Margaret Root Kustritz antigens, causing some of the antigens to either not be recognized by them or to be recognized incorrectly. Those who make the latter case leap to the conclusion that what we are doing is causing an autoimmune

illness, in which antibodies or T cells are activated to attack host tissue. The scientific approach is not especially effective in evaluating any of this. Client compliance is a non-medical component of the puzzle. If you only have one chance to vaccinate an animal, is it best to do so against all diseases of concern, knowing that the client might not bring the animal back for additional vaccinations if you choose to restrict what you offer at a given time? The United States Department of Agriculture (USDA) must approve all vaccinations used by veterinarians and must certify that they are pure, safe, powerful, and effective. What details will be on the vaccination label is decided by the manufacturer based on this USDA clearance procedure.

A vaccination is deemed safe by the USDA if it does not result in "undue local or systemic reactions." There is no need for ongoing risk monitoring after the vaccine has been approved and put on the market. By "any unwanted side effect or unanticipated impact (including absence of desired outcome) linked with the administration of a licensed biological product," the USDA defines an adverse response. The USDA receives notification of any unfavorable response that veterinarians report to the manufacturer. The manufacturer may not be aware of harmful effects if veterinarians don't report them. These are some details provided by Dr. Richard Ford: "Whether the response is known to have been brought on by a vaccination or is just thought to have been, there is no need to record a vaccine adverse reaction in veterinary medicine. Formal reports from the veterinarians to the USDA are seldom submitted, despite encouragement to do so. When veterinarians do report confirmed or potential problems, they often get in touch with the manufacturer directly [5]–[7]. Nevertheless, neither the licensing organizations nor the vaccine producers are required to provide extra information to a veterinarian on the quantity or kind of vaccine adverse events. Veterinarians are currently not in possession of any information pertaining to the monitoring or documenting of vaccine-related adverse effects in companion animals. For diagnostic or treatment services connected to a known or suspected adverse event, manufacturers are not required to pay the owner or the veterinarian. A vaccine's actual efficacy is often uncertain. Challenge testing, in which animals with and without vaccinations are exposed to the virus and the percentage of sick animals is compared, is not always carried out. For all vaccines authorized by the USDA, the duration of immunity the period of time an animal is immune from illness following vaccination is unknown.

RISK FACTORS FOR IMMUNOLOGIES

Environmental variables, host characteristics unique to that animal, and agent factors unique to that vaccination are among the risk considerations to be taken into account. Malnourished animals, those suffering from another illness or condition, and anxious animals are less likely to react effectively to immunization. It's possible for young animals (such puppies and kittens under 16 weeks old) to still retain high levels of antibodies from their mother that were ingested when they fed on their first day of life. These antibodies can make the vaccination ineffective by inactivating it. Environmental considerations consider the whole population. The possibility that any one animal may be exposed to a particular virus increases with population size. More danger applies to animals that are introduced to new animals, such as via the introduction of a new pet, boarding, or grooming. The virus and sickness itself are the last item to evaluate. One virus that kills all the dogs and cats it infects is rabies, which may also kill exposed people if they are not treated very enough. The enormous danger of dying from the virus outweighs any risks associated with immunization.

Examples of Horse Vaccine Regimen Risk Factors:

- Farm size and type
- Vaccine cost, availability, and efficacy

- Risk of adverse reactions to vaccination
- Risk of infection and disease (geography, horse age, occupation, movement patterns)
- Medical, economic, and logistical consequences of disease should it occur
- Potential for infection to spread to other horses or humans

Considerations for Disease Prevention

Diseases may be caused by a variety of things. The infection triangle is another name for their interaction. The development or prevention of illness depends on all three elements environment (such as management techniques), host, and pathogen and each of these aspects must be taken into account while preventing disease, as shown in Figure 1.

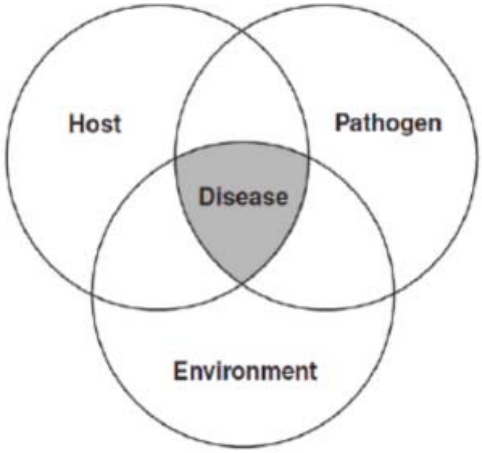


Figure 1: These three factors affect how diseases arise or are prevented.

CONTRADICTIONS OF VACCINATION

Preservatives in the vaccine, contaminants, the organism itself, items added to boost the immune response (adjuvants), and the administration of many vaccinations at once have all been linked to adverse reactions to vaccination. Most of the time, neither the source nor the precise propensity of a negative consequence are known. Systemic and local vaccination responses are the two primary categories. Systemic responses are often non-specific and occur throughout the body, not only where the vaccination was administered. A few examples include anorexia, fever, and soreness. There might be allergic responses. This may occur suddenly, with clinical symptoms beginning right away after immunization and lasting up to two days. Respiratory discomfort and facial puffiness are indications of an allergic response. There is little logic in this technique as neither vaccination nor allergic responses are "dose" dependent. Some people recommend delivering less vaccine to reduce allergic reactions. Autoimmune illnesses are those in which an individual's healthy tissue begins to be destroyed by their immune system. There is minimal scientific proof of a link between vaccination and autoimmune illness, despite popular belief to the contrary. Preventive Veterinary Medicine 21 Pain, swelling, and hair loss or color change at the injection site are examples of local adverse vaccination responses. Typically, benign sites of inflammation are swellings that appear quite quickly after the immunization, are not painful, and feel soft.

These take weeks or months to resolve. If the vaccination is accidentally delivered close to a nerve, pain may ensue. Due to their chemical makeup, certain vaccinations hurt more when

given than others. A vaccination's ability to spread the illness it was intended to prevent is known as vaccine virulence, which is the last conceivable side effect. Only modified live vaccinations that include the whole virus may do this. The probability of this depends heavily on the host into whom the vaccination is administered. A vaccination that is safe for older animals, for instance, could make very young animals sick. Given to pregnant animals, several modified live vaccinations may cause birth abnormalities. By administering an authorized feline vaccination to ferrets, for example, or employing the incorrect delivery method, vaccines are more likely to become virulent (for example, cats that lick at the injection site may take some vaccine in by mouth, with a return to virulence when the vaccine contacts the mucous membranes of their gums). There are core and non-core vaccines (risk-based). The core vaccines are those that are advised for administration to all animals based on the following criteria:

- Universal susceptibility to disease caused by a specific infectious organism.
- Significant risk that other animals in the area will contract the disease.
- Likelihood of significant medical consequences for the animal as a result of infection and disease.
- Availability of a vaccine that is both safe and highly effective.
- Potential risk of zoonosis.

In other words, core vaccines are those for infectious illnesses for which the link between benefit, risk, and cost is obvious for all animals and vaccination is an easy option. Only when an animal's lifestyle places them at an elevated risk of disease exposure are non-core, or risk-based, immunizations advised. Usually, these illnesses will go away on their own or react well to therapy. Using some form of scoring criteria, like the one below, to decide whether or not to administer a vaccination to a particular animal is one way to make this decision.

Vaccination Success

The CDC in Atlanta has preserved annual data on illness incidence for many nations. Compares levels in 1997 and 2002, a few years after the introduction of the vaccine, with incidence rates of various prevalent children infectious illnesses during a severe epidemic before the vaccine was approved. Most have very high levels of effectiveness. The whooping cough virus, pertussis, is an exception that has lately seen a rise in incidence, and this may need the inclusion of a second dose of the vaccine. Show that vaccinations may be incredibly successful if the agent only produces an acute illness and little to no antigenic drift. The Elimination of Certain Infectious Diseases Has Made Progress. Eliminating certain infectious illnesses would be the apex of a vaccine campaign. A century and a half elapsed before Jenner's (28) proposal that his novel vaccine technique might be utilized to eliminate smallpox was given serious consideration [8].

Smallpox

The Russians suggested the universal elimination of smallpox to the World Health Assembly (WHA) in 1954 after controlling smallpox infections in their nation. WHO started a 10-year underfunded, voluntary initiative? While affluent nations made significant gains, poor nations saw 2 million fatalities and 15 million instances of sickness in 1964. The first instance of the $300 million, 10-year-funded initiative was treated in 1977 despite various challenges including vaccination shortages and conflicts.

Poliomyelitis

Might this remarkable result be repeated with a different infectious disease? Measles and poliomyelitis were two options. Both met the standards, yet neither had the ideal qualities. The former was selected because there had previously been considerable success in reducing disease transmission in industrialized nations. WHO, Rotary International, the United Nations Children's Fund (UNICEF), and the CDC launched the Global Polio Eradication Initiative in 1988, and additional organizations also joined. There were several challenges. Several people had the illness for many months, and at one point, one of the three virus strains used in the vaccination underwent a mutation and became more virulent. The deadline has to be gradually extended until 2005 due to the need of repeated immunizations. Less than 1000 cases of the virus were reported in six countries in 2004, although Nigeria accounted for the majority of cases.

A religious community in Kano province denied immunization due to worries that the shot was tainted with HIV and other elements that would harm their children's ability to conceive. Although such contamination accusations were disproved in the middle of 2004 and the worry subsided, 12 formerly infection-free nations in West and Central Africa had had infectious cases. If a continuing financial deficit of USD $100 million is closed, the re-vaccination of children under the age of five in 22 nations in this area would start in late 2004 and continue into 2005. The necessity for such financing stems from the possibility that up to 1 million nearby youngsters may need new vaccinations for every instance of illness discovered. It would be a catastrophe if the additional funds was not made available since the disease was on the verge of being successfully eradicated. The start of this immunization campaign was in early October 2004 [9], [10].

CONCLUSION

There are now more than 30 vaccinations available against 26 illnesses, mostly bacterial and viral, among the more than 80 known infectious agents harmful for humans. These vaccines significantly reduce the risk of sickness and death following exposure to the infectious agents. This page explains the nature of vaccinations, including live attenuated agents and components, as well as their effectiveness, safety, and the types of immune responses that vaccines induce. As of now, every approved vaccination produces highly specific antibodies that bind to the infectious pathogen and essentially prevent illness. There are now efforts being undertaken to create vaccinations against many of the remaining infectious agents since these vaccines have been so successful in affluent nations at reducing mortality after a future infection. Several of the latter are challenging to control; they might result in long-lasting infections or exhibit significant antigenic diversity. Many novel strategies to enhance specific immune responses, including vaccination with DNA or chimeric live vectors, viral or bacterial, are being closely examined.

REFERENCES

[1] G. Ada, “Overview of vaccines and vaccination,” *Molecular Biotechnology*. 2005. doi: 10.1385/MB:29:3:255.

[2] A. Facciola *et al.*, “Vaccine hesitancy: An overview on parents’ opinions about vaccination and possible reasons of vaccine refusal,” *J. Public health Res.*, 2019, doi: 10.4081/jphr.2019.1436.

[3] C. Hervé, B. Laupèze, G. Del Giudice, A. M. Didierlaurent, and F. T. Da Silva, “The how’s and what’s of vaccine reactogenicity,” *npj Vaccines*. 2019. doi: 10.1038/s41541-019-0132-6.

[4] O. B, "Overview of Vaccines and Global Vaccination Coverage," *Vaccines Vaccin. Open Access*, 2017, doi: 10.23880/vvoa-16000112.

[5] P. Zimmermann and N. Curtis, "Factors that influence the immune response to vaccination," *Clinical Microbiology Reviews*. 2019. doi: 10.1128/CMR.00084-18.

[6] A. Kata, "Anti-vaccine activists, Web 2.0, and the postmodern paradigm - An overview of tactics and tropes used online by the anti-vaccination movement," *Vaccine*, 2012, doi: 10.1016/j.vaccine.2011.11.112.

[7] E. Dubé, C. Laberge, M. Guay, P. Bramadat, R. Roy, and J. Bettinger, "Vaccine hesitancy: An overview," *Human Vaccines and Immunotherapeutics*. 2013. doi: 10.4161/hv.24657.

[8] J. A. Malik, A. H. Mulla, T. Farooqi, F. H. Pottoo, S. Anwar, and K. R. R. Rengasamy, "Targets and strategies for vaccine development against SARS-CoV-2," *Biomedicine and Pharmacotherapy*. 2021. doi: 10.1016/j.biopha.2021.111254.

[9] E. Korkmaz, S. C. Balmert, T. L. Sumpter, C. D. Carey, G. Erdos, and L. D. Falo, "Microarray patches enable the development of skin-targeted vaccines against COVID-19," *Advanced Drug Delivery Reviews*. 2021. doi: 10.1016/j.addr.2021.01.022.

[10] C. M. Wang, S. C. Chen, and K. T. Chen, "Current status of rotavirus vaccines," *World Journal of Pediatrics*. 2015. doi: 10.1007/s12519-015-0038-y.

[11] E. Dubé, M. Vivion, and N. E. MacDonald, "Vaccine hesitancy, vaccine refusal and the anti-vaccine movement: Influence, impact and implications," *Expert Review of Vaccines*. 2014. doi: 10.1586/14760584.2015.964212.

CHAPTER 13
VACCINES AND VACCINATIONS: INDIVIDUAL ANIMALS

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

Whether dead or alive, pure antigens from these species may be present in vaccines. The greatest protective responses are often elicited by vaccines made using live organisms. Since purified antigens and dead organisms cannot develop and disseminate inside the host, they may be less immunogenic than live ones. They are thus less likely to optimally boost the immune system. Nonetheless, they are often less costly and could even be safer. For instance, live viruses from vaccinations invade host cells and quickly multiply. The viral antigens are subsequently processed by the infected cells, resulting in a type 1 response that is dominated by cytotoxic T cells. In contrast, pure antigens and dead organisms often elicit type 2 responses that are dominated by antibodies. This kind of reaction may not provide the best defense against particular species. As a consequence, adjuvants are often needed in vaccinations that include purified antigens or dead organisms to increase their potency.

KEYWORDS:

Animal Husbandry, Antibodies, Immunogenic, Vaccines, Vaccinations.

INTRODUCTION

AFFECTS OF IMMUNOLOGY IN DOGS AND CATS

The frequency of animal immunizations is a topic of intense debate among small animal physicians and pet owners at the moment. There is no vaccination that is 100 percent safe or 100 percent effective. All animals do not experience the same level of protection from vaccinations. How can we determine whether to vaccine a specific animal in light of this? Your veterinarian does this by evaluating the risk factors specific to your animal and taking into account potential negative effects. Systemic responses happen all across the body, not only where the vaccination was administered. Nonspecific reactions like these might result in anorexia, fever, and pain that can continue up to 36 hours following immunization. The likelihood of this non-specific reaction happening is highest in patients older than one year old and after the administration of repeated vaccinations [1]–[3].

There might be allergic responses. This may occur suddenly, with clinical symptoms beginning right away after immunization and lasting up to two days. In dogs, 51% of these responses cause skin swellings, often in the face and ears, and 40% cause vomiting with or without diarrhea in the digestive system. The digestive tract is impacted by 66% of these responses in cats, the respiratory system by 22%, and the skin by 12%. There is no evidence to suggest that any specific vaccination or manufacturer increases the risk of allergic reactions in canines and felines. Autoimmune illnesses are those in which an individual's healthy tissue begins to be destroyed by their immune system. There is no scientific proof that vaccinations in dogs and cats may cause autoimmune illness, despite some people's theories to the contrary. Pain, swelling, and hair loss or color change at the injection site are examples of local adverse vaccination responses. Typically, benign sites of inflammation are swellings that appear quite

quickly after the immunization and are mild and painless. They disappear over a period of weeks to months and are most often seen in dogs after rabies or distemper vaccinations, as well as in cats following rabies immunization. Prior to vaccination, dogs with a history of negative responses, particularly allergic reactions, may get treatment with an antihistamine, a corticosteroid, or both. This shouldn't change how they react to the vaccination since just one percent of these reactions damage the skin, often manifesting as ear and facial swellings, and forty percent affect the digestive system, resulting in vomiting and/or diarrhea. The digestive tract is impacted by 66% of these responses in cats, the respiratory system by 22%, and the skin by 12%. There is no evidence to suggest that any specific vaccination or manufacturer increases the risk of allergic reactions in canines and felines. Autoimmune illnesses are those in which an individual's healthy tissue begins to be destroyed by their immune system. There is no scientific proof that vaccinations in dogs and cats may cause autoimmune illness, despite some people's theories to the contrary. Pain, swelling, and hair loss or color change at the injection site are examples of local adverse vaccination responses. Typically, benign sites of inflammation are swellings that appear quite quickly after the immunization and are mild and painless. They disappear over a period of weeks to months and are most often seen in dogs after rabies or distemper vaccinations, as well as in cats following rabies immunization. Prior to vaccination, dogs with a history of negative responses, particularly allergic reactions, may get treatment with an antihistamine, a corticosteroid, or both. The way they react to the vaccination as a whole shouldn't be affected by this [4].

Some immunization practices for small animals are under scrutiny. The main vaccination regimens given to adult dogs and cats are the ones that are under scrutiny. According to some statistics, adult animals may continue to be immune for 5-7 years after their original immunizations as young animals, negating the need for the yearly revaccination that doctors have long advised. Adults are not routinely revaccinated for major diseases in human medicine, and in many situations, childhood vaccinations provide lifetime immunity. It has been proposed that measuring antibody concentrations (titers) in animals could be used to determine whether vaccination was necessary for a specific animal. However, the best way to measure antibodies in animals is unclear, and we are unsure of what antibody concentration is actually effective in protecting against disease. Since it does not take into consideration cell-mediated immunity, this is likewise an incorrect indicator of the animal's immunological condition.

Higher antibody titers have been shown to be closely connected to protection against feline parvovirus, canine parvovirus, canine adenovirus (hepatitis), and canine distemper (panleukopenia). If antibody titers are high, they may be used to prove that immunity was brought on by vaccination. If they are low, it does not exclude the animal from producing an anamnestic reaction, however. Young animals nearing the end of their core vaccine series, dogs from breeds with a genetic lack of response to parvovirus vaccination (such as rottweilers, Doberman pinschers, and pit bull terriers), dogs with a history of negative vaccine reactions, dogs with chronic illness, and elderly dogs are a few examples of patients for whom antibody titer testing may be helpful. On all counts, rabies is a peculiar instance. Laws requiring rabies vaccinations on a regular basis may not be supported by research. For dogs that have a history of negative responses or chronic illness, veterinarians are not permitted to forego the mandated rabies vaccine. One year after the original immunization, every rabies vaccine is boostered. Rabies antibody titers are not regarded as a legal indication of immunity but rather as a legal sign of proper immunization.

Horses Are Vaccinated

Just a tiny portion of the infectious illnesses to which horses are predisposed have commercial vaccinations. Despite this, immunization helps to lower the prevalence and severity of common

bacterial and viral infections. There is no "one-size-fits-all" vaccination schedule that is suitable for use with all horses. Based on an evaluation of the following factors, vaccination programs are created specifically for each person and farm:

- Risk of infection and disease (geography, horse age, occupation, and movement patterns).
- Medical, economic, and logistical repercussions of disease should it occur.
- Potential for infection to spread to other horses and/or humans.
- Farm size and type.
- Vaccine cost, availability, and efficacy.
- Risk of adverse vaccination reactions.

While many equine vaccinations may be purchased "over-the-counter," horse owners seldom possess the knowledge and expertise necessary to carry out this kind of study. Hence, horse owners and managers should consult an equine veterinarian who is knowledgeable with their farm, animals, training and performance objectives, and budget before deciding on the best vaccination schedule for each particular horse. That said, similar to what was mentioned for small animals, there is normally a selection of core vaccinations that are pushed for use in all horses within a certain geographic area. For instance, the terrible and sometimes deadly illness tetanus, which is brought on by the bacteria Clostridium tetani, is very contagious among horses. The little injuries and punctures that horses often experience may easily get contaminated by this bacterial organism, which is common in the soil and surroundings. The use of available vaccinations is advised for all horses since they are very safe and efficient. Tetanus toxoid would be the most crucial core vaccination for horses, if you had to choose just one. The benefit-risk-cost ratio for the remaining commercial vaccination products is less apparent and may change significantly across individual horses, various farms, and various geographic locations [5], [6].

These items fall under the category of risk-based (non-core) vaccinations, which are suggested for certain horses but not for others. Equine veterinarians utilize their expertise and knowledge to identify farms and horses that might benefit from certain risk-based vaccinations. For instance, only young foals are impacted by rotavirus-related diarrhea. Only newborn foals in the first few months of life experience sickness as a consequence of infection; adult horses often carry the virus in their gastrointestinal systems. Year after year, this virus causes large rates of illness in certain breeding farms, but it has no effect on any other farms. The rotavirus vaccination, which is given to pregnant mares late in gestation to elicit large levels of anti-rotavirus antibodies in colostrum, is best used on farms with a strong history of rotavirus enteritis. The foal consumes and absorbs these antibodies on the first day of birth, which helps to lower the risk of infection and sickness in the future. There is no justification for administering this vaccine to adult horses other than broodmares, and not all broodmares need it. One component of an infectious disease control scheme is vaccination. Owners and managers of horses should be aware that farm management methods are equally crucial (for example, sanitation practices, good nutrition and parasite control, controlling horse traffic, quarantine of new arrivals, and quarantine of horses with known contagious disease). They should be aware that although vaccination decreases the risk of infectious illness, it cannot completely remove that risk, it does not ensure protection at the level of the individual animal. Many vaccinations need numerous doses before achieving protective immunity, and protective immunity may not be attained for days to weeks after vaccine administration. Some vaccines

are more effective than others. Some horses react to vaccination better than others [7], [8]. Owners who are in charge of managing their own vaccinations should be informed that incorrect handling, administration, and storage of vaccine supplies will reduce their efficacy.

The dam is often immunized in the last stages of pregnancy to provide the foals with immune protection. Colostrum from the mare contains concentrated antibodies, which are passed to the foal during the first few hours of life when it suckles colostrum. For many months, these antibodies provide defense; however, after that, their levels steadily drop, and the foal has to be immunized to activate its own active immunity. The first vaccinations are given to foals who drank enough colostrum from a mare that had gotten the recommended vaccinations when they were about 4-6 months old. If babies are immunized before this time, maternal antibodies will prevent a strong immunological response to the immunization. Contrarily, unvaccinated mares' foals do not have large maternal antibody concentrations, thus immunization should start sooner. Although the specific time period during which maternal antibody concentrations decline is difficult to predict, foals often get more doses of the vaccine in the first series than adult horses receiving the vaccination for the first time. For the first tetanus immunization of adult horses, a 2-dose initial series is suggested. For foals, however, a 3-dose first series is suggested. This strategy aids in ensuring that all foals—even those in whose maternal antibodies may have remained longer than usual—are sufficiently protected. The great majority of horse vaccinations are given intramuscularly (IM), with a small number being given intranasally.

Veterinary Preventative Medicine

Adverse effects after vaccination are frequent, however they often only include modest, temporary muscular swelling and pain at the injection site. Horses sometimes have hives, lethargy, fever, or inappetence; these conditions may be self-limiting or need veterinarian care. Anaphylaxis, purpura hemorrhagica, endotoxemia, laminitis, or infection of muscle tissue with the anaerobic bacteria Clostridium sp. are among the severe, and even fatal, systemic responses that horses can encounter (clostridial myonecrosis). All vaccinations have an inherent risk of side effects, even when they have been handled, stored, and given properly, as owners should be aware. When the veterinarian administers vaccines rather than the owner or manager, it is ensured that the right vaccine product has been chosen, that it has been handled, stored, and administered properly, and that any acute adverse reactions can be treated quickly while the veterinarian is still on the premises. Serum antibody titers are not often used to determine whether or not vaccination is necessary or to evaluate a horse's degree of immunity to a specific infectious illness. For a meaningful interpretation of these titers to be guided at this time, there are not enough data available.

ESSENTIAL INFLUENSCES

According to the AVMA, core vaccines "defend against illnesses that are endemic to an area, those of potential public health importance, those that are mandated by law, virulent/highly contagious, and/or those providing a risk of severe disease." In order to be used in the majority of patients, core vaccinations must display a high degree of patient benefit and a low level of risk, both of which core vaccines have amply proved 60 Margaret Root Kustritz. These horse vaccinations are thought to fit these requirements: Western and Eastern Equine Encephalitis (WEE) and Tetanus (tetanus toxoid) (EEE) Virus West Nile 1. Rabies Tetanus The bacteria Clostridium tetani is the source of this terrible and often deadly illness. The organism's spores are common and mostly found in soil, from where they may easily enter the body via wounds, punctures, surgical incisions, and exposed tissue, including the umbilicus of newborn horses. At the location of an injury or invasion, bacteria proliferate inside devitalized tissues and create

a neurotoxic that travels down motor neurons to the spinal cord and central nervous system (CNS). While most animals, including humans, are vulnerable to the effects of this neurotoxic, horses are particularly sensitive to them. Tetanus toxin prevents the release of inhibitory neurotransmitters inside the CNS, which leads to a loss of normal balance and control over the contraction of muscles. Horses with this condition gradually tighten, stiffen, and spasm their muscles over the course of seven to ten days. This condition is exacerbated by stimulation and excitement. Horses often have the typical sawhorse attitude, high tail head, prolapse of the third eyelid, and difficulty understanding and chewing feed owing to an excessive contraction of the masticatory muscles (also known as a "lockjaw"). Due to their inability to move or eat regularly due to the muscular spasms, they experience excruciating pain and anxiety.

When the laryngeal, intercostal, and diaphragm muscles are harmed, respiratory failure often results in death. Tetanus antitoxin (antibodies that target the neurotoxic), penicillin to kill the C. tetani, wound debridement and treatment to prevent future neurotoxin generation, sedatives, nutritional assistance, intensive nursing care, and a calm atmosphere may all be used to treat affected horses. The likelihood that a horse will live relies on the severity and speed of the disease's development as well as the effectiveness of the treatment. Tetanus may be readily avoided with immunization, which is excellent news! Tetanus toxoid, a formalin-inactivated version of the tetanus neurotoxin that prompts a strong humoral immune response after IM treatment, is included in every vaccine currently on the market. Before the neurotoxic may harm the Brain, the antibodies made in response to immunization attach to it and render it inactive.

Tetanus toxoid comes in a variety of brands, and different preparations may include it alone or in combination with other antigens as a component of a multivalent vaccination. In addition to one or more risk-based immunizations, some kits also include all of the essential horse vaccines. Adult horses who have never been vaccinated before get a 2-dose series via IM injection spaced 4-6 weeks apart as their first vaccine, followed by an annual booster shot. In order to guarantee that high quantities of protective antibodies may be passed to the foal through colostrum, broodmares get their yearly vaccine four to six weeks before giving birth. Thereafter, starting at about 4 to 6 months of age, foals get a 3-dose series. This is followed by a single yearly booster dosage, much as for people. If a horse has surgery or suffers a wound or puncture more than six months after their prior immunization, they often need supplementary boosters. Real protection most likely lasts far longer than this, but given the horse's particular vulnerability to this deadly illness, we err on the side of caution [9].

NON-CORE (RISK-BASED) Vaccinations

The inclusion of risk-based vaccinations in the immunization program is based on a risk-benefit-cost analysis. Their usage varies by location, across various populations of horses within a region, and even amongst different horses on the same farm. Since horse owners and managers often lack the information and expertise necessary for the best program design, risk-based vaccinations should only be administered under the direction of an equine veterinarian. The following vaccinations are the most often administered risk-based immunizations in North America: Potomac Horse Fever (PHF), Equine Viral Arteritis (EVA), Equine Herpesvirus (EHV; rhinopneumonitis or "rhino"), Influenza, Strangles, Botulism, Rotavirus Diarrhea, Anthrax, and Leptospirosis. Herpes Virus Equine herpesviruses 1 and 4 (EHV-1 and EHV-4) are respiratory viruses that produce severe fever, lethargy, inappetence, serous nasal discharge, and cough, with complete recovery taking place within two to three weeks. Young horses are more susceptible to develop clinical illness, particularly those that begin training at facilities where substantial comingling takes place. Nevertheless, EHV-1 is a significant contributor to abortion in broodmares that are pregnant and, in rare instances, it may enter the CNS and cause

weakness, uncoordination, and the inability to pee or defecate. Epidemiological outbreaks of the neurological form of the illness happen sometimes, notably in herds of horses gathered at racing or exhibition grounds. Direct contact with nasal secretions, viral aerosolization through coughing and sneezing, and in the case of EHV-1, contact with aborted fetuses, fetal fluids, and the infected placenta are all ways that the virus is transmitted. Most horses get the viruses early in infancy and stay infected; the viruses have a complicated biology with a latency stage from which reactivation, viremia, and viral shedding may happen under stressful conditions. Because of these variables, infection is almost hard to manage, which explains why EHV outbreaks may happen in horse populations that are kept in isolation. As a consequence of frequent exposure to the viruses, the majority of adult horses acquire some protection; while these horses seldom experience severe respiratory illness from infection, they may nevertheless help the virus propagate within a community.

However, this age- and exposure-related immunity does not save horses against abortion or neurological damage. Due to this complicated viral biology, the great frequency of latent infection, the fact that the majority of horses with active infection only have minor respiratory symptoms, and the fact that vaccinations are only partly protective, EHV vaccines have been relegated to the risk-based category. The main reasons to use an EHV vaccination are to prevent EHV-1-induced abortion in mares who are pregnant. Controlling the symptoms and progression of respiratory tract illness (rhinopneumonitis) in young performance and show horses who are especially vulnerable to exposure to EHV-1 and EHV-4 Although individual EHV-1 vaccinations are approved and labeled for the prevention of abortion in broodmares, EHV-1/EHV-4 vaccines are licensed as respiratory disease preventive aids. None of the present EHV vaccines have been shown to be effective in preventing herpes myeloencephalitis, the CNS form of EHV-1 infection, and none of the current EHV vaccines are approved for this purpose. All vaccinations, with the exception of one, include EHV-1 and EHV-4 that have undergone formalin inactivation, or EHV-1 alone (abortion vaccines). One of these products offers an option for intranasal usage once an initial set of IM injections has been given, however the majority of them are exclusively provided via IM administration.

Items approved for use in the prevention of abortion often contain more viral antigen than those approved for use in the treatment of respiratory illness, and these medicines also trigger higher immune reactions. There is just one modified-live EHV-1 vaccine available, and it has been approved as a tool for preventing respiratory illnesses caused by EHV-1. A previously uninfected adult horse is first given a 3-dose series of a killed viral respiratory vaccine by IM injection spaced 4-6 weeks apart. Afterwards, horses are boostered every 6–12 months, depending on the level of immunological protection sought. Every six months, booster shots are often given to horses under the age of five, those on breeding farms who come into contact with pregnant mares, and performance and show horses. Broodmares are immunized with a high-antigen EHV-1 product at 5, 7, and 9 months of gestation to avoid abortion.

Moreover, this regimen guarantees that colostrum includes a significant amount of anti-EHV-1 antibody. Foals then get three doses starting at about four to six months old, followed by boosters every six months. Influenza Horses often get the viral respiratory illness influenza. Like horses infected with EHV-1/EHV-4, afflicted horses show severe fever, lethargy, inappetence, serous nasal discharge, and cough, and they recover completely un two to three weeks. The virus spreads by direct contact with nasal secretions as well as through coughing and sneezing-induced viral aerosolization. Similar to EHV, young horses are more prone to get the illness, particularly if they are being trained in areas where substantial comingling takes place (training/show barns, racetracks). Unlike herpesviruses, which spread continuously throughout a population, this virus only causes illness when an infected horse is brought to an

uninfected group. Because of this, the control of influenza is more successful than the control of rhinopneumonitis after a 14-day quarantine of new arrivals. In order to guarantee that horses are protected against viruses that are currently in circulation, vaccinations often include numerous strains of virus and are updated on a regular basis. This is because the influenza virus has a tendency to modify its genetic and structural composition over time. Horses Preventive Veterinary Medicine Vaccination against influenza is recommended for horses under the age of six, show/performance horses, and animals housed at stables with a lot of horse traffic. Elderly horses kept in a confined herd have a relatively low incidence of illness and infection. Currently, there are three influenza vaccines available on the market, the majority of which provide protection lasting at least six months: A lot of vaccinations against inactive viruses (IM administration, but for one product boosters may be administered intranasally). Often included in multivalent vaccinations for infectious disorders like EHV-1/EHV-4. One modified-live vaccination; two live canary pox recombinant vector vaccines (IM administration) (intranasal administration).

The first series is different for each kind of vaccination. A previously unvaccinated adult horse will get a 3-dose series of a killed virus vaccine through intramuscular injection (IM), followed by booster injections every 6–12 months, depending on the horse's age, projected exposure level, and desired degree of immune protection. After a 2-dose first series given by IM injection spaced 4-6 weeks apart, horses must be booster-injected every 6–12 months for the canary pox recombinant vaccine. The modified-live intranasal vaccination only needs one initial dosage, with boosters needed every 6 or 12 months. Broodmares get vaccinations every six months, with one dose given 4-6 weeks before foaling. After that, vaccinations for foals start about 6 months old; for adults, 72 months. The basic regimen, according to Margaret Root Kustritz, varies depending on the vaccination, but subsequent boosters are given every 6 months.

Strangles

The bacteria Streptococcus is the prevalent and very infectious respiratory condition known as strangles in horses. Horses of any age may be impacted, although young horses are most at risk. The organism is readily distributed on tools, tack, feed and water buckets, grooming items, human hands or clothes, and it is transferred by direct contact with infected nasal secretions or purulent material from burst lymph node abscesses. The most germs are shed by horses that are actively ill, although carriers who are clinically well may still release bacteria and cause illness outbreaks. Fever, profuse purulent nasal discharge, lethargy, inappetance, and gradual enlargement, abscessation, and rupture of submandibular, retropharyngeal, and parotid lymph nodes, with drainage of purulent material following, are some of the classic symptoms of the illness. The majority of horses recover completely within a few weeks, but sometimes, life-threatening complications such upper airway obstruction, pneumonia, infection spreading to the abdomen area (bastard strangles), and purpura hemorrhagica, a serious immune-mediated illness, occur.

Strangles may spread to a significant number of horses in a stable if strict biosecurity measures aren't performed, disrupting the training and competition schedule for weeks or months. Even after recovering completely, the infected horses may continue to carry germs in their guttural pouch and throat for months, which might lead to the infection of other horses. Antibiotics are not often used to treat strangles since they tend to Veterinary Preventive Medicine 73 impede the disease's development and recovery. Anti-inflammatory drugs are used as the mainstay of supportive care to reduce fever and get horses to eat and drink. Antibiotics are administered to horses who have life-threatening problems, while corticosteroids and immunosuppressive medication must be administered concurrently to horses that have immune-mediated diseases. Strangles vaccination is advised for horses deemed to be at high risk of exposure as well as for

sites where the disease is a recurring issue. The frequency and severity of strangles are reduced by immunization, but the illness cannot be totally eliminated. Due to the biology of the causing organism, historical attempts to create safe and effective strangles vaccines failed. Several of the vaccinations that have been introduced to the market over the years have a significant risk of side effects and produce only somewhat effective immune responses. A single modified-live vaccination given by intranasal injection and subunit vaccines containing pure extracts of the Streptococcus equi equi M-protein virulence factor are the two kinds of vaccines now on the market. While more challenging to deliver and with a larger chance of side effects, the modified-live vaccination is thought to be more effective.

Both vaccines have the potential to result in purpura hemorrhagica. Adult horses who have never been vaccinated before get a 2-dose series of the modifiedlive intranasal vaccine, given 3 weeks apart. Afterwards, horses are boostered every 6–12 months, depending on the predicted degree of exposure and the level of immunological protection sought. The subunit vaccination has to be given in an initial 2- or 3-dose series given 2–4 weeks apart, then boosters need to be given every 6 months after that. The modified-live intranasal vaccination is 74. The subunit product is provided 4-6 weeks before to foaling as necessary since Margaret Root Kustritz is not authorized for use in broodmares. Thereafter, starting between the ages of 4-6 months (subunit vaccination) or 6-9 months (intranasal vaccine), foals get a 3-dose series, followed by boosters every 6 months if a continuing risk of exposure is expected. Strangle-surviving horses generate powerful immunological responses that provide defense for around five years. Since immunization in the presence of preexisting immunity raises the risk of purpura hemorrhagica, subsequent vaccinations should be administered with care [10].

The bacteria Clostridium botulinum produces a toxin that causes this severe and sometimes fatal illness. Bacterial spores may enter the body by eating or wound contamination, where they then grow and generate a toxin. If horses eat rotting or improperly preserved hay, haylage, or silage or feed contaminated with rotting animal carcass remains, they could also consume preformed botulinum toxin (a decomposing dead rabbit incorporated during round bale production, for example). The biological effects of botulinum toxin, which prevents acetylcholine release at the neuromuscular junction and results in a severe flaccid paralysis of muscle, are extremely sensitive to horses. Clinical symptoms in horses include tremors, dysphagia (inability to chew and swallow food), generalized weakness that progresses quickly to recumbency, secondary injury from falls, and death from respiratory paralysis. Various subtypes of Cl. botulinum produce 8 distinct toxins, with types B and C accounting for the majority of cases (90 and 99%, respectively). The majority of cases of equine botulism are caused by 75 (10% of cases).

Although Florida has the highest prevalence of Type C botulism, the Mid-Atlantic region and Kentucky have the highest prevalence of Type B botulism. Antitoxin (antibodies that target the neurotoxin), antibiotics to kill the C. botulinum organism, laxatives to encourage the passage of any toxin within the gut, nutritional support, intensive nursing care, and mechanical respiratory ventilation for horses in respiratory failure may all be used to treat affected horses. The likelihood of survival relies on the severity and speed of the disease's development, how quickly it was discovered, how aggressively it can be treated, and if the horse is still standing. It might take horses who survive weeks to completely recover. For horses living in endemic areas or those whose transportation to endemic areas is planned, vaccination is advised. Due to the rarity of the illness in Minnesota, horses are not regularly vaccinated against botulism. To provide the best possible safety for the mare and her foal in that environment, Minnesota broodmares who will be sent to Kentucky in the spring for foaling and breeding are routinely immunized.

REFERENCES

[1] D. J. Lynn, S. C. Benson, M. A. Lynn, and B. Pulendran, "Modulation of immune responses to vaccination by the microbiota: implications and potential mechanisms," *Nature Reviews Immunology*. 2022. doi: 10.1038/s41577-021-00554-7.

[2] J. Esparza, S. Lederman, A. Nitsche, and C. R. Damaso, "Early smallpox vaccine manufacturing in the United States: Introduction of the 'animal vaccine' in 1870, establishment of 'vaccine farms', and the beginnings of the vaccine industry," *Vaccine*, 2020, doi: 10.1016/j.vaccine.2020.05.037.

