Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 04, Issue: 06 (NOV-DEC, 2024)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Livestock and Its Breeding Technology

(*Garima Kaushik Parashar and Mahima Rana)
GRD IMT, Rajpur Road, Dehradun, Uttrakhand-248001, India
*Corresponding Author's email: garimakaushik1991@gmail.com

Livestock is a word made from adding two words "live" and "stock". It was first used between 1650 and 1660. Livestock is the practise of rearing farm animals like cow, buffalo, etc. in agricultural setting for use and their products. Their uses are for milking, meat and draught purpose. It has been contributing to food production, income generation, and even cultural practices thus making it vital for many cultures and economies worldwide. The term typically excludes animals kept for companionship, such as pets, and may also exclude animals like fish raised in aquaculture.

Livestock in India

India has one of the largest livestock populations in the world, with over 535 million animals as per the 20th Livestock Census (2019). The country ranks first in the world in terms of cattle population, with approximately 300 million cattle, including over 190 million cows. India is also the world's largest producer of milk, with a production exceeding 210 million metric tons annually (as of 2022), accounting for about 23% of global milk production.. Livestock is a key asset for over 70 million rural households, and it provides critical income and nutrition, especially in regions where crop farming is less viable.

Livestock in World

Globally, livestock plays a crucial role in the agricultural economy, providing essential food products, raw materials, and income for billions of people. According to the *Food and Agriculture Organization* (FAO), the global livestock population stands at approximately 30 billion animals, encompassing cattle, sheep, goats, pigs, poultry, and other species. As of 2021, the world's cattle population is estimated to be around 1.5 billion, while there are over 1.7 billion sheep and goats combined. In terms of meat production, the FAO reports that in 2022, global meat production reached nearly 350 million metric tons, with pork, poultry, and beef being the top three most consumed meats. China is the largest producer and consumer of pork, accounting for about 50% of global pork production, while the United States is the leading producer of beef. Livestock also plays a vital role in food security, especially in low-income and developing countries, where they are a source of protein and essential nutrients. Livestock is an indispensable part of the global agricultural system, with an estimated 1.3 billion people relying on it for their livelihoods.

History of Livestock

The history of livestock domestication spans thousands of years and has shaped human societies in profound ways. Here are some key milestones in the development of livestock farming, along with the species and approximate time periods:

1. **Cattle (*Bos taurus* and Bos indicus)**:

Domestication: Cattle were domesticated around **8,000–10,000 years ago** in the Fertile Crescent (modern-day Turkey, Iran, and Iraq). Early cattle were wild aurochs (*Bos primigenius*), which were large and powerful animals.

- **Spread**: Domestication spread across Europe, Asia, and later to the Americas after European colonization.

2. **Buffalo (*Bubalus bubalis*)**:

- **Domestication**: Water buffalo were domesticated around **5,000 years ago** in the Indian subcontinent and Southeast Asia. The Asian buffalo (Bubalus bubalis) became a key draft animal and source of milk, while the African buffalo remained wild.
- **Spread**: Water buffalo spread to other parts of Asia, Europe, and later to the Americas.

Key Developments

- **Agricultural Revolution (10,000–12,000 years ago)**: The transition from hunting and gathering to settle farming communities marked the beginning of systematic livestock domestication.

- **Industrial Revolution (18th–19th century)**: Livestock farming saw significant changes with the advent of mechanized agriculture, selective breeding, and the rise of large-scale farming.
- **20th Century and Beyond**: The global livestock industry expanded dramatically with technological advances in breeding, feed, veterinary care, and transportation. The rise of factory farming has transformed the production of meat and dairy.

Role of Livestock in Indian Economy

- **GDP Contribution**: The livestock sector contributes around **4.5% to India's Gross Domestic Product (GDP)** and about **25.6% to the agricultural GDP** as of recent estimates.
- **Employment**: Livestock provides direct and indirect employment to over **70 million people**, mostly in rural areas. It is particularly vital for smallholder farmers and landless labourers, who rely on livestock for income and sustenance.

Key Sectors

1. **Dairy**:

- India is the world's largest producer of milk, with an annual production exceeding **210 million metric tons** (2022), which accounts for around **23% of global milk production**.
- The dairy sector is valued at approximately **₹10 lakh crore (₹10 trillion)** and supports **over 100 million dairy farmers** across the country. The dairy industry contributes significantly to the rural economy, particularly in states like Uttar Pradesh, Maharashtra, and Gujarat.

