ANIMAL HUSBANDRY AND DAIRYING

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ABSTRACT

Animal husbandry and Dairying is the need of today. We are significantly dependent on it for high protein sources for e.g., meat, eggs, milk, etc. Today, animal husbandry is a growing market, which has a very high demand. Hence, it is very important from a future point of view to make advancements in this upcoming field. Traditional methods used in animal husbandry and dairying were very much laborious, time and cost consuming. It became difficult to provide an adequate number of yields to a large population. If any changes in genetics needed to be done in animal husbandry, it was totally based on trial-and-error method which is time consuming. To overcome such issues, we need to focus on advanced technologies.

This article mainly focuses on advanced technologies to which we have shifted to such as –

(a) Genetic improvement – Gene editing technology
(b) Remote sensing
(c) Robot milking in Dairying

All these have helped humankind in many ways to achieve a smooth working in many processes.

Keywords- Animal husbandry, dairying, genetics, dairying technology, animal husbandry innovations, dairy technology, nanobiotechnology, dairy farming.

I. INTRODUCTION

Animal husbandry is that field of agriculture that focuses on the animals that are raised for their meat, fibre, milk, and other products. It includes the management, breeding, and care taking of the livestock.
It plays a vital role in the economy of a country, as it provides employment and promotes income generation and a major portion of the farming sector depends on animal husbandry for their livelihood.

The practice of animal husbandry has been in existence since the time of early civilizations such as the ancient Egyptians who raised sheeps, goats, and pigs on farms.
The need for husbandry originated in the olden days to primarily have food on hand when hunting was futile.
Certain systems have been in place since a long time, known as intensive and extensive systems.
In an intensive system, the cattle is kept in a non-grazing location, such as a cow shed, wherein all the forage is brought to them and are not usually taken outdoors whereas in an extensive system, the animals are free to roam around under the supervision of the farmer, caretaker, or herdsman.

Time-to-time the methods have been evolved but the concept and purpose has stayed the same. As humans got exposed to technology, the methods have been modified accordingly. Now, in recent times many equipment in animal husbandry have been replaced with new ones.

The food products acquired from these animals are usually very rich sources of nutrition, protein, fat, etc and hence the animals have to be taken care of well to be bred commercially.

Animal husbandry involves several different animals such as cows, goats, pigs, chicken, etc that are reared for their meat, fibre, and more food products.

Worldwide, there are four main types of animal husbandry that is practised-
1. Dairy farming
2. Poultry farming
3. Fish farming
4. Bee farming

A. Recent developments in Animal Husbandry

Upgradation of any field is important in order to enhance the efficiency, productivity and for accuracy. Since the innovations have been done, the animal husbandry process has been updated. The integration of technology plays a major role in the welfare of animal husbandry. (Parvez, 2023)

Modern inventions such as Artificial intelligence, Sensors, Data analysis, Automation & robotics technology have made remarkable progress in animal husbandry. Few inventions are –

1. Automated feeding systems
2.Genetic selection
3.Environmental monitoring
4.Data analysis
5.Waste management
6.Telemedicine
7.Artificial insemination
8.Precision livestock farming

Lets look at a few of these new technologies

- Remote Sensing

This technology proved to be a boon at the period of covid-19. It can capture temperature, humidity, carbon dioxide levels, ammonia, water/food consumption, environment, etc. No direct contact of humans is needed. It reduces labour cost too.

- Genetic Improvement

Geneticity plays an important role in every life process of the livestock. The genetic material / genome determines the overall characteristic and traits of the livestock.

Earlier, a natural method of reproduction was used for breeding. The natural method may not satisfy a few requirements such as – adaptation to new climate, meat quality, milk production, disease resistance, etc. Due to this many offspring were not the desired ones. If the livestock is not able to produce desired quality of meat, eggs, milk or wool due to genetic makeup of it, then those livestock were less yielding & non profitable. They weren't able to satisfy the requirements listed above and more. Eventually the main purpose of livestock husbandry was not fulfilled.

To overcome this major issue in animal husbandry, advancements have been made in genomics of animals. Genomics is a branch of molecular biology that is concerned with the structure, function, evolution and mapping of the genome.

The advancements in the genome of animals facilitates us to acquire specific characteristics/traits of animals. Once the traits are acquired, the advantage of it then can be taken to the maximum level.

The advancements in genomics in favour of animal husbandry are –

a. Cloning,
b. desired genetic design,
c. transgenic animals,
d. recombinant DNA technology,
e. gene editing,
f. gene sequencing, etc.

All these techniques are newly found but among these the most important ones are gene editing & small interfering RNA

(i). Genome Editing – CRISPR-Cas9 a gene editing tool -

Genome editing, the name itself describes the process that involves changes in the entire set of DNA (genome). It is the process of adding desired genes, to remove undesirable genes or to modify undesirable genes in a genome of an animal.