[3] M. J. Day, C. Crawford, M. Marcondes, and R. A. Squires, "Recommendations on vaccination for Latin American small animal practitioners: a report of the WSAVA Vaccination Guidelines Group," *J. Small Anim. Pract.*, 2020, doi: 10.1111/jsap.13125.

[4] R. Velez and M. Gállego, "Commercially approved vaccines for canine leishmaniosis: a review of available data on their safety and efficacy," *Tropical Medicine and International Health*. 2020. doi: 10.1111/tmi.13382.

[5] A. J. Basinski, S. L. Nuismer, and C. H. Remien, "A little goes a long way: Weak vaccine transmission facilitates oral vaccination campaigns against zoonotic pathogens," *PLoS Negl. Trop. Dis.*, 2018, doi: 10.1371/journal.pntd.0007251.

[6] R. Marlin *et al.*, "Targeting SARS-CoV-2 receptor-binding domain to cells expressing CD40 improves protection to infection in convalescent macaques," *Nat. Commun.*, 2021, doi: 10.1038/s41467-021-25382-0.

[7] K. L. Flanagan, A. L. Fink, M. Plebanski, and S. L. Klein, "Sex and gender differences in the outcomes of vaccination over the life course," *Annu. Rev. Cell Dev. Biol.*, 2017, doi: 10.1146/annurev-cellbio-100616-060718.

[8] A. Escolano, P. Dosenovic, and M. C. Nussenzweig, "Progress toward active or passive HIV-1 vaccination," *Journal of Experimental Medicine*. 2017. doi: 10.1084/jem.20161765.

[9] B. Vila Nova *et al.*, "Evaluation of the humoral immune response induced by vaccination for canine distemper and parvovirus: A pilot study," *BMC Vet. Res.*, 2018, doi: 10.1186/s12917-018-1673-z.

[10] E. Muñoz-Atienza, "Systemic and Mucosal B and T Cell Responses Upon Mucosal Vaccination of Teleost Fish," *Frontiers in Immunology*. 2021. doi: 10.3389/fimmu.2020.622377.

CHAPTER 14
DISEASES IN BEEF AND DAIRY CATERPILLARS TO GET VACCINATED AGAINST

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

The management of cattle health must include vaccination. Successful cow vaccine programs should take host variables, risk of exposure to diverse bovine diseases in their wild form, and timing of immunization in relation to predicted disease challenge into account. Almost all consulting veterinarians advise immunizing high-risk, stressed calves when they arrive at the feedlot. This proposal, however, disregards a number of elements related to vaccination effectiveness. New evidence-based vaccination recommendations for cattle in the different parts of the beef and dairy production systems may be revealed by further study examining vaccine interactions in stressed cattle and possible cumulative effects of endotoxin from repeated bacteria injection.

KEYWORDS:

Agriculture, Endotoxin, Ovine Respiratory Disease, Management, Vaccination

INTRODUCTION

Infectious illnesses may reduce production and profitability while endangering the health and welfare of dairy and beef cattle. The use of vaccines is crucial for the management and prevention of many illnesses. A vaccine program, however, cannot replace healthy eating, sufficient ventilation, excellent cleanliness, and other health management practices. While vaccines aid in the prevention of infectious illnesses, no vaccination can guarantee complete herd immunity. The overall level of herd immunity is increased through vaccinations, which reduces the severity of clinical sickness and the transmission of infectious diseases. Along with the herd veterinarian, vaccination plans should be created. Every cattle or dairy operation's specialized vaccination regimens are impacted by the herd's unique characteristics, including disease history, biosecurity, management, housing, and other elements. It is important to take into account the kind of vaccine—such as modified living or killed—the manufacturing stage, the expenses, and the advantages. Strict formulas that apply to every production unit are unworkable and, if not implemented in particular herds with expert care, even harmful [1], [2].

The goal of vaccination programs for beef cattle herds is to safeguard the animals against illnesses brought on by bacteria, viruses, and protozoans. The immune system of an animal is stimulated by vaccinations to mount a defense against an invader. If the immune system is ever exposed to the microbe, it will "remember" how to mount a defense against it. While vaccinations cannot stop exposure to infectious agents, they can improve an animal's resistance to infection or lower the severity of sickness if it does happen. The majority of cow vaccinations are administered intravenously, while some may also be administered orally or intranasally. While antibiotics are often injected into animals, using one of these medications to treat an illness is different from vaccinating the animal. Manufacturers of animal health products spend a lot of money trying to get the US Department of Agriculture to approve their vaccinations.

They need to demonstrate both the vaccine's safety and its ability to carry out the tasks listed on its label. For further information, see to Extension paper ANR-1416, "Understanding Protective Claims on Vaccination Labeling."

While the commercial names for vaccines might be perplexing, the label will always include the illnesses and bacteria that the vaccination protects against. Sometimes, various words utilized in the name might also be perplexing. Words like 4-way, 5-way, 7-way, or 8-way relate to the number of distinct subtypes of a microbe in a vaccine rather than any specific form of vaccination. These names are most often used in reference to vaccinations against leptospirosis or clostridial diseases that include different subtypes of Leptospira or Clostridium organisms.

DISCUSSION

Several vaccines

The majority of vaccinations either use modified, dead, or chemically altered organisms. An animal's resistance to illness will rise if a vaccination is utilized properly, whether it is changed live, dead, or chemically altered, but each form of vaccine does have its limits. When administered in accordance with the instructions on the product label, modified live vaccines (MLV) include a tiny quantity of virus or bacterium that has been changed such that it does not cause clinical illness. In the vaccine-protected animal, the virus or bacterium may still grow and cause a controlled illness. An efficient immune response is triggered when the animal's immune system recognizes the replicating bacterium. Bovine herpes virus 1, which causes infectious bovine rhinotracheitis (IBR), bovine viral diarrhea virus (BVDV), bovine respiratory syncytial virus (BRSV), and parainfluenza-3 virus are among the viruses that may be treated with MLVs (Pl3). If you strictly adhere to the label instructions, several MLVs are safe to use in pregnant cows. Also, due to the minor chance that nursing calves may momentarily shed the vaccination virus and infect the cows, certain MLVs are not recommended for use in calves. Nevertheless, provided the cows have had the necessary vaccinations following the label instructions, several MLVs may be administered safely in calves nursing pregnant cows. The use of MLVs in weaned calves, including replacement heifers, is likewise safe. Cattle that are not sufficiently inoculated may be the consequence of improper vaccination practices [3], [4] .

Generally Speaking In the Development of a Vaccination Program Blood from animals that have developed a hyperimmune response to a certain illness is used to make antiserums. They provide instant protection since they have antibodies that can fight that illness. They often only provide protection for two or three weeks and are of a brief duration. Antiserum is often costly, administered in quite high doses, and unavailable for many infectious disorders. It is often used when a disease epidemic, such enterotoxemia in nursing calves, is taking place. Certain vaccines are created by altering the infectious agent in such a manner that the organisms continue to live, reproduce, and provide the vaccinated animal immunity while remaining disease-free. As several modified live viral (MLV) vaccinations have the potential to infiltrate the fetus and result in birth abnormalities or termination, they should not be administered to uninformed pregnant animals. Bovine viral diarrhea and injectable modified live infectious rhino-tracheitis vaccines are two examples.

Modified live vaccinations often result in more protection than dead vaccines, although they can carry some danger when administered to pregnant or under extreme stress calves. When administered to young calves, vaccines often fail to stimulate the creation of new antibodies. While very young animals have an immune system that is capable of responding to vaccinations or antigens, it is underdeveloped in comparison to older animals and may not be able to do so as well. Colostrum-acquired antibodies from the dam that shield the calf against a variety of viral illnesses may also obstruct and inactivate the antigens in the vaccination. This

phenomenon, known as maternal antibody interference, may explain why certain infectious illnesses are not vaccinated against in very young calves [5]. There are vaccinations, nevertheless, that may boost the immune system even in young animals. Regarding the administration of immunizations to animals less than 4 to 6 months old, get advice from your veterinarian.

Programs for Immunization of Beef Cow-Calf Herds

Newborn calves

Newborn calves may get oral doses of vaccines against the cow rotavirus and bovine coronavirus. The oral MLV vaccination must be administered before colostrum consumption for it to be effective. Infectious bovine rhinotracheitis (IBR), parainfluenza (PI3), the bovine respiratory disease complex, leptospirosis, campylobacter, clostridial infections, and brucellosis are among the illnesses in beef and dairy cattle that should be vaccinated against. The herd often has respiratory and reproductive problems as a result of bovine viral diarrhea (BVD). In many nations, it is a serious illness economically. The virus that causes the sickness, known as the bovine viral diarrhea virus, may either be the only cause of the illness or a component of a sizable infection complex. A pregnant cow with the infection may miscarry, have a stillbirth, or give birth to a healthy calf. Infected calves may be present throughout pregnancy or after delivery. Calves that are born with the BVD virus will never recover from it and will continue to release the virus into the environment around the farm. Adults who have BVD may exhibit a wide range of symptoms, including fever, fatigue, appetite loss, eye discharge, nasal discharge, diarrhea, and reduced milk supply.

Cerebellar hypoplasia, which manifests in infected calves as ataxia, tremors, a broad stance, and inability to suckle, is a possible condition. 104 Kustritz, Margaret Root Virus-Associated Bovine Rhinotracheitis The infectious respiratory ailment known as IBR is brought on by the bovine herpesvirus I. Both young and aged animals may be impacted. Clinical manifestations of IBR include respiratory illness (mucosal hyperemia, erosive mucosal ulcers, nasal discharge, coughing), as well as conjunctivitis, abortion, and encephalitis. IBR causes acute inflammation of the respiratory system. Following the first infection, the virus remains dormant in the brain's neurons as a latent infection. The virus goes through recrudescence under stress and might shed through the nose and eyes [6], [7]. Animals that are seropositive for bovine herpesvirus 1 cannot be transported to nations that are free of the illness and cannot be kept in artificial insemination (AI) facilities since an infected cow never completely clears the virus. Identifying and eliminating carrier livestock from the herd is necessary. Parainfluenza The PI3 virus enters the upper respiratory mucosa by direct touch and aerosols (sneezing, coughing). PI3 exclusively causes respiratory illnesses. Mild infection is seen in adult cattle. The fact that PI3 infection predisposes animals to concurrent infection with IBR or bacterial respiratory pathogens is the most significant effect of PI3 infection in bovine respiratory illness. Complicated Bovine Respiratory Disease The three infections mentioned above are among the many that contribute to bovine respiratory illness complex. Bovine respiratory syncytial virus (BRSV) and bacteria including Pasteurella multocida, Mannheimia haemolytica, and Histophilus (previously Hemophilus) somnus are additional pathogens that cattle may be immunized against to reduce this illness complex. To spread illness, these pathogens work together. Stress factors such as parasites, weaning, a change in diet, variations in the environment's temperature and humidity, and weather may make disease worse. The age of the animal, the implicated organism(s), and the illness stage all affect the clinical symptoms. Fever and bovine respiratory illness are intimately related; fever is one of the most prevalent causes of it in cattle, and in infected animals, it may be the first indication of the disease.

Additional symptoms include mental drowsiness, anorexia, quick shallow breathing, and eye and nasal discharge (watery to purulent to bloody). Early on in the disease's progression, coughing will be light and hesitant; later on, it will become noticeable ("honking"). Leptospirosis Leptospira bacteria are the source of the zoonotic illness leptospirosis. The frequency of illness varies geographically and has several distinct serotypes. Hardjo-bovis, pomona, canicola, icterohaemorrhagiae, and grippotyphosa are examples of serovars. The bacteria are carried by maintenance hosts, also known as reservoir hosts, who expose other vulnerable animals to them. Animals such as cattle, pigs, dogs, raccoons, skunks, and rodents are maintenance hosts for leptospirosis. Animals may get an infection from serovars maintained by other species or by serovars maintained by their own species (host-adapted infection) (non-host-adapted infection). Leptospirosis may spread indirectly via the environment or directly between animals.

The primary hosts for L. hardo-bovis are cattle, where the illness is less severe but still has a large economic effect. Some seorvar-infected cattle, particularly those with L. pomona, have more severe disease. The age of the affected animal, the serovar that caused the infection, and the level of resistance or immunity in the herd all influence the clinical indications. Host-adapted diseases in cattle may harm animals of any age, although they mostly impact fertility and the renal system (106 Margaret Root Kustritz). For weeks or months, infected cattle may continue to excrete the organism in their urine. L. pomona is often the cause of non-host adapted infection in cattle, which mostly affects the hemolymphatic, urinary, and reproductive systems. Hemolytic anemia, which results in crimson urine and jaundice, is what distinguishes acute illness.

Infertility, stillbirths, and abortion are a few months after infection among the reproductive consequences. Mastitis, which causes reduced milk supply and thick, yellow milk, may affect lactating cows. Campylobacter When infected bulls mate with vulnerable cows and heifers, they may transmit the disease campylobacteriosis, previously known as viriosis, which is brought on by the bacteria campylobacter fetus. Bulls carry the disease asymptomatically after infection. It is most probable that transmission will only be venereal. Since cows and heifers lack immunity, the illness spreads quickly once it is introduced to a herd. The chances of conception fall to around 40%. The illness incidence decreases as immunity grows, but reinfection often happens when immunity dwindles around a year after the original infection. In chronically infected herds, conception rates typically range from 65 to 75 percent, with replacement heifers (newly imported animals) suffering the most. The infection may stop a fertilized egg from implanting in the uterine lining or, more typically, it can kill the growing embryo.

The cow returns to heat after the embryo is lost, and since she now has immunity, may typically be successfully bred again. Sometimes, the illness leads to infertility that is permanent. Cattle are often killed by clostridial infections before any clinical symptoms appear. These illnesses are brought on by bacteria that produce very persistent spores that are present all over the environment, are readily ingested by grazing cattle, and enter the body via wounds. Veterinary Preventive Medicine 107 Healthy animals may have bacteria living in their gastrointestinal tracts and spores maybe present in their tissues. While not all Clostridium species are pathogenic, those that are often result in death. Examples include:

- Malignant edema caused by C. septicum
- Blackleg caused by Cauvoei
- Enterotoxemia caused by C. perfringens types A, B, C, and D

- C. botulinum - botulism; C. tetani – tetanus

Contributing elements are required for the bacterium to grow and cause illness. This might include harm or intrusive processes like surgery, childbirth, or puncture wounds. Clostridial organisms in the gut may be allowed to grow and cause illness as a result of dietary changes, overeating, and acidity. Clinical symptoms vary depending on the particular organism and may include flaccid paralysis, sudden death in otherwise healthy animals, lethargy or depression, high fever, anorexia, localized stiffness or muscle spasms, port wine-colored urine, and acute lameness and swelling in the hips and shoulders with a crackling sound when the skin is touched (botulism). Brucellosis

The infectious illness brucellosis may spread across different animal species and between animals and people [8], [9] . Typically, Brucella abortus is the responsible bacteria in cattle. Being highly contagious, 108 Margaret Root Kustritz brucellosis spreads quickly among cattle. Late-term abortion is the main clinical symptom, and the aborted calf, its membranes, and its fluids are all highly bacterially contaminated.

CONCLUSION

Immunologic defense against economically significant livestock illnesses is provided through vaccines. When vaccinations are administered at the wrong time, recipients are immunosuppressed, and/or the infectious challenge is higher than the immunologic protection provided by immunization, vaccine efficacy may not be attained. Since there are few randomized, controlled field trials that assess vaccine effectiveness and some immunization methods flout vaccine label instructions, vaccine recommendations for cattle sometimes depend on anecdotal information and tradition rather than scientific data. Veterinarians should take into account recent studies comparing the effectiveness of on-arrival vs delayed immunization in freshly acquired stocker and feedlot animals observed in the field.

REFERENCES

[1] J. M. Bello *et al.*, “Antimicrobial susceptibility of Mannheimia haemolytica and Pasteurella multocida isolated from ovine respiratory clinical cases in Spain and Portugal,” *Small Rumin. Res.*, 2019, doi: 10.1016/j.smallrumres.2019.08.008.

[2] T. Navarro, J. J. Ramos, M. Ruíz de Arcaute, and J. M. González, “Predisposing factors inducing ovine respiratory complex in intensive-reared lambs,” *Small Rumin. Res.*, 2019, doi: 10.1016/j.smallrumres.2019.07.013.

[3] F. Wouters, A. T. B. Wouters, T. T. N. Watanabe, M. P. Soares, C. E. F. Cruz, and D. Driemeier, “Pneumotoxicosis in Sheep Caused by Ingestion of Trema Micrantha,” *Vet. Pathol.*, 2013, doi: 10.1177/0300985813478208.

[4] X. Dao, C. C. Hung, Y. Yang, J. Wang, and F. Yang, “Development and validation of an insulated isothermal PCR assay for the rapid detection of Mannheimia haemolytica,” *J. Vet. Diagnostic Investig.*, 2022, doi: 10.1177/10406387211068447.

[5] L. Viana, R. C. Gonçalves, J. P. de Oliveira Filho, A. C. Paes, S. B. Chiacchio, and M. G. Ribeiro, “In vitro susceptibility to antimicrobials of Mannheimia haemolytica and Pasteurella multocida isolated from healthy ovine and with respiratory diseases,” *Brazilian J. Vet. Res. Anim. Sci.*, 2007, doi: 10.11606/issn.1678-4456.bjvras.2007.26598.

[6] D. Lacasta, A. Fernández, J. M. González, J. J. Ramos, A. Ortín, and L. M. Ferrer, “Gangrenous pneumonia, ovine respiratory complex and visceral form of caseous

lymphadenitis: Relevance in lower respiratory tract disorders of adult sheep," *Small Rumin. Res.*, 2019, doi: 10.1016/j.smallrumres.2019.08.004.

[7] G. E. Jones, J. S. Gilmour, and A. G. Rae, "Investigations into the possible role of Mycoplasma arginini in ovine respiratory disease," *Res. Vet. Sci.*, 1985, doi: 10.1016/s0034-5288(18)31811-3.

[8] A. E. Karagianni *et al.*, "Transcriptional Response of Ovine Lung to Infection with Jaagsiekte Sheep Retrovirus," *J. Virol.*, 2019, doi: 10.1128/jvi.00876-19.

[9] E. Mazzetto *et al.*, "Replication of Influenza D Viruses of Bovine and Swine Origin in Ovine Respiratory Explants and Their Attachment to the Respiratory Tract of Bovine, Sheep, Goat, Horse, and Swine," *Front. Microbiol.*, 2020, doi: 10.3389/fmicb.2020.01136.

[10] N. O'Boyle, C. C. Berry, and R. L. Davies, "Differentiated ovine tracheal epithelial cells support the colonisation of pathogenic and non-pathogenic strains of Mannheimia haemolytica," *Sci. Rep.*, 2020, doi: 10.1038/s41598-020-71604-8.

CHAPTER 15
PARASITE CONTROL

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

Provide an explanation of fecal flotation tests, including fecal egg counts and fecal egg count decrease tests. List the common domestic animals' external and internal parasites of concern. Provide examples of typical parasites' life cycles and how they relate to control. Explain the medications and techniques used to manage parasites in domestic animals. Explain how to maintain the pasture to prevent parasites. The use of pesticides is often important to the management of external parasites. Typically, they are pyrethrins or organophosphates. Dust bags, back-rubbers (oilers), animal sprays, pour-ons, and insecticide-impregnated ear tags are some delivery methods or combinations of methods.

KEYWORDS:

Agriculture, Animal Husbandry, Environment, Insecticide, Management, Veterinary Preventive.

INTRODUCTION

Both internal and external parasites, such as worms and fleas and ticks, rob the host of nutrition and may spread illness. This chapter will highlight examples of how knowing the life cycles of various parasite species in diverse habitats might reduce infection or infestation and aid in parasite management in the environment. The major distinction between large and small animals' general care seems to be this. Concerns concerning parasite resistance to existing deworming drugs exist in big animals, and considerable care is taken to prevent the formation of resistant parasites. To ensure that there are always vulnerable worms in the larger population and that we are not just killing off susceptible worms and leaving behind more and more resistant worms, this may entail leaving a small population of worms untreated. To eradicate all internal and external parasites in small animals, where they may pose a serious threat to public health [1]–[3] . This does not imply that there are no resistance-related worries, since resistance in hookworms, a canine intestinal parasite, was identified in 2021.

PARASITE INFECTION AND DIAGNOSTIC METHODS

The class that is discussed the most often is gastrointestinal parasites. Fecal flotation assays and fecal egg counts are two standard methods for assessing the presence of gastrointestinal parasites. Fecal flotations are essentially measured by fecal egg counts. Fecal flotations are sometimes referred to as fecal floats. A fecal egg count (FEC) is a quantitative evaluation, while a fecal flotation is a qualitative evaluation of the eggs in a sample. Fecal flotations only provide a semi-quantitative evaluation of egg load since they are lenient with the quantity of solution and feces utilized for each float. FECs calculate the number of eggs using a formula after measuring the quantity of feces and solution used. FEC are the primary test used to conclusively establish the level of drug resistance in an animal or herd since they are often conducted more once; in order to interpret them, they are performed over time. Knowing how prolific a nematode is as an egg layer is crucial when assessing a fecal float or FEC. For instance, a whipworm only produces approximately 1000 eggs every day, but a Toxocara canis

(roundworm) can generate over 20,000. As a result, having more whipworm eggs on a float or FEC than Toxocara eggs does not always indicate a significant worm load. Lastly, be aware that fecal flotation tests cannot detect all gastrointestinal parasites. For instance, tapeworm eggs are often discharged as segments, or proglottids, and since the proglottids are too heavy to float and the individual eggs aren't in the feces, it's usually impossible to identify tapeworm infections by fecal flotation tests [4] .

BEEF CATFORDS

From mild immunological suppression, discomfort, irritation, appetite suppression, and reduced output to severe clinical illness and death, parasites might potentially harm beef cattle. A preventative health program should handle immunity (vaccinations), management practices, handling, and nutritional considerations that represent a thorough understanding of both farm-specific challenges and objectives as well as the beef production system. Parasites on the inside Roundworms (nematodes), tapeworms (cestodes), flukes (trematodes), and protozoa are examples of internal parasites 136 Margaret Root Kustritz (such as coccidia). As roundworms are thought to be the most economically significant, many initiatives focus on managing them. The emphasis of this section on internal parasites in beef cattle will be roundworms. The treatment of internal parasites depends on an understanding of the parasite life cycle and the amount of parasite load. The fundamental stages of internal (gastrointestinal) parasites in cattle are as follows:

- Adult parasites infest cattle's digestive systems and lay eggs that are excreted in the dung.
- When a parasite egg is excreted on pasture, it starts to grow into a first-stage larva (L1), molts into a second-stage larva (L2), and then molts again into a third and infective stage larva (L3).
- The first two stages of the larva in the fecal pad are relatively stationary as the larva feed on the bacteria and other debris in the feces.
- At the third larval stage, the larva leave the fecal pad and go to a neighboring patch of grass where cattle eat them.
- To survive during winter or drought circumstances, L3 larvae retain an external sheath covering that offers additional protection from environmental factors. Because of the sheath's ability to restrict eating, L3 larvae have a short lifespan.
- Temperature and moisture have a big impact on egg development, according to Veterinary Preventive Medicine.

In the spring, when the temperature is warm again, eggs that were laid in the midst of winter will begin to hatch. Infected larvae that grow from eggs passed in the midst of a drought or other harsh circumstances cannot travel away from the spot and may be eaten by a host animal when it consumes grass because they lack moisture. If temperatures are warm and moisture is abundant, eggs that are discharged under favorable circumstances may transform into infectious larvae in only a few days. After being eaten by cattle, the infectious larvae develop into adults over the course of 3–4 weeks (shorter in younger animals, longer in older calves), start to lay eggs, and are then shed onto pastures to re-start the cycle. Certain larvae, also referred to as L4 larvae, might become inhibited or hypobiotic (go into hibernation) in the wall of the abomasum. This procedure may take place in the northern hemisphere during the winter and in the southern hemisphere during the summer, with these larvae growing and developing

into adult worms when the environment is more conducive to egg survival.

Generally, producers get a sizable positive return on their investment when internal parasites are controlled. Roundworms are the primary target of internal parasite management in beef cattle. To identify the individual worms that are present, diagnostics are required. This is significant for beef cattle because the roundworm life cycle relies on the shedding of eggs on grass, the development of larvae, and the consumption of larvae while grazing. The control of roundworms is essential since grazing grasslands is a major component of the production of meat from cattle, according to 138 Margaret Root Kustritz. Cattle will face a parasite problem as long as they have access to grass. The use of pasture management tools as well as the administration of anthelmintic (dewormer) medications as a form of treatment should be included in control practices. These practices should take into account the class (or age) of cattle, nutrition status, stress level, season, and likelihood of parasite contamination of the environment [5]–[7].

DISCUSSION

Grazing other species on the pasture, letting the pasture fallow, and dragging dung pats during the dry season to let them dry up are some pasture management practices. Beef cattle may be treated with anthelmintics in a variety of ways, including paste, injectable, drenched, poured on, bolus, and as a feed or mineral addition. Products vary in price and duration of action but may be divided into two groups: macrocylic lactones and benzimidazoles. Commercially available benzimidazoles (white dewormers) include albendazole, fenbendazole, or oxfendazole. The majority of the main adult gastrointestinal parasites as well as several of their larval stages are successfully combatted by benzimidazoles. Products have a brief period of action and exist in a variety of oral forms. Avermectins and milbemycins are macrocyclic lactones. Ivermectin, doramectin, eprinomectin, or moxidectin are ingredients in goods used for commerce.

At low dosage levels, macrocyclic lactones offer an effective and wide antiparasitic range. They are effective against a variety of larval stages, including hypobiotic larvae, as well as a variety of external parasites. For usage on cattle, products come in oral, subcutaneous, and pour-on forms. Depending on the product, effectiveness may last up to 35 days. Deworming strategies employed on beef cattle are referred to as strategic deworming. This is the practice of sometimes treating cattle to lessen environmental pollution for a length of time at least equivalent to the life cycle of the parasite eradicated, in addition to getting the benefit in that animal to minimize economic loss. The key to strategically deworming cattle is to put them on pastures that are not affected. This is done by deworming cattle before spring turnout or, in the north, by treating them in the autumn (following killing frost). When cattle are treated in the autumn, they should be free of internal parasites throughout the winter and into the spring turnout (assuming an effective product was used). When cattle are sent out into pasture in the spring, they are parasite-free and do not shed eggs. If the grass is infected, the cattle will eat the infectious larvae there.

The cows will lessen the burden on the grass by eating the infectious larvae rather than shedding new ones (Veterinary Preventative Medicine 143). (acting as vacuum cleaners). The infected larvae that were consumed will eventually reach adulthood, and cows will begin shedding eggs. Deworming treatments are timed strategically to lessen the worm load on the cattle and the pasture contamination during the parasite season (spring/early summer). These treatments may and should be scheduled to coincide with other management practices, such as calves' summer vaccinations and cows' and calves' autumn processing. Timings and the sort of grazing program may vary according on the geographic region, such as in the south where the weather (moisture)

is variable. When on a grazing program, calves and stockers should be taken into account within a strategy plan. Before to weaning, while the cow is nursing, and when the stocker is actively grazing are times to be concerned.

During the weaning process, calves shouldn't be dewormed. Prior to the strain of weaning, preweaning therapy might lessen its possible detrimental effects on immunological function while also enhancing performance. A suitable time to deworm cattle is whenever they are transitioning from pasture to a dry lot situation. This should reduce the cow's parasite burden for the duration of the dry lot (much as in the autumn when there is no green grass to graze). Similar principles are used to manage other forms of internal parasites including tapeworms (cestodes), flukes (trematodes), and protozoans (like coccidia). The various life cycles of these many parasite kinds, as well as the effectiveness of the medications used to cure them, must be understood.

Anti-Parastitic Drugs

The extensive and frequent use of over-the-counter oral anthelmintics during the last 30 years has greatly reduced the incidence of parasite-related sickness among the general population, but it has simultaneously sped up the development of parasite drug resistance. Every horse on a farm would typically have a deworming every 8 weeks, and sometimes even more regularly. In other words, a method that was overly rigid and indiscriminate was used. The lack of novel parasite control medications in the pipeline raises serious concerns about resistance problems.

Current guidelines aim to provide effective protection against parasite-related sickness while preventing the emergence of new resistance issues. We now advise a more planned and focused strategy that, for the majority of horses, results in considerably less frequent deworming than previous methods. With over-the-counter, commercial oral paste treatments that are dosed based on body weight, horses are dewormed. Ivermectin and moxidectin, macrocyclic lactones, pyrantel pamoate and tartrate, benzimidazoles (fenbendazole and oxibendazole), and praziquantel are among the available treatments (available only in combination with ivermectin or moxidectin). The majority of parasite resistance to far has been linked to the drugs benzimidazole and pyrantel, although lately some avermectin resistance has also started to emerge. The parasite species that are most likely to show resistance are the ascarids and tiny strongyles [8] .

There are several herbal and organic deworming solutions on the market that are heavily marketed to horse owners and managers, but there is no scientific proof to support their efficacy. They haven't been formally evaluated for safety and effectiveness, and the FDA hasn't given them a drug license or approval. Manufacturers of non-drug items are able to make practically any claim they choose without having to provide any supporting information since non-drug products are given far greater latitude in labeling.

Software Design for Parasite Control

Serial quantitative fecal egg count (QFEC) monitoring is used in adult horses to help determine which horses should be dewormed and with what products. Strongyle eggs per gram (epg) of manure measurements assist owners and veterinarians in: I estimating individual parasite burdens; (ii) identifying horses with moderate to heavy parasite burdens who will benefit from deworming; (iii) identifying the particular horses within the herd who serve as the major long-term parasite reservoirs and need more frequent deworming; and (iv) determining which specific deworming products are effective against parasites on horses. Horses are classified as low shedders (0–200 epg), moderate shedders (200–500 epg), or heavy shedders (> 500 epg) based on their FEC. Most mature horses in a well-managed herd fall into the low-shedding

group, requiring as few as two deworming treatments per year (spring and fall). While regional differences in management of intermediate shedders exist, these horses normally need at least one more deworming treatment throughout the parasite transmission season. Because of the egg reappearance period (ERP) for the dewormer given in the spring, these horses typically require one more treatment for strongyles between April and October in Minnesota. Heavy shedders need to be treated all during the spring/summer parasite season, but never before the anticipated response period (ERP) for the deworming medications employed [9].

Graph Showing Horse Shedding

In order to assess the effectiveness of certain deworming drugs against both strongyles and ascarids, feces egg count reduction tests (FECRT) are utilized. This involves measuring the % decrease in fecal egg counts as a result of therapy by doing FEC tests before worming and then again 14 days afterwards. Different drugs and parasites have different thresholds for suspicion of resistance, but generally speaking, a dewormer should be reducing egg counts by 90-95% or higher if the parasite is sensitive to its lethal effects.

Adult horses in this kind of program are only dewormed once or twice a year since they are naturally resistant to parasites and have low worm loads. As a result, many of the population's worms are protected from the repeated exposure to deworming drugs that favors the development of treatment resistance. In contrast, horses with large worm loads are chosen for more frequent medication since they are more susceptible to illness and make the most contribution to environmental pollution. This exerts some selection pressure for resistance development, but the greater population of worms that are still genetically vulnerable balances this (refugia). Resistance develops more slowly the more worms there are in a refugia.

Because of their high degree of sensitivity to parasitism in general and ascarids in particular, foals, weanlings, and yearlings are treated differently. It is now advised to treat children at least four times in their first year of life, with the first therapy occurring between the ages of 2-3 months with a benzimidazole (for example, fenbendazole). A second deworming is advised right before weaning at about 6 months of age, followed by an FEC to identify whether worm loads are largely made up of strongyles or ascarids. Between about 9 and 12 months of age, the third and fourth treatments are given, and they should largely focus on strongyles. Praziquantel should be a part of one of the treatments to deal with tapeworms. Weanlings who have just undergone deworming need to be released onto the cleanest pastures with the lightest worm/egg loads.

As fecal egg counts are ineffective for diagnosing tapeworm or bot infestations, most horses just get yearly treatment for these conditions in the late autumn on the premise that a sizable infestation already exists. The sole drug approved for the treatment of tapeworms is praziquantel, while ivermectin or moxidectin are used to treat bots. By scheduling this therapy for late autumn, the current population of tapeworms and bots is "cleared out" at a period when quick reinfection is impossible since the flies and mites that transmit them are no longer active. As flies and mites seem to restart transmission the following spring, horses will start to re-accumulate those parasites.

Management of the Environment

The periodic delivery of anthelmintic medications, like with other species, is just one component of an efficient control program. Environmental cleanliness and management are equally crucial. The best strategy is to remove manure from pastures and paddocks; twice-weekly manure collection is advised. It is only advised in areas where spreading manure would cause it to dry up quickly to drag or harrow paddocks and pastures to break up manure pats.

Enough heat is produced during the composting of manure and dirty bedding to destroy parasite larvae and eggs. Spreading non-composted manure on pastures is never a good idea since it will raise the parasite contamination level. As well as alternating pastures and grazing different livestock species on rested pastures, lowering animal numbers, stocking density, and overgrazing will all help to limit parasite exposure. Before being set out with resident horses, new horses should have an FEC upon arrival and, if necessary, a deworming.

CONCLUSION

A kind of internal parasite called heartworm infests the circulatory system. Infected mosquitoes inject young worms into the dog or cat. As these young worms mature, they settle in the heart where they mate and give birth to more worms that circulate in your dog or cat, completing the life cycle by infecting mosquitoes that prey on other animals. Everywhere your dog or cat comes into contact with mosquitoes including inside they might get heartworm. Heart, lungs, and other crucial organs are severely and even fatally damaged by adult heartworms. Coughing, exhaustion, appetite loss, and maybe fainting spells are some of the clinical indications of heartworm illness. Many sick cats and dogs don't exhibit any symptoms of illness. Every year, your dog will be checked for this illness by your veterinarian; cats should also be examined. Prevention is recommended since treatment might be challenging. As there is no cure for cats, prevention is essential. Thankfully, heartworm illness is less common in cats than in dogs because cats are more resistant to the condition. An annual test and monthly prophylactic medication administration are recommended for your dog. Puppy heartworm prevention may begin as early as 6 to 8 weeks of age. Be aware that many heartworm treatments also shield your pet against the previously mentioned intestinal parasites.

REFERENCES

[1] M. K. Nielsen, K. Pfister, and G. Von Samson-Himmelstjerna, “Selective therapy in equine parasite control-Application and limitations,” *Veterinary Parasitology*. 2014. doi: 10.1016/j.vetpar.2014.03.020.

[2] M. K. Nielsen, “Sustainable equine parasite control: Perspectives and research needs,” *Vet. Parasitol.*, 2012, doi: 10.1016/j.vetpar.2011.10.012.

[3] M. B. Molento, “Parasite control in the age of drug resistance and changing agricultural practices,” *Vet. Parasitol.*, 2009, doi: 10.1016/j.vetpar.2009.06.007.

[4] E. Pettersson, M. Sjölund, T. Wallgren, E. O. Lind, J. Höglund, and P. Wallgren, “Management practices related to the control of gastrointestinal parasites on Swedish pig farms,” *Porc. Heal. Manag.*, 2021, doi: 10.1186/s40813-021-00193-3.

[5] M. A. Taylor, “Parasite control in sheep: A risky business,” *Small Rumin. Res.*, 2013, doi: 10.1016/j.smallrumres.2012.11.010.

[6] A. M. Becher, D. C. van Doorn, K. Pfister, R. M. Kaplan, M. Reist, and M. K. Nielsen, “Equine parasite control and the role of national legislation – A multinational questionnaire survey,” *Vet. Parasitol.*, 2018, doi: 10.1016/j.vetpar.2018.07.001.

[7] R. M. Kaplan and M. K. Nielsen, “An evidence-based approach to equine parasite control: It ain’t the 60s anymore,” *Equine Vet. Educ.*, 2010, doi: 10.1111/j.2042-3292.2010.00084.x.

[8] Y. Bloemhoff *et al.*, “Parasite control practices on pasture-based dairy farms in the Republic of Ireland,” *Vet. Parasitol.*, 2014, doi: 10.1016/j.vetpar.2014.05.029.

[9] J. Jung and O. J. Kim, "'It all started from worms': Korea-Japan parasite control cooperation and Asian network, 1960s - 1980s*," *Korean Journal of Medical History*. 2018. doi: 10.13081/kjmh.2018.27.49.

[10] C. Jack, E. Hotchkiss, N. D. Sargison, L. Toma, C. Milne, and D. J. Bartley, "Determining the influence of socio-psychological factors on the adoption of individual 'best practice' parasite control behaviours from Scottish sheep farmers.," *Prev. Vet. Med.*, 2022, doi: 10.1016/j.prevetmed.2022.105594.

[11] A. P. Stringer and W. Linklater, "Everything in moderation: Principles of Parasite control for wildlife conservation," *Bioscience*, 2014, doi: 10.1093/biosci/biu135.

CHAPTER 16
REPRODUCTION CONTROL

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

The veterinary pharmaceutical sector creates the animal vaccinations that are now sold in Europe and other areas of the globe. It costs money and takes a long time to create a vaccine for use in animals. The road to the successful creation and introduction of a vaccine is fraught with difficulties. After the proof of concept, which is based on solid academic research, industrial development of a vaccine for veterinary use often begins. Only once the veterinary authorities have given marketing authorization may a vaccination be made accessible to the veterinary community.

KEYWORDS:

Agriculture, Animal Industry, Management, Reproductive Physiology, Veterinary.

INTRODUCTION

The commercial development of a vaccine has to be understood in the perspective of economics, as opposed to academic proof of concept experiments. Pharmaceutical firms that compete with one another make and sell veterinary vaccinations. There are two primary target markets for veterinary vaccinations, each with its unique dynamics. These markets are (1) companion animals and (2) the agricultural or production animal industry. The agriculture industry has evolved to become increasingly industrialized and price-sensitive during the last several decades. The public's attitude of companion animals, on the other hand, has altered, increasing the need for medical care. In general, vaccinations for industrial animals are made in bigger volumes and at cheaper costs than vaccines for companion animals, which are made in smaller volumes and cost more to manufacture. Moreover, it should be understood that developing vaccines for low-incidence illnesses or vaccinations for animals that are maintained in small numbers is difficult for profit-making businesses to justify.

Together with operating expenses, there is also the cost of adhering to MA and manufacturing-specific legal and regulatory requirements. Regulatory standards are always being reviewed, and due to changes in the regulatory landscape, vaccinations that may have been registered 20 years ago may not be registrable today. Also, it might be challenging to meet regulatory standards for a certain vaccination idea. At factories that have received official certification, vaccines are manufactured on a large scale. The manufacturing standard is explicitly outlined in the Good Manufacturing Practice (GMP) regulations, which have been adopted into legislation. The economic climate, mounting legal and regulatory pressure, and the altered agricultural landscape since the advent of veterinary medicinal product licensing in Europe some 25 years ago have resulted in a notable consolidation among the veterinary vaccine producers [1].