2. **Meat Production**:

- India is also one of the largest producers of meat, particularly **buffalo meat**. It is the **largest exporter of buffalo meat** in the world, accounting for more than **25% of global exports**.
- India's cow meat production is limited due to legal and cultural restrictions. In fiscal year 2019, cattle meat production across India amounted to about 326 thousand metric tons. The southern state of Kerala was the largest producer of cattle meat in the country.

3. **Other Livestock Products**:

- Livestock is also crucial for the production of **manure** and other by-products, which are important for sustainable agriculture in rural India.
- FYM (Farmyard Manure) made from cattle dung is a natural, nutrient-rich fertilizer that improves soil fertility, enhances moisture retention, and promotes healthy plant growth. It is commonly used in organic farming to enrich the soil with essential nutrients like nitrogen, phosphorus, and potassium.

Rural Economy and Food Security

- **Livelihoods**: Livestock is a primary source of income for millions of rural against crop failures and provides financial stability.
- **Nutritional Security**: Livestock products, particularly milk, meat, and eggs, provide essential proteins, fats, vitamins, and minerals to the Indian diet. The sector plays a pivotal role in addressing **malnutrition**, particularly in rural and tribal areas.

Useful Terms in Livestock

1. **Lactation period**: In cattle, the lactation period refers to the time span during which a cow produces milk after giving birth (parturition). Typically, the lactation period in cattle lasts for about 10 to 12 months, depending on factors such as breed, nutrition, management practices, and the individual cow's health. The lactation period begins immediately after calving and continues until the cow's milk production starts to decline, typically as the cow prepares for her next pregnancy.
2. **Early Lactation:** This is the first few weeks post-calving, where the cow produces the highest volume of milk, typically rich in nutrients like colostrum.
3. **Mid and Late Lactation:** The milk production gradually decreases as the cow progresses toward the end of the lactation period.
4. **Dry Period:** This is a rest phase before the next calving, where the cow is typically not milked, allowing her udder to recover and prepare for the next lactation cycle.
5. **Estrous Cycle**: The estrous cycle in cattle is the regular, repeating process of physiological changes that prepare a cow for mating and pregnancy. It typically lasts about 21 days, although it can vary between 18 to 24 days, and is controlled by hormonal fluctuations.

Breeding in Livestock

Breeding in livestock refers to the practice of mating selected animals to produce offspring with desirable traits. It is a key aspect of livestock management, aimed at improving productivity, health, and genetic traits across generations. The primary goals of livestock breeding are to enhance characteristics such as milk yield, meat quality, disease resistance, reproductive efficiency, and adaptability to environmental conditions.

Types of Breeding

There are majorly three types of breeding

1. **Natural Mating:** Natural mating refers to the traditional method of mating animals where the male (stud) and female (dam) are physically brought together for reproduction without the use of artificial techniques like artificial insemination (AI). It relies on the natural behaviour of animals, and is commonly used in smaller farms or in extensive production systems, particularly in less technologically advanced regions. In **India**, around **60-70% of the breeding in cattle** occurs naturally, especially in rural and tribal areas, where artificial insemination (AI) is not as widespread. n **sub-Saharan Africa**, natural mating is more common due to limited access to veterinary services and breeding technologies. In countries like **Kenya** and **Tanzania**, **80-90% of breeding** in cattle and small ruminants is still done naturally. In the **United States**, natural breeding is common in large-scale operations for certain livestock species like cattle, especially in beef production, though AI is also widely used in dairy farming.

Advantages of Natural Mating

Cost-Effectiveness:

- No need for the procurement and storage of semen or the use of artificial insemination (AI) technologies, which can be expensive. This makes natural breeding an economical choice for smallholder farmers or in areas with limited access to AI services.

No Need for Specialized Equipment:

- Unlike artificial insemination, which requires specialized equipment, training, and veterinary involvement, natural breeding requires no such investment, making it more accessible in resource-limited settings.

Behavioural Adaptation:

- Natural mating allows animals to exhibit their natural breeding behaviours. This can be particularly important for species like sheep and goats, where mating behaviour is an important component of successful reproduction.

Reduced Risk of Genetic Issues:

- Some breeders argue that natural mating minimizes the risk of inadvertently passing on poor genetic traits due to improper handling or storage of semen during artificial insemination.

Adaptability in Extensive Systems:

- In extensive systems where animals roam over large areas, natural breeding is often the most practical option because it suits the less-controlled environment.

Disadvantages of Natural Mating

Limited Genetic Diversity:

- Natural breeding often relies on a small pool of breeding males, which may limit genetic diversity, leading to inbreeding and the spread of hereditary diseases or undesirable traits.
- The **inbreeding coefficient** can increase in small or closed herds, reducing long-term herd health and productivity.