Alleles on genes which occupy specific locations are responsible for traits that an animal depicts. If any undesirable trait is shown by an animal, that allele can be replaced or modified to a desired level which would give us satisfactory results. This is done by "GENETIC EDITING" using molecular tools, for E.g.- CRISPR-Cas9.

CRISPR – Cas9 stands for 'Clustered Regularly Interspaced Short Palindromic Repeats' that are sequences in genomes of bacteria & the Cas9 is a protein which acts as molecular scissors which is used to cut DNA at specific locations. It is also a part of the immune system of bacteria. This CRISPR-Cas9 is used by bacteria to cut the DNA of viruses as a part of a defence mechanism.

The mechanism of gene editing in animals is –

There are 2 main elements of the process – To design guide RNA & to introduce Cas9.

a) To design the guide RNAs – It is essential to locate the spot where the targeted gene resides. Making complementary RNA molecules will help us to locate the target genes. If the DNA which is to be is known and gene sequence of it is known the complementary RNA is produced.

For e.g., If the sequence in DNA which to be modified is 'CAAGACTCAAA'. Now, a sequence is made which is complementary to a specific portion of it. Suppose the complementary sequence is 'TGAGTTT'. Now RNA containing this complementary sequence will be synthesised in the lab.

b) Introducing Cas9 with gRNA – It is introduced in the cells of the targeted animal and later the gRNA with the complementary sequence binds to that DNA sequence. The gRNA guides the movement of Cas9 protein to the targeted site. Once it detects the site it cuts at a specific point where the gRNA is bound to DNA.

c) HDR Repair – If the gene is to be modified, a repair template is also introduced in the targeted cells. This repair template has the sequence of the modified genes which results in desired modifications, e.g., introducing myostatin, which codes for proteins that control muscle growth. If such a gene is introduced it can result in overgrowth of muscle and provide a muscular animal which can be used for meat or transportation.

NHEJ Repair – This is used when the gene is to be deleted. Here there is no replacing of that deleted gene. In this case, if a trait is not needed or unmodifiable, the specific sequence of DNA is deleted and not modified.

This technique is very useful to modify genes which would yield more meat, milk or eggs. It can be of great use in the food industry because larger yield is obtained using less no. of livestock. Also, if the livestock are more in no. there would be a larger amount of food available.

B. Usage of Vaccines

Veterinary vaccines play a very vital role in the healthcare of animals as they prevent them from several diseases and maintain a good immune system.
Vaccination is the process of administering a vaccine that prepares an immune response against a particular disease before the animal comes in contact with that disease-causing organism. It is a very safe and effective way of developing the immune system to protect animals against harmful diseases.
It is also very helpful in decreasing the mortality and morbidity rates in farms and improving animal welfare.

Vaccination is also very helpful to the farmers and caretakers as it helps them to create a safe and sustainable environment around the animals they take care of and breed as well.
It also prevents diseases from being spread from one animal to another and also between animals and humans.
In veterinary science, most of the vaccines are created to protect animals against viruses, and others are made for protection against some bacteria and toxins.
When an animal is vaccinated, its system recognizes that disease-causing foreign particle beforehand and builds an immediate response to it. (Sander, 2020)

II. LATEST TECHNOLOGIES IN VACCINES MADE FOR DAIRY AND FARM ANIMALS

(a) The Trojan Horse Vaccine Technology

A vectored vaccine uses a non-pathogenic agent as a vector to carry protective genes in the body from the pathogen. Here, the protective gene is cloned and it is then inserted into the genome of the vector. The vector behaves like a shuttle to transfer the foreign particles. After this, a mimicked infection is generated in the body for which an immune response is created.
Such vectored vaccines are something like a Trojan house.

Advantages of vectored vaccines-
i) Generally, they do not cause any adverse effects or reactions
ii) They can be adjusted to meet the upcoming new diseases and threats
iii) They make it easy to distinguish infected animals from vaccinated ones

(b) Vaxxiteck

Vaxxiteck is the first ever HVT-based vector vaccine that has been developed for poultry. The vector, HVT, is the herpesvirus of the turkey.
The HVT vector carries the immunogenic protein or substance to protect against IBD in poultry. IBD stands for infectious bursal disease that is widespread and is highly contagious in young chickens and turkeys.
A new version of Vaxxiteck was created in 2019, known as Vaxxiteck HVT+IBD+ND, which is trivalent vaccine, protecting against three different diseases, Marek's Diseases (MD), Infectious Bursal Disease (IBD), and Newcastle Disease (ND). Another updated version was created in 2020, inducing an immune response against Infectious Laryngotracheitis (ILT).
Vaxxiteck has proven to be an important landmark since all these diseases are very widespread, highly infectious and affect poultry health worldwide.