In this analysis, we first provide an overview of the legal and regulatory framework for manufacturing in the EU. We next go through recent advancements in manufacturing techniques before describing the theories behind bacterial, viral, and parasite vaccines as well as immune potentiators.

THE FEMALE'S REPRODUCTIVE PHYSIOLOGY

Each of the follicles in the ovaries, which number in the hundreds, houses one egg or an ovum. Each estrous cycle starts with the selection of a cohort of follicles to start the development process. Gonadotropin releasing hormone [GnRH] and pituitary hormones are released from the hypothalamus and pituitary, respectively, to encourage development (follicle stimulating hormone [FSH] and luteinizing hormone [LH]). The proestrus, or early heat, symptoms are brought on by the follicle's secretion of estrogen as it grows. Around 9 days following the start of proestrus, estrogen levels begin to decline. At this point, the buck will stand in estrus or standing heat, at which point a surge of LH is produced, resulting in ovulation. Ovulation that occurs on its own. Queens ovulate artificially. The most frequent cause of GnRH release and subsequent ovulation in this species is copulation. The eggs are discharged from the follicles into the uterine tube in either spontaneous or induced ovulators, where fertilization takes place. The zona pellucida, a thick capsule, and a layer of follicular cells around the egg. Spermatozoa put into the bitch's reproductive system go through a process called capacitation in which the 176 Acrosome response on the spermatozoon's head and induction of hypermotility by Margaret Root Kustritz. Capacitated spermatozoa infiltrate the zona pellucida and eat the layer of cells surrounding the egg. One spermatozoon fertilizes each egg because an electrochemical response blocks the entrance of additional spermatozoa as soon as one reaches the inner layer of the zona pellucida. Cell division starts right away. The growing embryos enter the uterus within a few days, but they don't embed in the uterine wall and begin to generate placentas until 12–18 days in dogs and cats following the LH surge, respectively.

The male's reproductive physiology

Male dogs' testicles should descend into the scrotum between 8 to 14 weeks of age, and they must do so by 6 months for the dog to be regarded as normal. In male cats, the testicles typically descend at birth but may not become palpable until 6–8 weeks of age. The spermatogonia found in the testes will divide into spermatozoa when the hormone testosterone is present. GnRH and LH release from the brain and pituitary, respectively, drive testicular Leydig (interstitial) cell production of testosterone. Preventive Veterinary Medicine 177 The testis produces spermatozoa, but until they pass through the epididymis, a nearby tissue, they are neither mobile nor fertile. The epididymis is where the spermatozoa that are ejaculated during semen collection are found.

CONTROL OF REPRODUCTION

Contraception any method that temporarily stops reproduction but may be undone so that the person can still reproduce afterwards.

Sterilization

Any process that renders a person incapable of reproducing for life. There are currently no products on the market, although research is being done on non-surgical techniques for sterilizing cats and dogs. Operating Room Sterilization 178 Kustritz, Margaret Root The procedures described in the literature for sterilizing bitches and queens include ovariectomy (surgical removal of the ovaries), hysterectomy (surgical removal of the uterus, also known as a "ovary-sparing spay"), ovariohysterectomy (surgical removal of the ovaries and uterus), and tubal ligation (tying off the uterine tubes). Nowhere in the world is tubal ligation often utilized as a method of contraception for bitches or queens. In Europe, ovariectomies are often performed, and they seem to provide the same advantages and risks as ovariohysterectomy (OHE or spay). Ovariectomy is reportedly less invasive and time-consuming than OHE. In one research of 264 dogs, 126 of which had received ovariectomy and 138 of which had undergone

OHE, there were no discernible variations in the incidence of urogenital issues over the course of the 8–11 years that followed the operation. Both groups reported having urinary incontinence, although there was no statistically significant difference in the incidence of the condition between them. The uterus must be completely removed up to the cervix during an ovary-sparing spay; this procedure is neither faster nor less invasive than OHE. OHE continues to be the most used surgical sterilizing technique in the US. Castration (the surgical removal of both testicles) and vasectomy (tying off the spermatic cord) are recorded sterilization procedures for male dogs and cats. The most used surgical sterilizing technique is castration[2].

Preventive Veterinary Medicine

The ideal age for surgically sterilizing cats and dogs the veterinary literature does not specify the ideal age at which OHE or castration of dogs and cats should be performed. Prior to adolescence, which is defined as the development of typical breeding behavior, semen quality, and first estrus in males and first estrus in females in the United States, the majority of veterinarians advise spaying or neutering of cats and dogs when they are around 6 months old. In certain nations, veterinarians advise against performing elective surgical sterilization on dogs and cats before their first estrus or until they are at least six months old. In fact, elective gonadectomy is severely discouraged or even prohibited in several nations since it is seen to be immoral. For the sake of this discussion, it is assumed that the veterinarian is familiar with the ethical considerations surrounding elective gonadectomy and operates in a nation where such a procedure is seen as acceptable by both professional organizations and the general public. Dogs and cats may be seen as either individuals or as a part of a broader animal community. This must be considered when recommending an appropriate age for doing an elective gonadectomy. As they are not yet connected to a responsible owner or guardian, animals at humane organizations should be assessed alongside the general population. A dog or cat with an owner or guardian may be seen as an individual or as a member of a broader community.

Dogs and cats without owners or guardians must be sterilized Millions of unwanted dogs and cats are put to death every year in the United States due to a significant pet overpopulation issue. Many of them are surrendered, while many others are abandoned and given to the humane organization as strays. Some of these are feral animals. existent 180 As compared to animals that have been spayed or neutered, animals who have been adopted from the humane association while still in tact are far more likely to be returned or to repopulate the shelter with their progeny. Despite the fact that the majority of intact animals are adopted out along with a spay-neuter agreement, compliance with such agreements has been shown to be less than 60%. Studies have shown that up to 61% of dog and cat owners were unsure or believed that their animal would somehow be "better" after having at least one litter. There is a significant lack of knowledge among pet owners regarding normal reproductive physiology among dog and cat owners. Up to 57% of bitch owners were unaware that bitches cycle at least twice yearly. Up to 83% of queen owners were unaware that queens are polyestrous from spring to early fall. In a study of houses with dogs and cats, 68% of the 317 litters of cats and 56% of the 154 litters of dogs were unplanned, with the majority of the owners saying they were unaware the female had been in heat. The gonadectomy of dogs and cats prior to adoption is one tool in the fight against overpopulation that should be used at this time, despite the fact that everyone would like to think that better education of pet owners would result in more responsible pet ownership and despite the fact that increasing education is a worthy goal that should be pursued. Several studies showing the safety of gonadectomy in pups and kittens as early as 7 weeks have been reported. To that end, I advise that before being adopted from humane groups, all male and female dogs and cats should be spayed or castrated.

Spaying and neutering of pets accompanied by a steward or owner Behavioral and medical Veterinary Preventative Medicine 181 issues might be pros or drawbacks of spaying or castrating. You may find the following definitions to be helpful: The number of new instances in a population over time, or incidence, Morbidity is the severity of the ailment in individuals who have it death as a result of the condition.

According to some estimates, behavioral problems including a fear of storms are becoming more common. Dogs have a documented 6.1% incidence of post-surgical problems, most of which are minor and resolve on their own. The frequency of prostatic neoplasia, transitional cell carcinoma, osteosarcoma, and hemangiosarcoma is typically low, but the morbidity and death rates are substantial. With the other malignancies mentioned, there is a breed propensity, but not for prostatic neoplasia. The incidence of ACL damage in dogs is rather high (1.8%), and there may be significant morbidity, even though this ailment is often thought to be treatable with surgery. Again, certain breeds are more prone to ACL damage than others, most notably huge and enormous breeds. Despite the increasing occurrence of obesity, the owner or guardian may limit morbidity. Compared to male cats, the proper suggestion for castration in male dogs is less obvious. Even though a given male dog may have many more children than a given bitch, castration is not advised when viewing the animal as an individual due to the high morbidity involved with the procedure as a potential risk factor for the illnesses listed above. The breed of the dog, his expected working life or activity level, and the owner's intentions regarding the usage of the animal for breeding should all be taken into consideration when making this decision, in my opinion. Male dogs are often castrated by owners in order to curb typical male reproductive activities that humanity have judged improper, including mounting.

The negative effects of OHE in female dogs include surgical complications, an increased risk of hemangiosarcoma, cutaneous mast cell tumors, osteosarcoma, lymphosarcoma, and hip dysplasia, an increased risk of ACL injury, obesity, and diabetes mellitus, a potential rise in aggression in at least one breed and reactivity in one breed, and an increased risk of urethral sphincter mechanism incompetence (estrogen-responsive urinary incontinence). Dogs have a documented 6.1% incidence of post-surgical problems, most of which are minor and resolve on their own. Similar as in male dogs, there is a low incidence but substantial morbidity of tumors purportedly linked to gonadectomy. For many [3] different tumor kinds, breed predispositions exist. Obesity is more common following OHE, although the owner may manage morbidity. The incidence of ACL damage in dogs is rather high (1.8%), and there may be significant morbidity, even though this ailment is often thought to be treatable with surgery. Again, certain breeds are more prone to ACL damage than others, most notably huge and enormous breeds.

English Springer Spaniels have been known to become aggressive following OHE; some research suggests that this impact may be more prevalent in fawns who already had aggressive characteristics. Female spayed dogs sometimes have urethral sphincter mechanism dysfunction, particularly those that weigh more than 20 kg. The condition may often be treated medically and has a low mortality rate in female dogs. There is evidence to support the idea that spaying fawns when they are older than 3-5 months may reduce occurrence. Preventive Veterinary Medicine 187 It is less obvious how to propose OHE for female dogs than it is for female cats. Undoubtedly, OHE significantly lowers the risk of mammary neoplasia and pyometra, both of which have high incidences and severe morbidities. Nonetheless, it is important to assess any potential propensity for certain tumor forms with extremely significant morbidity or ACL damage. I think this advice has to be given on a case-by-case basis, taking into account the breed of the dog, her expected working life or activity level, and the owner's intentions about usage of that animal for breeding. The owners, guardians, and breeders of dogs

and cats have access to a lot of information both accurate and inaccurate about this subject. It is in our best interests as veterinarians to be knowledgeable about the most recent veterinary research and to base our recommendations on facts rather than on folklore or anecdotes.

DISCUSSION

Immunologic Regulation of Reproduction

Immunization of the animal against one of the tissues or hormones mentioned above is how immunologic methods of contraception function. For instance, when an animal receives a vaccination against a tissue, the animal develops antibodies against that tissue that either kill the tissue or impair its ability to function normally. For dogs or cats, there is currently no commercially available vaccination for contraception. The substances under investigation include:

Vaccinated bitches and queens may or may not continue to cycle, and the length of time until re-vaccination is necessary varies significantly among individuals. This procedure may or may not be reversible; ovarian pathology, including as ovarian atrophy and polycystic disease, has been seen after bitches were immunized against swine zona pellucida proteins. GnRH is a substance to which animals do not easily produce antibodies. Animal test subjects' immune responses have been 194 Nonetheless, this vaccination could be the strongest contender for commercial distribution in the foreseeable future, according to Margaret Root Kustritz variable. Since many years ago, researchers have been looking for the elusive "spay vaccination." Lately, a deliberate effort has been undertaken to bring together scientists who share similar views and to make sure that resources and ideas are shared. The Found Animals Foundation and the Association for Contraception in Cats and Dogs have worked together to expand the number of research studies conducted in the area of dog and cat sterilization and contraception. Targeted cytotoxins, gene silencing, and immunocontraception are some current research topics. As at the time of writing, no such items are offered for sale commercially. Dogs and cats have shown significant promise for products licensed for use in other species, and it is anticipated that an injectable form of reproductive control will be accessible within the next five to ten years[4].

Sclerosing Substances for Fertility Regulation Drugs or substances called sclerosing agents are injected into the testes or epididymes to produce localized inflammation, damage, or scar testicular or epididymal tissue, limiting the generation and migration of spermatozoa. As spermatogonia found inside testicular tissue cannot regrow, sterility may be attained by destroying both the tissue and the spermatogonia. Many substances have been researched. One substance, NeutersolTM, was given FDA approval in 2002 for treatment in pups aged 3 to 10 months with testicular widths between 10 and 27 mm. As of this writing, no commercially accessible product is available in the United States for this chemical; it was most recently sold under the brand name ZeuterinTM. Each testis receives an injection of the substance (zinc gluconate with arginine), with a dosage based on testicular width. While sedation may be necessary, the majority of dogs are said to handle the injection well. Vomiting and temporary testicular or scrotal enlargement are among the adverse effects that might occur right away. ZeuterinTM should not be administered to dogs with cryptorchidism, scrotal itch, or testicular or epididymal deformity. Not as much as with castration, testosterone secretion was reduced. Studies are still being conducted to assess the product's safety, effectiveness as a contraceptive or sterilant, and impact of lower testosterone levels on behavior and prostate illness.

Each batch that is bought or created is tested to make sure it complies with acceptance standards in order to guarantee the quality of the raw materials used in manufacturing. For biologically derived starting materials, which are often utilized in the manufacture of vaccines, there are

additional criteria (e.g. ensuring exclusion of extraneous agents). When passages from the Master Seed are made to create a bank of Working Seed, from which all production batches are formed, seed stocks of the vaccine strain and manufacturing cell-lines are laid down in a seed lot system. To reduce the possibility of transmitting transmissible spongiform encephalopathies, the original Master Seed must have a known history of its isolation and prior passages (TSEs). Moreover, the identification of the vaccination antigen and purity (the lack of extraneous agents including bacteria, fungus, mycoplasma, and viruses) must be established.

The maker of a commercial vaccination must register all pertinent in-process tests as well as tests to be done on the completed product, providing limits of acceptability that must be satisfied before the batch may be issued for sale, in order to verify that each batch of the vaccine is the same quality. Moreover, based on at least three batches of the vaccine in the final container, the producer must demonstrate that the quality of the vaccine, when manufactured on a (semi) commercial scale, is assured until the end of its shelf life.

Safety

Safety comes first and foremost. The foundation of determining product safety is a clear conviction that the advantages of the product exceed any possible hazards, including threats to the customer, the environment, the vaccine's administrator, the food made from treated animals, and the target species being immunized. The generation of experimental data using batches with the maximum potency or titre (see below) must be done in accordance with the guidelines of good laboratory practice (GLP). The safety of an overdose and subsequent doses of the vaccination must also be shown, in addition to the safety of a single dosage (such as injection site reaction, clinical signs). It is necessary to plan safety studies utilizing vulnerable target species and the suggested schedules. Live vaccinations must also meet other unique conditions, such as (genetic) stability (the vaccine shouldn't become virulent over subsequent passages), and there should be little chance of genetic recombination and/or genomic reassortment. Depending on the nature of the illness, adjuvant, or vaccination, research on the immune system or reproductive capability may also need to be done. The use of vaccinations containing genetically modified organisms is subject to additional regulations (GMO).

Effectiveness and power

The capabilities of a product must match those listed on the label (e.g. reduce virus shedding, limit typical clinical signs, disease) This data should ideally come from field trials conducted under Good Clinical Practice-Veterinary (VICH-GL9) 3 guidelines as well as from laboratory research that, if at all feasible, make use of validated experimental challenge models. Experimental evidence is required to establish the onset and duration of immunity, such as a few days to a year, followed by an annual vaccine to maintain the degree of protection. These results must demonstrate that animals are adequately protected 1 year after the primary immunization and that animals that receive a single booster vaccine 1 year after the main vaccination are still protected 1 year later

Vaccination challenge trials are often used to confirm a certain antigen's protective effect. The various laboratory animal or in vitro testing that are performed on each batch of final vaccines are connected to this protective effect. The least level that has been shown to be effective in the target animal serves as the pass level for batch release (correlate of protection). It might take years to establish a reliable potency test if the correlate of protection is unknown. Also, the maker is required to disclose information that ensures a product's capacity to immunize and, therefore, its protective impact during its whole shelf life. Each MA in the EU is given a summary of product characteristics (SPC) that has been authorized and describes the pharmaceutical form of the medicine, the target animal (categories), contraindications, the

suggested vaccination schedule, and the mode of administration. Also, the SPC includes use guidelines including withdrawal times, product pairings, and suggestions for reducing the risk of concurrent illnesses during the vaccination period as they might prevent the production of an active immune response [5].

Production systems

The creation of dependable, mass-production antigen manufacturing techniques, such as the utilization of cell culture substrates, is required due to the rising regulatory, GMP, and financial burdens placed on vaccine makers. The front-end of continuous cell-line development has recently received more attention in the search for highly productive cell culture procedures than the utilization of primary cells such fibroblasts from chicken embryos (CEF). The creation of more prolific and stable cell-lines utilized for antigen production has been made possible by advancements in protein expression systems, high throughput screening techniques, and cell characterisation approaches. The final product's quality and consumer safety are already taken into account during cell-line creation, or at the very beginning of a project to generate a vaccine. Examples of this concern include the creation of and transition to animal-free culture medium for cells, the discovery of acceptable animal-free substitutes for specific components like bovine serum, and finally the creation of completely chemically defined culture media.

Sophisticated production process development methodologies are needed at every level of the process, from early development through scale-up to big numbers, because to the rising need for better antigen yields combined with shorter product development and manufacturing process timeframes. With working quantities of only a few milliliters and models for large-scale cell culture procedures, the current generation of micro bioreactors makes it possible to test many conditions in a single experiment. This gives the chance to comprehend the process at the cellular level and makes it possible to extrapolate to large-scale bioreactor operations in a better and more reliable way. The development of analytical technologies that allow for in-line monitoring of antigen production has the advantage of allowing for the study of key immunogenic antigen characteristics like glycosylation or cell metabolites that affect overall cell growth and, in turn, antigen, and it also helps ensure the consistency, dependability, and scalability of entire processes.

Early attempts to commercially generate the proteins made by bacterial, yeast, and mammalian cells needed expensive reusable gear. This requires thorough cleaning and re-sterilization procedures, as well as the validation of these procedures in accordance with the guidelines outlined in GMP standards. This established method put a lot of pressure on standard operating procedures (SOPs), which often led to expensive prices and in-depth staff training. The biggest expenses in manufacturing are facility time, which may account for up to 55% of a plant's overall production costs, and validation, which can run between 10% and 20% of a plant's cost. By increasing the number of campaigns or runs each year, the antigen yield per run, and adding technology that enables factories to function as both multipurpose and multi-product production facilities, these expenses may be decreased [6]. Moving to disposable manufacturing is a strategy that biotech manufacturers are using increasingly often to save costs. More and more firms are using "use once, toss away" technologies at different phases of the manufacturing process. By decreasing the amount of downtime between campaigns, it increases throughput and, thanks to the adaptability of the use of disposable systems in existing clean rooms, it also enables the creation of multipurpose plant designs. Additionally, the lengthy lead times in the initial fabrication and installation of stainless-steel equipment may be eliminated by using disposable individual components or whole systems. A disposable system's design is often custom manufactured and is mostly determined by the application.

The amount to be processed, the product's chemical compatibility, the number of production runs per year, the processing conditions (such as pressure, temperature, flow rates, and mixing times), the product's sensitivity to extractable materials, which are present in all plastics, and vendor validation support are important considerations to make during the design phase of such an application. Nowadays, the most often used parts are bioreactors, connectors, clamps, containers, filters, and tubing. Several of the substances used in a biotechnology production suite may now be delivered in either disposable systems or hard piped stainless steel. Contamination hazards, validation efforts, and labor time may all be significantly reduced if components are already pre-assembled and sterilised when they are provided. Pre-assembled disposable components significantly increase a manufacturer's reliance on its suppliers and put the manufacturer's ability to provide vaccines sustainably in jeopardy.

Mosquito vaccinations

Traditionally, chemotherapeutic drugs have been used to treat and/or manage the most significant parasite illnesses in both people and animals. The creation of parasite vaccines has been sparked by a number of events, including treatment resistance. As a consequence, there are currently many commercially available vaccinations to protect against parasite illnesses. More parasite vaccinations are anticipated to hit the market and help reduce parasitic infections. If the infection is treated, the host often gains some degree of protection against numerous parasite infections. This shows that there is enough immunogenic potential in the parasite to use it as a vaccine. A vaccine and/or vaccination technique that develops protective immunity while reducing the induction of disease are the subject of research. It is possible to distinguish between several strategies, including the use of live vaccinations, attenuated live vaccines, dead vaccines, and subunit vaccines.

Live vaccination (complete life-cycles)

Temporary infections The live vaccinations against chicken coccidiosis are the most evident examples of such a vaccine. The illness is self-limiting since it is a transitory infection (the parasite "passes" through the chicken), hence no chemotherapy is required to treat it. A predetermined low dosage must be administered to the animals, and the infection must begin simultaneously in every chicken in the flock in order to prevent the development of pathology. Selection of strains with lower virulence Variables may exist in the virulence of parasite strains produced from a single isolation. For instance, passage through splenectomized animals with Babesia bovis isolates might select for strains with lower virulence. In Australia and Africa, cattle are being vaccinated with these parasite types. Animals acquire immunity against recurrent challenge infections, and the infection that arises is less severe. Governmental agencies supply these immunizations [7].

Similarly, strains of Eimeria with lower virulence may be chosen from isolates. Some strains of coccidiosis vaccinations for broilers that are commercially available comprise hens that have been repeatedly passed through. In comparison to the wild-type parent population, these "precocious" strains produce fewer offspring and need shorter time to mature into oocysts. Strains that are susceptible to heat Some parasite strains that vary from the wild-type strains in that they result in a self-limiting infection have been chosen. The temperature-sensitive strain of Toxoplasma gondii is one example. This strain, which is the consequence of chemically induced attenuation, may be effectively transmitted in vitro at relatively low temperatures but will not do so at the target animal's body temperature. The infection will thus self-heal. There is no commercialization of this vaccine.

Treatment of infections Chemotherapy is also necessary to treat the infection if the parasite has a propensity to remain in the host for extended periods of time. The live vaccination used to

prevent infection with Theileria parva is an example of this strategy. The virulent T. parva strain isolates used to infect cattle and treat them with a long-acting tetracycline formulation in order to manage the infection provide the basis for the vaccination. Africa continues to use this technique, and the vaccine is made in Malawi by the Centre for Ticks and Tick-Borne Diseases (CTTBD).

Live vaccination (incomplete life-cycles)

Many parasite species have complex life cycles with many life cycle phases that, sometimes, include more than one host. In certain situations, the early life-cycle phases are sufficiently immunogenic to generate protective immunity; another method for creating vaccines is to choose parasite strains with short life cycles. The T. gondii S48 strain is a prime example. This strain is unable to progress from the tachyzoite stage to the bradyzoite stage and does not produce tissue cysts as a result. The tachyzoites cause a brief infection in the host while inducing defense mechanisms. The life cycle of parasites has also been shortened using irradiation. The Dictyocaulus viviparus L3 larvae, which do not grow beyond the L4 stage, are part of the live vaccination used to prevent lungworm infection in cattle. Cattle protected by vaccination are resistant to L3 larvae challenge (Urquhart, 1985).

It is theoretically possible to genetically alter aggressive parasite strains to lessen their virulence. For example, parasite strains might be genetically modified such that, when the vaccine is produced, the parasites are completely virulent and, when given to the host, they result in a self-limiting illness. A tetracycline-dependent regulatory region was cloned in front of an important gene in Toxoplasma gondii to test this theory. During the tetracycline-containing vaccine manufacture phase, the parasite may grow. After being injected into the target animal, tetracycline will prevent the production of the necessary gene, which will prevent the parasite from continuing to spread.

Destroyed vaccines

Entire creatures one may wish to inactivate the parasites before creating a vaccine if live vaccine strains are not accessible or if using live vaccinations is not preferred. Such preparations cannot generate protective immunity on their own; a suitable adjuvant and formulation are required. Examples of such vaccines include one that prevents neospora caninum infection from causing abortion in cattle and another that protects dogs against giardiasis [8].

Subunit vaccinations the identification of essential antigenic elements of an organism that may be included in a vaccine can be facilitated by a more thorough examination of the immune response developed during a natural infection or vaccination-induced immunity. Likewise, an adjuvant is necessary for the development of protective immunity in such preparations. One such example is the vaccination against canine babesiosis caused by infection with Babesia canis. It includes soluble antigens that the parasite has released or expelled. The production of these antigens after B. canis infection in dogs results in illness, according to research. Animals who have received vaccinations immediately generate antibodies that neutralize these antigens. The adjuvant seems to be important since saponin is effective but oil-based adjuvants have shown little to no activity.

In certain instances, recombinant DNA technology is used to manufacture the antigens. The finest example is a vaccination for Taenia ovis in sheep, which is based on parasite antigens made using recombinant technology and induces antibodies that prevent oncospheres from adhering to the gut epithelium. The most effective adjuvant was found to be saponin. The vaccination against the cow tick, Boophilus microplus, is another such. Recombinantly created

tick gut wall antigens are included in the vaccination. High amounts of antibodies against the ticks' stomach wall are developed after immunization of cattle. These antibodies are consumed by the tick when it feeds on the immunized animal, and they cause the tick's gut epithelium to be destroyed, killing the parasite

Immunopotentiators or adjuvants for vaccines

Immunopotentiators have recently attracted a lot of media interest as important adjuvants in innovative human vaccines. Prophylactic vaccinations against the human papillomavirus (HPV), a new pandemic influenza virus, as well as experimental vaccines against allergies and tumors, are a few examples. Adjuvants for vaccines, also known as key platform technologies, are known to distinguish one vaccination from another based on similar antigens. Also, it is acknowledged that vaccinations intended to prevent certain illnesses need to match up specific antigen(s) with a crucial immunopotentiator that selectively activates the crucial immune system with minimum side effects.

Particularly among human vaccineologists, there is a noticeable growth in knowledge of the significance of immunopotentiators. The use and significance of adjuvants for veterinary vaccine makers have long been clear. Conventional veterinary vaccines are generally more immunogenic than pure subunits or peptide antigens, which are favoured in human vaccinations since they are made of relatively unpurified extracts of microbial cultures. Naturally, the makeup of the target antigen may influence immunogenicity and total immune reactivity. Another recent development is a rise in scientific understanding of the mechanisms behind the actions of several immunopotentiators, particularly as a consequence of work on innate immunity receptors. These discoveries make it possible to design vaccines and adjuvants more logically, preferably based on anticipated immunophenotypes after immunization.

Mechanistically, there are two main categories of vaccine adjuvants: (1) vaccine delivery methods that help with the time, dosage, and location of the antigen, also known as signal 1 facilitators; and (2) signal 2 facilitators, which directly activate certain (innate) immune cells. Adjuvants used in vaccines may encourage the production of T helper (Th)1, Th2, Th3, Th17, or regulatory T cells (T reg), a stimulation formerly known as signal 3. This can affect the quality of the immune response. The vaccine functions because immunopotentiators elicit and enhance antigen-specific T and B cell responses to both crude antigen preparations and subunit vaccines with low immunogenicity, respectively. They play a significant role in determining the immunophenotype of the body's reaction to the vaccination antigen. Vaccine adjuvants, for instance, have the power to affect and hasten the establishment of immunity, which may become important during emergency vaccination or at a young age (post-hatch or after delivery), when the progeny is naive to microbial assault.

Adjuvants used in vaccines may also boost the overall size of the antigen-specific response to help the body build up just the right amount of effector T cells or protective antibody concentration. Adjuvants may also lengthen the time that vaccine effector immune responses last, allowing for fewer or no booster immunizations, which is crucial when mass vaccinations are administered. Moreover, certain adjuvants for vaccines have the potential to improve the immunophenotype, such as by inducing cell-mediated T cell immunity, which is thought to be essential for the control of a variety of intracellular infections. Some adjuvants make it possible to save money on antigen doses, which is important when dealing with pricey or time-consuming antigen manufacturing methods.

Crucially, immunopotentiators have the potential to produce brief undesirable side effects, either locally or systemically. The relative value of the vaccination and the medical necessity to prevent or cure the illness of interest determine the amount of adoption. Regrettably, no one

adjuvant can meet all demands. Instead, a wide variety of possible immunopotentiators are available. Due to our incomplete understanding of the immunophenotype that is elicited by the majority of classical vaccine adjuvants, we are unable to choose vaccine adjuvants rationally during vaccine design.

The finest immunopotentiator has traditionally been chosen by trial-and-error and chance. Thankfully, more systematic and scientific research on immune induction in general and immunopotentiation in particular has been made possible recently by mechanistic studies based on new discoveries, particularly about innate immunity receptors. This is true increasingly not just for animals of veterinary importance but also for mice and humans, whose immune systems have been the most researched. This new information will make it possible to create innovative therapeutic vaccines as well as new and enhanced immunopotentiator-based prophylactic vaccinations[9], [10].

CONCLUSION

Accines are crucial in the fight against animal illnesses, especially in the food-producing sectors. Yet, traditionally researched and manufactured vaccinations presently account for a major portion of this. As mentioned above, regulatory, GMP, and financial limitations place limits on how far veterinary vaccine research may go in the sector. For obvious reasons, strong regulatory procedures are in place and will be bolstered further to guarantee the supply of vaccinations that are both safe and effective. To accomplish these goals, the GMP and GLP quality systems were designed. At all phases of vaccine development, these QA procedures are put in place beginning with the proof of concept for a new vaccine. Just seed material is generated under a GMP regimen in the early stages, whereas a fully functional GMP system is used in the later stages.

The pressure put on vaccine producers led to the creation of dependable and adaptable large-scale manufacturing techniques. More cell culture systems, culture medium without animal products, multipurpose facilities, and throwaway production materials are all excellent examples of this trend. In light of this, we have discussed contemporary business developments, particularly the use of biotechnology in vaccine research and manufacturing. For bacterial, viral, and parasite vaccinations, examples of both biotech and conventional vaccine methods' effectiveness have been shown. A separate review covering the epidemiology, pathophysiology, and vaccines currently in use for virus-related disorders has been prepared (Patel and Heldens, accepted for publication). This will provide a more thorough and in-depth assessment of the vaccination alternatives currently under research and available. As previously said, there are now just a few biotechnology-based vaccinations available or in late-stage research against bacterial, viral, or parasite infections; nevertheless, it is anticipated that the number of products based on biotechnology/bio-engineering will rise in the next years.

Based on advancements in the study of animal illnesses, immunology, and adjuvant functioning mechanisms, knowledge of the processes by which adjuvants function is growing. This makes vaccine development more logical. Genetic engineering techniques have been widely used and will be used even more in the future, despite the fact that the majority of current veterinary vaccines are derived and produced by conventional attenuation and/or inactivation processes in tissue culture, but they have yet to deliver on the promise of improved vaccines. It's crucial to understand that because infections are continually evolving in order to live and get beyond the host's defenses, there may never be a perfect vaccination. We must continuously do basic academic research to better understand the behavior of pathogens if we are to expand our capacity to safeguard both the health and welfare of people and animals. To do this, we must keep developing and bettering our industrially produced vaccinations.

REFERENCES

[1] Z. min Li, T. lei Zhang, J. zhong Gao, X. qing Li, L. juan Ma, and X. xiong Bao, "Preliminary prediction of the control reproduction number of COVID-19 in Shaanxi Province, China," *Appl. Math.*, 2021, doi: 10.1007/s11766-021-4065-2.

[2] M. M. von Degerfeld, M. Serpieri, P. Banchi, and G. Quaranta, "Field anesthesia of free-ranging nutrias (Myocastor coypus) for surgical reproduction control," *J. Wildl. Dis.*, 2021, doi: 10.7589/JWD-D-20-00174.

[3] S. Goericke-Pesch, "Reproduction control in cats. New developments in non-surgical methods," *J. Feline Med. Surg.*, 2010, doi: 10.1016/j.jfms.2010.05.005.

[4] E. Risi, "Control of reproduction in ferrets, rabbits and rodents," *Reprod. Domest. Anim.*, 2014, doi: 10.1111/rda.12300.

[5] V. D. Dixit and N. Parvizi, "Nitric oxide and the control of reproduction," *Animal Reproduction Science*. 2001. doi: 10.1016/S0378-4320(00)00224-4.

[6] B. Surya, M. Ruslan, and H. Abubakar, "Inequility of space reproduction control and urban slum area management sustainability (Case study: Slum area of Buloa Urban Village in Makassar City)," *J. Eng. Appl. Sci.*, 2018, doi: 10.3923/jeasci. 2018.6033.6042.

[7] E. Baglioni, "The Making of Cheap Labour across Production and Reproduction: Control and Resistance in the Senegalese Horticultural Value Chain," *Work. Employ. Soc.*, 2022, doi: 10.1177/0950017021999569.

[8] K. G. Rasool, K. Mehmood, M. Husain, M. Tufail, W. S. Alwaneen, and A. S. Aldawood, "De novo transcriptome analysis and identification of reproduction control genes from the red palm weevil Rhynchophorus ferrugineus," *PLoS ONE*. 2021. doi: 10.1371/journal.pone.0251278.

[9] S. Whirledge and J. A. Cidlowski, "Glucocorticoids and Reproduction: Traffic Control on the Road to Reproduction," *Trends in Endocrinology and Metabolism*. 2017. doi: 10.1016/j.tem.2017.02.005.

[10] J. G. Schenker and V. H. Eisenberg, "Ethical issues relating to reproduction control and women's health," *Int. J. Gynecol. Obstet.*, 1997, doi: 10.1016/S0020-7292(97)02866-X.

CHAPTER 17
VETERINARY TOXICOLOGY REGULATORY CONSIDERATION

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

The US Food and Drug Administration (FDA) is a federal regulatory agency with a scientific background entrusted with protecting and advancing public health by supervising and regulating a number of products crucial to consumers' health and welfare. The FDA has authority over most food products, with the exception of meat. Poultry, and some egg products), animal food, both human and animal drugs, medical and veterinary equipment, biologic therapeutics (such as human vaccinations, blood, and blood products), consumer, medical, and industrial radiation-emitting goods, cosmetics, and tobacco products. In the latter half of the 19th century, Harvey Washington Wiley, the senior chemist of the US Department of Agriculture (USDA) Division of Chemistry (later the Bureau of Chemistry), began looking into the misbranding and adulteration of food and medicine items in American commerce. The FDA was founded in this manner.

KEYWORDS:

Agriculture, Animal Drugs, Food and Drug Administration (FDA), Veterinary.

INTRODUCTION

The US Food and Drug Administration (FDA) is a federal regulatory body with a science-based mandate to safeguard and advance public health via the monitoring and control of several goods are required for the customers' health and welfare. Except for meat, the majority of food items are within the FDA's purview. Animal food (poultry and certain egg products), human and Drugs for animals, medical equipment, veterinary equipment, biologic therapeutic agents (such as vaccinations, blood,). Human blood products, radiation-emitting goods for personal, professional, and/or medical purposes, cosmetics, as well as tobacco. The FDA's past may be read here that may be dated back to the 19th century, Chemical expert Harvey Washington Wiley is the Division of Food Safety (DFS) US Department of Agriculture Chemistry, afterwards known as the Bureau of Chemistry, started investigating the falsification and adulteration of Food and medicine items are traded in the US. Wiley released the Division's conclusions and pushed for new federal regulations to establish universal guidelines for the introduction of food and medications interstate trade, which led to the passing of the Food With the 1906 Medicines Act (FDA, 2015a) [1].

Food and Drink

The Drugs Act was the first federal law to prohibit the interstate transportation of contaminated or misbranded food, drink, and pharmaceuticals. FDA, USDA's Bureau of Chemistry, is in charge of administration. The regulatory authority of the Bureau of Chemistry Later, they were reorganized into a new USDA agency, the the former Food, Drug, and Insecticide Organization. FDA ultimately had a new name. Food and Drug Administration Act 1906 was eventually superseded by more comprehensive laws in In light of the catastrophe of "Elixir Sulfanilamide," in which over. A poisonous substance was used to create a medicine that caused 100 deaths. The updated Federal Food, FFDCA, often known as the Act), was enacted. The regulatory jurisdiction over pharmaceuticals has greatly grown because to this statute.

Requiring premarket safety evaluations of all new products as well as prohibiting misleading therapeutic claims on medicine labels labeling. The legislation also permitted factory inspections. And increased enforcement authority, established new regulatory requirements for foods, and placed control of cosmetics and medical devices under federal regulation. In 1940, From the USDA to a department, the FDA was moved. It eventually become the Department of today Human Services and Healthcare.

The Kefauver–Harris Amendment to the since the passage of the FFDCA, a new medicine must additionally present sufficient effectiveness data for its particular application in addition to the need of premarket safety demonstration. Medication endorsed between FDA reviews of 1938 and 1962 were also conducted. The 1962 amendments also increased the FDA's jurisdiction to monitor drug production plants and imposed certain limitations on drug promotion. Congress introduced legislation in 1968 to reinforce Act provisions relating to animal welfare. The 1968 Animal Drugs Amendments mandated that food additives, medicinal feeds, and animal medications be safe for the animal they were designed to be used on Also, they are safe for food-producing animals. Safe for the environment, and suitable for human consumption. Studies on effectiveness were also necessary. An extensive account of FDA regulation On the FDA's website, you may find functions. There have been some changes made to the FFDCA relates to numerous FDA regulation areas. Details regarding noteworthy changes is accessible on the website of the FDA [2].

Organization FDA

The Office of the Commissioner and four primary directorates that manage the FDA's key duties—Medical Products and Tobacco, Foods and Veterinary Medicine, Global Regulatory Operations and Policy, and Operations make up the organization's present structure. Also, the FDA is geographically divided into component Districts and Regional Offices, where field personnel are placed. To assist the FDA's efforts to safeguard consumers within its regulatory framework and to make the best use of available resources, the Office of the Commissioner offers consolidated agency-wide program direction and management services. The Centers for Human Drugs, Biologics, Medical Devices, and Tobacco Products are highly coordinated and led by the Office of Medical Products and Tobacco. Also, the office is in charge of the agency's unique medical initiatives. The Center for Device and Radiological Health (CDRH), the Center for Biologics Evaluation and Research (CBER), the Center for Tobacco Products, and the Center for Drug Evaluation and Research (CDER) make up this Office (CTP).

The Office of Foods and Veterinary Medicine (OFVM) is charged with a broad variety of duties that include ensuring that food labels provide accurate and helpful information as well as safeguarding the safety and security of foods for both people and animals. To carry out the FDA's food safety, nutrition, and animal health activities, the Center for Food Safety and Applied Nutrition (CFSAN), the Center for Veterinary Medicine (CVM), and the Office of Regulatory Affairs (ORA) collaborate within OFVM. The Office of Regulatory Affairs and the Office of Foreign Programs make up the Office of Global Regulatory Operations and Policy, or GO. The GO Office provides executive oversight, strategic leadership, and policy direction to the FDA's domestic and international efforts to ensure the quality and safety of products. These efforts include field operations, compliance and enforcement activities, global collaboration and data sharing, the development and harmonization of standards, and field operations. Many agency tasks, including finance and budget, buildings engineering, information management and technology, human resources, crisis management, and emergency operations are under the control of the office of operations.