Lower Control over Breeding:

- Farmers have less control over the selection of specific genetic traits. Unlike artificial insemination, where semen from superior animals can be selected for specific traits (e.g., higher milk yield, disease resistance), natural breeding depends on the natural compatibility of the animals, which may not always result in optimal genetic outcomes.

Risk of Disease Transmission:

- There is a higher risk of transmitting infectious diseases between animals during natural mating, especially if the animals are not well-vaccinated or in good health.
- This can lead to outbreaks of diseases like **brucellosis** or **foot-and-mouth disease**.

Poor Record-Keeping:

- Natural breeding makes it harder to track the genetic lineage of animals, which can be problematic in herd management, especially for breeding programs where pedigree tracking is crucial. The use of artificial insemination, on the other hand, allows better documentation of genetics.

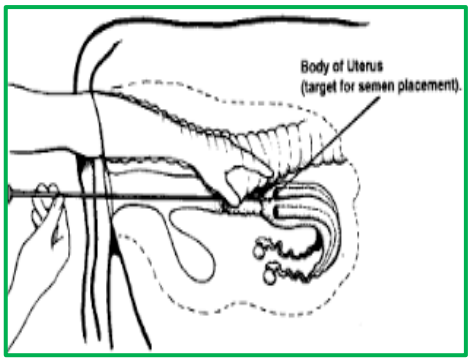
Reproductive Performance:

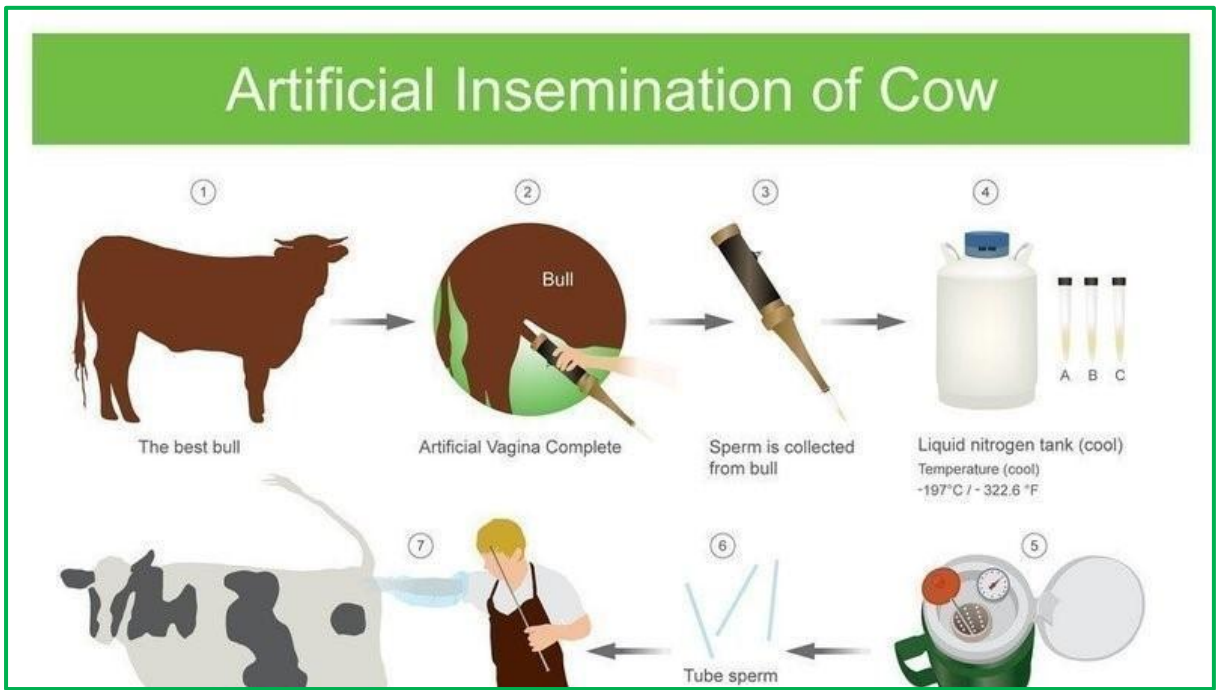
- Natural breeding can sometimes lead to lower reproductive performance in terms of conception rates, especially in cases where the female animal is not in optimal health or where the male does not have high fertility.