(c) Usage of mRNA vaccines

Vaccines with mRNA carry instructions to create a protein from a certain pathogen which immune cells learn to recognize and thus form a defence against it.
Unlike traditional vaccines, mRNA vaccines increase the buildup of vaccine proteins over time and they foster the development of a strong immune system.

mRNA vaccines do not go back to their pathogenic form and they do not mix with other pathogens. Also, once the genetic sequence of a certain pathogen is known, mRNA vaccines can be produced very quickly.
In recent developments, mRNA vaccines have also been altered in such ways that the body does not immediately reject it and the vaccine is delivered using lipid nanoparticles ensuring that the mRNA is not degraded before it has the chance to make the proteins.

(d) Indigenous vaccine developed for lumpy skin disease in cattle

ICAR (Indian Council for Agricultural Research) has recently developed a vaccine to combat the lumpy skin disease found in cattle.
This disease, spread through mosquitoes, flies, and ticks became a huge problem for cattle rearers, farmers, and breeders around the country as the health of animals deteriorated, which resulted in an increase in the morbidity rate and a decrease in the milk production.
Thus this vaccine is a major breakthrough as it has helped to defeat this disease which was spread across the country.

Table 1: Vaccination schedule for livestock and poultry
(Source- http://ecoursesonline.iasri.res.in/mod/page/view.php?id=61934)

Name of vaccine	For species
Foot and Mouth	Cattle, buffalo, sheep and goat
PPR	Sheep and goat
Sheep pox	Sheep
Anthrax spore	Cattle, sheep and goat
Black quarter Alum precipitated	Cattle and sheep
Hemorrhagic Septicemia oil adjuvant	Cattle, buffalo, sheep and goat

III. REPRODUCTION

As new technology has made great leaps in various sectors, it has also done the same in the breeding techniques for livestock, farm animals, and poultry.
Reproduction has also become significantly dependent on new scientific methods as it increases the production, gives us the desired result, and to also produce offspring from animals that were considered infertile.

The lack of reproductive abilities is one of the most important causes of economic losses caused in the animal world. Due to this, modern reproductive biotechnologies are considered and are also known to be quite effective in meeting future needs and sustaining agricultural production.
The recent developments in reproductive techniques are- artificial insemination, embryo transfer, cryopreservation, transgenesis, cloning, etc.
Efforts are also being made to spread knowledge about these advanced assistive reproductive techniques which can be helpful to improve the status of livestock reproduction. (Pursley, Cibelli, 2020)

IV. ARTIFICIAL INSEMINATION

Artificial insemination(AI) is used widely across the globe to overcome the low reproduction rates in chickens, turkeys, cattle, etc.
It is a process wherein the semen is manually collected from the male species and inserted into the female species.
The first research about artificial insemination of domestic animals was performed on dogs in 1780 by the Italian scientist, Lazanno Spalbanzani.
AI technology has helped to improve the efficiency and rate of genetic selection, introduction of new genetic material by import of semen, focus on selective breeding needs, and also making use of the frozen semen even in the event of the death of the donor. This technology also helps to reduce the spreading of sexually transmitted diseases.
Using this technology, it has become possible to produce a large number of offspring from an outstanding male.
The semen from exotic breeds is utilised to increase the production of local livestock populations.
Currently, more than 100 million cattle, 40 million pigs, 3.3 million sheep, and 0.5 million goats are artificially inseminated every year using AI technology.

Advantages of AI -

- The semen of a desired sire can be used even after their death.
- The semen collected can also be taken to rural areas for insemination where technology has not yet fully developed.
- It increases the rate of conception.
- It fulfils the needs of selective breeding.
- Adequate research can be done to maximise production.
- Reduces the risk of sexually transmitted diseases,

Disadvantages of AI -

- Requires well-trained operations and expertise.
- Requires more time than natural services.
- It is costly.
- Proper cleaning of instruments and sanitary conditions must be maintained.

V. CRYOPRESERVATION

Embryo freezing is one of the most advanced methods today wherein the embryo is stored or preserved at low temperature conditions and it is revived for usage as required. It is a very useful method for endangered species.
Cryopreservation has relatively high success rates and it has helped to maintain long-term fertility.
It has also proven useful for the gene dispersal of genetically superior species from one generation to another and the transport of semen for long distances even to interior locations.
Recently high security vitrification devices such as pipette tip, fiber plug, vitrification spatula, sealed pulled straw, plastic blade and other convenient devices have been introduced to obtain better results.
During the past few decades, noteworthy progress in cryopreservation of mammalian oocytes and embryos has been achieved.