The FDA's National Center for Toxicological Research (NCTR), which was created by executive order in 1971, is a significant research unit that is essential to the agency's mission to advance and defend public health. The NCTR collaborates with researchers from across the FDA, from other governmental organizations, from academia, and from business and industry to develop cutting-edge technologies, scientific training programs, and specialized technical skills that are essential to the success of FDA product centers in their regulatory functions. The NCTR performs critical path, FDA mission-critical research that is peer reviewed with the goal of decreasing hazards associated with FDA-regulated goods and creating a scientifically sound foundation for regulatory decisions.

Research aims to define the intricate processes that regulate potentially dangerous compounds or microbes' toxicity, comprehend crucial biological events in the expression of toxicity, and create tools to better evaluate human exposure, susceptibility, and risk. Biochemical and molecular safety and toxicity markers, neurotoxicology, microbiology, chemistry, genetic or reproductive/developmental toxicology assessments, and systems-biology assessments for characterizing biomarkers are all areas of expertise that must be coordinated in the custom assessment of chemicals of vital interest to the FDA. Using quantitative risk assessment techniques, the NCTR has created and is standardizing technologies including genomics, proteomics, metabolomics, and nanotechnology to find and describe early indicators of toxicity. Also, the NCTR represents the FDA on important committees of the National Toxicology Program (NTP), a program that assesses how chemicals affect human health [3].

The US Code (USC), the Code of Federal Regulations (CFR), and specific guidance papers may be referred to throughout this chapter. All permanent and general American legislation, including the FFDCA, are included in the USC. Based on the FFDCA's provisions and other laws that apply to FDA, regulations are created by FDA. The Federal Register's executive departments and agencies publish their rules, which are codified in the CFR. FDA regulations are included in Title 21 of the CFR. Every year, the CFR is amended once for each title (or volume). Each year, around April 1, a new Title 21 is released and typically made accessible on the US Government Publication Office Electronic CFR website (US GPO, 2017). Guideline papers are statements of the FDA's current position on a certain topic. These standards for the processing, content, and approval of applications, as well as for the design, development, manufacturing, and testing of regulated goods, are produced for the FDA review staff and regulated industry. They also design inspection and enforcement protocols as well as rules aimed at achieving uniformity in the FDA's regulatory approach. Guidance papers cannot be enforced via administrative or judicial procedures since they are either rules or laws. If an alternative strategy complies with the standards of the relevant legislation, regulations, or both, it may be employed.

DISCUSSION

New Veterinary Drugs Approved

A drug sponsor is required to show, as part of the preapproval process for new animal drugs, that the drug has the desired effect, is safe for the target animal and the environment, can be manufactured effectively to maintain the product's identity, strength, quality, and purity, and, in the case of drugs approved for use in animals used for food production, that the edible products derived from treated animals are safe for human consumption. For the purposes of this chapter, a novel animal drug's "sponsor" is the organization in charge of compiling all pertinent data, presenting it to the CVM for evaluation, as well as continuing to monitor the medication's efficacy and safety following approval. The drug "sponsor" also owns the NADA. NADA requirements are outlined in 21 CFR Part 514. Seven pieces (usually referred to as

technical sections) are completed by sponsors in order to methodically handle each of the necessary components. The seven technical parts are: Target Animal Safety (TAS); Chemistry, Manufacturing, and Controls (CMC); Effectiveness; Environmental safety, all other information, human food safety (HFS), and labeling. The FDA has established rules and several guideline papers outlining the prerequisites for approval and the kinds of research that may be required to get authorization to commercialize animal medicinal products. The length of this chapter does not allow for a description of every stage in the procedure necessary to get FDA clearance; nevertheless, a quick synopsis of the TAS and HFS evaluation here is a procedure developing novel animal medications. The CVM website also offers a thorough explanation of the procedure [4], [5].

Basic considerations for the Target Animal Safety Assessment

When a medicine is used as directed on the label, the drug sponsor must demonstrate that the drug is safe for the target animal species. The particular animal species for which a medicine will be allowed to be used is known as the target animal species. The TAS information required for approving a specific medicine varies on the drug type, species and class of the animal, method of administration, indication, dosage, and frequency of administration, as well as any other parameters that may be present. The FDA-CVM Guidelines for Industry (GFI): TAS for Veterinary Pharmaceutical Products (FDA/CVM, 2009a) outlines the fundamentals of TAS assessment. The United States, the countries of the European Union, and Japan are the countries that make up the International Cooperation on Harmonization of Technical Requirements for Registration of Veterinary Medicinal Products (VICH), a program that aims to harmonize the technical requirements for veterinary product registration among its member countries.

The following description of the TAS technical section's components is highly condensed. Each of these elements will be required for certain pharmaceuticals, while less information may be required for others, for which a wealth of knowledge is already accessible and drug action and safety are well recognized. The principles of Good Laboratory Procedures (GLP), as outlined in 21 CFR Part 58, must be followed while conducting laboratory safety investigations such as margin of safety tests. Nonclinical laboratory investigations are covered by the GLP requirements, which also make sure that techniques and processes for data collection, processing, and reporting are standardized. This enables a sufficient degree of accuracy and quality control for the studies and data presented for evaluation. The GLP requirements also guarantee that documents are accessible to prove that the research was carried out as stated in the study protocol and final study report. Characteristics of Pharmacology and Toxicology All data provided by the sponsor that might be used to assist plan the pivotal TAS trial is included in the pharmacologic/toxicologic characterisation. Also, it may aid in better anticipating and comprehending any possible negative consequences that can manifest in the target animal. Published research and early investigations, as well as numerous target and nontarget laboratory animal studies, pharmacokinetic, pharmacodynamic, and toxicological studies, may all be included in the pharmacologic/toxicologic characterisation package.

Research on other laboratory safety

To address particular safety concerns in the intended target species or class of animals, further safety studies may be required. These specialized investigations include those on reproductive safety, safety studies on certain animal classes (such as neonatal or geriatric), safety studies on injection or administration sites, and safety studies on the mammary gland [6].

Field Effectiveness Studies' Safety Information

Field (clinical) effectiveness studies provide the additional safety data required. In contrast to margin of safety investigations, field studies are carried out in settings that are clinically analogous to how a novel animal medication would be used (e.g., client-owned diseased animals of various breeds, classes, and ages). These investigations enable the discovery of a few unfavorable results that are rare and would have gone undetected in smaller margin of safety trials. More significantly, these trials provide information on the safety of medications in sick animals. The FDA's current best thinking on how to perform efficacy studies is provided in the Good Clinical Practice (GCP) Guidelines.

Hazardous Drug Reactions: An Overview

Any adverse event (ADE), as presently defined by regulation in 21 CFR y514.3, is connected to the use of a Whether or not the new animal drug was used in accordance with the approved labeling (i.e., according to label directions or in an extra-label manner, such as but not limited to different administration routes, different species, different indications, or dosages other than those on the label), as well as whether or not the new animal drug was thought to be drug related. The term "adverse event" (ADE) covers a variety of situations, including but not limited to: an adverse event occurring in animals during the use of an animal drug product by a veterinarian, livestock producer, or other animal owner or caretaker; failure of a new animal drug to produce its anticipated pharmacological or clinical effect (lack of expected effectiveness); or an adverse event occurring in humans as a result of exposure during the production, testing, handling, or use of a new animal drug.

Reporting of Adverse Medication Experiences

The reporting of ADE by veterinarians and customers is optional in the US. Nonetheless, obligatory ADE reporting obligations as outlined by regulation may apply to producers and sellers of FDA-approved animal medications (21 CFR y514.80). All spontaneous reports, whether obtained by the FDA via a voluntary or required process, are unsolicited information from consumers or veterinarians. In accordance with 21 CFR y514.80, "Records and reports relating experience with novel animal medications for which an authorized application is in force," makers and distributors of FDA-approved animal pharmaceuticals are required to make spontaneous reports. The four main kinds of ADE reports are: (1) 3-day field alerts; (2) initial 15-day alert reports; (3) follow-up reports; and (4) periodic reports. 3-day field alert reports, as described in 21 CFR, provide details on product and manufacturing flaws that might lead to severe ADEs. Serious, unforeseen ADE reports are filed as "expedited" or 15-day alert reports. These reports must be provided by the applicant to FDA on Form FDA 1932 within 15 working days after initially obtaining the information, in accordance with 21 CFR y514.80(b)(2). If important new information is discovered while the applicant is looking into ADEs that are the subject of 15-day alert reports, followup reports must be provided on Form FDA 1932. The periodic medication experience report, which is provided every six months for the first two years after approval and once a year after that, includes reports of ADEs that are not severe and unexpected as well as reports of product flaws that are not anticipated to result in substantial ADEs.

The majority of required ADE reports (from manufacturers) are delivered electronically using the Electronic Submissions System (ESS), which is connected with the FDA Electronic Submissions Gateway (ESG) and supports batch or individual reports. The Safety Reports Portal, or SRP, allows manufacturers to submit individual reports using a Rational Questionnaire (RQ). The SRP is not currently set up to handle consumer or veterinary reports of adverse medication events. On the CVM website, you may find further details on voluntary reporting of adverse events. All reports, both required and optional, are archived and analyzed in the CVM ADE database.

During the last ten years, ADE reporting to the CVM has expanded significantly. In the fiscal years 2004 and 2015, the CVM received 28,825 and 91,592 ADE reports, respectively. An rise in the number of medication approvals, label information that includes contact information for pharma firms, and public interest in reporting alleged product issues are only a few of the potential causes of the considerable increase. Also, widespread access to the media and the Internet has raised public knowledge of medication safety.

Veterinary devices and illicit drugs

Only businesses selling FDA-approved and conditionally authorized animal medicines are required to submit an ADE. There aren't any prerequisites for submission as of yet. ADEs for unapproved animal medications or pharmaceuticals used in animals but not yet authorized by the FDA. Medications listed on the FDA's Index of Legally Marketed Unapproved Novel Animal Medicines for Minor Species (the "Index") are an exception to this rule. These medications are sold legitimately for a particular purpose in a small number of species (FDA/CVM, 2014). While these identifiers on labeling are not presently required by legislation, many authorized animal medications may be recognized by the inclusion of a NADA number on the label, or a C-NADA number in the case of conditionally approved pharmaceuticals. The CVM encourages veterinarians and/or animal owners to report ADEs for unapproved animal medications, including compounded products [7].

While there is presently no need for premarket clearance for devices used in veterinary medicine, the FDA does have regulatory control over these products and may take the proper regulatory action if a product is misbranded, mislabeled, or adulterated. Suture material, certain kinds of bandage material, intravenous catheters, anesthetic apparatus, and imaging equipment are a few examples of devices often employed in animals. Animal devices must be safe, effective, and appropriately labeled; this is the manufacturer's and/or distributor's obligation.

The CVM receives reports of adverse occurrences connected with marketed equipment from makers and distributors of veterinary devices, even though this is not required by law. The majority of adverse event reports for animal devices that the CVM receives come directly from veterinarians or animal owners.

Detection of safety signals

The World Health Organization defines a safety signal as "reported information on a potential causative association between an adverse event and a medicine, the relationship being unknown or previously underdocumented" (WHO, 2017b). Drug safety reviewers sometimes are unable to carefully examine each report due to the enormous amount of ADE reports the CVM receives each year.

As a result, the CVM is using data mining techniques, which utilize computer algorithms to examine data in large, intricate databases, to more effectively discover safety signs. These techniques do not take the place of an actual clinical analysis of the case reports that produced the signal and an evaluation of those cases to ascertain the relevance of the signal for medical care. Signals are mainly hypotheses rather than causal relationships, hence case series analysis is required to confirm them. In order to better concentrate time and resources, signal identification methods enable the CVM identify possible safety alerts in massive data volumes.

A medical examination of the case reports producing the safety signal is finished if one is found through the ADE review procedure. Doing a summary review, which comprises a list of clinical indicators for a specific product in decreasing order of their reporting frequency, is a step in this procedure for more recently authorized drugs. The construction of a Postapproval

Experience (PAE) section may be suggested for inclusion to the medication labeling once the clinical sign profile observed postapproval is compared with the labeled adverse events for the product. A list of documented adverse experiences for the product is provided in the PAE section, and the CVM decides which occurrences should be included in this area of the labeling based on the frequency and seriousness of the incidents. By revising the label and educating the customer about any possible concerns, this approach helps ensure the safe and effective use of animal medicine products. The FDA may take regulatory actions other than label revisions if ADEs during the postapproval period show that the product's hazards exceed its anticipated benefits.

ADE reports may sometimes be used to identify modifications other than postapproval experience that could be required for labeling. Fluoroquinolones and retinal toxicity in cats is a well-known case. At an oral dosage of 2.5 mg/kg twice daily, enrofloxacin was licensed for use in cats in 1989 to treat skin infections brought on by susceptible strains of Pasteurella multocida, Staphylococcus aureus, and Staphylococcus epidermidis. In 1997, a supplementary authorisation modified this dosing regimen to allow for a range of 520 mg/kg as a single day dose or split twice daily. In preapproval TAS tests, cats treated with up to 25 mg/kg/day for 30 days or up to 125 mg/kg for 5 days did not exhibit any ocular abnormalities. Four complaints of blindness in cats treated with enrofloxacin were received by the CVM between 1992 and 1997, and an additional 52 cases of feline blindness were received by the CVM between 1997 and 2000. (Hampshire et al., 2004). The majority of studies stated that afflicted cats received daily doses of more than 5 mg/kg. In a postapproval study conducted by the drug's sponsor, cats given the 5 mg/kg dosage for up to 21 days showed no abnormalities in their eyesight; however, cats given doses of 20 mg/kg and higher showed moderate to severe retinal degeneration. A PAE section was added to the label in 2001 to cover the symptoms of blindness and retinal degeneration. The sponsor also modified the recommended dose for cats from 10 mg/kg/day to a maximum of 5 mg/kg/day. Also, a class statement was added to each fluoroquinolone that was given approval for use in cats, warning veterinarians to take care when treating felines with these medications since fluoroquinolone usage has been linked to serious retinal effects (FDA/CVM, 2001). Fluoroquinolones are substrates for the ABCG2 transporter, which is present in various tissues including the blood-retina barrier, according to research published in 2011[8], [9].

Communication of Safety Information

The main source of information on a drug's efficacy and safety is its labeling for animal drugs, which has been authorized by the FDA and summarizes the relevant scientific literature. information required for the drug's safe and efficient usage. The FDA must approve any portions of the labeling for prescription animal medication items that are aimed at veterinarians but may also contain sections for pet owners. Client Information Sheets may be needed by the FDA as part of the authorized labeling for animal medications, similar to the medication guidelines for people that are often issued with human pharmacy prescriptions. They are produced in "consumer-friendly" language and include information on the advantages and disadvantages of using certain medications in ways that are simple to comprehend. Nonsteroidal antiinflammatory medicines designated for use in companion animals are a good example of an animal drug whose labeling includes Client Information Sheets. Labels for certain drugs used on animals may need to include precautions or warnings about use on humans. For instance, Regu-Mate (altrenogest) Solution 0.22% is recommended to prevent mares from going into estrus[10].

Specific human warnings about the possible effects of medication exposure on human female reproductive are included on the drug label for this product. The use of this particular product

on humans has not been authorized. Data on other products in the same pharmacological class that have been used in people are utilized to extrapolate the information on this product's labeling. The progestational activity of altrenogest is what causes the predicted effects. With a single exposure, there may be immediate consequences; however, frequent exposure might lead to longer-lasting adverse effects, including headaches, menstrual cycle disturbance, stomach or uterine discomfort, increased or reduced uterine bleeding, and pregnancy extension[11], [12].

CONCLUSION

An early warning of developing food-borne illnesses and issues may be given by reporting adverse incidents involving pet food to the CVM. Moreover, owners and/or veterinarians are urged to get in touch with the products. While manufacturers are not compelled to send such complaints to the CVM, there should be a place for the distributor on the product label to report any possible issues that may be related to the product and/or packaging. Included in the category of pet food goods are pet meals, snacks, puppy and kitten milk substitutes, pet nutritional supplements, and pet drinks. Unpleasant scents, bulging cans or pouches, leaky containers, or strange items are a few examples of pet food product issues. Reports of adverse events might include pet diseases or clinical symptoms that a pet owner or veterinarian thinks are brought on by consuming pet food products. How to report a problem with pet food is explained on the CVM website (FDA/CVM, 2016b).

The Safety Reports Portal (SRP) as of 2010 and the FDA District Offices are the main avenues through which the FDA accepts reports about adverse occurrences involving pet food and product issues. Both are elements of the Pet Food Early Warning and Surveillance System (PFEWSS), which was developed after the FDA Amendments Act (FDAAA) of 2007 was passed in response to the contamination of pet food with cyanuric acid and melamine, which resulted in the largest recall of pet food in American history. Around 11,000 complaints about pet food were sent to the FDA in the first few weeks of this issue. Renal failure resulted from the formation of crystals inside the kidneys of dogs and cats ingesting the tainted pet meals due to the contamination of melamine and cyanuric acid. The SRP's Livestock Food Reporting section became live in 2014. Using this portion of the web, consumers and veterinarians may report adverse incidents and product issues relating to animal feeds. Calling the consumer complaint coordinator at the FDA District Office that covers the reporter's home area is another option for owners and veterinarians who want to report adverse occurrences involving pet or livestock food or product issues (FDA, 2017). Problems with animal food may be quickly addressed by the FDA and producers with early discovery.

REFERENCES

[1] R. S. Sellers *et al.*, “Scientific and Regulatory Policy Committee Points to Consider*: Approaches to the Conduct and Interpretation of Vaccine Safety Studies for Clinical and Anatomic Pathologists,” *Toxicol. Pathol.*, 2020, doi: 10.1177/0192623319875085.

[2] S. J. Bright-Ponte, T. Zhou, and M. J. Murphy, “Regulatory Considerations in Veterinary Toxicology: An FDA Perspective,” in *Veterinary Toxicology: Basic and Clinical Principles: Third Edition*, 2018. doi: 10.1016/B978-0-12-811410-0.00006-4.

[3] I. de la Casa-Resino, A. Haro Castuera, R. Casimiro Elena, C. Rubio Montejano, and R. Carapeto García, “European legislation for veterinary medicines: Would a monograph system improve the environmental risk assessment?,” *Integr. Environ. Assess. Manag.*, 2021, doi: 10.1002/ieam.4431.

[4] R. S. Sellers *et al.*, "Scientific and Regulatory Policy Committee Points to Consider*: Clinical and Anatomic Pathologists in Conduct of Vaccine Safety Studies," *Toxicol. Pathol.*, 2019, doi: 10.1177/0192623319875085.

[5] M. M. Swindle, A. Makin, A. J. Herron, F. J. Clubb, and K. S. Frazier, "Swine as Models in Biomedical Research and Toxicology Testing," *Vet. Pathol.*, 2012, doi: 10.1177/0300985811402846.

[6] E. Annys *et al.*, "Advancing the 3Rs in regulatory toxicology - Carcinogenicity testing: Scope for harmonisation and advancing the 3Rs in regulated sectors of the european union," *Regul. Toxicol. Pharmacol.*, 2014, doi: 10.1016/j.yrtph.2014.04.009.

[7] S. G. Wynn and B. J. Fougère, *Veterinary Herbal Medicine*. 2007. doi: 10.1016/B978-0-323-02998-8.X5001-X.

[8] S. Bright, "Postmarket Surveillance and Regulatory Considerations in Reproductive and Developmental Toxicology: An FDA Perspective," in *Reproductive and Developmental Toxicology*, 2011. doi: 10.1016/B978-0-12-382032-7.10007-4.

[9] Department of Health and Ageing, "A review to update Australia's position on the human safety of residues of hormone growth promotants (HPGs) used in cattle," *Review*, 2003.

[10] R. C. Garg, W. M. Bracken, A. M. Hoberman, B. Enright, and B. Tornesi, "Reproductive and developmental safety evaluation of new pharmaceutical compounds," in *Reproductive and Developmental Toxicology*, 2017. doi: 10.1016/B978-0-12-804239-7.00006-8.

[11] Food and Drug Administration (FDA), "Department of Health and Human Services, Food and Drug Administration, Center for Drug Evaluation and Research (CDER), Center for Veterinary Medicine (CVM) Guidance for Industry," *Bioanal. Method Valid.*, 2018.

[12] E. Curry-Galvin, "The ProHeart debate," *J. Am. Vet. Med. Assoc.*, 2005.

CHAPTER 18
AN OVERVIEW ON VETERINARY PHARMACOLOGY AND TOXICOLOGY

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

In addition to being acknowledged as major fields, veterinary toxicology and pharmacology were also fast developing and changing in the middle of the twentieth century. Veterinary pharmacology and toxicology emerged as new disciplines that were closely related because they were involved in the development of new compounds, particularly new antimicrobials and antiparasitics to control infection diseases and analgesic/non-steroidal anti-inflammatory drugs affecting various animal species. By the middle of the 1950s, veterinary pharmacology and toxicology were a highly active area of veterinary medicine. New antimicrobials must meet new regulatory standards, which raises the expense of their research and development. In drug development projects, toxicology, which is strongly connected to pharmacology and pharmacokinetics, is crucial to the success or failure of a new drug candidate.

KEYWORDS:

Agriculture, Antimicrobial, anti-inflammatory, Veterinary Toxicology, Pharmacology.

INTRODUCTION

It is well known that the majority of veterinary medications come from either the plant protection goods or the human pharmaceutical business (antibiotics, analgesics, antiobesity, anticancer, cardiovascular) (insecticides, parasiticides). Since there are many distinct animal species, breeds, ages, sexes, and (patho) physiological statuses that may react differently to various medications, foods, feeds, pesticides, industrial products, pollutants, and toxins, veterinary pharmacology and toxicology is not a simple subject. The fundamental concepts of veterinary toxicology and pharmacology are the variations between and within species as well as within and among animal populations. It is understood that various chemical substances are metabolized and excreted in different ways depending on the species. Extrapolating dose regimens between species was common practice in the 1960s of the 20th century, but today it is understood that pharmacokinetics/toxicokinetics (PK/PD) differences still exist for drugs, pesticides, contaminants, or toxins, which is the cornerstone of veterinary pharmacology and toxicology.

Also, the sensitivity has been enhanced and changes have been made to the analytical procedures used to assess xenobiotic plasma/tissue concentrations. Analytical techniques all share a subset of validation requirements, regardless of whether they are intended for use in pharmacokinetic (PK) and metabolism research, residue depletion studies, or regulatory control programs for pollutants and residues of veterinary medications. Specificity, accuracy, precision, limit of detection, limit of quantitation, susceptibility to interference, and details on technique calibration are performance parameters that must be established for every method validation. The other factors for evaluating regulatory techniques include practicability, applicability under typical laboratory circumstances, and robustness. The two main components of residue programs are monitoring and surveillance. Animal tissues such as liver, kidney, muscle, milk, eggs, honey, or fat are used for monitoring pharmaceuticals with

maximum residue limits (MRLs). Animal feed, drinking water, dung, urine, and hair are among the various categories of samples and matrices that are regularly employed [1]. These may be taken before to slaughter and are often used to check drugs that are forbidden. Since it has been shown that anabolic steroids may still be found in hair years after administration, while they are no longer detectable in urine or dung, hair analysis has become more and more common. Hair samples from both live and dead cattle may be used in the study, which has been touted as a powerful tool for limiting the use of clenbuterol in animal production. The use of thyreostatics is monitored by the thyroid gland; the eye, vitreous fluid, or retina have been proposed as tissues for residue screening, including clenbuterol, ractopamine hydrochloride, and zilpaterol hydrochloride with -adrenoceptor activity (1, 2). Both pigmented and non-pigmented hair and feathers exhibit this accumulating effect; it was discovered that the concentration of clenbuterol in bovine brown or white hair was around one-third that of black hair.

Veterinary toxicology was a very busy branch of veterinary medicine by the middle of the 1950s. Once the study of poisons and intoxication, toxicology is now more appropriately referred to as the "science of safety" due to its critical role in ensuring the safety of everyday items like as food, feed, pharmaceuticals, pesticides, and industrial goods. The issues surrounding domestic animal poisonings were examined using biochemical and molecular interactions as well as techniques from other fields. Clinicians who treat poisoned animals must be aware of the mechanics, possible advantages, and hazards of antidotes. Just a handful of the many antidotes that are now on the market are frequently utilized. They include therapeutic antibodies, different vitamins, acetylcysteine, naloxone, sodium bicarbonate, atropine, and flumazenil. Even so, only a small percentage of poisonings employ most of them. The majority of antidotes have minimal randomized trial data to support their usage.

A mechanistic knowledge of the poisoning and the anticipated impact of the antidote on the patient's clinical course, as a result, is often the foundation for judgments on whether to utilize them. Significantly, the majority of poisoned animal patients who are treated in a veterinary hospital or clinic may recover with only supportive care [2].The use of antidotes in more severe poisonings is often decided upon based on a risk/benefit analysis supported by poor quality data. It led to the emergence of a new generation of veterinarians. The budding veterinary toxicologist needed to be well-versed in both qualitative and quantitative analytical procedures, as well as physiology, pathology, and chemistry. Clinical episode evaluation and understanding of metabolic and excretory functions were required. Pharmacology and the molecular behavior of a broad range of substances are topics that toxicology gets intimately acquainted with. Pharmacology is the study of pharmaceuticals employed at dosages to create therapeutic effects on an organism, while toxicology is the study of toxicants that have negative effects on an organism.

Pharmacology and toxicology may be thought of as two distinct ends of the same subject. It was required to comprehend the remedies to be used for various intoxications. In order to arrive at logical interpretations and conclusions for the multiple issues being handled, it is sometimes necessary to filter through a perplexing and bewildering assortment of indications, lesions, and analytical findings. The field of veterinary medicine primarily concentrated on domestic animals, especially those utilized for food and horses for transportation. The veterinary profession, with its connection to domestic cattle, spurred expansion of veterinary pharmacology and toxicology as more specialized agricultural and production methods grew. Subsequently, an increasing number of companion animals, such as horses (used in equestrian activities related to competitive sports and recreational activities), dogs and cats (as integral family members), and other animal species (i.e., will/exotic animals), affected the veterinary

profession (6). The development of veterinary pharmacology and toxicology has led to a significant increase in the market for drugs for dogs and cats that are antiparasitic, analgesic, antiobesity, cardiovascular, and anticancer. It was made stronger when science-based medicine eventually augmented observation-based medical practice in both sectors of veterinary care (i.e., domestic and companion animals and wild/exotic animals). Around this time, veterinary toxicologists and pharmacologists started to assume a significant role in veterinary medical diagnostic labs. The rise of the comparative medicine aspect of veterinary medicine grew increasingly obvious and was strengthened with the strengthening of the scientific foundation of veterinary medicine, especially the quality of the science in the veterinary medical curriculum. While doing translational and biomedical research, the field of comparative medicine employs animal models of human and animal illness. Comparative pathology, toxicology, and pharmacology were all a part of biomedical research. Increased veterinarian involvement in research on domestic and companion animals, which are traditionally of concern to the profession, as well as participation in a wider range of biomedical research activities using the traditional laboratory animal species, which are primarily motivated by concern for human health, were associated with these changes in the field. Veterinarians are currently doing pharmacological and toxicological research as their main focus in increasing numbers [3].

Translational sciences include toxicology and pharmacology. Fundamental understandings of medication action and destiny are translated into therapeutic treatment by pharmacology. Toxicology is the translation of science, turning theoretical understanding into practical applications to protect the environment, human health, and animal health. Toxicology is a translational science that applies fundamental and clinical research to issues in disciplines that are important to toxicology. To evaluate new dangers while developing medications, chemicals, and materials, a strong foundation in fundamental scientific research in toxicology is required (9). Modern veterinary toxicology and pharmacology could be seen as disciplines decreasing risk at the animal-human-ecosystems interface and supporting the concept of "One Planet, One Health."

While there are distinctions in size and economic variables between human and veterinary medicine, the evolution of veterinary pharmacology and toxicology is the same as that for people. Its two origins, the science of pharmacology and toxicology and the profession of veterinary medicine, both underwent change at the same time as veterinary pharmacology and toxicology. There will continue to be suggestions for new exposure biomarkers. It will be important to undertake trials to verify the usefulness of each putative biomarker of exposure. Recognizing the dynamics of the pharmacokinetics/toxicokinetics of different medications and toxicants and establishing quantitative connections between exposure and dosage at any given point during the intoxication provide a unique challenge.

There are several possible indicators for both effectiveness and hazardous reactions. New molecular markers are regularly discovered in all areas of medicine, from various forms of cancer to numerous functional illnesses of every organ system. Pharmacologists and toxicologists must decide whether biomarkers are sufficiently well verified in terms of their relation to illnesses and reasonably priced to merit their use in exposure-response investigations from among this array of prospects. This takes into account the brand-new, extremely technical genomic techniques. Designing validation studies presents a unique difficulty in ensuring that the experimental approach is focused on discovering particular disease-related endpoints or toxicant-related effects rather than serving as just another, although more sophisticated, marker of non-specific toxic effects. The utilization of a single high exposure dose and a few brief observation periods was a significant problem in many earlier validation investigations. Such

studies may not be able to determine changes that are particular to a toxicant and may not be able to assess exposure-related changes in biomarkers.

MEDICAL PHARMACOLOGY

Pharmacology for animals is the study of pharmacological characteristics and all facets of how they interact with living things. Any chemical substance (other than food) used in the treatment, prevention, diagnosis, or cure of illness, or the regulation of physiological processes is a drug. Chemistry, biochemistry, biology, physiology, pathology, toxicology, and medicine are just a few of the associated clinical and non-clinical disciplines that the science of pharmacology draws information and techniques from. Animal pharmacology is an experimental field of study that examines the characteristics of medications and how they affect live things. It has included research on drug sources (pharmacognosy), the magnitude and time course of the observed pharmacological effect on the body (pharmacodynamics; PD); the relationship between administered doses; the observed biological fluid/tissue concentrations of the drug; and the duration of the drug's presence in the body (pharmacokinetics; PK); use in the treatment of diseases (therapeutics); and the effects of poisoning (toxicology).

Studies on the metabolism of target species and farm animals were used to determine the residue criteria for veterinary medications in foods of animal origin. Usually, radioactive isotope-labeled compounds are used to identify and quantify the metabolites, degradation products, and other transformation products. To make sure that substances occurring in significant quantities in edible commodities have been included in the toxicological testing or to determine whether further testing of individual metabolites is required, the metabolites obtained in these studies are qualitatively compared with metabolites identified in laboratory animals, typically rats. Studies on laboratory animals' metabolisms are useful for identifying mammalian metabolic [4].

Particular attention should be paid to side effects and residue formation, and the potential of these interactions has to be included into the review process for drug-drug and drug-feed additive interactions. Yet, the logically based selective use of veterinary medications, which calls for qualified veterinarians, is unquestionably the best way to avoid the occurrence of residues. It is important to identify the shape and distribution of residues produced by each allowed application method in each species, as well as the depletion of residues in edible tissues or foods obtained from animals. The results of the total residue and metabolism study can be used to identify the target tissue and the proper marker residue, which is either the parent drug or one of its metabolites or a combination of these with a known relationship to the concentration of the total residue in each of the different edible tissues at the anticipated withdrawal time. It is important to locate a "marker residue," which is often the medication form (parent chemical or metabolite) that is present in the target meal for the longest time at the greatest concentration.

It is important to assess how well these differences may be extrapolated to humans; for instance, many sex differences in rat metabolism do not exist in people. The most significant source of interspecies variances and human variability in the compound's biodisposition and, in many instances, the production of hazardous consequences, is represented by the enzymes engaged in the metabolism of foreign substances. Similarities and differences in xenobiotic metabolism and effects between humans and test animals are examined in these in vitro studies since this knowledge may be crucial to extrapolations often employed in risk assessment. The study of the clinical effects of medications on animal patients is the focus of the subfield of veterinary clinical pharmacology, which aims to improve therapeutic dose regimes. This veterinary specialty naturally entails knowledge of the PK and PD characteristics of medicines as well as

their hazardous consequences. In a veterinary environment, clinical pharmacology is the clinical field that studies how best to provide medications to animal patients in order to maximize their prophylactic or therapeutic advantages while minimizing any negative side effects.

A clinical science called "veterinary clinical pharmacology" merges disease biology and basic pharmacological principles to provide animal patients a rationale for their therapeutic treatment. According to Brown, the aim of veterinary clinical pharmacology is to employ pharmacological concepts to better effectively treat animal patients and use drugs in veterinary medicine. Good doctors must have a basic grasp of veterinary clinical pharmacology. The following test steps are part of the demonstration of effectiveness: a description of the method of action; selection of the dosage and dosing interval, dose confirmation studies, including persistent efficacy trials; and, where necessary, clinical field trials. Similar to this, knowing the pharmacological effect of medications is useless without a fundamental grasp of the underlying physiology and pathophysiology of the system or tissue negatively influencing the patient's health or welfare.

Both infectious and non-infectious disorders have ways for performing clinical effectiveness trials. In order to be useful in the process of developing novel animal drugs, these methods may comprise research in a disease model or other methods for assessing the response to the therapeutic agent (16). The research design is based on the clinical endpoint selection, which is crucial. There are numerous drugs whose effectiveness goals are quite simple to assess (such as antibiotics and anthelmintics) (i.e. clinical and bacteriological response as determined by the use of appropriate clinical, postmortem, and bacteriological diagnostic methods, and the determination of mortality rate; decrease in worm count, decreased temperature). It is more challenging to identify effectiveness objectives for substances that are neither antibiotics nor growth promoters. Veterinary pharmacology assists in determining the most suitable endpoints, making them more quantifiable, repeatable, and a good representation of the clinical field environment. Whereas "therapeutics" refers to the broad category of methods used to treat illness, including medication, surgery, radiation, behavioral therapy, and other methods. The general criteria for evaluating the effectiveness of such goods are often included in the demonstration of efficacy of veterinary medications. The trial may be classified into one of the following three categories: confirmatory, exploratory, or composite trial, depending on its purpose. Confirmatory trials may include controlled field trials, dosage-determination studies, and dose confirmation trials. In the case of antimicrobials, the PK/PD connection, if established, as well as the severity of the condition, should always be taken into account when determining the dosage, the dosing interval, and the number of administrations of the medication. When the PK/PD connection is well established using validated models, it may be reasonable to skip dose-determination studies and instead assess the effectiveness of one or a small number of regimens in a clinical trial. Nevertheless, the selection of the PK/PD metric thought to be the greatest predictor of effectiveness must be prospectively supported by independent evidence in order to be accepted. Toxicological testing of novel medications is a need for clinical investigations with the goal of determining any possible adverse effects of drug candidates and pharmaceuticals at or above the therapeutic range [5], [6].

DISCUSSION

PHARMACOKINETICS/TOXICOKINETICS

The study of the features of the duration and extent of drug exposure in people and populations is known as pharmacokinetics (PK), and it examines how medications are absorbed, distributed, metabolized, and excreted (ADME). The mathematical explanation of time

variations in drug concentration in the body is known as PK (18); studies like these serve as the experimental foundation for medication dosing regimens in diverse animal species.

The word "bioequivalence" refers to medication formulations whose rates and extents of absorption are sufficiently comparable to exclude the possibility of clinically significant variances in either effectiveness or safety. A comparative PK research is often conducted in order to compare the formulations' Cmax (maximum concentration) and AUC (area under the curve) using statistical and biological criteria in order to show that they are bioequivalent for systemically active medicines. Comparisons of clinical or other pharmacological outcomes may be required for medicines that do not act systemically. Many elements must be standardized during the creation of dosage forms to guarantee the predictable and repeatable biological availability of the active ingredient. The sources of possible bioequivalence between products have been identified as the following physicochemical and formulation-induced characteristics [7].

PREDICTED INDEXES USING PHARMACOKINETIC/ PHARMACODYNAMIC DATA

A PK/PD model is a mathematical representation of the link between pharmacokinetics and pharmacological impact that offers therapeutically applicable information. A growing corpus of research supports the use of PK/PD relationships for specific antibacterial drugs in order to determine the dosages and intervals that are most likely to be effective and least likely to cause side effects, as well as the selection of resistant organisms. This idea has consequences for the effectiveness and safety of antibiotics (19). A scientific method to aid researchers in choosing an appropriate dose regimen for confirmatory clinical testing is PK/PD modeling. A PK/PD model combines a statistical model (specifically, the intra- and interindividual variability of PK and/or PD origin) with the PK model, which describes the relationship between dose, systemic drug concentrations, and time, the PD model, which describes the relationship between systemic drug concentration and the effect vs. time profile. It is possible to optimize individual doses using PK/PD ideas (20). A opportunity to actively participate in analysis, interpretation, and debate will be appreciated. Elements of the PK/PD connection will be reinforced on data analysis, modeling, and simulation by concepts, fundamental theory, and real-world data.

The doses to be utilized in dose-determination experiments may be justified by using the PK/PD relationship. It may be conceivable in certain circumstances to forego dosage-determination studies and to confirm the effectiveness of one or a very small number of dose regimens in clinical trials if the PK/PD connection is well established using approved methodologies (dose confirmation and clinical field studies). Acceptable means Justification for the suitability of such a strategy should be offered in the future. The conclusion is that a successful antibiotic should be both PK and PD selective, disseminate in the pathogen's area of origin, and have no PD effects on the animal being treated's comensal microbiota or the environment's ecosystems. We now need to update the dose guidelines for the antimicrobial classes available on the market and employ narrow spectrum antibiotics as a preference.

Veterinary medications come in a wide variety of chemical and class structures and often undergo metabolism after being administered to an animal species via any means. Due to varying half-lives, there are species variations in the transformation and excretion of various medicines. Injection, implantation, cutaneous application by spray or pour, and inclusion in feed or water are some of the modes of administration that may produce varying rates of absorption as well as variations in the distribution of the substance in the tissues and the makeup of the residues. Last but not least, given that veterinary drugs are administered to a diverse

range of target animals with varying species, breeds, ages, sexes, and (patho) physiological statuses, the biological variation merits greater consideration both during the development of new compounds and during the practitioner's application of the drugs [8].

Animal Toxicology

Given that it deals with so many different toxins, veterinary toxicology is a tremendously complicated field. The study of toxicants, such as medications, food additives, natural poisons, consumer goods, and particular compounds, as well as their identification, characterisation, destiny in the body, and biological consequences, falls under the wide category of toxicology. The majority of substances that are now often found in animal poisonings are synthetic compounds. A frequent presenting in emergency veterinary care is acute poisoning. Veterinary toxicology also focuses on treating illness problems brought on by toxins. Nowadays, veterinary medicine, and more especially veterinary toxicity, must be integrated with environmental medicine.