Labour-Intensive:

- Natural breeding requires more manual labor in terms of managing mating pairs, especially in larger herds or flocks. Farmers have to ensure that the correct male and female are paired, monitor mating behaviours, and provide supervision during mating.

***2.* Artificial Insemination:** Artificial insemination (AI) in livestock breeding is a reproductive technique where semen is collected from a male animal and artificially introduced into the reproductive tract of a female animal, rather than relying on natural mating. This method is widely used in the breeding of cattle, sheep, pigs, and horses to improve genetic quality, increase productivity, and manage breeding schedules. AI allows for the widespread use of superior genetics, as semen from top-tier males can be distributed globally, overcoming geographical barriers. It also reduces the risk of transmitting sexually transmitted diseases and injuries associated with natural mating.





Advantages of Artificial Insemination:

1. **Improved Genetics:** AI allows the use of semen from high-quality sires, improving the genetic potential of offspring.
2. **Disease Control:** AI reduces the transmission of sexually transmitted diseases, promoting healthier herds.
3. **Cost Efficiency:** It eliminates the need for maintaining bulls or other male animals, reducing costs associated with their care and management.
4. **Better Breeding Control:** AI enables precise timing of insemination, improving conception rates and allowing for the synchronization of breeding.
5. **Increased Productivity:** AI enables the rapid multiplication of desirable traits, enhancing overall productivity in terms of milk, meat, or wool.

Disadvantages of Artificial Insemination:

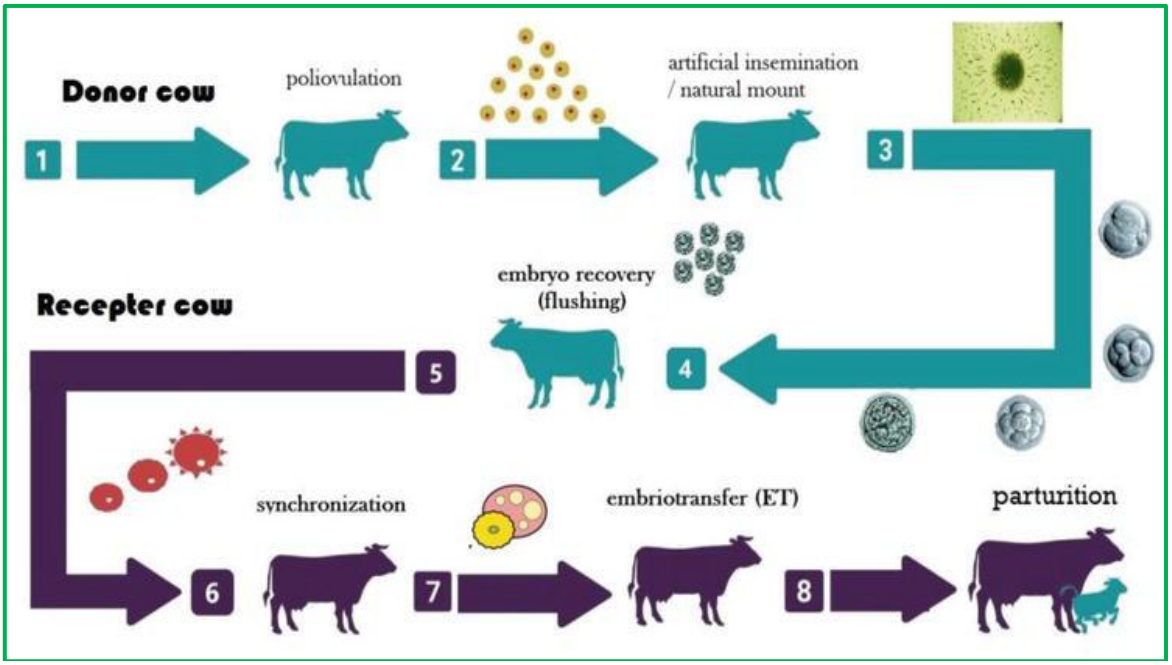
1. **Technological and Skill Requirements:** AI requires specialized knowledge and equipment, and improper handling can lead to poor results or failure.
2. **Cost of Semen and Equipment:** Although AI reduces some costs, the initial investment in equipment, semen, and training can be high.
3. **Labour Intensive:** In some cases, AI can be more labour-intensive than natural breeding, especially in large-scale operations.

4. **Genetic Diversity Concerns:** The widespread use of a few elite sires might reduce genetic diversity over time, potentially leading to inbreeding or genetic bottlenecks.
5. **Reduced Success Rate:** While AI generally has high success rates, it may still result in lower conception rates compared to natural mating, especially in certain livestock species.