Preservation of oocytes reduces the risk and expense that is involved in the transport of live animals, risk of disease transmission, and also provides insurance against catastrophes and natural disasters.
Cryopreservation is a low-tech, cost effective, and an effective method for safeguarding genetic diversity. (Bakst, Dymond, 2013)

VI. DAIRYING

Dairying primarily focuses on the breeding and utilisation of animals such as cows, buffaloes, and other dairy animals for the production of milk and other dairy products.

A. Importance of dairying

Milk is one of the most widely used products in the world. It is rich in nutrients and also helps to improve the digestibility of humans, and hence it is also included in several diets.
In India, milk is produced by small farmers as well as large farmers and the production of the same is the source of income for thousands of farmers.
The demand for milk has started to increase in cities as well as rural areas. This is mainly because of the following reasons- increase in population, growing health awareness, spread of education, etc.
Dairy farming in India has evolved through the years, from an agrarian way of life to a professional manufacturing industry. Dairying also provides a source of income with a relatively low level of risk.
Notably, India is the highest milk producer and ranks first position in the world, contributing 24% of the global milk production in the year 2021-22.

B. Different Cattle Breeds Involved in Dairying

India traditionally makes us of indigenous breeds of cattle. One of the interesting characteristics of the indigenous breed is the presence of humps. The breeds of cattle that are ‘milk-yielding’ or produce high milk levels are called the ‘milch’ type breed.
Some of these are-
Gir breed, found in the Kathiawar region of Gujarat
Hariana, found in Haryana, western U.P., and eastern Rajasthan
Tharparkar, found in Marwar region of Rajasthan and Gujarat
Sahiwal, in the Montgomery district of undivided India
Deoni, in Karnataka, Maharashtra, and the Latur and Bidar districts.

There are also several exotic cattle breeds that are raised in India with the primary objective of improving the milk production. These are-
Holstein Friesian breed, originated in Holland
Jersey breed, originated in the English Channel
Brown swiss, originated in Switzerland, and
Ayrshire, originated in Scotland.

C. Breeding Technology

Traditional breeding techniques included manual extraction of milk from cows. This would include a lot of labour. The process was very time consuming too. To minimise the labour expenses and the time required, Robot milking technology is being used on a large scale.

Robot milking was first introduced in the late 20^{th} century. But its prototypes were established in 1990. This technology is also known as automated milking system. Automated systems such as robotic machines are used for milking.

The robotic milking systems works as followed –

When a cow enters the milking station, the sensors in the robots detect the position of the udders. Udders may be contaminated with micro biological elements which would eventually enter the milk during the milking process. Therefore, it is important to make sure that it is sanitised and well cleaned before the milking starts. Once the mammary papillae are sanitised the arms of the robot attach the cups under it. By applying a small vacuum pressure, the milk is extracted into the cups. After the tank is completely filled with the milk, the robotic arms get detached from the mammary papillae. Here, the robotic milking process gets complete.

Robot milking not only extracts milk with automated system, but it also checks upon other factors like –

Mastitis Detection – Mastitis is an udder infection, which spoils the milk while the milking process. This can be detected by robots b sensing the colour/temperature of milk. Mastitis increases the electrical conductivity of milk. Therefore, by conductivity sensors attached to the cups, the electrical conductivity of the milk is known. Similarly using temperature sensors, the robot checks the temperature of milk. If the milk has a higher temperature than usual; it detects it and confirms the presence of mastitis infection. One more criterion which helps in detecting the infection is the colour change. Infected milk appears more yellowish in colour and Such colour change is detected by cameras installed in the robot.

These systems are even capable of storing historical records of each cow. If it detects any abnormal patterns like the increase or decrease in milk flow rate or amount of milk produced by the cow, it signals the system and further investigation on that particular cow is carried on.

Robotic milking is such an automated system which is able to detect the quality of milk there itself in a short time. It saves the time needed for initial quality checks. Such technology is very beneficial in the dairying industry to save labour cost and time as well.

VII. CONCLUSION

In this article, since we have taken an overview of how advanced technologies were used to overcome many problems like high labour cost, time consuming tasks, energy consuming tasks, etc, still many more technologies of higher level than this are yet to be discovered and implemented. The main principle focuses on designing the technology and how quickly and efficiently the results are obtained with minimal errors. In such cases, AI based technologies have been a helping hand to all the researchers which also suggests few plots of the experiment while also displaying its results.

Looking at several important and developing sectors of the world, animal husbandry and dairying is also one such sector which has immense growth potential with the help of biotechnology, genetic engineering, artificial techniques, etc and thus resulting in more produce and job opportunities. Both animal husbandry and dairying play vital roles in the global food and dairy production, economic development, and rural livelihoods. These practices require a combination of traditional knowledge and modern technology in order to ensure a sustainable and efficient production while considering the welfare of animals and environmental sustainability.

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