The characteristics of the exposed individual (such as species, gender, age, preexisting disease states, nutritional status, and prior exposure to the agent or related compounds) as well as the route of exposure, the duration, and the intensity of the exposure all affect the nature of the toxic responses (6). The vast differences in how domestic, marine, wild, and zoo animals react to toxins considerably complicate the field of veterinary toxicology. Of course, there are a lot more things that might affect a chemical's total toxicity. Today's veterinary toxicologists have the greatest obstacle in fully comprehending each toxicant's whole profile, including its mechanisms of toxicity.

The area of veterinary toxicology is a multidimensional mix that benefits from and advances the veterinary medical profession, the science of toxicology, and, more generally, medical science. Some people have described toxicology as a separate scientific field. I see toxicology as a field of applied research that addresses crucial Using a variety of scientific fields and professions, address social concerns. The study of toxicosis and deficiencies, the identification and characterization of toxins and the determination of their fate in the body, as well as the diagnosis and treatment of toxicoses in domestic animals and companion animals, are all aspects of veterinary toxicology, which has a strong applied background. Nevertheless, the area has expanded to encompass worries about contamination in foods for humans made from animals as well as for helping to perform and evaluate safety/risk analyses for drugs, food additives, consumer goods, and particular chemicals.

The recent global discovery of melamine contamination in pet and swine feed demonstrates the applicability of veterinary toxicology to contemporary issues in animal health and food safety, especially with regard to its toxicological features. Due of the rarity of instances seen in a clinical environment, veterinary toxicology may be difficult. When a toxicosis develops, several animals are often involved, and lawsuits may also be involved [9]. By comprehending both healthy and disease-related processes that extend from the molecular level to the integrated mammalian organism and, in fact, communities, veterinarians have a variety of opportunities to make significant contributions to society.

Clinical toxicology is a branch of veterinary medicine that focuses on safeguarding food-producing, exotic, and companion animals. Clinical toxicology for animals combines experimental and preventative toxicology with clinical veterinary medicine. In their natural habitats, clinical animals are exposed to both manmade chemicals and medications as well as natural toxicants. These issues, which might manifest as a clinical condition of unknown etiology, are often initially addressed by the practicing veterinarian and the diagnostic or clinical veterinary toxicologist. Understanding the causes of poisoning, the conditions of

exposure, and the kind of poisoning's diagnosis, its treatment, and the implementation of management or educational initiatives to avoid poisoning are all of great interest in veterinary medicine. The afflicted organ systems and disturbances that need to be regulated to preserve the animal's life may first be determined by using the clinical diagnosis, but the etiologic diagnosis is the most crucial diagnostic since it allows for the development of particular treatment and preventative measures. Determining exposure and obtaining proof of the impact of interrelated elements that might change toxicity are crucial components in clinical toxicological assessment.

TOXICOGENOMICS AND PHARMACOGENETICS

As different toxicants have the capacity to affect all of the body's cells and organ systems, the relationship between dosage and unfavorable health outcomes includes a number of pathways. In parallel to the terminology for the kinetic phase, scientists have increasingly tried to model these interactions, which they refer to as toxicodynamics (TD) or PD models. It seems evident that several routes might be implicated in an illness that produces toxins, and that our understanding of the various phases would advance along with our understanding of fundamental biological processes. For instance, the explosion in basic biology knowledge at the level of the genome (genomics), proteins (proteomics), and metabolism (metabolomics) has provided a basis for exploring the mechanistic basis of toxicant-induced disease with a level of sophistication that was unimaginable just a short time ago. Also, comparative toxicology and pharmacology will be better understood thanks to genomics, which will allow us to employ animals and models more effectively.

Transcriptomics, proteomics, and metabolomics (or metabonomics), which describe the synthesis and evolution of mRNA, proteins, and metabolites, are all included under the umbrella term of genomics. Proteomics, genomics, and metabolomics will create medium- to high-throughput approaches, and the bioinformatics revolution and the resulting explosion of toxicological data will assist to clarify bioactivity and toxicity processes in both in vitro and in vivo models. New biomarkers of impact or exposure will be developed and established with the use of these strategies. It is necessary to significantly enhance the use of innovative technological techniques (based on omics technology) for efficient safety evaluation if we are to be more successful. Omics analyses are increasingly recognized as crucial methodological components of systems or integrative biology, and it is now feasible to monitor broad changes in all RNAs, proteins, or metabolites in cellular systems or tissues (transcriptomics, proteomics, metabonomics, metabolic profiling, etc.).

This contains a variety of fresh molecular biomarkers that have drawn a lot of interest. The omics will make it possible to thoroughly examine the biological systems of several different animal species. Transcriptomics, proteomics, and metabolomics are the terms used to describe the now-feasible processes of determining the expression levels of many gene transcripts, proteins, and metabolites. As it is now possible to evaluate changes in the transcription of more than 20,000 genes in different cell types and tissues in multiparameter tests, genomics may be utilized to find novel targets. The transcriptome data from a toxicological research and how they might be interpreted in relation to the disease, as well as other biological data, are of great interest.

One of the most important information sources for the future generation of risk assessment judgments will undoubtedly be the toxicogenomics data, which are now being utilized more often in the evaluation of chemicals' effects on human health. This course aims to demonstrate how toxicogenomics data can become a key component in hazard identification, dose-response analysis, and selection of scientifically justifiable uncertainty factors given the general

familiarity of toxicologists with high-dimensional transcriptional profiling data and major traditional ways in which such data are analyzed, presented, and interpreted. This course will be educational for risk assessment practitioners and the toxicology research community by superimposing the opportunities currently provided by both traditional and high-throughput genomics data onto the human health assessment paradigm. This also increases the scientific impact of the basic toxicology studies.

High-throughput screening (HTS) enables the identification of compounds with the best in vitro potency, effectiveness, or toxicity, as well as those with good PK features. Improved hESCH-based HTS tests are being developed for the evaluation of cardiotoxicity; cardiac toxicity is a prominent problem in drug development [10]. A mixture of the parent compound and its metabolites may be excreted in the urine and feces after systemic administration of the substances. In the case of antimicrobials, this may result in their selective pressure on the microbiota that are harbored by waste, manure/slurry, and beyond in water and soil. In addition, certain antimicrobials remain persistent in the environment for weeks or months. Over 70% of the antibiotics given to animals used for food excrete as active compounds into the environment (34). Farm residues may include drugs and genes associated with antibiotic resistance, which may pollute natural habitats. The selection of resistant microorganisms is the most obvious effect of antibiotic discharge in natural settings. Now, pristine ecosystems with no history of antibiotic contamination are home to the same resistance genes discovered in clinical settings. Excreta from animals on pasture will be discharged directly into the ground, while slurry and manure spreading will be the primary entrance point for animals raised intensively.

The use of chemical additives in cattle feed has long been a source of debate (example: possible negative impacts of insect-free manure), but with certain medications, the effects on non-target dung insects and dung dispersion are what cause the most worry (e.g., macrocyclic lactones). For instance, doramectin will be intermittently introduced into the environment by the direct defecation of sheep or the field application of sheep dung containing expelled medication residues. Several models based on assumptions derived from experience with pesticides, industrial chemicals, and guidelines have been developed for regulatory agencies anticipating concentrations of veterinary medicines in soil, groundwater, and surface waters in order to assess the risks posed to the environment by medications used to treat livestock. The volume, consumption pattern, metabolism, persistence in dung and slurry, sorption and persistence in the environment, and ecotoxicity of a veterinary drug will all affect its possible environmental effects. Studies have shown that a variety of conditions, including temperature, pH, and the presence of manure, have an impact on the half-lives of veterinary medications in soils, which may survive there for days to years.

CONTAMINATION OF ANIMAL FEED

Recently, there have been a number of contamination crises affecting the production of animal feeds, including transmissible bovine encephalitis brought on by prions, unexpected sources of dioxin contamination in milk, meat, and eggs (38), and the presence of residues or unapproved substances, like melamine in milk, milk products, and animal feeds (39). The contamination of feed with enterobacteriaceae and anaerobes as well as the presence of environmental pollutants and contaminants, such as persistent organic pollutants (POPs), present in a wide range of feed material and capable of accumulating in animal tissues, make feed hygiene another crucial topic that needs to be brought to light (i.e., dioxins and dioxin-like polychlorinated biphenyls and brominated flame retardants). Animal feed may include hazardous heavy metals, other chemical components, and naturally occurring toxins such poisonous plant metabolites, bacterial, and fungal toxins.

The danger that chemical pollutants or residues in animal feed pose to people has received more attention in recent years. This resulted from several instances of milk, eggs, or other animal products being contaminated with toxins from the environment. Because of the many new chemical pollutants in feed, upper limits must be established (MLs). By the so-called transfer factors of chemicals from animal feed to animal products, the carry-over or cross-contamination from feed to food must be ascertained through animal tests. The chemical concentration in the animal food items (measured in milligrams per kilogram of wet weight) is divided by the chemical concentration in the animal feed (measured in milligrams per kilogram of dry weight) to get the transfer factor. Data on transfer rates from various chemical contaminants in food products, such as pesticides, dioxins and furans, polychlorobiphenyls (PCBs) and polybrominated biphenyls (PBBs), heavy metals, mycotoxins, hormones, veterinary drugs, nitrosamines, and other substances not included in the aforementioned classes, have been compiled A cautious worst-case estimate assumes that all contaminants eaten are transmitted to the animal product, such as the meat, if a research on the carry-over is not available. Several coccidiostats, notably polyether ionophore, have been tested for carry-over or cross-contamination.

The European Food Safety Authority (EFSA) recently assessed the health risk to non-target species arising from ingestion of cross-contaminated feed with coccidiostats at levels of 2, 5, or 10%, and a modification of the risk estimates is contained in the work. We must use creative strategies to increase scientific understanding in order to meet these problems, both present and future. Similarly, we need a channel to improve efficient communication among scientists from various backgrounds who have a shared interest in veterinary pharmacology and toxicology in order to effectively translate scientific findings and applications in this sector. This was the impetus for the establishment of a veterinary pharmacology and toxicology speciality section in the worldwide, open-access, peer-reviewed, online journal Frontiers in Veterinary Science. It brings me great pleasure to announce the launch of this new veterinary pharmacology and toxicology speciality section. The section's mission is to publish the most important and fascinating new findings in basic and fundamental pharmacology and toxicity research. The veterinary pharmacology and toxicology speciality section will feature original research papers as well as summaries of recent advancements in a variety of fields and prospective viewpoints [11][12].

CONCLUSION

Researchers studying medications and poisons in all animal species may publish their findings in the international journal Veterinary Pharmacology and Toxicology (livestock, poultry, game birds, avian, rabbits, companion animals, horses, wildlife, zoo animals, farmed fish and shellfish, bees, and laboratory animals). The section accepts high-quality original manuscripts on any topic related to pharmacology and toxicology, including toxicodynamics and pharmacogenetics, toxicogenomics and toxicogenetics, pharmacokinetics and toxicokinetics, adverse effects of drugs, xenobiotics, plants, and toxins, contaminants, pesticides, and drug residues in food animals and food products, clinical pharmacology and therapeutics, toxicology and the environment, AMR, and clinical toxicology pharmacology and toxicology in Toxicology supports multidisciplinary research, invites papers in both established and developing fields of study, and works to further advancements in these crucial fields worldwide.

REFERENCES

[1] A. Anadón, “Perspectives in veterinary pharmacology and toxicology,” *Front. Vet. Sci.*, 2016, doi: 10.3389/fvets.2016.00082.

[2] Ademola Adetokunbo Oyagbemi, "Corrigendum to: Novel antihypertensive action of rutin is mediated via inhibition of angiotensin converting enzyme/mineralocorticoid receptor/angiotensin 2 type 1 receptor (ATR1) signaling pathways in uninephrectomized hypertensive rats (Journal of Food Biochemistry, (2020), 44, 12, 10.1111/jfbc.13534)," *Journal of Food Biochemistry*. 2021. doi: 10.1111/jfbc.13679.

[3] R. F. Witkamp, "Genomics and systems biology - How relevant are the developments to veterinary pharmacology, toxicology and therapeutics?," *Journal of Veterinary Pharmacology and Therapeutics*. 2005. doi: 10.1111/j.1365-2885.2005.00662.x.

[4] Z. Lin, R. Gehring, J. P. Mochel, T. Lavé, and J. E. Riviere, "Mathematical modeling and simulation in animal health – Part II: principles, methods, applications, and value of physiologically based pharmacokinetic modeling in veterinary medicine and food safety assessment," *Journal of Veterinary Pharmacology and Therapeutics*. 2016. doi: 10.1111/jvp.12311.

[5] S. M. Rivera-Velez, J. Navas, and N. F. Villarino, "Applying metabolomics to veterinary pharmacology and therapeutics," *Journal of Veterinary Pharmacology and Therapeutics*. 2021. doi: 10.1111/jvp.12961.

[6] L. B. Cobbin, "TRENDS IN VETERINARY PHARMACOLOGY AND TOXICOLOGY," *Aust. Vet. J.*, 1981, doi: 10.1111/j.1751-0813.1981.tb05797.x.

[7] anonymous, "14th International Congress of the European Association for Veterinary Pharmacology and Toxicology," *J. Vet. Pharmacol. Ther.*, 2018.

[8] M. B. Strong, "Journal of veterinary pharmacology and therapeutics," *Vet. Parasitol.*, 1980, doi: 10.1016/0304-4017(80)90083-7.

[9] J. K. Mworia, C. M. Kibiti, M. P. Ngugi, and J. N. Ngeranwa, "Antipyretic potential of dichloromethane leaf extract of Eucalyptus globulus (Labill) and Senna didymobotrya (Fresenius) in rats models," *Heliyon*, 2019, doi: 10.1016/j.heliyon.2019.e02924.

[10] "Keynote Lectures," *Sci. Pharm.*, 2010, doi: 10.3797/scipharm.ak-10-02.

[11] J. R. E. Del castillo, "KN Developing a virtual learning environment for veterinary pharmacology and toxicology," *J. Vet. Pharmacol. Ther.*, 2015.

[12] M. N. Martinez, "Bioequivalence accomplishments, ongoing initiatives, and remaining challenges," *J. Vet. Pharmacol. Ther.*, 2014, doi: 10.1111/jvp.12063.

CHAPTER 19
PHARMACEUTICALS AND VETERINARY DRUGS

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

Application of veterinary drugs in livestock production is inevitable as they are essential for treatment of diseases, prevention of diseases, modification of physiological functions, improvement of growth and productivity as well as for ensuring food safety. However, recent reports have revealed that the use of veterinary drugs in large amounts and consistently could result in deposition of antimicrobial residues in muscle and organs of animal. Consumption of these residues in animal products may pose health risk to consumers including development of antibiotic resistance bacteria, allergy, reproductive disorder and hypersensitivity reaction. It is in line with this that this chapter seeks to examine the cause, occurrence, mode of detection, health implication and possible solution to veterinary drugs residues in meat and meat product

KEYWORDS:

Agriculture, Antimicrobial, Drugs, Veterinary, Antimicrobial Resistance.

INTRODUCTION

In order to cure illnesses (therapeutic), prevent illnesses (prophylaxis), alter physiological processes (such as with tranquilizers and anesthetics), enhance development and productivity (growth boosters), and ensure the safety of food, veterinary medications must be used in livestock production. The veterinary medications are used all around the globe and include a wide range of chemical constituent types, including as vaccinations, antibiotics, antiparasitics, and beta-agonists. By enabling earlier weaning, larger animal densities, better carcass yields, higher meat quality, and the use of less expensive feed sources, these medications have been utilized to increase the profitability and productivity of contemporary food-animal production. Tetracyclines, amprolium, penicillin, streptomycin, sulphonamides, tylosin, aminoglycosides, -lactams, macrolides and lincosamides, quinolones, sulfonamides, and tetracyclines are among the antimicrobials that are frequently used in livestock production. Antiparasitic agents include anthelmintics or coccidiostats,

Antimicrobials are drugs (of natural, synthetic, or semi-synthetic origin) that, when used in small doses, prevent the growth or kill germs without harming the host. "Antimicrobial" will be used interchangeably with "antibiotic" throughout this research. Several of the antimicrobials used in cattle are the same as or very similar to those used in people. The majority of antibiotics used on cattle may result in the growth of bacteria that are resistant to antibiotics in muscle food, which can subsequently be transferred to people via food and other means [1]. Nowadays, it is anticipated that more than 100 mg of antimicrobials are used annually per kilogram of animal production worldwide. Also, it has been shown that more than 80% of all antibiotics used in the veterinary industry are growth promoters, exceeding the overall usage of antibiotics in human medical treatment in the majority of situations. Aarestrup found in a research that animal use of antibiotics worldwide is double that of human consumption. In fact, according to the Food and Drug Administration [8], food animals account for over 80% of the antimicrobial consumption in affluent nations like the USA. According to estimates, about 45, 148, and 172 mg/kg of antibiotics per animal are used yearly worldwide

in the production of cattle, poultry, and pigs, respectively. Antimicrobial usage by cattle is expected to rise globally, from 63,151 tons in 2010 to 105,596 tons in 2030.

Recent findings, however, have shown that frequent and heavy usage of antibiotics may cause the deposition of antibiotic residues in animal muscle and organs. Consumer health risks from consuming these residues in animal products, particularly via meat and meat products, include the development of antibiotic resistance and hypersensitive response. According to reports from the FAO and WHO, poor nations have antimicrobial residue levels in edible animal products that are far higher than is acceptable. The European Commission Council Regulation established maximum residual limits for veterinary medication residues in various animal feeding items in order to prevent this (European law). The maximum veterinary residue limits for substances including tetracycline, oxytetracycline, streptomycin, gentamicin, sulphonamides, and quinolones, among others, were noted as being 100, 100, 200, 100, and 75 g/kg, respectively. Thus, it is crucial that animal products (especially meat and milk) be examined to make sure that residual levels do not go beyond allowed limits. Due to the substantial danger to human health posed by bacteria that are harmful to humans becoming medication resistant as a result of unintended intake of antimicrobial residues in food items. In keeping with this, the latest research on the origins, occurrences, methods of detection, health implications, and potential solutions for veterinary medication residues in meat and meat products will be the main emphasis of this chapter[2].

Factors that contribute to antibacterial traces in meat and animal products:

Animal disease outbreaks

In most nations throughout the globe, livestock production is one of the agricultural areas with the quickest rate of growth. Unfortunately, several illnesses brought on by various infectious bacteria that are present across the world impede the health and development of this animal. Many new illnesses have emerged during the last 10 years, and additional new potential pathogens are expected to emerge by 2020. Antimicrobial medications are now widely used to preserve and maintain the health of the animal throughout production as well as to assure safe food after harvest due to the emergence of pathogenic bacteria.

As ill and untreated animals develop more slowly and may ultimately die, this places a significant financial burden on farmers and the government by sharply lowering their revenue and means of subsistence. In a research, FAD found that 60% of domestic sales and distribution of medically significant antimicrobials in the United States in 2016 were used in food-producing animals for the treatment and prevention of these infections. Tetracyclines made up 70% of this estimate's sales, followed by penicillins at 10%, macrolides at 7%, sulfas at 4%, aminoglycosides at 4%, lincosamides at 2%, and cephalosporins and fluoroquinolones at less than 1% apiece. However, misuse or excessive use of antimicrobials among livestock and in adherent to withdrawer time has resulted in the spread of antimicrobial residues (either the parent compound or its metabolite) in muscles, especially meat and meat products. Antimicrobial use in livestock is frequently dependent on the number of animals, the production system, the prevalent risk factors for disease, and the ability to obtain antimicrobial agents income.

Antimicrobial residues found in muscle meal may be acutely or cumulatively allergic, organotoxic, mutagenic, teratogenic, or carcinogenic, which poses a danger to human health. According to a paper, antimicrobial-resistant bacteria may actually serve as a reservoir for resistance genes that can be passed on to pathogenic or commensal bacteria in the digestive tract, which compromises the ability to treat bacterial illnesses effectively. The treatment of diseases in both people and animals may be seriously threatened by this. The use of precise

antimicrobial medications in livestock production is thus essential for a reduction in the total number of animals suffering from infectious illnesses.

Demand for meat and meat products is too high:

Most people's diets all across the globe include a sizable amount of meat. Being an excellent source of proteins, vital amino and fatty acids, vitamins, minerals, and other bioactive components, its ingestion provides considerable health advantages. According to estimates, each person consumes 42.9 kg of meat on average per year, with industrialized nations eating twice as much (76.1 kg) as underdeveloped nations (33.6 kg). By 2050, the consumption of meat and meat-related goods is predicted to double. Due to global population growth, meat consumption will continue to rise, with the developing world seeing the greatest demand increases over the next decades. Antimicrobials are being used more often to treat livestock infections and boost production in an effort to produce enough meat to satisfy this demand (growth promoters). Globally, the production of cattle now uses more than 300 antimicrobials, anti-coccidials, feed additives, and hormone-like substances.

Around 323 metric tons of meat were produced worldwide in 2017, and it is predicted that this number would increase by 15% by 2027, according to an OECD/FAO. The demand for beef and sheep meat will rise more than that for chicken and pig meat over the course of the next ten years. According to some reports, the United States, India, Argentina, Mexico, China, Turkey, and the Russian Federation would account for a large portion of the increased output. According to a report, the rise in the number of animals bred for food production and the rise in consumer demand for livestock goods, such as meat and dairy products, are to blame for the rising antimicrobial usage. Antimicrobial use in food animal production was anticipated to be 63,151 (1560) tons globally on average in 2010, and by 2030, it is predicted to rise by 67% to 105,596 (3605) tons, or perhaps double in certain nations, including Brazil, India, Russia, South Africa, and China. For instance, it has been predicted that by 2030, antimicrobial usage in the production of pigs and chickens in Asia would increase by 129% and 124%, respectively. In both industrialized and developing nations, antimicrobial resistant strains have been found in food animals, particularly in those where the use of antimicrobials for growth promotion is still largely uncontrolled. In their investigation, discovered that several Escherichia coli strains isolated from retail meats (pork, chicken, beef, and deer) were susceptible to one or more antimicrobial agent classes (tetracycline, b-lactams, and quinolones). Broilers' exposure to fluoroquinolone medications also led Moniri and Dastehgoli to identify a fluoroquinolone-resistant Escherichia coli from those animals. Bacteria from food animals typically exhibit resistance to a variety of antimicrobial agents, including those routinely used in humans, as a result of the use of antimicrobial medications in livestock production [3], [4].

Other crucial drivers

In addition to the aforementioned causes, other elements that may contribute to antimicrobial resistance in meat and meat products include inadequate antimicrobial dosage, a lack of enforcement of laws governing the use of antimicrobials in livestock, poor financial standing of livestock farmers, a lack of education and experience among farmers, and husbandry practices. For instance, a research indicated that most of the poultry famers did not practise or comply with antimicrobial withdrawal times before slaughter or sale of their product for consumption. Low therapeutic dosages and large concentrations of antimicrobial residues in meat products might result from noncompliance with antimicrobials withdrawal periods. Animals administered an antibiotic are prohibited from being processed until the withdrawal time has passed by law. The usage of antibiotics may be reduced with excellent management, which includes clean living conditions and enough food. Examples include the selling or killing

of treated or medicated animals meant for rendering, the unlawful sale of veterinarian prescription medications, and insufficient animal identification and traceability systems, particularly in developing nations.

DISCUSSION

Impact on the economy and the health of consumers

Veterinary drug residues are the residual levels of antimicrobials, antibiotics, or their toxic metabolites discovered in the flesh, organs, or other products such as milk and eggs of food-producing animals following slaughter. Due to the treatment failing due to the growth of resistant microbes, consuming such food items presents a serious health risk. The following reports on various effects of antibiotic residues on human health.

Health effects on consumers

Resistance to drugs

Swan noted the emergence of vancomycin resistance to Enterococci in animals administered avoparcin in 1969, signaling the potential of transmission of resistant bacteria via the food chain in treated animals. Antibiotic-containing animal diets have been linked to antimicrobial resistance, which may make it difficult to treat both animals and people. Drugs have reportedly been known to be utterly useless in certain circumstances. Given the known phenomenon of the transfer of microbial resistance from animal to human, it follows that resistant microbes may enter humans either directly via contact or indirectly through consumption of animal goods and byproducts (e.g. milk, egg, etc.). The worry is that antimicrobial treatment will fail because of a resistant strain[5].

Responses due to allergies or sensitivities

A patient who has been sensitized to a chemical substance (such a medication) may develop an allergy or an immune-mediated reaction. These allergic responses, which are often mediated by IgE, may be brought on by the injection of medications or macromolecules like proteins, lipids, or carbohydrates.

Dayan confirmed that an estimated 4–11% of people worldwide had penicillin allergies. Such a group of people are at risk of developing an allergy, which might result in a skin rash or possibly severe anaphylaxis, if they consume meat products that include penicillin residues. IgE-mediated allergic anaphylaxis has been associated to penicillin and other anesthetic medications after their administration during the perioperative phase. After sulfonamide exposure in humans, some skin responses range from a mild rash to severe toxidermia. Such a negative outcome, nevertheless, was not a direct result of ingesting animal products with relatively tiny quantities of sulfonamides. Moreover, research has shown that allergic reactions to macrolide antibiotics such as erythromycin and clarithromycin might cause harm to hepatic liver cells.

A cancer-causing factor

The term "carcinogenic" refers to any substance or agent that has the ability to change an organism's genetic makeup, causing them to proliferate and become violent. In contrast, the term "carcinogen" refers to any substance that encourages carcinogenesis, the development of cancer, or has carcinogenic activity. Covalently binding intracellular elements including DNA, RNA, proteins, glycogen, phospholipids, and glutathione is how carcinogenic residues work. Diethylstilbestrol (DES), a hormone-like substance used in animals raised for food, was outlawed due to its potent carcinogenic properties. The International Agency for Research on

Cancer (IARC) states that there is enough evidence that metronidazole causes cancer in animals, but not enough to cause it in people.

Disruptions of normal intestinal flora

The intestinal microbiota is crucial to human physiology. They put harmful germs under control and stop them from colonizing the digestive system. Antimicrobials used for therapeutic reasons, however, have been proven to have the capacity to modify or change the ecological makeup of the gut flora. The antimicrobial medication dose, administration method, bioavailability, metabolism, duration of drug exposure, and dispersion throughout the body, including excretion route, all affect the degree of change, however. The use of broad-spectrum antibiotics has been linked to reports of gut flora disruption. Frequently prescribed medications including vancomycin, metronidazole, nitroimidazole, streptomycin, and tylosin are often linked to the diagnosis of gastrointestinal issues in people [6].

Effect mutagenic

Mutagens are chemicals or substances that have the capacity to change the genetic composition of a cell or an organism by causing mutations in DNA molecules. According to studies, DNA bases and alkalizing chemicals are both mutagenic. A rising concern among the general population of humans is a potential drug-related chromosomal break or gene mutagen.

Teratogenic Impact

It has been shown that hazardous medication or chemical metabolites may cause fetal malformations during pregnancy. At the crucial stage of gestation, these medications or teratogens impair the structural and functional integrity of the growing embryo or fetus. Research have shown that benzimidazole, an anthelmintic, is very hazardous to embryos when consumed during the first few weeks of conception or pregnancy because it is not only mutagenic but also has teratogenic effects.

Effects on the World Economy

The use of antibiotics in livestock, whether at therapeutic or subtherapeutic doses, and the resulting residues in food animals, have become a worldwide problem and cause for worry. A decrease in consumer confidence and the ensuing negative effects on the global economy are the results of the growing awareness of the potential risk of diseases like cancer as well as the distortion of the body's functional and system integrity (i.e., the endocrine, nervous, reproductive, and immune systems) brought on by the consumption of such "compromised" food of animal origin. Nevertheless, the committee of countries does not typically agree with the maximum residual limits (MRLs) established by the Codex Alimentarius Commission (Codex) for veterinary medication residues as an international food safety standard. There are variations in food safety standards across nations and countries as a consequence of Codex and the World Trade Organization (WTO)'s inability to enforce the implementation of MRLs. Such discrepancies often result in trade disputes, which cause exports of meat and meat products to gradually drop.

Research on the evolution of antimicrobial resistance in animals used to produce food after consumption are many. The need to reduce exposure to antibiotic residues in food is also becoming more widely recognized. Antibiotic overdose, noncompliance with withdrawal periods, and ongoing use of antibiotics that are prohibited for use in treating commercial animals are the causes of antimicrobial residues in meat and meat products. Given the aforementioned, particular laws have been established to shield people from exposure to potentially dangerous veterinary drug, pesticide, and environmental pollutant residues in food

of animal origin. According to European Regulation (EC) No 470/2009, maximum residual limits (MRLs) have been established for veterinary medications, insecticides, and environmental pollutants. The Regulation aims to not only detect antibiotic residues but also to compel their quantitative examination.

Two fundamental phases are involved in the control of antibiotic residues in animal-derived foods: first, the animal product is tested qualitatively or quantitatively. Here, antimicrobial residue is found by qualitative analysis, and it is often classified as either positive or negative. The quantitative screening technique is used to identify and quantify a specific residue, and the residue's concentration is also given. If findings are favorable, a confirmation process using a more delicate physico-chemical technique is often carried out for a particular antibiotic.

Microbial detection technique

While it was first used in 1964 to monitor the dairy sector in an effort to avoid issues in the fermentative dairy industry, it is currently used as a regulatory residue screening tool in slaughter animals and has been since that time. The microbial inhibition assay may evaluate the whole range of antibiotics in a single test [7]. The tube test or the plate test are the two methods used in the microbial inhibition experiment. A tube, vial, or ampule containing a growth medium infected with (spores of) a sensitive test bacterium and supplemented with a pH or redox indicator is used in the tube test. There is a color from the acid created by the developing bacteria when the temperature and pH are right. Nonetheless, it has been used to the study of other matrices. In the plate test, the test sample is applied to the layer of the plate that has nutritional agar that has been infected. The creation of an opaque layer by the expanding bacteria, which results in a clear growth-inhibited region surrounding the sample, is used to identify the presence of an antibiotic residue. In Europe, this technique is often used to check for antibiotic residues in animals destined for slaughter.

Immunological approach

The antigen-antibody interactions theory underlies immunological methods, which are often quite specific and aid in the detection of residues from animals used for food. Antimicrobials are often detected using the enzyme-linked immunosorbent test (ELISA), which is based on reagents that have been enzyme-labeled. The direct and indirect sandwich ELISA are two examples of the several antigen-quantification ELISAs. Sandwich ELISA is based on the idea of identifying certain antigens that have related epitopes to other antigens. The indirect sandwich ELISA has the benefit of being very sensitive and specific. Using a counter, radioimmunoassay determines the immunological complex's radioactivity[8], [9].

Chromatographic technique

Although its fast decline over the last ten years, liquid chromatography is still beneficial in the qualitative and quantitative screening of several contaminants in food animals [68]. Pumps are used in high-performance liquid chromatography (HPLC) to move a column of solid adsorbent material through a pressured liquid solvent holding the sample combination. Each component in the sample interacts with the adsorbent material somewhat differently, resulting in various flow rates for the various components and causing the components to separate as they flow out of the column. The identification of antimicrobials in meat, fish, and internal organs has been done using it[10], [11].

CONCLUSION

The outcomes of this study have shown that antimicrobial medication use to treat and prevent animal illness has effects that go far beyond the farm, raising concerns about the presence of veterinary drug residue in food items. Hence, the answer to antimicrobial residues will call for coordinated regulatory authorities to keep an eye on how antimicrobial medications are being used to treat illnesses and to impose penalties on careless use. In order to quickly find and track antimicrobial residues in meat products, it is more important to support analytical techniques that are sensitive, selective, and trustworthy.

REFERENCES

[1] M. Llompart, M. Celeiro, and T. Dagnac, "Microwave-assisted extraction of pharmaceuticals, personal care products and industrial contaminants in the environment," *TrAC - Trends in Analytical Chemistry*. 2019. doi: 10.1016/j.trac.2019.04.029.

[2] R. Yasmeen, L. Asif, and S. Djeffal, "Impact of Diclofenac a Non-steroidal Anti-inflammatory Veterinary Pharmaceutical Drug on Vultures," *Pakistan Journal of Zoology*. 2022. doi: 10.17582/JOURNAL.PJZ/20191121081106.

[3] M. E. Dasenaki and N. S. Thomaidis, "Multi-residue determination of 115 veterinary drugs and pharmaceutical residues in milk powder, butter, fish tissue and eggs using liquid chromatography-tandem mass spectrometry," *Anal. Chim. Acta*, 2015, doi: 10.1016/j.aca.2015.04.013.

[4] A. Sabitov, N. Ibragimova, M. Lyu, and D. Bolatova, "About The Need For Developing Risk Management For Ensuring Safety From Antiobiotic And Veterinary Drug Residues In Kazakhstan," *J. Sustain. Sci. Manag.*, 2021, doi: 10.46754/JSSM.2021.06.022.

[5] A. Wilkowska and M. Biziuk, "Determination of pesticide residues in food matrices using the QuEChERS methodology," *Food Chemistry*. 2011. doi: 10.1016/j.foodchem.2010.09.094.

[6] C. Vatovec, J. Kolodinsky, P. Callas, C. Hart, and K. Gallagher, "Pharmaceutical pollution sources and solutions: Survey of human and veterinary medication purchasing, use, and disposal," *J. Environ. Manage.*, 2021, doi: 10.1016/j.jenvman.2021.112106.

[7] S. G. Carvalho *et al.*, "Advances and challenges in nanocarriers and nanomedicines for veterinary application," *International Journal of Pharmaceutics*. 2020. doi: 10.1016/j.ijpharm.2020.119214.

[8] P. Gómez-Ramírez, G. Blanco, and A. J. García-Fernández, "Validation of multi-residue method for quantification of antibiotics and nsaids in avian scavengers by using small amounts of plasma in HPLC-MS-TOF," *Int. J. Environ. Res. Public Health*, 2020, doi: 10.3390/ijerph17114058.

[9] M. E. Dasenaki, A. A. Bletsou, G. A. Koulis, and N. S. Thomaidis, "Qualitative multiresidue screening method for 143 veterinary drugs and pharmaceuticals in milk and fish tissue using liquid chromatography quadrupole-time-of-flight mass spectrometry," *J. Agric. Food Chem.*, 2015, doi: 10.1021/acs.jafc.5b00962.

[10] S. G. Carvalho *et al.*, "Polymeric-based drug delivery systems for veterinary use: State of the art," *International Journal of Pharmaceutics*. 2021. doi: 10.1016/j.ijpharm.2021.120756.

[11] FDA, "Pharmaceutical CGMPs for the 21s Century - A risk-based approach," *Food Drug Adm.*, 2004.

CHAPTER 20
GREENHOUSE GAS REDUCTION TECHNIQUES FOR THE ANIMAL HUSBANDRY INDUSTRY

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

Methane and nitrous oxide are two non-CO2 greenhouse gases that are considerably emitted by humans. This document reviews the key mitigation measures as well as the methane and nitrous oxide emissions connected to agriculture. The most significant source of methane generation, particularly in the care of cattle, is the rumen. Cattle dung produces a less quantity of methane, but it is still a significant amount. The majority of methane produced in pig and poultry agriculture comes from manures. Fertilizers containing nitrogen, animal dung spread on land, and urine left behind by grazing animals are the major sources of nitrous oxide

KEYWORDS:

Agriculture, Animal Husbandry, Fertilizers, Fermentation, Greenhouse Gas.

INTRODUCTION

The most efficient methane mitigation solutions use a source approach, or altering animals' diets to be more efficient. Yet, by making the best use possible of the gas generated by manures, such as for the creation of electricity, methane emissions may also be significantly decreased. An example of an integrated on-farm solution is the regular and thorough removal of waste from animal housing in conjunction with farm-based biogas generation. The best ways to mitigate nitrous oxide emissions from farm land include reducing fertiliser nitrogen input, choosing the right fertiliser form, adding nitrification inhibitors, managing land drainage, and reducing land compaction by restricting grazing. In contrast, managing bedding material and solid manure reduces nitrous oxide emissions from housing and storage [1].

The most main greenhouse gases, carbon dioxide (CO_2), methane (CH4), and nitrous oxide (N2O), have seen large increases in atmospheric concentrations worldwide during the last 150 years. Significant cuts in those gases' emissions would be essential for stabilization at current levels and even lower concentrations, which are required to lessen climate change and its accompanying consequences (IPCC, 2001). Adoption of mitigation measures from all sectors, including industry, agriculture, energy, and families, is required to achieve these reductions. The entire amount of greenhouse gas (GHG) emissions from agriculture is substantial. Agriculture is where between 20 and 35 percent of the world's GHG emissions come from These numbers represent 40 and more than half of the human CH_4 and N_2O emissions, respectively (IPCC, 2001). Most of the N2O is generated on the field (manure ejected during grazing, chemical fertilisers), and from animal housing when straw or litter is employed. Animals and their excreta (manure) are the most significant sources of CH4 in agriculture. Each party to the Kyoto Protocol is required to provide techniques and tools that are suitable for measuring, monitoring, and verifying GHG emissions and their reductions. This study provides a concise review of the many strategies for lowering CH4 and N2O emissions from the main agricultural sources, notably from animal systems, with an emphasis on European agricultural practices.

DISCUSSION

Sources and procedures

N2O and methane come from many cycles. Methane typically results from the breakdown of carbon (C) elements during the digestion of feed and manure, while N2O is connected to the nitrogen (N) cycle, with manures and chemical fertilizers serving as the main suppliers.

Methane

In monogastric species, like pigs, CH4 is mostly generated in the large intestine, while the rumen is the most significant location of CH4 generation in ruminants (breath) (flatus). Livestock manures, whether kept outside or inside in sub-floor pits, are also important sources of CH4, since both slurry and solid manure piles often provide favorable conditions for methanogenesis (Husted, 1994). The following information was discovered by the author regarding CH4 generated from enteric fermentation and manure, respectively, for different animal species. The majority (about 80%) of CH4 in dairy husbandry comes from enteric fermentation, while the majority (almost 70%) of CH4 on pig and poultry farms comes from manures. Differences in diets and housing arrangements are to blame for the considerable variation in the overall CH4 emission from dairy cows.

Enteric Fermentation

The amount of feed eaten, the amount of energy consumed, and the composition of the diet all have a significant role on the rate of CH4 production from enteric fermentation in dairy cows (see IPCC, 1997).

The three most crucial elements are: First, the rate of organic matter (OM) fermentation; second, the type of volatile fatty acids (VFA) produced, which strongly influences the amount of excess hydrogen [H] produced in the gastrointestinal tract and the requirement for CH4 production as a sink of excess hydrogen; and third, the effectiveness of microbial biosynthesi[2]s.

Animals' waste

Anaerobic processes are used in the solid and liquid forms of manure fermentation (absence of oxygen). It has it has certain characteristics with enteric fermentation and is well explained. The fermentation process, in summary, consists of two steps:

(a) Acidogenic bacteria grow quickly and are active throughout a broad temperature range (3-70 8C), with an optimal temperature of 30 8C. Bacteria and substrate are well mixed to produce organic acids, [H], and CO2.