MOET (Multiple Ovary Embryo Transfer): Multiple Ovary Embryo Transfer (MOET) is a reproductive biotechnology used to enhance the genetic potential of livestock. In this process, a female animal (donor) is superovulated using hormones to stimulate the production of multiple eggs. These eggs are then fertilized with semen, and the resulting embryos are harvested. The embryos are subsequently transferred to surrogate females (recipients) that carry the embryos to term. MOET allows for the rapid multiplication of valuable genetic traits, particularly in high-producing or genetically superior animals.

Process of Multiple Ovary Embryo Transfer:

1. **Superovulation:** The donor female is given hormonal treatments (e.g., FSH and LH) to stimulate the ovaries to produce multiple eggs.
2. **Artificial Insemination (AI):** Once the eggs are mature, they are artificially inseminated with semen from a genetically superior male.
3. **Embryo Collection:** After fertilization, embryos are collected from the donor's reproductive tract at an early developmental stage (usually 7–8 days post-insemination).
4. **Embryo Evaluation:** The collected embryos are evaluated for quality before being either frozen for later use or transferred to suitable recipients.
5. **Embryo Transfer:** Healthy embryos are implanted into the uterus of synchronized recipient females, where they are carried to term and delivered.



Advantages of MOET

1. **Rapid Genetic Improvement:** MOET enables the widespread propagation of desirable genetic traits, as one donor female can produce multiple offspring in a single breeding cycle.
2. **Increased Reproductive Efficiency:** By transferring multiple embryos, the number of offspring produced from a single donor is greatly enhanced, improving reproductive efficiency.
3. **High-Quality Offspring:** MOET allows the use of superior genetics from high-quality sires, improving the overall herd's genetic potential.

4. **Preservation of Elite Genetics:** Embryos can be frozen, preserving valuable genetics for future use, which is particularly useful in the conservation of rare breeds or elite individuals.

Disadvantages of MOET

1. **High Costs:** The process requires significant investment in hormones, equipment, skilled labor, and veterinary care, making it expensive for many producers.
2. **Invasive and Technically Demanding:** MOET involves complex procedures such as hormone treatments, embryo collection, and transfer, which require specialized knowledge and expertise.
3. **Embryo Failure:** Not all embryos will successfully develop in recipients, and a proportion may be lost during collection or implantation.
4. **Limited Number of Donor Females:** While one donor can produce many embryos, the number of successful, high-quality donors may be limited, which can reduce the overall success rate of the program.
5. **Potential for Reduced Genetic Diversity:** Similar to artificial insemination, MOET might lead to the overuse of a few superior genetic lines, potentially reducing genetic diversity within a herd.

Conclusion

In conclusion, livestock plays a crucial role in global agriculture, food security, and rural economies. Livestock farming provides essential products such as meat, milk, eggs, wool, and leather, which are vital for human nutrition and economic stability. Additionally, livestock contribute to the maintenance of ecosystems through natural grazing and are integral to many cultures and societies worldwide. Advancements in breeding technologies, such as artificial insemination and multiple ovary embryo transfer, have enhanced the genetic potential and productivity of livestock, driving greater efficiency in production and improving livestock health. However, the industry faces challenges related to animal welfare, environmental sustainability, and disease management. Sustainable practices, technological innovations, and a focus on ethical farming are essential to ensuring the long-term viability of livestock production. Overall, livestock remains a cornerstone of agricultural systems, with its continued development being key to feeding a growing global population while addressing the environmental and social challenges of the future.

Breeding techniques in livestock aim to improve the genetic quality of animals for enhanced productivity and disease resistance. Among various methods like natural mating and MOET, artificial insemination (AI) is considered one of the most effective and widely used techniques. AI involves collecting semen from a selected male and introducing it into the reproductive tract of a female, bypassing natural mating. This technique offers several advantages, including the ability to select superior genetics from animals located far away, reducing the risk of transmitting diseases, and allowing the use of semen from genetically valuable sires. AI also enables more efficient breeding programs, as one dose of semen can inseminate multiple females, improving herd quality and productivity. With its ability to enhance genetic diversity and reduce breeding costs, AI stands out as the best breeding technique in modern livestock management.

References

1. https://en.wikipedia.org/wiki/Livestock#:~:text=Livestock%20are%20the%20domesticated%20animals,fur%2C%20leather%2C%20and%20wool.
2. https://dictionary.cambridge.org/dictionary/english/livestock
3. https://www.merriam-webster.com/dictionary/livestock
4. https://www.britannica.com/topic/livestock-farming