(b) Certain methanogenic bacteria that are thermophilic (>40 8C) or psychrophilic (20 8C) generate CH4 from organic acids. Temperature and the biodegradability of the manure both enhance the amount of methane produced from animal manure, commonly known as biogas.

The best reactor must take energy costs for extra heating into account even if digestion at higher temperatures produces more CH4. Production of CH4 is significantly influenced by the substrate's quality. It is necessary to achieve certain pH ranges and carbon: nitrogen ratios (13:1 to 28:1 is ideal). As animal dung digestion is a biological process, it is important to maintain low quantities of chemicals that hinder gas generation, such as ammonia/ammonium and sulphides.

Nitrous oxide

Nevertheless, it may also be released in deep litter systems and from solid manure piles. The primary sources of N2O are nitrogen fertilizer and animal manure applications to land as well as urine deposition by grazing animals. Even clamps used for silage may produce N2O. While CH4 is frequently produced from animal manures, N2O production can only occur under specific circumstances because it is the result of a combination of aerobic and anaerobic processes: (a) nitrification, which is the aerobic conversion of ammonium to nitrate; (b) denitrification, which is the anaerobic production of nitrogen gas from nitrate reduction (anaerobic).

The environmental elements oxygen status, temperature, moisture content, and preceding soil conditions, which regulate enzyme synthesis, therefore affect N2O emission. As manure typically has absolutely anaerobic conditions, processes (a) and (b) won't take place. Nevertheless, denitrification takes place after aeration when forced and controlled aeration of liquid manure (referred to as "aerobic treatment") or solid manure (referred to as "composting") is used to remove OM and nitrogen and water (drying), respectively. In addition to these instances of active nitrification and denitrification, processes (a) and (b) also take place in passive aeration situations, such as organic housing systems and systems with improved animal welfare where straw or litter may be added. As a consequence of the bedding's (partial) compaction and the combination of manure and straw/litter, passive aeration is encouraged, which leads to unchecked nitrification and denitrification. Despite the fact that ammonia emissions from these kinds of housing systems are often decreased, there is a major trade-off to N2O (and CH4), resulting in a net greater N-emission than that which has been reported with conventional, liquid manure based housing systems[3].

Methane

Per animal product, methane emissions will be any method that lowers the ratio of cattle "maintenance" to "producing" Hence, fewer CH4 emissions will result from quicker development, more milk production, and shorter dry spells in nursing cows. Similarly, a longer average lifespan for dairy cows—that is, more lactations during their lifetimes as opposed to the typical three-year window between conception and first calving—will result in less CH4 loss per unit of milk output. Moreover, management-based solutions and technological methods (such as aerobic digestion) may be used. Nevertheless, since the IPCC inventory is based on a standard emission factor, only mitigations that include a decrease in the number of animals would presently count as a reduction in the inventory. Some mitigation strategies, including those based on food modification, may result in "actual" decreases in CH4 generation, but at the moment they wouldn't be included in the inventory unless they directly caused a decrease in the quantity of cattle.

Diet Modifications

It is well known that dietary changes (such as the roughage: concentrate ratio or the amount of fiber, carbohydrates, sugars, and protein in the feed) have a significant impact on rumen function and ruminant performance. Similar to humans, dietary composition may have a significant impact on the amount and kind of protein, starch, and fiber that enter the large intestine of ruminants and pigs, as well as their subsequent supply of substrate for fermentation. In instance, a ruminant's large intestine's fermentative capacity is regarded as modest in compared to that of a pig's, but it is excessive in pigs. The amount of GHGs produced by farm animals may significantly change in response to changes in feeding practices or farm management. According to theory, the best ways to increase propionate production in ruminants and decrease excess [H] and subsequent CH4 formation are to (a) increase the

amount of starch or rapidly fermentable carbohydrates (soluble carbohydrates and starch in concentrates); (b) change the diet's feed intake and composition to increase animal productivity; (c) decrease [H] by adding (unsaturated) fat or stimulating acetogenic bacteria; and (d) increase the amount of [H]-reducing enzymes (through additives or probiotics).

Habitation and storage

Water does not readily dissolve methane. This indicates that any CH4 created will immediately diffuse into the home's air. In order to reduce emissions from the house and (indoor) storage, it is therefore necessary to concentrate on the following: (a) deep cooling of manure (10 8C) or a significant reduction of manure pH, for example, via additives; (b) removal of the gas source, for example, by frequently and completely removing manure from indoor storage pits; and (c) proper management of the bedding and manure heaps, for example, minimizing compaction, frequent addition of straw/litter,

Option (a) needs extra hardware in order to apply the additives or extract heat from the manure. In-house cooling of pig slurry decreased CH4 (and N2O) emissions by 21% less than without chilling. Additional reductions (up to 80%) may be achieved by adding additions like lactic acid and limestone. It is efficient to regularly remove the manure from the pits, but this will only be possible (and successful) if there is enough outside storage space and extra safeguards against outdoor CH4 emissions. It is possible to use anaerobic digestion (biogas generation), flaring or burning (chemical oxidation; burning), or specialized biofilters. The most obvious solution seems to be the production of biogas in conjunction with on-farm power/heat generation. The energy price (usage on one's own farm, supplying power to the public grid) and the ability (or inability) to co-digest waste products to boost gas output will be the major determinants of its viability. Although significant volumes of CH4 and N2O are generated under less-than-ideal circumstances, proper management of bedding material and manure piles (outdoor) will minimize GHG emissions[4].

Nitrous oxide

Options to lower N2O emissions from certain sources have been found and put to varying degrees of testing. The most effective potential specific options, according to a recent review of greenhouse gas emissions from agriculture in the UK, are: (1) the choice of fertiliser form, (2) nitrification inhibitors, (3) land drainage management, (4) storage of solid manure, (5) N2O:N2 ratio, and (6) housing systems and management.

The interactions between policies

There are significant relationships between nitrate leaching (risk of) and gaseous emissions mitigation techniques pollutant switching, hence system-level evaluation of mitigating measures is necessary (i.e. holistically). According to the reduction of NH3 will result in a 15% decrease in the emission of N2O, mostly as a consequence of modifications made to animal housing and the adoption of low emission manure application methods. Interactions that are in reverse are also seen.

Ammonia emissions would rise if cow housing systems were switched from straw to slurry to minimize N2O emissions. The N2O mitigation measures may have an impact on other policy matters. For example, using urea instead of ammonium nitrate would result in an increase in NH3 emissions. Increasing land drainage may increase NO3 \s leaching, both of which would result in higher indirect N2O emissions. The interplay between manure and fertiliser nitrate on N2O emissions may be significant since NVZ policies will lead to more organic manures being distributed throughout the growing season. When slurry and fertiliser nitrate are sprayed

together, N2O emission rises, with up to 5% of the NO3-N being lost as N2O. Before using a fertilizer containing nitrates, it is best to let the soil a few days to enable microbial breakdown of organic C in slurries to take place[5]–[7].

It was discovered that NH3 mitigation techniques used in animal husbandry had no impact on CH4 emissions. This is mostly due to the limited integration of the N- and C-cycles in agriculture, which results in different approaches for mitigation. Options for reducing methane emissions must be focused on managing manure within or outside of animal housing and feeding animals (enteric fermentation). Due to CH4's potential for energy generation, the production and use of biogas as a fuel via anaerobic digestion on farms contributes to reducing both CH4 and CO2 emissions (from fossil fuels). Moreover, anaerobic digestion creates a manure product with a higher level of NH3, which is easily absorbed by plants, accessible C, and may lower N2O emissions after being put on the ground. In addition, the decomposition of VFA in manure reduces the aroma (smell), which lessens the annoyance[8]–[10].

CONCLUSION

Emissions of the non-CO2 greenhouse gases CH4 and N2O from agriculture in general and animal production in particular contribute to global warming. Most emissions of CH4. While N2O is mostly released from fertilized soil, it is also produced by ruminants (animal + dung). Ruminant methane mitigation approaches include boosting productivity per animal, changing nutrition, lowering methanogen populations and activity, and reducing livestock numbers. By limiting uncontrolled storage, manure-related CH4 emissions may be decreased (indoors). Using created CH4 is possible with controlled storage (biogas). Options for reducing nitrous oxide emissions include improving N utilization (from fertilizers and manures), improving land drainage, and using nitrification inhibitors. Compaction and the application of high C additives might help reduce N2O emissions from solid manure piles. When slurries are put to soil, anaerobic digestion of the slurries may (a) directly decrease CH4 emissions by producing biogas (which produces heat and energy), and (b) indirectly reduce N2O emissions by lowering the easily accessible C content. Other measures, such as the need to decrease NO3, must be taken into consideration in GHG reduction alternatives. both NH3 volatilization and leaching It should be noted that if fertilizer N is used more effectively, such as by matching application rates and timing to crop needs, and if animal manures are used in conjunction with fertilizers to supply N for crop growth, the risk of excess mineral N remaining in the soil and potentially escaping as N2O should be reduced. Such an improvement in the management of manure and fertilizer would be crucial in decreasing not just N2O emissions but also other losses of nitrogen, such as ammonia and nitrate.

REFERENCES

[1] H. Shin, T. H. Kim, H. Kim, S. Lee, and W. Kim, “Environmental shutdown of coal-fired generators for greenhouse gas reduction: A case study of South Korea,” *Appl. Energy*, 2019, doi: 10.1016/j.apenergy.2019.113453.

[2] P. Thornley, P. Gilbert, S. Shackley, and J. Hammond, “Maximizing the greenhouse gas reductions from biomass: The role of life cycle assessment,” *Biomass and Bioenergy*, 2015, doi: 10.1016/j.biombioe.2015.05.002.

[3] S. Wang, B. Tarroja, L. S. Schell, B. Shaffer, and S. Samuelsen, “Prioritizing among the end uses of excess renewable energy for cost-effective greenhouse gas emission reductions,” *Appl. Energy*, 2019, doi: 10.1016/j.apenergy.2018.10.071.

[4] B. Raybould, W. M. Cheung, C. Connor, and R. Butcher, “An investigation into UK government policy and legislation to renewable energy and greenhouse gas reduction commitments,” *Clean*

Technol. Environ. Policy, 2020, doi: 10.1007/s10098-019-01786-x.

[5] C. Ö. Karacan, F. A. Ruiz, M. Cotè, and S. Phipps, "Coal mine methane: A review of capture and utilization practices with benefits to mining safety and to greenhouse gas reduction," *International Journal of Coal Geology*. 2011. doi: 10.1016/j.coal.2011.02.009.

[6] M. Jaccard, R. Murphy, B. Zuehlke, and M. Braglewicz, "Cities and greenhouse gas reduction: Policy makers or policy takers?," *Energy Policy*, 2019, doi: 10.1016/j.enpol.2019.07.011.

[7] S. Vares, K. Klobut, and A. Itänen, "Waste as a source for district heat production and greenhouse gas reduction: A case study," *WIT Trans. Ecol. Environ.*, 2014, doi: 10.2495/ESUS140741.

[8] C. H. Park, Y. J. Ko, J. H. Kim, and H. Hong, "Greenhouse gas reduction effect of solar energy systems applicable to high-rise apartment housing structures in South Korea," *Energies*, 2020, doi: 10.3390/en13102568.

[9] K. Roh, A. S. Al-Hunaidy, H. Imran, and J. H. Lee, "Optimization-based identification of CO2 capture and utilization processing paths for life cycle greenhouse gas reduction and economic benefits," *AIChE J.*, 2019, doi: 10.1002/aic.16580.

[10] Z. Kou, X. Wang, S. F. (Anthony) Chiu, and H. Cai, "Quantifying greenhouse gas emissions reduction from bike share systems: a model considering real-world trips and transportation mode choice patterns," *Resour. Conserv. Recycl.*, 2020, doi: 10.1016/j.resconrec.2019.104534.

CHAPTER 21
ALTERNATIVES TO ANTIBIOTICS: USING ALTERNATIVES TO ANTIBIOTICS IN ANIMAL HUSBANDRY

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

Sub-therapeutic doses of antibiotics are often used in food-animal feeds to protect animals from sickness and to increase productivity in contemporary animal husbandry. However, attempts to find "antibiotic alternatives" have been sparked by worries about the spread of germs that are resistant to antibiotics as a result of excessive antibiotic usage and a decline in the novelty of antibiotics. It's debatable if the substitutes could ever completely replace antibiotics. This article provides an overview of current advancements and viewpoints on antibiotic substitutes. There is a thorough discussion of the mechanisms of action, applications, and future prospects of various alternatives, including immune modulating agents, bacteriophages and their lysins, antimicrobial peptides, pro-, pre-, and synbiotics, plant extracts, and inhibitors targeting pathogenicity (bacterial quorum sensing, biofilm, and virulence). The viability of antibiotic substitutes is then carefully examined. It is difficult to predict that alternatives will take the place of antibiotics in veterinary treatment in the near future. The best and quickest approach to reduce the negative effects of antibiotic misuse and to guarantee the safety of food obtained from animals as well as the environment at this time is via the sensible use of antibiotics and the development of scientific monitoring systems.

KEYWORDS:

Animal Husbandry, Antibiotics, Animal Production, nanomaterials, Nanotechnology, Vaccine, veterinary medicine.

INTRODUCTION

Antibiotics have played unmatched roles in the prevention, control, and treatment of infectious illnesses in both people and animals since the discovery and use of penicillin in the 1940s. Also, it has been shown that using antibiotics in animal feeds helps to increase feed effectiveness, encourage animal development, and raise the standard of animal products. Recent research revealed a link between antibiotics' ability to promote growth and the bile salt hydrolase activity, an enzyme generated by gut bacteria that has a detrimental influence on the consumption and digestion of host fat. Antibiotics are thus useful instruments for guaranteeing the growth of an industrialized, intensive agricultural sector. Yet, the excessive use of antibiotics has led to concerns about the emergence of resistant bacteria and the potential transmission of these germs and their resistance elements from animals to people (Stanton, 2013). Multidrug Resistance (MDR) is connected to non-therapeutic antimicrobial applications, including resistance to medications that were never used on farms [1].

Nevertheless, the EU's animal production sectors have seen unanticipated consequences as a result of the restriction on the use of antibiotics in feed, including an increase in animal illnesses and a decline in animal productivity. The use of therapeutic antibiotics and disinfectants was also greatly raised as a consequence of the high prevalence of infections that arose as a result of the prohibition, which led to an increase in the overall quantity of antibiotics used in animals. Contrary to its "golden period," when many antibiotics were developed and made available for

use, the rate of new antibiotic discovery and development has been rapidly declining for decades. Between 2006 and 2010, the shortages of antibiotics grew by 283%. Because to the significant expense and danger involved in the development and use of such drugs, there are currently no new core moiety antibiotics that might possibly compensate for the resistance to currently available antibiotics.

The elimination of in-feed antibiotics has resulted in an increase in mortality and morbidity; nevertheless, a variety of substitutes and alternatives have been suggested to address this problem. Inhibitors for bacterial quorum sensing (QS), biofilm and pathogenicity, feed enzymes, antibacterial vaccinations, immunomodulatory drugs, bacteriophages and their lysins, antimicrobial peptides (AMPs), pro-, pre-, and synbiotics, plant extracts, are a few examples. Are these antibiotic substitutes really as successful in treating animal ailments as antibiotics? In this research, the development and use of antibiotic alternatives were examined, and the potential for such alternatives was highlighted.

Agents that Modulate Immunity

The interplay between the pathogen and the host's immune system leads to the development of an infection. By identifying and combating the infection, the immune system defends the body from sickness. The complement system, granulocytes, and macrophages, as well as other cellular and humoral defensive mechanisms, are all parts of the innate immune response. Immunotherapy, which is defined as the treatment of illness by generating, augmenting, or reducing an immunological response, uses immune modifying substances (immunomodulators). One of the most significant immunomodulators is vaccination, while other pharmacological substances may also function in this capacity[2], [3].

Vaccines against bacteria

Live-attenuated and inactivated/killed vaccines are the two main categories for traditional vaccinations. A suspension of dead or weakened bacteria is called bacterin, and it is used as a vaccine. Live-attenuated bacteria are able to display the whole spectrum of antigens while transiently reproducing in the host. Consider the vaccination against Salmonella. There have been several live Salmonella vaccine strains tried, with varied degrees of success. The main disadvantages of live strains are that they remain in the animal's body for a longer period of time and have a greater chance of returning to their original level of virulence. While there have been reports of several Salmonella live-attenuated vaccines, not all of them have been field-tested. Moreover, they fail to provide enough cross protection against serotypes that are not host-adapted.

Live vaccinations are riskier than those that have been killed. It is created by destroying bacterial cultures that have been generated in vitro and loading them with adjuvants based on oil to boost immune responses. They are stable in storage and fairly affordable to produce. Pasteurella multocida, Salmonella, Mycoplasma, Ornithobacterium, Haemophilus, Staphylococcus, Escherichia coli, and Bordatella Bacterins are presently included in the list of inactivated autogenous poultry vaccines.

Nevertheless, killed vaccines have a number of drawbacks, including a lack of pertinent protective antigens (PAs) as a result of in vitro growth conditions and killing processes, antigenic competition between non-protective and protective components, a lack of safety as a result of potentially harmful components like lipopolysaccharide, and a lack of broad-spectrum protection. Moreover, dead vaccinations need adjuvants, which restricts the vaccines' delivery possibilities. Also, the majority of the killed vaccinations are injectable medicines and aren't often used in intensive broiler operations.

There are worries that when bacterins are used more often, bacteria may become more aggressive. A subunit vaccine, on the other hand, is made up of either a single antigen or a number of specified antigens (predominantly proteins). These vaccinations don't have the biological and regulatory issues that come with live things. Nevertheless, since subunit vaccines are often not very immunogenic, they must be formulated with the right adjuvant (s). Salmonella subunit vaccines are being developed, although it is difficult to say which type of vaccines is more effective than the others. Apart from that, the low gut absorption and antigen degradation make the use of oral subunit vaccinations in big animals challenging [4].

Another possible advancement over traditional vaccinations is DNA vaccination. A DNA vaccination is composed of a tiny, circular piece of genetically modified bacterial DNA (referred to as a plasmid) that contains the DNA sequence(s) encoding the antigen(s) from a disease. The host cells "read" the vaccine DNA after it has been delivered into the body's cells, turning it into pathogenic proteins that would set off a variety of immunological reactions. A danger of integrating the genetic components of the vector into the host genome exists with DNA vaccines since their ability to protect is restricted to the encoded proteins on the vector. The use of viral antigens administered in mouse models is discussed in the majority of the literature on DNA vaccines. Yet, the outcomes are often unsatisfactory when applied to big animals. Consequently, it is doubtful that DNA vaccines will be available until the plasmid dosage can be managed and the issues with successful delivery are resolved.

The market for antibacterial vaccines is relatively underdeveloped compared to the antiviral vaccine industry, which is very developed. For instance, despite evidence of immunization against both C. jejuni and E. coli O157 in chicken and cattle, respectively, neither vaccine is commercially accessible. Immunization with bacterins has not shown any protective effect in the case of E. coli O157. While E. coli and Brachyspira hyodysenteriae vaccines have been reported for treating swine dysentery, safety and effectiveness data are still missing, impeding the commercialization of these biological products. aureus vaccines are being produced to treat bovine mastitis, however a comprehensive analysis of 24 in vivo trials indicates that these vaccinations may not always be evaluated for effectiveness due to methodological issues and a lack of stricter scientific standards (such double blind techniques). In addition, the market's antibacterial vaccination protection rates for animals are poor. The creation of a vaccination that is both feasible and economical, so that it may be used in underdeveloped nations, is still a major issue. With chicken vaccinations, the most significant obstacle to widespread immunization is often the cost and availability of the vaccine. Although vaccinations may reduce our need for antibiotics, they are a supplement, not a substitute.

Additional Immunomodulators

Immunomodulators, primarily immunostimulants, may increase innate immune activity without targeting any particular pathogens and strengthen the host's resistance to illness. When used in the treatment of infectious diseases, immunotherapy can modify the immune system's reaction to a microbe (for example, by using cytokines and cytokine inhibitors), alter an antigen-based response (for example, by using interferons), and reduce end-organ damage by using non-specific anti-inflammatory drugs. Innate defense mechanisms that operate on receptors and activate intracellular gene(s) that may cause the creation of antimicrobial compounds may be activated by -glucans, bacterial products, and plant components[5].

There are several immunostimulants, with at least a dozen groups and hundreds of different types. Thymosin, oregano oil, and nucleotides have been the leading immunostimulants since the 1990s. Subsequently, research using immunostimulants have also included probiotics, botanicals, and their extracts. Using -1, 3/1, 6-glucan (derived from yeast cell walls) as a feed

additive to protect animals against microbes has been shown in studies on animals to have considerable health advantages. It is hypothesized that adding immunostimulants to feed can help animals' natural defenses against diseases at times of high stress including grading, reproduction, transfer, and vaccination.

The effectiveness of immunostimulants depends on a variety of circumstances. Several animal species respond differently to immunostimulants. They do not show a linear dose-effect relationship and are often more effective during or just before infection. Immunostimulants have a wide range of actions, including the inhibition of the host immune system's defense mechanisms. Adaptive immunologic events may result in immune-mediated processes that are harmful to systemic or organ-specific homeostasis when immunogenic stimulation continues or autoregulatory immune systems stop working. The administration of immunostimulants as a feed supplement has been shown to be of substantial help in increasing the animals' inherent defense with minimal harm to the growing fishes in larval fish farming. On the other hand, immunomodulating a neotenous animal before it has a fully developed immune system may be detrimental to the emergence of a typical immunological response.

There are currently no standardized methods for assessing the effectiveness and security of immunostimulants. According to research, the immune system of goats was unaffected by a supposed immunostimulant made of Propionibacterium acnes extract, Ochrobactrum intermedium lipopolysaccharides. While it implies that the substance is a type of immune system "tonic" without really stating the processes, the widely held belief that immunostimulatory plant natural compounds and their potential therapeutic application is fairly vague. It is stated that the paradigm of oral plant immunostimulants, deriving from initial in vitro investigations, lacks clinical data. There is currently no solid information on orally taken immunostimulants in the scientific literature. In general, immunotherapy to modify the immune response can only be used as a supplement to antibiotic treatment.

DISCUSSION

Dietary enzymes

Dietary components that are either not digested by digestive enzymes or absorbed slowly enough for bacteria in host stomachs to compete for them are a major source of nutrition for the proliferation and development of bacteria in the intestine. Exogenous enzymes operate to create nutrients for certain bacterial populations in addition to influencing nutrient absorption. Hence, the microfloral populations are directly impacted by their usage. The most common feed enzymes are a blend of several glycanases, while phytase is the only degrading enzyme that is employed just once. In the production of monogastric food animals, recombinant synthetic enzymes including phytases and carbohydrases are created commercially and marketed as feed additives. The formation of intestinal mucus, endogenous losses, and the digestion of calcium, phosphorus, and minerals are all significantly impacted by phytose. These changes in the nutrient supply and intestinal environment also affect the selection pressures on bacterial species. In broiler hens, xylanase given to a wheat-based diet reduces the pathogenic consequences of C. perfringens. The concentration of C. perfringens and gastrointestinal lesions caused by the bacterium in the ilium were considerably decreased by feeding hens encapsulated lysozyme as a feed addition [6].

Phytase has an established market, although other feed enzymes have distinct flaws. Normally, the activity of the enzyme is poor; the cost is expensive; and the manufacturing and quality control lack standards. Feed enzyme stability and activity are mostly influenced by the manufacturing process. It is well knowledge that animal reactions to feed enzyme additions are not always predictable, and these variations may be due, among other things, to the kind of

enzyme used, the quantity used, the existence of enzyme side effects, the content of the diet, and animal variance. It has long been understood how feed enzymes affect the intestinal microbiota, for example by improving the host's absorption of nutrients and by supplying fermentable oligosaccharides. Nevertheless, it is still unclear how much of this impact adds to the overall advantages of using enzymes, and it is also unclear which key microbial species are involved. Current research demonstrates that the goal should be to enrich the ileum and cecum with Clostridium cluster XIVa species and E. coli while reducing the levels of Lactobacillus spp. if the use of enzymes is to replace preventive antibiotics. The feed enzymes may be utilized effectively up until a precise description of a desired flora can be recorded.

The antibacterial impact of enzymes is not immediately apparent since they do not directly destroy bacteria but instead simply diminish the substrates for bacterial development. Aspergillus niger and Penicillium are the primary sources of glucose oxidase (GOD), which can selectively oxidize D-glucose to create gluconic acid and hydrogen peroxide (Geisen, 1999). When hydrogen peroxide builds up to a certain point, it may injure intestinal bacteria and prevent their growth while consuming oxygen in the colon, which may promote the development of Bifidobacterium, Lactobacillus, and other advantageous anaerobic bacteria. A GOD, lactoperoxidase, and guaiacol-based enzyme gel was able to both suppress the development of new biofilms and remove those that already existed. Since that this enzyme's mode of action differs from that of other feed enzymes, additional research into how GOD affects feeding is warranted [7], [8].

Perspectives

Alternatives to antibiotics should have the following qualities: I be non-toxic or have no negative effects on animals; (ii) be simple to remove from the body or only leave short-term residues; (iii) not cause bacterial resistance; (iv) be stable in feed and animal gastrointestinal tracts; (v) be easily decomposed and have no negative effects on the environment; (vi) not affect palatability; (vii) not disrupt the normal intestinal flora of animals; In actuality, there are presently no antibiotic alternatives that satisfy all of the aforementioned criteria.

When it comes to the efficiency of preventing sickness and promoting growth, antibiotic alternatives still fall well short of antibiotics. Just a few bacterial infectious illnesses may presently be managed by vaccinations, and antibacterial vaccines are often used to prevent bacterial infections. Animal health is mostly preserved via immunomodulators and feed enzymes, which do not directly harm or inhibit microorganisms. Currently, bacteriophages are exclusively utilized in food, and their safety is still debatable. Plant extracts and probiotics have complicated chemical makeups and poor stability, which may have a variety of impacts and safety issues. While most QSIs are hazardous to eukaryotic cells, research on inhibitors that target bacteria's QS and pathogenicity is ongoing. Biofilm inhibitors only perform well when used with antibiotics, however.

AMPs may cure bacterial infections, but their high price and limited antibacterial range prevent them from being widely used. They can also cause bacterial resistance. In contrast, proteinaceous substances such as commercially available feed enzymes, AMPs, bacteriophage lysins, QS quenching enzymes, and enzymatic biofilm inhibitors are inherently unstable and rapidly broken down in the gastrointestinal system. Yet, compared to all other antibiotic alternatives, antibiotics have a higher ability to directly inhibit or kill germs. Moreover, antibiotics are produced using a single, relatively pure active component, and excellent manufacturing practices assure high levels of stability, uniformity, and quality. Humans have not yet discovered a method that is more clinically successful than choosing the right medications to treat the targeted bacterium [9].

The main justification for the EU's restriction on low dosage antibiotics as feed additives is antimicrobial resistance. Penicillium, the bacterium that makes penicillin, has actually coexisted with other bacteria for tens of thousands of years. Penicillin resistance was first identified after penicillin had been used extensively. While antibiotic alternatives have not yet been linked to bacterial resistance, with so many of these alternatives in use, bacteria may ultimately change to develop resistance. Drug pressure is proportionate to the likelihood of drug resistance developing and spreading. The irregular and unlawful use of antibiotic substitutes may have the same detrimental effects as the conventional usage of antibiotics.

Because of the unfavorable agricultural conditions and high disease incidence in many developing nations, antibiotics continue to be a useful tool in the prevention and management of animal illnesses. It has been shown that the EU's prohibition on growth boosters necessitates an increase in agricultural cleanliness. [10] Without a significant change in the production environment, the incidence of bacterial illnesses in the target animals will probably rise as the quantity of "old" antibiotics used in feed decreases as a result of the prohibition. This could result in more sophisticated antibiotics being used therapeutically, which might have unexpected consequences that present new problems for the public health. Moreover, there is no scientific data that distinguishes between the use of antibiotics for treatment and prevention in terms of the development of resistance. Political and societal pressure may cause the implementation of such a policy, but bacteria may not always "listen" to the policy-makers, thus it is important to weigh the benefits and risks before doing so. Hence, the choice to employ in-feed antibiotics should be founded on sound scientific principles. It is impossible to replicate the restriction on using antibiotics as growth promoters everywhere in the globe.

Traditional antibiotics' effectiveness still has room for improvement. Several "ancient" medicines are still effective against certain MDR bacteria by identifying novel bacterial targets. It has been shown that extended-spectrum-lactamase-producing E. coli (ESBL-Ec) infections may often be treated without the use of carbapenems. The association of molecules may also enhance the antibacterial activity of antibiotics, and novel formulations can enable targeted medication delivery through nanoparticles. Moreover, it is preferable to utilize broad-spectrum bactericidal medications in empirical treatment to eliminate the assumed infectious microorganism(s), which may or may not be MDR. It is crucial to switch to the most appropriate narrow-spectrum agent once an infection is under control and the results of the culture and susceptibility tests have been reported. This will reduce the possibility of negative drug effects and the risk of the emergence of antibiotic-induced resistance[11].

CONCLUSION

To maintain the long-term sustainable growth of animal husbandry, judicious use of antibiotics and ongoing research of antibiotic substitutes are required. For responsible use of antibiotics and the creation of regulations and policies governing their use, we must firmly specify the target animals, the length of the treatment, and the withdrawal time. In order to keep antibiotic resistance and food-chain residues within predetermined acceptable limits, we must also increase the oversight and enforcement of legislation. Additionally, since recent developments in Europe demonstrated a distinctly more positive outcome of the prohibition of antibiotic growth promoters than was anticipated during the first years after the prohibition due to an improvement in animal welfare, we must improve the management of animal nutrition and production hygiene. Alternatives to antibiotics will need much investigation. We should expand our research into the impacts of combining the use of antibiotics and their alternatives in order to preserve powerful antibiotics for effective human treatment in addition to doing research and developing innovative, safe, and effective substitutes.

REFERENCES

[1] H. Yang *et al.*, "Antibiotic application and resistance in swine production in China: Current situation and future perspectives," *Frontiers in Veterinary Science*. 2019. doi: 10.3389/fvets.2019.00136.

[2] A. Grant, C. G. Gay, and H. S. Lillehoj, "Bacillus spp. as direct-fed microbial antibiotic alternatives to enhance growth, immunity, and gut health in poultry," *Avian Pathology*. 2018. doi: 10.1080/03079457.2018.1464117.

[3] J. Park, J. H. Oh, H. K. Kang, M. C. Choi, C. H. Seo, and Y. Park, "Scorpion-venom-derived antimicrobial peptide css54 exerts potent antimicrobial activity by disrupting bacterial membrane of zoonotic bacteria," *Antibiotics*, 2020, doi: 10.3390/antibiotics9110831.

[4] A. Thakur, A. Kumar, M. Sharma, R. Kumar, and B. Vanita, "Strategies to Minimize the Impact of Antibiotic Resistance in Livestock Production System," *Int. J. Curr. Microbiol. Appl. Sci.*, 2019, doi: 10.20546/ijcmas.2019.803.273.

[5] M. Erdem Büyükkiraz and Z. Kesmen, "Antimicrobial peptides (AMPs): A promising class of antimicrobial compounds," *Journal of Applied Microbiology*. 2022. doi: 10.1111/jam.15314.

[6] G. Kulshreshtha *et al.*, "Antimicrobial effects of selected, cultivated red seaweeds and their components in combination with tetracycline, against poultry pathogen salmonella enteritidis," *J. Mar. Sci. Eng.*, 2020, doi: 10.3390/jmse8070511.

[7] L. Lin, N. Long, M. Qiu, Y. Liu, F. Sun, and M. Dai, "The inhibitory efficiencies of geraniol as an anti-inflammatory, antioxidant, and antibacterial, natural agent against methicillin-resistant staphylococcus aureus infection in vivo," *Infect. Drug Resist.*, 2021, doi: 10.2147/IDR.S318989.

[8] M. Nkansa, H. Agbekpornu, B. B. Kikimoto, and C. I. . Chandler, "Antibiotic Use Among Poultry Farmers in the Dormaa Municipality, Ghana. Report for Fleming Fund Fellowship Programme," *London Sch. Hyg. Trop. Med.*, 2020.

[9] P. N. Miroshnikov and K. V. Zhuchaev, "The Application Of Essential Oils In Livestock As An Alternative To Feed Antibiotics," *Innov. Food Saf.*, 2021, doi: 10.31677/2072-6724-2020-30-4-59-64.

[10] M. Hässig, S. Eugster, and F. I. Lewis, "Evidence-Based Use of Antibiotics in Meat Calves," *Open J. Vet. Med.*, 2015, doi: 10.4236/ojvm.2015.53009.

[11] PEIP-AGRI, "EIP-AGRI Focus Group Reducing antibiotic use in pig farming," *Eur. Comm.*, 2014.

CHAPTER 22
NANOTECHNOLOGY APPLICATION IN ANIMAL HUSBANDRY

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

While the use of nanoparticles in veterinary medicine and animal production is still relatively new, they have long been employed as diagnostic and therapeutic agents in human health. Due to rising concerns about microbial antibiotic resistance, the cattle sector has recently faced increased production pressures that rely on the use of antibiotics as growth promoters. Laws and regulations are being amended to stop the use of in-feed antibiotics in the animal production sector as a result of several nations reporting a rise in the prevalence of bacteria that are resistant to antibiotics. This creates the requirement for acceptable alternatives to be identified for inclusion in feed. Several studies have shown that nanoparticles may be effective candidates for antimicrobials and the stimulation of animal development.

KEYWORDS:

Animal Husbandry, Antibiotics, Animal Production, Nanotechnology, Vaccine.

INTRODUCTION

The only way to make agricultural output competitive is to introduce breakthrough technology quickly. This is true for both the acceleration of manufacturing procedures and the enhancement of their quality and safety, with a focus on minimizing adverse environmental consequences. Given that the environment is now contaminated by industrial and domestic waste, experts are gravely worried about the safety of meat, milk, eggs, and fish since human health directly relies on the quality of the food ingested. Nanotechnologies are techniques for managing nanoparticles that lead to the development of novel techniques for processing, manufacturing, state modification, characteristics, and product shape of raw materials, materials, or semi-finished goods [1].

Metals, polymers, natural chemicals, and nanostructured materials are the four classes of nanoparticles that are now in use or being developed. Nanoparticles may support a variety of biotechnical tasks via various methods of action, even if various engineering procedures are needed depending on the group. When huge bits of metal are reduced to nanosizes and powdered, the resulting physical characteristics of the resulting material are altered. These particles have attracted interest from the medical community because to their applications in imaging and as antibacterial treatments that lyse the cell walls of Gram positive and Gram negative bacteria. Certain metal nanoparticles may be better suited for external or topical administrations to prevent accumulating in the body, since some species may cause negative dosage-toxicity reactions, however this is not always the case. One significant disadvantage of these particles is that metal is not biodegradable. Polymers that have been produced or broken up into fragments that are just a few nanometers long are known as polymeric nanoparticles or nano-polymers. By attaching nano-polymers to different materials, their biocompatibility and degradation may be enhanced while their usefulness is increased. Since working doses of biocompatible nanoparticles will have little to no negative side effects on patients or consumers, biocompatibility is very helpful for the medical and food sectors. Polymeric

nanoparticles with a fluorescent or radiolabeled component may be employed for medical imaging similarly to the metal variants, however dose toxicity would still need to be taken into account. Natural materials with little processing, such as natural polymers or proteins, are used to create nanoparticles. Natural substances have a higher likelihood of being biocompatible, absorbed by the body, and degradable with few modifications. Synthesized nanoparticles, including lipid- and protein-based nanoparticles from natural substances, are used to create nanostructured materials. Natural and nanostructured nanoparticles may encapsulate or superficially adhere to functional groups, such as medications and nutrients, to act as the only functional unit or carriers. Nature-derived nanomaterials could seem to be a safer option, but if they are not properly developed or dispersed correctly in a biological system, they might cause hazardous or immunogenic reactions. Notwithstanding these possible drawbacks, using nanotechnology has considerably more benefits [2].

The production and processing of agricultural goods, agricultural engineering, and technical service are the primary areas of their use in the agro-industrial complex, according to the study of the established nanotechnological processes and nanomaterials. Figure 1 illustrates the areas where nanotechnology is being used in animal husbandry to produce highly productive animal breeds. The application of natural nanoproducts and nanotechnology in agriculture is led by the French business OLMIX. It is important to draw attention to research on the development of the organomineral complex, which became well-known under the trade name Amadeite, from among the many projects undertaken by the business. This is a novel nanomaterial - intercalated clay, the adsorption capability of which surpasses all current counterparts. Based on Amadeite, special medications were developed to promote the function of biocatalysis in animal digestive systems and to rid feed of pathogens, bacterial toxins, and mycotoxins.

Presently, 60 percent of feed contains insufficient amounts of carotene. As a result, entire feed production together with balancing additives and premixes must be established. Compound feeds, premixes, and BVMK are produced nowadays by modern businesses and are competitive with those from outside. According to tests, using nanoproducts boosts the profitability of livestock and poultry. Create strategies for employing nanoadditives to lower the dosages of tranquilizers and hormones used in products.

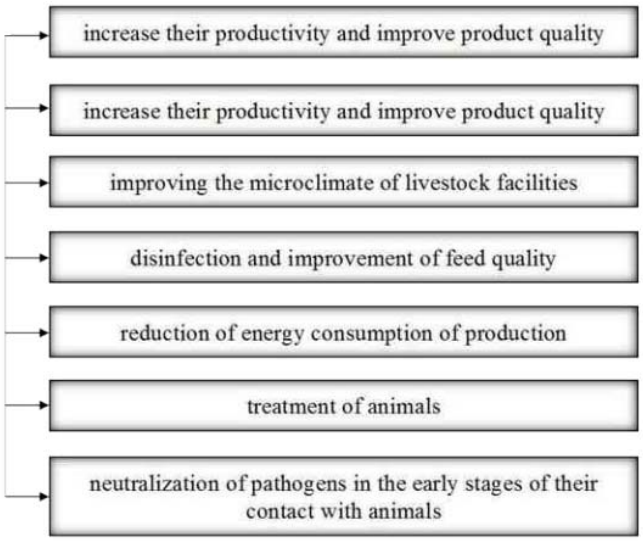


Figure 1: Illustrate the areas where nanotechnology may be used in animal husbandry.

The animal blood and organs are not adversely affected by the nanoadditive, which has no

hazardous effects. Environmentally friendly nanotechnology is being used by Russian scientists to electro-preserve silage using an electro-activated preservative. It is utilized as an alternative to costly organic acids that call for stringent safety regulations. By up to 95%, this innovative nanotechnology improves feed preservation. Animals may be fitted with biological nanodevices that enable real-time data transmission and process automation. Contemporary biological nanochips, in particular the species identification of pathogens of particularly serious illnesses and poisons, aid in the diagnosis of somatic and infectious disorders. Diseases of calves with a symptom complex of diarrhea throughout the neonatal and lactation periods are prevented and treated [3].

Nowadays, the technological prerequisites have been satisfied and the production of a vast group of nanomaterials based on the metals Ag, Cu, Co, Mn, Mg, Zn, Mo, and Fe has been developed. To boost the production of fish, birds, and other wildlife, iron nanoparticles are added to premixes. The biological function of silicon in living creatures and its constituents, silatrans, have been investigated in light of current advances in nanotechnology. From bacteria to people, living things at all phases of evolution are affected physiologically by silatrans. Materials containing antimicrobial silver nanoparticles were obtained. They are used as chlorine-free disinfectants, in dressings, and in veterinary medicine to control staphylococci and other pathogens. Filters, milking machines, and other pieces of dairy industry equipment are effectively equipped with silver nanoparticles to prevent milk fermentation. The method for producing "Slastik" fodder sugar via extensive grain fodder processing is created. The end result enables you to adjust cow diets for quickly assimilated carbs.

The presence of ammonia and carbon dioxide in the air is particularly hazardous for young animals with the increase of pig farm building by 110,500,000 heads, reaching the maximum permitted concentration of MPC (0.02 milligrams / l) in the summer. Polluted air is electrochemically cleaned without being released into the environment by passing through a nanodisperse water and slaked lime solution. Ultraviolet irradiation of hatching eggs and young birds for the goal of disinfecting them from harmful microorganisms and stimulating perinatal (during incubation) growth of young birds are two technical procedures of chicken farming made possible by nanoelectrotechnology. Research have revealed that dividing up the young birds on the floor enhances the hatchability of chickens to 94 and their preservation to up to 99% [4].

Ozone-ultraviolet irradiator (OZUF) installation experiments that were carried out in a chicken house for developing repair young stock in the Moscow area serve as an example of the potential for the adoption of nanoelectrotechnology in the practice of agricultural production. The feasibility of using such irradiators on chickens was demonstrated during the production testing, which also confirmed the efficacy of the UVFO irradiator's disinfection regime and technology as well as the beneficial impact of bactericidal UVA on the microclimate and microbial composition of the air.

DISCUSSION

Veterinarian Science

Nanomedicine is a fascinating topic in nanotechnology that is making development in both diagnostics and therapies. In biomedical research, metallic and nanostructured particles are helpful diagnostic instruments that may be utilized to see how a cell is doing or where a medicine is being distributed in the body. Magnetic resonance imaging (MRI) may be used to scan magnetic nanoform metals, such as iron oxide, in vivo at high concentrations. By two-photon excitation or light activation, nanostructured particles may glow. Exciting advancements in molecular-based lab-on-a-chip technologies for qualitative and quantitative

biological assessments have been developed in addition to these diagnostic nanoparticles. These lab-on-a-chip technologies are a desirable alternative because to their modest analyte and reagent volume requirements, little waste production, and reduction in waiting times. There are many microscale items on the market right now, and nanoscale products are only starting to appear.

Using fluorescent nano-carriers, drug distribution may be seen. To track the location of bound chemotherapies, for instance, light triggered, fluorescent nanostructured glucose and sucrose-derived nanoparticles may be utilized have shown the biocompatibility of carbohydrate-derived nanoparticles in a human lung cancer cell line. According to their research, the conjugate nanoparticles' cytotoxicity was shown to be comparable to that of cells treated simply with the chemotherapy medication methotrexate after binding to it. [5] The capacity to track the medicine is a benefit of using a nanoparticle to deliver this medication that fluoresces after being activated by light. A carrier nanoparticle that can be triggered by two-photon excitation may generate a 3D spatial picture across a larger tissue depth than a particle activated with visible UV light, allowing for even better tracking. Since chemotherapies are often administered in large dosage regimens, the ability to track their distribution in the body using fluorescence may assist to lessen unwanted side effects by directing them more precisely where they are needed.

All nanoparticle drug carriers do not exhibit fluorescence, and the ways in which they bind to and release drugs might differ significantly, particularly for nanostructured particles. Pharmaceutical substances may be trapped by cylindrical nanotubes within an internal matrix that is encased in a poly (L-lactide) or poly (D-lactide) layer on the outside. These enantiomers interact with one another in solution to change their shapes from cylinders to spheres, releasing any components that were previously confined. The two nanotubes must contact for the drug to be released; external stimuli, as in certain light-activated nanoparticles, are not necessary. Some nanostructured particles, such as albumin-dextran nanoparticles containing hydrophobic medicines, may be self-loading. By hydrophobic and electrostatic interactions, dextran-stabilized albumin from bovine serum may bind medication in aqueous solutions. Ibuprofen testing revealed that albumin-dextran nanoparticles could bind 0.7 units of the painkiller for every unit of the conjugated particle. In the future, these nanostructured materials may be used as a way to improve release selectivity and shorten the time between drug administration and action. They also propose novel mechanisms for pharmaceutical absorption and release in nanomedicine [6], [7].

Reproduction

Animals intended for slaughter are the center of animal production. Finishing animals are the descendants of individuals with superior genotypes and phenotypes who are meant for breeding. Breeders are highly valued for their characteristics and capacity for reproduction. Via the functional groups they contain, certain nanoparticles have been shown to improve fertility and preserve spermatozoa. Because to the lesser danger to producers and animals, artificial insemination is often used in animal production as a live cover strategy substitute. Artificial insemination, which is often used to increase the selection of livestock features and diversify genetic backgrounds, has the potential to be improved by the incorporation of nanotechnologies including non-invasive bioimaging of gametes, nanopurification, and cryoprotectants.

It is first necessary to understand the biology of cattle gametes and reproductive barriers to fertilization in order to maximize the effectiveness of artificial insemination. In order to better comprehend the mobility of mammalian spermatozoons and oocytes as well as their interactions in a physiological context, quantum dots have recently been investigated as a study

methodology. Since they are biocompatible, photo-stable, and have a higher signal intensity than organic fluorescent molecules previously employed to imaging gametes and other cell types in vivo, these self-illuminating, inorganic nanoparticles are of interest to the study of theriogenology. Using pig male gametes, showed that bioluminescent resonance energy transfer-conjugated quantum dot (BRET-QD) nanoparticles are capable of real-time monitoring in vitro, in situ, and ex vivo (Sus scrofa domesticus). Depending on their size, emission wavelengths, and conjugation options, quantum dots may provide targeted or non-targeted imaging. In a manner comparable to fluorescent proteins, but at larger tissue depths, this designed nano particle offers a novel technique to see the molecular and cellular activities occurring during fertilization. For in vivo imaging on bigger animals, a greater concentration of quantum dots may be needed since their signal intensity is dose-dependent. Given that many present quantum dots include heavy metals like cadmium and lead, which have the potential to be deadly at high concentrations, the composition of quantum dots should be further improved for biocompatibility. Cytotoxicity, however, may be reduced or even avoided if quantum dot concentrations and surface chemistries are properly chosen.

To distinguish unhealthy, unharmed sperm from damaged sperm, semen may be nanopurified. For a protein-based elimination approach, one technique is to coat magnetic nanoparticles with antibodies against ubiquitin, a surface marker of faulty sperm. Using magnetic nanoparticles coated with lectins, a lectin-based approach binds glycan revealed at the sperm's surface as a result of acrosomal destruction. As a result, more females may be fertilized with a single sample of diluted, nanopurified ejaculate. Further discovery of spermatozoa biomarkers will enable for greater selection ability and fertility enhancement, as targeted by the antibody or lectin techniques.

By using nano-protectant compounds in extenders, sperm cryopreservation may be improved. Extenders are buffering chemicals that are used to dilute sperm and provide it the nutrients it needs for long-term preservation. To stop bacterial growth from lowering sperm quality and infecting artificially inseminated females, they preserve and contain antibiotics. Future extender antibiotics could be replaced with antimicrobial nanoparticles as certain antibiotics have been shown to affect sperm motility and viability in a dose-dependent manner. Nanoparticles may also assist the incorporation of natural materials in extenders to boost sperm motility. According to research teams, sperm maintained at room temperature may live longer when honey, sugarcane juice, tomato juice, and pineapple juice are added if and , of It would be advantageous to use extenders with a larger capacity for preserving samples going through freeze-thaw cycles since sperm may be transported abroad over a number of days [8].

The increased use of nanoparticles in molecular biology methods may enable further developments in reproductive biotechnology. One such method is sperm-mediated gene transfer, in which proteins and nucleic acids may be loaded onto mesoporous silica nanoparticles. These nanoparticles have no negligible impact on sperm function or quality and may establish robust connections with spermatozoa in vitro. As long as modest doses of polymers are employed, transfections using polymeric nanoparticles such as PDMAEMA, chitosan, and polyethylenimine have been shown to be superior to those using conventional viral methods. The ideal molecular weight for PDMAEMA transfection has been established to be 60 kDa. The molecular weight of the nanopolymer has a significant impact on transfection efficiency and toxicity. With further research and development, nanoparticles could be very important in animal reproduction. Nonetheless, it should be emphasized that certain nanoparticles are spermatotoxic which may have major effects if animal reproduction is impaired. By weakening membranes and fragmenting DNA, zinc oxide and titanium oxide

nanoparticles are two examples that decrease in vitro sperm viability in a dose- and time-dependent manner. When zinc oxide nanoparticles were treated with human sperm, discovered that a concentration of 500 g/mL considerably increased cell death after 45 minutes and a dose of 100 g/mL significantly increased cell death after 180 minutes. The viability of buffalo sperm (Bubalus bubalis) cultured with 100 g/mL of titanium oxide nanoparticles was decreased. Titanium oxide was discovered to prematurely boost sperm capacitation, the last stage of sperm maturation needed for egg penetration and fertilization, at a concentration of 10 g/mL. Although using nanoparticles for the purpose of boosting reproduction may be a step in the right direction for the animal production business, care should also be taken[9].

Future Potential

The range of uses for nanotechnology in the animal production sector will grow as it advances and attracts more attention. It is likely possible in the near future to regularly add nano-supplements to livestock feed to improve it; however, it will take more time before nanoparticles completely replace antibiotics in feed because many biocidal candidates still need to be tested in vivo before going through clinical trials and food safety tests in accordance with government regulations. Nanoparticles have previously been used outside of animal production, such as in antiseptic wound dressings, and more will come. It is crucial to look at nanoparticle cytotoxicity in both cancer cell lines and normal, healthy cell lines for research interested in nanoparticles with anti-cancer potential. Claiming the nanoparticle under examination only has anti-cancer characteristics and only utilizing cancer cells may be deceptive since the nanoparticle may be harmful to all cell types. In vivo investigations are essential for verification of nanoparticle functionalities found in in vitro research. Table 3 lists nanoparticle studies pertinent to the animal agriculture sector as well as knowledge gaps that will call for more study [10].

CONCLUSION

The growth of molecular animal husbandry, a new branch of animal husbandry, is facilitated by the development of nanotechnology. Work on genotyping and molecular detection of hereditary animal illnesses for creating highly productive cow breeds has started in Tatarstan. The detection of genes linked to economic features, stress tolerance, infectious illnesses, as well as genes containing recessive mutations genetic disorders is a major focus of DNA technology today. Every invention has a unique chain of genesis and development. While it is currently difficult to evaluate the advantages of introducing nanotechnology to agriculture, it is reasonable to predict that doing so will lead to the following outcomes. Almost every aspect of agriculture uses nanomaterials and nanotechnology, including crop cultivation, animal husbandry, poultry farming, fish farming, veterinary medicine, processing industries, and the manufacture of agricultural equipment.

REFERENCES

[1] S. Jiang and Q. W. Shen, “Principles of gene editing techniques and applications in animal husbandry,” *3 Biotech*. 2019. doi: 10.1007/s13205-018-1563-x.

[2] Y. Zhou *et al.*, “Application of Bacillus coagulans in animal husbandry and its underlying mechanisms,” *Animals*. 2020. doi: 10.3390/ani10030454.

[3] Z. Deng, K. Hou, J. Zhao, and H. Wang, “The Probiotic Properties of Lactic Acid Bacteria and Their Applications in Animal Husbandry,” *Current Microbiology*. 2022. doi: 10.1007/s00284-021-02722-3.

[4] N. A. Zinovieva, N. A. Volkova, and V. A. Bagirov, "Genome Editing: Current State of Research and Application to Animal Husbandry," *Applied Biochemistry and Microbiology*. 2019. doi: 10.1134/S000368381907007X.

[5] Z. Yan, Z. Yan, S. Liu, Y. Yin, T. Yang, and Q. Chen, "Regulative Mechanism of Guanidinoacetic Acid on Skeletal Muscle Development and Its Application Prospects in Animal Husbandry: A Review," *Frontiers in Nutrition*. 2021. doi: 10.3389/fnut.2021.714567.

[6] N. Sonawane, D. Tekam, A. K. Bhanotra, and M. Sawant, "Role of mobile application in animal husbandry development," *ASIAN J. Anim. Sci.*, 2019, doi: 10.15740/has/tajas/14.1/16-22.

[7] G. Pen, N. Yang, D. Teng, R. Mao, Y. Hao, and J. Wang, "A review on the use of antimicrobial peptides to combat porcine viruses," *Antibiotics*. 2020. doi: 10.3390/antibiotics9110801.

[8] N. Báez-Quiñones, "Economic appraisal of the environment and its application in the Cuban animal husbandry sector.," *Pastos y Forrajes*, 2018.

[9] N. A. Zinovieva, N. A. Volkova, and V. A. Bagirov, "Genome editing: State of the art and application to animal husbandry," *Biotekhnologiya*, 2018, doi: 10.21519/0234-2758-2018-34-3-9-22.

[10] X. Yuan *et al.*, "A review on the preparation of chitosan oligosaccharides and application to human health, animal husbandry and agricultural production," *Carbohydrate Polymers*. 2019. doi: 10.1016/j.carbpol.2019.05.050.

CHAPTER 23
ROLE OF NANOTECHNOLOGY IN VETERINARY MEDICINE

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

The development of novel methods for manipulating materials at the nanoscale has advanced a number of medical fields. There are hundreds of nanomaterials available right now that may be classified based on their form, place of origin, or intended use. Nanotechnology offered fresh approaches to persistent issues. They are used for diagnostic purposes in the medical sciences or for medical treatments. They may also be used to create nanoadjuvants and nanovaccines. Their use to gene therapy and cancer treatment ushered in a new age of medicine. Many nanotechnology-related applications have recently begun to penetrate the veterinary industry. They are making growing inroads into the fields of animal medicines, diagnostics, veterinary vaccine manufacturing, farm disinfectants, animal breeding and reproduction, and even animal nutrition. Their substitution of widely used antibiotics has a direct impact on public health. By doing this, they lessen the issue of drug resistance in veterinary and human medicine as well as the issue of drug residues in milk and meat. Furthermore, sanitary and pet care items were developed using nanotechnology. In this overview, the benefits of employing nanomaterials over their analogs are discussed, along with the several kinds of nanoparticles and uses of nanotechnology in veterinary medicine.

KEYWORDS:

Animal Husbandry, Antibiotics, Animal Production, nanomaterials, Nanotechnology, Vaccine, veterinary medicine.

INTRODUCTION

The term "nanotechnology" was originally used in 1974 to refer to the use of scientific instruments for manipulating materials at the nanoscale. Typically, materials with one or more of their three dimensions measuring 1-100 nm are referred regarded as being on the nanoscale. Examples of naturally occurring nanoscaled biological components are DNA (2.5 nm width) and protein molecules (in average 5 nm). A human hair, on the other hand, is roughly 80,000 nm wide. The application of nanotechnology in biological research is now referred to as nanobiotechnology. Similar to this, nanomedicine is described as the use of various technologies based on nanotechnology to provide quicker and more effective solutions for medical issues or the treatment of diseases. It is not only able to solve the problems that traditional medicine faces, but it also makes it possible to comprehend diverse physiological and pathological processes. A thorough grasp of such processes opens up new opportunities and treatment ideas for issues that are currently present. There are also other terms in use, including nanotheranostics. They are brand-new compounds with simultaneous diagnostic and therapeutic effects. Their utilization provides us with useful information regarding medication distribution, release site, and interference effectiveness.

These details about the personalization of the personalization of the personalization of the personalization of the personalization of the personalization of the personalization of that individual [1] Smart therapeutic/diagnostic substance delivery assays have been made possible in recent years because to the remarkable advancements in nanotechnology. They have the ability to detect

illnesses before symptoms show up, treat diseased or cancerous cells alone while avoiding healthy ones, replace missing hormones or enzymes, and do much more. The smart delivery systems may be made to make decisions on their own via self-regulatory mechanisms in reaction to changes in temperature, pH value, or the presence of certain compounds. The newly created nanobiomaterials (usually 5- 20 nm in size) are made to resemble various biological receptors, ligands, DNA, and proteins structurally. Under certain biological circumstances, these structural resemblances enable their interaction with cellular membranes and tissues.

The biodegradable, lipid-based nanocarriers are one of the most popular nanobiomaterials. Their application stops nanoparticle bioaccumulation in cells and long-term toxicity. They are quickly absorbed and broken down by macrophages. The intended use, target cells' characteristics, the type and quantity of payload agents, the preference for tissue internalization versus a longer half-life in the circulation, the need for rapid excretion, the method of clearance (renal/reticuloendothelial system), the intensity of the contrast image, the bio-distribution, the desired level of immune system stimulation and the type of immunization, among other factors, all influence the choice of the appropriate size of nanoparticles [2], [3].

DISCUSSION

Because big NPs are often avoided because they may cause embolisms, certain sizes of NPs may be employed in medical domains. Moreover, they will be phagocytosed and removed from the circulation quickly. The incredibly tiny size of NPs ensures that the kidney will quickly eliminate them. In addition, when the ratio of their surface area to their volume rises, very small-sized materials may also become more poisonous and reactive, in addition to clearly increasing their biological and chemical reactivity. Reactive oxygen species (ROS) and free radical generation are thus increased. ROS that has been released cause oxidative stress, inflammation, and severe cell damage. The mitochondria are where the NPs love to gather, interfering with the cellular antioxidant defense system.

Nanoscale materials often differ from their counterparts in terms of their physical, chemical, and biological characteristics. The molecules become more reactive (bio-active) and better soluble as a result of size reduction. Their potential rises and they are more stable and resistant to oxidative inactivation. Based on this phenomenon, NPs are not only used as carriers but can also be used in the reformulation of conventional medications to increase their solubility, improve their pharmacokinetics, and decrease their side effects and immunotoxicity, for example, the cancer therapy drug Paclitaxel (Cremophor-EL) may cause anaphylactic reactions in susceptible patients, which can be avoided by using the nano-albumin formulation of Paclitaxel (Abraxane) [4].

Thus, the development of a new science for nano-pharmacokinetics is necessary owing to the novel properties that the same material acquires when it is nanosized. There are several varieties of recognized NPs at the moment. A nanoparticle typically has a core that is encased in a shell (capsule). One of two methods is intended for the NPs to deliver their burden to their targets. The medicinal or diagnostic chemicals either adhere to the NPs' surface or get encapsulated or imprisoned there. The NPs' capsulation is quite significant. It enhances imaging, drug loading, degradation, and diffusion. By using certain coating materials, it is possible to hide the particles and defend them from the immune system's assaults (such PEG), catalyst-induced destruction, and high pH conditions. The kind of capsule used affects the particles' load capacity, distribution, metabolism, excretion, stability within the body, and route of administration.

The fate of the NPs once they enter the cells differs depending on the endocytic/transport route that is being exploited. This is dependent on their physiochemical characteristics, which

include the material utilized, form, size, and charge. Comparing the newly produced NPs to conventional diagnostic and therapeutic agents, they offer revolutionary benefits. We have ground-breaking answers for conventional veterinary issues thanks to nanotechnology. It has limitless potential for several areas of veterinary medicine and animal health. The NPs may be used to kill a variety of animal diseases, including intracellular pathogens and blood parasites that cause severe chronic infections. The combined compounds have a high affinity for attaching to antibodies, making them useful for both therapeutic and diagnostic applications.

To create sophisticated nanovaccines, NPs may also attach to a variety of antigens and proteins. Nanovaccines might take the place of the currently utilized adjuvent and increase the duration of protective immunity due to the regulated release of the bound antigens. Nanotechnology is being used in veterinary medicine in a variety of ways that go beyond only disease prevention and management, making it more profitable for farmers to raise animals. Animal nutrition, reproduction, even animal welfare, and safety-derived items like body lotions and pet care products like Shampo are other uses for nanotechnology. The variety in the structure, characteristics, and nature of the created NPs is what enables such a wide range of nanotechnology applications. In the next sections of this review, several NP kinds and their uses in the area of veterinary medicine will be covered in more depth [5], [6].

They have an iron core (Fe3O4 or Fe2O3) that is covered in a shell of fluorescent silica that contains chemotherapy medicines. To the outer layer (polymeric shell) antibodies against tumor-specific antigens are linked. The polymeric shell aids in stability as well inside the particles. The shell must be black to prevent interfering with the fluorescence. They are employed as multifunctional theranostic complexes in numerous magnetic resonance medical applications for cancer detection and treatment because of their magnetic characteristics. Polyethylene glycol (PEG) is often coated on the particles to stop them from adhering to one another like magnets and to shield them from immune system assault. As an alternative, silica coatings in NPs employed as contrast agents in cancer imaging are chosen because they increase light absorption.

Ceramic nanoparticles, which are fully harmless and simple to construct, offer several benefits over other varieties. They are readily moldable into various shapes, porosities, and sizes. They provide defense for their load against high temperatures and low pH levels. Quantum dots: small crystals with a diameter of 2 to 10 nm that are semiconductor nanomolecules that can be activated by light. They were first developed for optoelectronic applications. The semiconductor portions are commonly manufactured of CdS, CdSe, CdTe, ZnS, and ZnSe (Torres-Sangiao et al. 2016).

The quantum dot is made up of an inorganic core and shell, as well as an aqueous coating that may be coupled to different biomolecules.There is a crystal within the core and they may create inexpensive, simple, long-lasting probes that often last for many hours or days. They may be marked with biomarkers like DNA or proteins, allowing blood samples to be screened for the presence of certain proteins, infections, and tumor markers. As a result, they are often used in immunodiagnostics and diagnostics.

The physical characteristics of quantum dots make them the best imaging agents. They also provide brand-new diagnostic, pharmacological discovery, and genetic analysis techniques. They can monitor medications and biomolecules in the body and observe cell pathways, which improves knowledge of physiological, pathological, and pharmacological research. Nanoemulsion: a mixture of water and stable oil droplets at the nanoscale. With the application of surfactant and co-surfactant, a thin layer is applied to the oil drop to stabilize them physically (not chemically). Oil-in-water and water-in-oil nano-emulsions are the two

different forms. Nanoemulsions are made using a variety of techniques, primarily high- or low-energy ones. According to Rodriguez-Burneo et al. (2017), low energy technique generated nano-emulsions are more stable at 4 °C and room temperature during a two-month period.

To create magnetic nanoemulsions, hydrophobic magnetic NPs may be added to the oil droplets. The iron particles retain their non-magnetic condition in the absence of external magnetic fields, and are smaller in size than the single domain NPs. In order to be steered to their goal by the introduction of a guiding external magnetic field, they revert to their initial magnetic characteristics as long as they are exposed to one.

Once the field is removed, they regain their non-magnetic condition but lose their magnetism. This is crucial to do in order to avoid the magnetic NPs adhering to one another within the body. The therapeutic efficacy of the nano-emulsions as bactericidal and viricidal medicines seems promising. Surface tension causes the oil droplets to stick to the membrane or envelope when they come into touch with bacterial or viral envelops in the animal body. Once they merge, the medicine is released into the bacterial cell.

They might serve as delivery systems for antigens in vaccination formulations. One nanoparticle may include a variety of antigens. As an antigen store, water in oil emulsion nanoparticles (NPs) on the other hand, release the antigens gradually, causing the production of large titers of antibodies. Some researchers are concerned about the negative effects of fat drops on RBCs and sperm cells if administered systemically, despite the fact that nano-emulsions are safe to employ since they have no impact on eukaryotic cells.

Nanotechnology applications in veterinary medicine

The same is made available to veterinarians through nanotechnology choices like the doctors, such as sophisticated disinfectants, tissue engineering, vaccine manufacture, medicines, and diagnostics. Animal health and production, animal breeding and reproduction, and animal nutrition all already make use of nanotechnology. The delivery of the medications directly in the target cells permits the use of extremely low dosages, which in turn minimizes the drug leftovers and withdrawal period in farm animals[7].

Uses of nanotechnology in the detection and treatment of animal diseases

For the most severe issues confronting veterinarians, such as TB, brucellosis, methicillin-resistant Staphylococcus aureus (MRSA), foot-and-mouth disease (FMD), and even diseases with intracellular or blood pathogens, nanotechnology provides ground-breaking answers. Trials to target the administered medicines to mastitic udders are now being looked at. One of the numerous benefits of using nanodrugs over traditional medications is their ability to make decisions on their own. For instance, when gentamicin is bound to a hydrogel by a peptide linker, the gentamicin remains inactive as long as the linker is there. Only Pseudomonas aeruginosa's protease enzyme is capable of dissolving the peptide linker, hence gentamicin can only be released and activated in the microbe's presence. The pathogenic microflora in the stomach may be bound by NPs that target bacterial toxins and receptors before being expelled from the body.

The creation of NPs paired with antibodies or nucleic acid allows the development of quick, sensitive, specific, and portable diagnostic procedures. The creation of nano- and biochips aided not only in the identification of infections but also in the comprehension of genetic risk factors. The high density nano-array chips can concurrently examine and find thousands of genes, antigens, or disease biomarkers. Moreover, DNA and protein microarrays were created to be employed in the analysis of gene expression and therapeutic efficacy. Target DNA or

protein detection was made possible even in nano- or pico-liter sample sizes with the advent of the LOC era (Lab-on-a-Chip). NPS was further used in a variety of diagnostic settings, including as an imaging agent for cat MRIs.

Nanovaccines and nanoadjuvants

The NPs are increasingly employed in the area of veterinary vaccine production. They perform basic immunomodulatory tasks that enhance the immune responses. They boost peptide cross-presentation and stimulate or modify the antigen-presenting cells. Moreover, they may function as adjuvants to delay the release of the antigens, enhancing the effectiveness of the vaccination. The antigen-loaded NPs may also specifically target lymph nodes, increasing the effectiveness of the vaccination. There have been many advancements made in the creation of various veterinary nanovaccines, including: (1) nano-emulsion vaccines, such as recombinant Bacillus anthracis spore-based vaccine and influenza virus vaccine, which develop mucosal immunity after intranasal administration; (2) PLGA NPs, such as Helicobacter pylori vaccine, Tetanus toxoid, Bordetella pertussis vaccine, Rota virus (e.g., TB vaccine).

For veterinary use, additional nanovaccines were created against FMD (based on gold nanoparticles), Newcastle disease (nanocapsulated to be administered orally), influenza virus (poly gamma glutamic acid vaccine to be applied intranasally or nanopatch TM to be applied topically), or herpes simplex virus 2 (on calcium phosphate NPs). Additionally, empty capsid and core like particle vaccines (CLPs) of African horse sickness (the outer capsid proteins).

In vitro animal reproduction and nanotechnology

The area of animal reproduction has a variety of nanotechnology applications that improve the overall reproductive performance at various phases, beginning with the diagnosis and treatment of reproductive problems, detection of Estrus to sperm sorting and freezing, and finishes with nanodevices directly interfering with calving and managing reproductive issues such retained placenta. The NPs may be used to provide reproductive hormones over an extended period of time. They guard the provided hormones and vitamins from oxidation and degradation (for example, vitamins and steroid hormones) as well as hydrolysis (e.g., gonadotropic hormones). Nanosensors are very sensitive, nanoscale devices that come with movable biomolecule probes. The nanomaterial-based probes are often employed for diagnostic reasons. They may be modified to detect estrus as well as metabolic and hormonal problems, as well as infectious infections of the vaginal tract [8].

The tubes are inserted under the skin of the calves and glow when the cows enter the estrus cycle. For the purpose of cow monitoring, the test uses estradiol sensors to measure the hormone level in the blood and transmit real-time measurements of the cows to a centralized computer. Nanocapsules containing bull semen may be aimed to the ovum in order to fertilize cows. Sperm and oocyte sorting may be done with the use of nanotechnology. The ability to choose the fetus's sex using biochips is currently being developed. Embryos or sperms may be cryogenically preserved using nanosystems. The ultra-quick freezing and subsequent rapid and homogenous thawing of the gametes by laser light are made possible by microinjecting cryoprotectant propylene glycol containing the gold/metal NPs. The whole procedure was carried out on a chip using the microfluidics method.

Depending on the toxicity of particular metals NPs, like cadmium, when administered in low concentrations, the NPs may potentially be utilized for animal sterilization as contraceptives. The animals' reproductive system is where the metal NPs will have their greatest impact. They may also utilize antibodies attached to NPs or heating the gonads using external magnetic field to avoid the usage of harmful NPs approach.

Nanotechnology in animal welfare

Pet health care is a developing sector globally. The creation of new pet goods also used nanotechnology. Their physical and chemical characteristics aided in the creation of surface disinfectants and deodorizers. The manufacturing of pet care products often incorporates nanotechnology, like with shampoos that include silver nanoparticles[9], [10].

CONCLUSION

Several different types of nanoparticles have been created because to the quick progress in developing and manipulating nanomaterials. In turn, this permits customization of the interferences from medicine. All areas of veterinary medicine, including diagnosis, treatment, immunization, animal production and reproduction, nutrition, and cleanliness, have seen dramatic advancements because to nanotechnology.

REFERENCES

[1] L. B. Ianiski *et al.*, "Nanotechnology in veterinary medicine: a review," *Ciência Rural*, 2022, doi: 10.1590/0103-8478cr20210195.

[2] A. El-Sayed and M. Kamel, "Advanced applications of nanotechnology in veterinary medicine," *Environ. Sci. Pollut. Res.*, 2020, doi: 10.1007/s11356-018-3913-y.

[3] *et al.*, "A Review on Concept of Nanotechnology in Veterinary Medicine," *ES Food Agrofor.*, 2021, doi: 10.30919/esfaf481.

[4] D. P. Bai, X. Y. Lin, Y. F. Huang, and X. F. Zhang, "Theranostics aspects of various nanoparticles in veterinary medicine," *International Journal of Molecular Sciences*. 2018. doi: 10.3390/ijms19113299.

[5] P. Vikrama Chakravarthi and S. N. Balaji, "Applications of nanotechnology in veterinary medicine," *Vet. World*, 2010, doi: 10.5455/vetworld.2010.477-480.

[6] Ali Bilgili and M. Haydar Uysal, "Use Areas of Nanotechnology in Veterinary Medicine," *J. Food Sci. Eng.*, 2019, doi: 10.17265/2159-5828/2019.06.003.

[7] M. Z. Troncarelli, H. M. Brandão, J. C. Gern, A. S. Guimarães, and H. Langoni, "Nanotechnology and Antimicrobials in Veterinary Medicine," *Microb. Pathog. strtegeies Combat. them Sci. Technol. Educ.*, 2013.

[8] A. Ali *et al.*, "Role of nanotechnology in animal production and veterinary medicine," *Tropical Animal Health and Production*. 2021. doi: 10.1007/s11250-021-02951-5.

[9] J. A. Coppo, "Nanotecnología, medicina veterinaria y producción agropecuaria," *Revista Veterinaria*. 2009. doi: 10.30972/vet.2011886.

[10] F. R. Varallo, M. Forgerini, M. T. Herdeiro, and P. de Carvalho Mastroianni, "Harmonization of Pharmacovigilance Regulation in Brazil: Opportunities to Improve Risk Communication," *Clin. Ther.*, 2019, doi: 10.1016/j.clinthera.2019.01.013.

CHAPTER 24
A STUDY OF THE USE OF NANOTECHNOLOGY IN CONTEMPORARY VETERINARY SCIENCE

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

The word "nanotechnology" describes the processing of materials at the atomic or molecular level, particularly for the creation of minuscule devices capable of calculation, function, and organization. The size range of 1–100 nm is often referred to as the microscopic level. For this particular post, we choose to examine how nanotechnology is used in veterinary care and emphasize its contributions to bettering animal health and productivity. With the creation of a system for the distribution of smart medications, nanotechnology has a major impact on the treatment of illnesses in veterinary medicine and other facets of animal production. These days, nanotechnology has completely changed veterinary medicine and animal science fields by introducing novel, miniature tools and materials that are advantageous to living things. Quantum dots, polymeric nanoparticles, magnetic nanoparticles, nanopores, nanoshells, fullerenes, liposomes, and dendrimers are a few examples of the nanoparticles utilized for illness diagnosis, therapy, drug administration, animal breeding, and reproduction. While nanotechnology is recognized as one of the most important technologies that has previously been used in a variety of fields, veterinary science is just just beginning to use it.

KEYWORDS:

Animal Husbandry, Antibiotics, Animal Production, nanomaterials, Nanotechnology, Vaccine, veterinary medicine.

INTRODUCTION

The capacity to compute, operate, and arrange matter at the nanoscale is known as nanotechnology. The scale normally refers to the matter in the size range of 1-100nm in at least one dimension but is frequently expanded to encompass materials in size below 1nm. It is not restricted to a single industry; rather, it is an enabling collection of technology that spans all industries and academic fields. Nanotechnology makes use of the principles and methods of the nanoscale to comprehend and alter biosystems, which make use of biological ideas and components to create new nanoscale systems and technologies. Among the most astounding man-made materials, rationally created nanostructures display unique chemical, physical, and/or biological properties. Because of these qualities, nanostructures may be used in an extraordinary range of industries, including electronics, agriculture, and health care.

Closing the gap between macroscopy and microscopy, where nanoparticles are the ideal medium to connect with biological systems, is one of the main advantages of nanotechnology. Large active surfaces, readily adjustable surface chemistry that enables binding to tiny molecule medicines, imaging labels, and ligands including antibodies, peptides, and nucleic acids are just a few of the characteristics that set nanoparticles apart from bulk materials. Also, because of their tiny size, they may interact only intracellularly and extracellularly, allowing for greater permeability and retention in tumor tissues as well as extravasation through endothelial cells [1]. It is anticipated that in the twenty-first century, nanotechnology will make a significant number of advances that will increase the practice of clinical veterinary medicine

and have the potential to revolutionize veterinary care, animal welfare, and other aspects of animal production. Animal nutrition scenarios ranging from nutrient uptake and use, animal waste adjustment as expelled from livestock, pathogen detection, and much more will be made possible by veterinary nanotechnology. It will also improve systems of diagnosis and treatment delivery, offer new gears for molecular and cellular breeding, animal history from birth to consumer table, and much more. In this study, we choose to examine the use of nanotechnology in veterinary care and emphasize its contributions to bettering animal health and productivity.

Categories for nanoparticles

Nanoparticles are minuscule particles that range in size from 1 nm to 100 nm. Throughout the last several decades, a wide range of newly created materials have been used to create particles such as nanocrystals, polymers, dendrimers, silica oxides, carbon, metal oxides, lipids, and quantum dots. These are some of the often-utilized nanoparticles.

Fullerenes

Fullerenes are nanoparticles made completely of carbon-based compounds. Its potential for application in nanomedicine has been thoroughly investigated, and their usage in the industrial industry is already well-established. High aspect ratio, thermal, electrical, and mechanical properties are only a few of the qualities that carbon nanoparticles possess that make them effective in treatment and regenerative medicine. Carbon Nanotubes (CNTs), which may have a single or many walls, are one of the fullerenes utilized in nanotechnology that are most often employed (SW, MW). Due to their 'needle-like' capacity to penetrate cells and ability to obtain nuclear exposure by shortening their length, SWCNTs provide a novel method for drug delivery. As CNTs may be charged or conjugated with medications to increase therapeutic efficiency, this phenomenon is very helpful[2].

Atomic dots

Nanocrystals called quantum dots, which range in size from 2 to 10 nm, may glow when exposed to light. They are made up of an inorganic core, whose size determines the hue of the inorganic shell that is released, and an aqueous organic coating that is mixed with biomolecules. It may be utilized for both clinical and diagnostic biological objectives. It can also be used to image sentinel nodes in cancer patients in order to stage tumors and plan treatment.

Liposomes

Liposomes are artificial nanoscale-sized spheres made of cholesterol and phospholipids from nature. The first medication delivery system to be tested used liposomes. These are colloidal or micro-particular carriers, generally ranging in size from 80 to 300 nm. They may be used as efficient medication administration methods. When administered as liposomal medications as opposed to conventional formulations, toxic and cancer-treating medications such amphotericin and hamycin exhibit higher effectiveness and protection.

Nanoparticle magnets

The capacity of antibodies to attach to the surfaces of magnetic nanoparticles, such as iron oxide paramagnetic compounds, and the potential for targeting using an external magnetic field make them interesting candidates for the therapy of illness. Superparamagnetic iron oxide nanoparticles with a diameter of less than 10 nm and exceptional magnetic characteristics are often the most effective materials. The term "ferromagnetic fluids" or "ferrofluids" refers to tiny, thermally agitated magnets that exist in liquid form. In order for super-paramagnetism to

occur, a magnetic field must be present; if this field is absent, magnetization will disappear, particles will stop interacting, and possible vascular embolization may be averted.

Nanopores

Desai and Ferrari first proposed the idea of nanopores in 1997. consists of wafers with a high porosity density and a maximum diameter of 20 nm. The holes let the movement of insulin, glucose, oxygen, and other substances. Using nanopores may help shield transplanted tissues from the host defensive mechanism. Pancreatic cells might be placed within the recipient's body after being folded inside the nanopore system. This tissue sample avoids rejection because it takes up nutrients from the neighboring tissues while evading detection by the immune system. It might be used as a more modern therapy for diabetes mellitus that is insulin-dependent.

Nanoshells

West and Halas have both manufactured nanoshells. A thin metal coating covers the silica nucleus nanoparticles that make up nanoshells. This may be administered utilizing immunological techniques to the right tissue. Tumor treatment is being investigated using this method. Using nanoshells that display the nanoshell's thermoablative feature, which is the ability to absorb infrared radiation when exposed from a source outside the body.

Nanotechnology applications in veterinary science

For the creation of nanoscale pharmaceuticals, controlled delivery systems, contamination detection, and the creation of molecular and cellular biology nanodevices, nanotechnology is employed. In addition to playing a crucial part in disease prevention via the adoption of a smart medication delivery system, it will play a significant role in the domains of animal welfare, veterinary care, and other animal production. One presently under development use of nanotechnology in medicine is the use of nanoparticles to deliver medications or other ingredients to certain cell types. Particles are designed to gravitate toward sick cells, causing certain cells to be handled directly. This is an overview of some of the most significant nanotechnological techniques in veterinary research.

Nanovaccines

A novel approach to immunization is emerging: the nanovaccine. Compared to conventional immunizations, nanovaccines may activate the immune system's humoral and cell-mediated responses. They hold the potential of diverting the body's immune system to attack pathogens and prevent the spread of infections and disorder. The tradition of using live, dead creatures for immunization has been replaced with a candidate that is far safer: synthetics and recombinants. Many novel vaccine candidates need a designed adjuvant that improves immunogenicity since they are often weakly immunogenic and susceptible to deterioration.

The development of nanotechnology has led to a number of innovative antigen-carrying techniques since traditional adjuvants are not adaptable. Such adjuvants based on nanoparticles may be created for a comfortable route of administration and a lower dosage frequency to produce a specific target immune response, such as the intranasal route to enhance the target mucosal immunity. This makes them especially well-suited for veterinary care, where handling several animals at once is necessary, or when standard immunization methods are impracticable because of extensive management systems or a lack of accessibility.

Nanopharmacuetics

In contrast to other areas of veterinary medicine, pharmacology and nanopharmaceuticals are at the forefront of what nanotechnology can create. Reiterating that nanotechnology makes it possible to produce new medications and has the potential to modify existing ones in order to improve their effectiveness is crucial while taking into account the area of pharmacology. As comparison to the free product equivalents, the pharmacokinetics and therapeutic indices of the drugs may be significantly improved by attaching them to nanoparticles by physical encapsulation, adsorption, or chemical conjugation. Treatment for intracellular infections brought on by bacteria involves the use of drug-charged nanoparticles that enter host cells by endocytosis and subsequently release drug payloads [3].

The use of nanoparticles for medication administration has various advantages, including improving the therapeutic effectiveness and pharmacological characteristics of the medicine. The efficiency of nanoparticles in increasing pharmacokinetics, minimizing undesirable side effects, and optimizing transmission to disease locations has been shown by many nano-drug delivery methods. Since the active ingredient is concentrated just in the morbid region during this technique, the needed amount of the medicine is employed, and side effects are significantly reduced. Patients' fees and discomfort will be decreased by using this highly focused strategy.

In turn, the use of nanoparticulate drug carriers will solve a number of significant drug delivery issues, such as improving drug solubility and safety, lengthening drug half-lives in the blood, minimizing side effects in organs other than the target, and concentrating drugs at the site of the disease. A drug may be dispersed in a hydrophobic nucleus, encased in a vesicle, disseminated over a gel, or attached to a nanoparticle sheet. Liposomes, polymeric nanoparticles, dendrimers, ceramic-containing capsules, micelles, and other nanoparticle-based drug delivery systems have all been employed to transport therapeutic agents for small molecules, peptides, and oligonucleotides.

Liposomes, which are spherical vesicles made of phospholipids and steroids, bilayers, or specific surfactants that shape spontaneously when other lipids are dispersed in aqueous conditions where liposomes may form, were the first to be examined as drug carriers. Drug solubility and pharmacokinetic features, such as the therapeutic index of chemotherapeutic medications, faster synthesis and a decrease in negative side effects, as well as an increase in in vitro and in vivo anticancer behavior, have all been found to be improved by liposomes. Drugs are encapsulated and then placed into liposomes. Drug release from liposomes is influenced by the liposome's structure, pH, osmotic gradient, and ambient conditions. Via adsorption, fusion, endocytosis, and lipid transition, lipidomal interactions with cells may be understood. There are several drug sources for liposomal formulations of anticancer drugs, neurotransmitters, antibiotics, and anti-inflammatory drugs.

Dendrimers have a broad range of use in drug delivery due to the molecular variety's potential therapeutic value. Dendrimers have a number of adaptable divisions with holes where drug molecules may physically bind. Fantastic encapsulation results from this little design. Its structure has a significant influence on nanotechnology by supplying well-controlled useful building components. They serve a number of purposes, including medicine delivery and cancer therapy. Dendrimers are employed effectively in drug delivery because they provide a drug at a precise rate by chemical manipulation, either by adjusting the hydrolytic release conditions or by selectively releasing drug molecules based on their shape or size. Rapid pharmacological responses and increased efficacy have been shown with high-load dendrimers.

Instead, stronger and more stable carbon nanotubes may also be used as product transporters. Cell specificities may be achieved by binding antibodies to carbon nanotubes with fluorescent or radioactive tagging. Nanotubes may enter cells either by cell membrane penetration or endocytosis. Carbon nanotubes may be made more soluble and utilized to carry drugs and other compounds by including carboxylic or ammonium groups into their arrangement.

DISCUSSION

Animal reproduction and breeding

In the areas of reproduction and reproduction, nanotechnology has begun to thrive. Such nanotechnology-based animal reproduction studies aim to characterize the nanoscale properties of gamete cells using atomic force microscopy and similar scanning microscopy techniques, construct nano-bio sensors for physiological or altered detection of the reproductive status, develop chemical strategies for the production of metal nanoparticles for fertility control applications, develop nanodevices for secure cryopreservation of gametes and embryos, and develop nanodevices for secure cryopreservation of sperm and eggs [4].

For dairy producers and pig farmers, managing the breeding process may be expensive and time-consuming. A nanotube implanted beneath the skin is one method now being investigated to allow real-time monitoring of changes in blood estradiol levels. Since the nanotubes can bind and detect the estradiol antibody by near-infrared fluorescence during the time of estrus, they are utilized to monitor estrus in animals. A central breeding monitoring and control system will include the signal from this sensor to actuate it. Moreover, nanotechnology tools like microfluidics, nanoparticles, and bioanalytic nano-sensors may help to find answers to other conundrums regarding animal health, development, and disease prevention and treatment. Modern techniques for enhancing traditional in vitro fertilization processes and the growth of in vitro embryos include microfluidic and nanofluidic. Recent studies have shown how effective microfluidics are in insulating motile sperm without the need for centrifugation.

Disease detection

In veterinary medicine, a disease's diagnosis may take a few days, a few weeks, or even a few months, especially in the case of chronic disorders without any outward signs of illness. There may have been an infection at that point, necessitating the euthanization of the whole herd. Nanotechnology has the potential to be identified and eliminated extremely early since it functions on the same scale as a virus or disease-infecting particle. As a result, nanotechnology may be an effective tool for delicate clinical diagnostics. The employment of nanotechnology tools for the investigation of animal illnesses or as animal models for the diagnosis of human diseases is exceptional, according to one school of thinking on health. Recent research suggests using quantum dots for in vivo imaging in tiny animal models.

Individual Photon Emission Unlike to CT and MRI, which only give anatomical information, nuclear medicine imaging modalities such as computed tomography (SPECT) and positron emission tomography (PET) provide metabolic and functional information. The combination of SPECT and PET with CT and MRI, however, offers comprehensive anatomical and metabolic data [5], [6]. Use non-invasive, targeted molecular imaging modalities that provide anatomical and physiological in vivo information to perform functional molecular alterations in vivo in order to control disease progression before it manifests with conventional morphological imaging techniques or laboratory tests. These molecular imaging techniques are provided by nuclear medicine by tracking how radiopharmaceutical substances (gamma and positron-emitters) are absorbed by the patient's body and seen by SPECT or PET scanners.

Cancer diagnosis and therapy

Cancer is a prevalent disease that has been the subject of much investigation. Conventional chemotherapeutic agent treatments have an effect on patients with various adverse concerns since they are not selective to tumor cells. The objective is to develop a mechanism that may use medicines to destroy cancer cells while preventing healthy ones in order to solve the issue. According to some, nanotechnology is a cutting-edge, intelligent technology that develops tools with the ability to distribute medications to various parts of the body. Submicron nanoparticles comprised of various components or devices are examples of such systems.

Because to the unique attribute of having a high surface-to-volume ratio, various functional groups may connect to nanoparticles and bind to specific tumor cells. Nanoparticles' modest size (10–100 nm) enables them to be collected preferentially at tumor locations since malignancies don't have a sufficient lymphatic drainage system. It is possible to create multifunctional nanoparticles that can recognize, diagnose, and then treat a tumor as a prospective cancer treatment [7], [8].

For the purpose of determining treatment strategies and evaluating their effectiveness, imaging cancer is crucial. Traditional imaging modalities like MRI and ultrasound may now better identify cancer thanks to the use of nanoparticles for picture comparison and enhancement. Other methods like optical-based cancer detection imaging have also been made possible. The effectiveness of the medication's ability to target and kill cancer cells while leaving healthy cells unharmed is directly related to the effectiveness of the therapy. So, one of the most important properties of innovative anticancer medicines would be their high level of selectivity for cancer cells. In this area, combining nanotechnology with medicine offers a viable way to enhance cancer treatment [9]–[11].

CONCLUSION

In summary, nanotechnology allows us to engage at the nuclear and molecular levels to investigate, control, and apply nanometer-dimensional space. It is an exciting and rapidly developing area of engineering. It has made new potential uses in molecular biology and biotechnology possible. By delivering in-depth information and revealing what is happening within an organism's inner anatomy, nanotechnology has changed practically all of the veterinary and animal science fields, particularly in industrialized nations. Comparative to other sister disciplines, nanotechnology is regarded as one of the major advancements now employed in a variety of domains, although it is still in the early phases of application to veterinary science. In addition, the technology's complexity and expensive cost made it difficult for underdeveloped nations, in particular, to utilise it in the field of animal research.

REFERENCES

[1] A. M. Almeida *et al.*, “Domestic animal proteomics in the 21st century: A global retrospective and viewpoint analysis,” *Journal of Proteomics*. 2021. doi: 10.1016/j.jprot.2021.104220.

[2] J. Reid, A. M. Nolan, and E. M. Scott, “Measuring pain in dogs and cats using structured behavioural observation,” *Veterinary Journal*. 2018. doi: 10.1016/j.tvjl.2018.04.013.

[3] L. Broz, A. G. Arregui, and K. O’Mahony, “Wild Boar Events and the Veterinarization of Multispecies Coexistence,” *Front. Conserv. Sci.*, 2021, doi: 10.3389/fcosc.2021.711299.

[4] K. E. Littlewood and N. J. Beausoleil, “Two domains to five: Advancing veterinary duty

of care to fulfil public expectations of animal welfare expertise," *Animals*. 2021. doi: 10.3390/ani11123504.

[5] R. D. Cardiff, J. M. Ward, and S. W. Barthold, "'One medicine - One pathology': Are veterinary and human pathology prepared?," *Laboratory Investigation*. 2008. doi: 10.1038/labinvest.3700695.

[6] J. Johnson *et al.*, "The first shared online curriculum resources for veterinary undergraduate learning and teaching in animal welfare and ethics in Australia and New Zealand," *Animals*, 2015, doi: 10.3390/ani5020362.

[7] Q. Groom *et al.*, "Holistic Understanding of Contemporary Ecosystems Requires Integration of Data on Domesticated, Captive and Cultivated Organisms," *Biodivers. Data J.*, 2021, doi: 10.3897/BDJ.9.E65371.

[8] H. M. Mamzer, "Ritual Slaughter: The Tradition of Pilot Whale Hunting on the Faroe Islands," *Frontiers in Veterinary Science*. 2021. doi: 10.3389/fvets.2021.552465.

[9] T. E. Nash, "Illustrated Dictionary of Parasitology in the Post-genomic Era," *Clin. Infect. Dis.*, 2018, doi: 10.1093/cid/cix978.

[10] Ö. G. Dilek, R. Dimitrov, and K. Stamatova-Yovcheva, "The role of imaging anatomy in the contemporary anatomical studies of domestic rabbits in veterinary and agricultural science," *Bulg. J. Agric. Sci.*, 2019.

[11] E. King *et al.*, "Qualitative research in veterinary medical education: Part 1-principles of qualitative design," *J. Vet. Med. Educ.*, 2021, doi: 10.3138/JVME-2019-0101-P1.

CHAPTER 25
ADVANCE APPLICATION OF NANOTECHNOLOGY IN VETERINARY MEDICINE

Dr. R.L. Meena, Assistant Professor,
School of Agricultural Sciences, Jaipur National University, Jaipur, India,
Email Id- r.l.meena@jnujaipur.ac.in

ABSTRACT:

Nanotechnology applications serve as the testing ground for more experimental and contentious methods, such as sex selection in breeding and nanocapsule vaccinations. Nanotechnology has several uses in veterinary medicine, including the detection and treatment of diseases, the delivery of drugs, the breeding of animals, and the enhancement and improvement of food products made from animals. The patterns of diagnosis and treatment are being changed quickly, cheaply, and in a shorter amount of time. The use of nanotechnology in veterinary care has generally been quite extensive, and additional research into the technology's practical applications for creating a sustainable demand and supply system that meets human needs in an ever-evolving environment is highly encouraged.

KEYWORDS:

Agriculture, Environment, Nanotechnology, Veterinary Medicine, Vaccines.

INTRODUCTION

Throughout the years, nanotechnology has evolved into a new enabling technology with immense potential, and is no longer just a notion or vision of the future world potential to change the global cattle and agricultural industries, including in India. New tools for molecular and cellular biology, biotechnology, veterinary physiology, reproduction, and many other fields may be made available via nanotechnology. Nanotechnology might be used to the science and engineering of agricultural, animal, and food systems in a number of ways, including disease detection. Research and development in nanotechnology are focused on comprehending and using methods for seeing, measuring, and controlling matter at the atomic, molecular, and supramolecular levels.

This corresponds to length scales between one and one hundred nanometers. A tailored medication delivery system might be activated by the farmer and veterinarian once a disease is detected since the physical, chemical, and biological characteristics of materials at this scale alter fundamentally and often unexpectedly. This is possible with nanotechnology and could allow for a variety of advancements in the fields of agriculture, animal sciences, and veterinary medicine, such as the conversion of food and agricultural wastes into energy and other useful byproducts through enzymatic Nano bioprocessing, advancements in reproductive science, breeding management, disease prevention and treatment in animals, and improvements in public health through food safety [1].

The uses of nanotechnology

The potential uses for nanotechnology in connection to livestock are nearly unbelievable, and they include issues with animal health, productivity, reproduction, and excellent hygiene procedures while raising and caring for food animals. While there is still considerable work to

be done and significant corporate advances to be made before nanotechnology is widely used in veterinary and animal sciences, there are many glimpses of applications.

While the use of nanoparticles in veterinary medicine and animal production is still relatively new, they have long been employed as diagnostic and therapeutic agents in human health. Due to rising concerns about microbial antibiotic resistance, the cattle sector has recently faced increased production pressures that rely on the use of antibiotics as growth promoters. Laws and regulations are being amended to stop the use of in-feed antibiotics in the animal production sector as a result of several nations reporting a rise in the prevalence of bacteria that are resistant to antibiotics. This establishes the need for acceptable substitutes to be developed for inclusion in feed. Nanoparticles may make suitable candidates for antimicrobials and the enhancement of animal development, according to several publications. The purpose of this post is to analyze the present state and developments of nanotechnological applications in animal production. Emerging roles for nutrition delivery, biocidal agents, and instruments in veterinary care and reproduction will also be covered. The effects on the quality of milk, eggs, and meat will also be shown.

The study of materials at the nanoscale is known as nanotechnology. Nanomaterials, which typically have at least one dimension between 1 and 100 nm (109 - 107m), are better known as particles. These nanoparticles are especially desirable because they occupy very little volume but have very high surface areas, increasing the ratio of surface to inside atoms. As a consequence, when bulky materials are reduced to nanosizes, their surface chemistries take on a greater role and change the material's physical characteristics. For instance, copper is renowned for being malleable, which makes it a good material for wiring and plumbing. Copper loses its malleability when it is reduced to a nanoscale because its surface atoms are rigid. While the surface atoms in the nanoform outnumber the internal copper atoms in a larger form, the latter facilitates bending. The surface area to volume ratio of nanoparticles may be increased to make them more adaptable as either a single functional unit or a carrier for other functional units that can be attached to or enclosed inside them. As new applications are found for nanoparticles, including gene therapy vehicles and medical diagnostics, their appeal grows [2].

NANOPARTICLE TYPES

Metals, polymers, natural chemicals, and nanostructured materials are the four classes of nanoparticles that are now in use or being developed. Nanoparticles have the potential to enable a variety of biotechnological tasks via various mechanisms of action, even if different engineering procedures are needed depending on the group. When massive chunks of metal have been reduced to nanosizes and powdered, the corresponding physical characteristics of the metal have been altered. These particles have attracted the interest of the medical community because to their applications in imaging and as antibacterial treatments that lyse the cell walls of Gram positive and Gram-negative bacteria. Certain metal nanoparticles may be better suited for external or topical administrations to prevent accumulating in the body as some species might cause negative dosage-toxicity reactions, however this is not always the case.

One significant disadvantage of these particles is that metal is not biodegradable. Polymers that have been produced or broken up into fragments that are just a few nanometers long are known as polymeric nanoparticles or nano-polymers. Other materials may be grafted with nano-polymers to possibly increase their biocompatibility and resistance to degradation while also increasing the range of applications for such materials. Since working doses of biocompatible nanoparticles will have little to no negative side effects on patients or consumers,

biocompatibility is very helpful for the medical and food sectors. Polymeric nanoparticles having a fluorescent or radiolabeled component, similar to metal variants, may be employed for medical imaging, however dose toxicity would still need to be taken into account. Natural materials with little processing, such as natural polymers or proteins, are used to create nanoparticles. Natural substances have a higher likelihood of being biocompatible, absorbed by the body, and degradable with few modifications. Synthesized nanoparticles, including lipid- and protein-based nanoparticles from natural substances, are used to create nanostructured materials. Natural and nanostructured nanoparticles may encapsulate or superficially adhere to functional groups, such as medications and nutrients, to act as the only functional unit or carriers. Nature-derived nanomaterials could seem to be a safer option, but if they are not properly developed or dispersed correctly in a biological system, they might cause hazardous or immunogenic reactions. Notwithstanding these possible drawbacks, using nanotechnology has considerably more benefits [3].

NANOTECHNOLOGY APPLICATIONS

The potential uses for nanotechnology in connection to livestock are nearly unbelievable, and they include issues with animal health, productivity, reproduction, and excellent hygiene procedures while raising and caring for food animals. There are several glimpses of uses for nanotechnology in the veterinary and animal sciences, as detailed below, even if much more study and significant firm advancements are required before it becomes commonplace.

Disease diagnosis and treatment

Animal illness early detection using biochips is possible. A biochip (also known as a microarray) is a device that is generally constructed from hundreds or thousands of small artificial DNA strands that are accurately placed on a silicon circuit. As a way to find the source of infections in response to public health risks like avian flu and mad cow disease, biochips may also be used to track the source of food and feeds and identify the presence of animal products from various species. In addition to DNA biochips, other types may identify trace amounts of proteins and chemicals in a sample, making them helpful for identifying illness or biowarfare agents. Biochips enable quick analysis and manipulation of biological materials including blood, tissue, and semen. Bioanalytical nanosensors are instruments or systems that employ biological tissue or material to measure or detect a chemical. They will let us find extremely minute levels of bacteria, viruses, or chemical contaminants in the farming and animal systems.

A novel kind of optically controllable nanoparticle called a "nanoshell" is made up of a core made of a dielectric material, like silica, and a very thin covering of a metallic material, like gold. Targeted drugs may be added on nanoshells to make them seek for and cling to the surface receptors of cancer cells before being injected into an animal's bloodstream. When the body is illuminated with infrared light, the temperature of the cells increases to roughly 55 °C, which "burns" and destroys the tumor. Others are exploring with "smart" super paramagnetic nanoparticles that, when injected into the circulation, target cells that contain tumor receptors. These nanoparticles are formed of iron oxides, which, when exposed to a magnetic field, improve their capacity to find tumor cells. The nanoparticles release an associated medication at the tumor location, killing the cancer cells. Quantum dots, which are nanometer-scale crystals initially created for optoelectronic uses, are another kind of nanomaterial. Animals' bloodstreams may be injected with quantum dots, which can identify dysfunctional cells. It may be able to illuminate the body with light and trigger the quantum dot to heat up enough to destroy the malignant cell since quantum dots react to light. Using probes and techniques based on nucleic acid engineering, powerful new solutions to cure or prevent certain illnesses are

provided. These numerous nanotechnology techniques could be used as a therapeutic assistance to lessen the health issues that animals face [4].

Medication delivery method

Small, sealed containers of the medicine to be supplied would most likely be present in intelligent drug delivery systems in animals. Smart medication distributions make it feasible to use antibiotics more sparingly than would otherwise be practicable. The cargo may be sent to the appropriate location in the body if it had a molecularly coded "address label." The "carriers" in such a system would be nano- and microscale mechanical systems. Onboard chemical detection and decision-making capabilities for self-regulated medicine administration or nutritional treatments might potentially be included in smart delivery systems. This will let cattle owners use antibiotics less often and spend less on medicine.

Smart delivery systems may also have the potential to monitor the effects of the distribution of medications, nutraceuticals, minerals, dietary supplements, bioactive substances, probiotics, chemicals and vaccinations. Therefore, future technological advancements will enable the development of more precise delivery systems using nanomaterials (materials that have the ability to control and catalyze chemical reactions at the nanoscale, such as buckeyballs, nanotubes, quantum dots, and dendrimers, etc.) for biological and bioactive organisms for the targeted site, as well as the development of integrated sensing, monitoring, and controlling capabilities.

Food safety via maintaining identity

A system known as an identity preservation (IP) system increases the value of agricultural products by informing customers about the procedures and activities involved in their production. The ability to provide stakeholders and customers access to data, records, and supplier procedures relating to the farm of origin, environmental practices utilized in production, food safety and security, and information on animal welfare problems is now feasible thanks to IP. IP at the nanoscale might greatly enhance quality assurance of the safety and security of agricultural and animal goods. The capacity to trace an animal's life from birth, through its medical history, its travels between a ranch, a slaughterhouse, and a meatpacking facility, all the way to the consumer's plate, may determine the future of the meat business.

Reproduction and Breeding

For dairy and swine producers, managing breeding is a costly and time-consuming issue. A nanotube implanted beneath the skin to offer real-time assessment of changes in the amount of estradiol in the blood is one approach that is presently being researched. The ability of the nanotubes to bind and detect the estradiol antibody during the time of oestrus by near infrared fluorescence makes them useful for monitoring oestrus in animals. A central monitoring and control system will use the input from this sensor to activate breeding. Animal science now uses microfluidics to greatly simplify conventional in vitro fertilization methods used in animal reproduction.

Physical sperm and egg sorting is employed in cattle breeding. Microfluidic and nanofluidic systems analyze by managing the flow of liquids or gases via a number of small channels and valves, sorting them in a manner similar to how a computer circuit sorts data through wires and logic gates. Geneticists are now quickly sequencing the genomes of cattle, sheep, poultry, pigs, and other animals in an effort to uncover gene sequences that link to qualities that are economically useful, such as disease resistance and meat leanness. With the mapping of the

human genome behind them. By integrating probes for these features on biochips, breeders will be able to swiftly identify champion breeders and filter out genetic disorders.

BIOCIDE:

Nanoparticles may provide a workable substitute for antibiotics and may help keep infections out of areas where animals are produced. Antibiotic overuse, a widespread practice in many nations, encourages the development of drug-resistant microorganisms. To address this rising issue, new laws restricting the use of prophylactic antibiotics in agriculture is becoming more popular. Due to the high-density nature of contemporary animal production facilities, which attracts and expedites disease transmission, limiting antibiotic usage needs the development of alternatives.

DISCUSSION

Distribution mechanism for drugs

Small, sealed containers of the medicine to be supplied would most likely be present in intelligent drug delivery systems in animals. Smart drug deliveries enable prudent antibiotics are used in fewer doses than would otherwise be feasible. The cargo may be sent to the appropriate location in the body if it had a molecularly coded "address label." The "carriers" in such a system would be nano- and microscale mechanical systems. Onboard chemical detection and decision-making capabilities for self-regulated medicine administration or nutritional treatments might potentially be included in smart delivery systems. This will let cattle owners use antibiotics less often and spend less on medicine. The effects of the distribution of medications, nutraceuticals, nutrients, dietary supplements, bioactive substances, probiotics, chemicals, and vaccinations may also be able to be seen through smart delivery systems. Therefore, future technological advancements will enable the development of more precise delivery systems for biological and bioactive organisms for the targeted site using nanomaterials (materials that offer the potential to manipulate structures or other particles at the nanoscale and to control and catalyze chemical reactions, such as buckeyballs, nanotubes, quantum dots, and dendrimers, etc.).

Disease diagnosis and treatment

Animal illness early detection using biochips is possible. A biochip (also known as a microarray) is a device that is generally constructed from hundreds or thousands of small artificial DNA strands that are accurately placed on a silicon circuit. As a way to find the source of infections in response to public health risks like avian flu and mad cow disease, biochips may also be used to track the source of food and feeds and identify the presence of animal products from various species. In addition to DNA biochips, other types may identify trace amounts of proteins and chemicals in a sample, making them helpful for identifying illness or biowarfare agents. Biochips enable quick analysis and manipulation of biological materials including blood, tissue, and semen [5].

Bioanalytical nanosensors are instruments or systems that employ biological tissue or material to measure or detect a chemical. We will be able to identify extremely little levels of a chemical pollutant, virus, or bacterium in farming and animal systems thanks to them. A novel kind of optically controllable nanoparticle called a "nanoshell" is made up of a core made of a dielectric material, like silica, and a very thin covering of a metallic material, like gold. To locate and bind to the surface receptors of cancer cells, targeted medicines may be added to nanoshells before they are injected into an animal's circulation. When the body is illuminated with infrared

light, the temperature of the cells increases to roughly 55 °C, which "burns" and destroys the tumor. Others are exploring with "smart" super paramagnetic nanoparticles that, when injected into the circulation, target cells that contain tumor receptors. These nanoparticles are constructed of iron oxides, which when exposed to a magnetic field improve their capacity to find tumor cells. The nanoparticles release an associated medication at the tumor location, killing the cancer cells. Quantum dots, which are nanometer-scale crystals initially created for optoelectronic uses, are another kind of nanomaterial. Animals' bloodstreams may be injected with quantum dots, which can identify dysfunctional cells.

The use of probes and techniques based on nucleic acid engineering provides potent new approaches to provide therapeutic or preventive care for specific illnesses. A system known as an identity preservation (IP) system increases the value of agricultural products by informing customers about the procedures and activities involved in their production. The ability to provide stakeholders and customers access to data, records, and supplier procedures relating to the farm of origin, environmental practices utilized in production, food safety and security, and information on animal welfare problems is now feasible thanks to IP. IP at the nanoscale might greatly enhance quality assurance of the safety and security of agricultural and animal goods. The capacity to trace an animal's life from birth, through its medical history, its travels between a ranch, a slaughterhouse, and a meatpacking facility, all the way to the consumer's plate, may determine the future of the meat business[6].

Reproduction and Breeding

For dairy and swine producers, managing breeding is a costly and time-consuming issue. A nanotube implanted beneath the skin to offer real-time assessment of changes in the amount of estradiol in the blood is one approach that is presently being researched. The ability of the nanotubes to bind and detect the estradiol antibody during the time of oestrus by near infrared fluorescence makes them useful for monitoring oestrus in animals. To activate breeding, a central monitoring and control system will include the input from this sensor. Animal science now uses microfluidics to greatly simplify conventional in vitro fertilization methods used in animal reproduction. Physical sperm and egg sorting is employed in cattle breeding. Microfluidic and nanofluidic systems analyze by managing the flow of liquids or gases via a number of small channels and valves, sorting them in a manner similar to how a computer circuit sorts data through wires and logic gates.

MEDICAL TREATMENT

Diagnostics and treatment are improving thanks to the intriguing topic of nanomedicine. Metallic and nanostructured particles are useful diagnostic tools in biomedical research that may be used to examine how a cell is functioning or how a drug is dispersed throughout the body. High quantities of magnetic nanoform metals, such iron oxide, may be scanned using magnetic resonance imaging (MRI). Two-photon excitation or light activation may be used to cause the fluorescence of nanostructured particles. In addition to these diagnostic nanoparticles, exciting developments in molecular-based lab-on-a-chip technologies for qualitative and quantitative biological evaluations have been made. These lab-on-a-chip technologies are a preferable substitute because they require minimum analyte and reagent use, produce less waste, and shorten turnaround times. Nowadays, there are a lot of microscale goods available, and nanoscale products are only beginning to do so; for more information, see Tian et al.

Drug distribution may be observed using fluorescent nano-carriers. For instance, light-activated, fluorescent nanostructured glucose and sucrose-derived nanoparticles may be used to detect the position of bound chemotherapies. The biocompatibility of carbohydrate-derived nanoparticles in a human lung cancer cell line has been shown by Ajmal et al. They found that

the cytotoxicity of the conjugate nanoparticles after attaching to it was equivalent to that of cells treated just with the chemotherapeutic drug methotrexate. One advantage of utilizing a nanoparticle to deliver this drug that fluoresces after being triggered by light is the ability to monitor the medication. For even better tracking, a carrier nanoparticle that can be activated by two-photon excitation may provide a 3D spatial image over a deeper layer of tissue than a particle activated by visible UV light. As chemotherapies are often provided in high dose regimens, the ability to monitor their absorption using fluorescence may help to reduce adverse side effects by concentrating them more effectively where they are required.

Fluorescence is not a property shared by all nanoparticle drug carriers, and the methods in which they bind to and release pharmaceuticals may vary greatly, especially for nanostructured particles. Cylindrical nanotubes may be used to trap pharmaceutical substances inside of an interior matrix that is externally covered in a poly (L-lactide) or poly (D-lactide) layer. During their transformation from cylinders to spheres, these enantiomers interact with one another in solution, releasing any bound components. For the drug to be released, the two nanotubes must come into touch; external stimuli are not required, unlike in certain light-activated nanoparticles. Some nanostructured particles, such albumin-dextran nanoparticles holding hydrophobic drugs, may be self-loading. Dextran-stabilized albumin from bovine serum may bind medicines in aqueous solutions via hydrophobic and electrostatic interactions. Ibuprofen binding experiments using albumin-dextran nanoparticles shown that 0.7 units of the analgesic may be attached to each unit of the conjugated particle. Future applications might include enhancing release selectivity and reducing the period between medication delivery and action using these nanostructured materials. Also, they suggest brand-new systems for drug absorption and release in nanomedicine.

REPRODUCTION

The ancestors of finishing animals are those with better genotypes and phenotypes that are intended for breeding. Breeders are highly prized for their traits and procreative ability. Some nanoparticles have been shown to enhance fertility and maintain spermatozoa through the functional groups they contain. Artificial insemination is often utilized in animal production as a live cover method substitution because to the reduced risk to producers and animals. The use of nanotechnologies, such as non-invasive bioimaging of gametes, nanopurification, and cryoprotectants, has the potential to enhance artificial insemination, which is often used to broaden the selection of livestock traits and diversify genetic backgrounds[7].

To make artificial insemination as efficient as possible, it is first required to comprehend the biology of cow gametes and reproductive obstacles to fertilization. Recently, quantum dots have been investigated as a research strategy to learn more about the physiological background of mammalian spermatozoon and oocyte motility and their interactions. Since they are more biocompatible, photo-stable, and have a stronger signal than the organic fluorescent molecules now used to image gametes and other cell types in vivo, the field of theriogenology is interested in these self-illuminating, inorganic nanoparticles. Feugang et al. demonstrated the real-time monitoring capabilities of bioluminescent resonance energy transfer-conjugated quantum dot (BRET-QD) nanoparticles in vitro, in situ, and ex vivo using pig male gametes (Sus scrofa domesticus). Quantum dots may provide targeted or non-targeted imaging depending on their size, radiated wavelengths, and conjugation choices.

This produced nano particle provides a fresh way to see the molecular and cellular activity taking place during fertilization. It functions similarly to fluorescent proteins but at deeper tissue levels. As quantum dots' signal intensities are dose-dependent, a higher concentration of them could be required for in vivo imaging on larger animals. The chemical makeup of

quantum dots should be further altered for biocompatibility since many current quantum dots include heavy metals like cadmium and lead, which may be fatal at high doses. Yet, if quantum dot concentrations and surface chemistries are carefully tuned, cytotoxicity may be decreased or even completely avoided.

Semen may be nano-purified to identify healthy, uninjured sperm from ill sperm. Antibodies against ubiquitin, a surface marker of damaged sperm, may be used to coat magnetic nanoparticles as part of a protein-based elimination approach. In lectin-based techniques, magnetic nanoparticles coated with lectins bind the glycan exposed at the surface of the sperm owing to acrosomal breakdown. Bull spermatozoa (Bos taurus) were nano-purified and achieved conception rates equivalent to unpurified semen at half the concentration with no adverse consequences for inseminated cows or calves. A single sample of diluted, nano-purified ejaculate may thereby fertilize many females. Improved fertility and selection capabilities will be made possible by enhanced spermatozoa biomarker detection using antibody or lectin approaches.

Sperm cryopreservation may be enhanced by utilizing extenders that include nano-protectant chemicals. Extenders are buffering substances that are used to saturate sperm with nutrients and dilute it for long-term storage. They guard against pathogens and transport antibiotics, preventing infections in artificially inseminated females and sperm degradation. Antimicrobial nanoparticles may eventually take the place of antibiotics since certain medications have been demonstrated to impair sperm motility and survival in a dose-dependent manner. Moreover, nanoparticles may make it simpler to incorporate natural substances in extenders to increase sperm motility. Studies suggest that the addition of honey, sugarcane juice, tomato juice, and pineapple juice may extend the life of sperm kept at room temperature. Although though nanoparticles weren't used in those experiments, it would be interesting to explore how sperm quality would change if each product's functional groups were provided by nanoparticles. As sperm may be distributed internationally over a number of days, it would be preferable to have extenders with a bigger capacity for maintaining samples going through freeze-thaw cycles.

More advancements in reproductive biotechnology may be made possible by the expanding usage of nanoparticles in molecular biology techniques. One of these approaches involves the use of mesoporous silica nanoparticles to transport proteins and nucleic acids during sperm-mediated gene transfer. These nanoparticles may form strong interactions with spermatozoa in vitro and have no discernible effect on sperm function or quality. It has been shown that when employing small amounts of polymers, transfections using polymeric nanoparticles—such as PDMAEMA, chitosan, and polyethylenimine are superior to those using traditional viral techniques. It has been shown that a molecular weight of 60 kDa is optimal for PDMAEMA transfection, and that the efficacy and toxicity of transfection are strongly influenced by the molecular weight of the nanopolymer [8].

Nanoparticles may have a significant role in animal reproductive with further study and development. While this is going on, it should be noted that certain nanoparticles are spermatotoxic, which might have an adverse impact on breeder reproduction. Zinc oxide and titanium oxide nanoparticles, for example, reduce in vitro sperm viability in a dose- and time-dependent manner by weakening membranes and fragmenting DNA. Barkhordari et al. found that when human sperm was exposed to zinc oxide nanoparticles, a concentration of 500 g/mL markedly enhanced cell death after 45 minutes and a dosage of 100 g/mL markedly increased cell death after 180 minutes. The viability of buffalo sperm (Bubalus bubalis) grown with 100 g/mL titanium oxide nanoparticles was reportedly reduced, according to Pawar and Kaul. At a dosage of 10 g/mL, titanium oxide has been shown to prematurely increase sperm capacitation, the last step of sperm maturation required for egg penetration and fertilization. While

considering the use of nanoparticles to aid reproduction, caution should be taken even if they may be points of progress for the animal production industry.

As nanotechnology develops and gains in popularity, the variety of applications for it in the animal production industry will expand. However, it will take more time before nanoparticles completely replace antibiotics in feed because many biocidal candidates still need to be tested in vivo before going through clinical trials and food safety tests in accordance with government regulations. It is likely possible in the near future to regularly add nano-supplements to livestock feed to improve it. One of the exterior uses for nanoparticles that have previously been included into several aspects of animal raising is antiseptic wound dressings. For research on nanoparticles with anti-cancer potential, it is essential to examine nanoparticle cytotoxicity in both cancer cell lines and normal, healthy cell lines. It may be misleading to state that the nanoparticle under investigation only has anti-cancer properties and only works with cancer cells. This is because the nanoparticle may be detrimental to all cell types. In vivo studies must verify the functions of nanoparticles that have been found via in vitro research[9], [10].

CONCLUSION

Geneticists are now quickly sequencing the genomes of cattle, sheep, poultry, pigs, and other animals after having completed the mapping of the human genome. Cattle in an effort to find DNA sequences linked to features with high economic value, like as disease resistance and leanness of meat. Breeders will be able to quickly identify champion breeders and rule out hereditary disorders by adding probes for these qualities on biochips. This analysis seeks to highlight the many uses for nanoparticles in animal production as well as to point out possible future use areas. Nanoparticles are now on the market, and with more research and development, their characteristics will be fine-tuned for a larger range of applications. While the use of nanotechnology in animal production is in in its infancy, promising findings from studies on feed, biocide, remediation, and reproduction are encouraging additional research.

REFERENCES

[1] A. A. Cruz and M. B. Molento, “Nanotechnology: Meeting the future of Veterinary Parasitology Research,” *Pesqui. Vet. Bras.*, 2015, doi: 10.1590/s0100-736x2015001000004.

[2] D. Narducci, “An introduction to nanotechnologies: What’s in it for us?,” *Veterinary Research Communications*. 2007. doi: 10.1007/s11259-007-0082-8.

[3] E. Osama, S. M. A. El-Sheikh, M. H. Khairy, and A. A. A. Galal, “Nanoparticles and their potential applications in veterinary medicine,” *J. Adv. Vet. Res.*, 2020.

[4] S. Saad, D. Abdel-Fattah, T. Khamis, and A. El-Sobky, “Potential Role of Propolis Nanoparticles in Medicine and Health: An Updated Review,” *Adv. Anim. Vet. Sci.*, 2022, doi: 10.17582/JOURNAL.AAVS/2022/10.3.589.598.

[5] A. S. Neculai-valeanu, A. M. Ariton, B. M. Mădescu, C. M. Rîmbu, and Ş. Creangă, “Nanomaterials and essential oils as candidates for developing novel treatment options for bovine mastitis,” *Animals*. 2021. doi: 10.3390/ani11061625.

[6] T. N. Dawood and E. H. Kareem, “Effect of nanomaterial on animal and human health : A review,” *Plant Arch.*, 2020.

[7] P. M. Skljarov *et al.*, “The use of nanobiomaterials in veterinary reproductology,” *Nanosistemi, Nanomater. Nanotehnologii*, 2021, doi: 10.15407/nnn.19.02.445.

[8] S. S. Patil, K. B. Kore, and P. Kumar, "Nanotechnology and its applications in veterinary and animal science," *Vet. World*, 2009, doi: 10.5455/vetworld.2009.475-477.

[9] N. R. Scott, "Nanoscience in veterinary medicine," *Vet. Res. Commun.*, 2007, doi: 10.1007/s11259-007-0083-7.

[10] P. Gutiérrez *et al.*, "Improved antibiotic detection in raw milk using machine learning tools over the absorption spectra of a problem-specific nanobiosensor," *Sensors (Switzerland)*. 2020. doi: 10.3390/s20164552.