THE SCIENCE WORLD
A Monthly e Magazine
ISSN:2583-2212
Popular Article
October 2024 Vol.4(10), 4022-4026

Importance of AI and Interesting fact about poultry Reproduction

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https://doi.org/10.5281/zenodo.14035006

Introduction

India has a vast resource of livestock and poultry, which play a vital role in improving the socio-economic conditions of rural masses. Poultry production in India has taken a quantum leap in the last four decades, emerging from conventional farming practices to a commercial production system with state-of-the-art technological interventions. Currently, the total poultry population in our country is 851.81 million (as per the 20th Livestock Census), and egg production is around 129.60 billion during 2021–22. The per capita availability during 2021–22 is around 95 eggs per annum. The egg production has shown positive growth of 6.19% during 2021–22. (DADHF Annual Report 2022-2023).

Significant of AI in poultry

Poultry farming in India has evolved significantly, shifting from traditional backyard rearing to a large-scale commercial industry over the past few decades. The country is home to nineteen recognized poultry breeds, which are distributed across various regions. In terms of reproductive technology, semen is the only gamete in chickens that can be cryopreserved for future use. However, the fertility rate with cryopreserved semen is low, making it an expensive option for large-scale application. Furthermore, cryopreservation protocols must be customized for each chicken breed or line, as results can vary and may not be consistently replicated across different breeds. Currently, the primary methods used in the poultry industry involve collecting fresh semen, diluting it with an appropriate diluent, and then using it for artificial insemination.

Use of Assisted Reproductive Technologies in poultry

Assisted Reproductive Technologies (ARTs), such as Artificial Insemination (AI), have significantly contributed to increasing poultry production by enabling the broader use of genetically superior cockerels with high productive performance. AI allows the rapid dissemination of genetic material from a small number of top sires to a large number of hens (Vishwanath and Shannon, 1997). While natural mating results in 80–85% fertility, AI can boost fertility rates by an additional 5–10% (Gee *et al*., 2004).

This technique also helps prevent the spread of venereal diseases through natural mating. Moreover, AI offers the advantage of one cockerel inseminating 20 to 30 hens, compared to only 8 to 10 hens per day through natural mating. Despite these benefits, poultry producers have also employed genetic selection and improved nutritional management practices to enhance poultry growth rates. However, these advancements have sometimes led to negative effects on reproduction (Bramwell, 2002).

Due to the sharp increase in chicken meat consumption, it has also become important to increase the production of layers to meet the demand. Assisted reproduction technologies (ART's), such as AI contribute to increase poultry production, as it allows a wider use of genetically superior cockerels with a high productive performance (Benoff *et al*., 1981). On the other hand, ART's have the potential benefit of allowing the preservation of semen collected from these cockerels for future use and for export if necessary.

Artificial insemination (AI) has been considered a valuable technique in the poultry industry (Benoff *et al*., 1981). One of the advantages of this technology over natural mating is the efficient use of males, which directly decreases the cost of AI by reducing the number of cocks needed (Benoff *et al*., 1981). This efficiency becomes particularly beneficial when fertility in broiler breeds declines due to males being selected for growth, which may result in compatibility issues between large and smaller breeds. In such cases, AI can play a crucial role in broiler breeder management and help resolve these compatibility challenges (Reddy, 1995).

The first successful AI in poultry was achieved in 1899 when Ivanov produced fertile chicken eggs using semen recovered from the ductus deferens of a cock after it had been killed (Lunak, 2010). The most widely used technique for intravaginal insemination in poultry was first reported by Quinn and Burrows in 1936.

The male reproductive system in birds is entirely internal, which contrasts with mammals, where the reproductive organs are external. This unique aspect of avian biology allows bird sperm to remain viable at body temperature, unlike mammalian sperm, which requires lower temperatures to remain viable-hence the external reproductive organs in male mammals (Brooks, 1990).

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Published 28/10/2024

Aisha and Zain (2010) describe artificial insemination (AI) in poultry as the process of collecting semen from male birds and introducing it to females to fertilize eggs. The primary goals of AI in poultry are to deposit the semen in the female's oviduct, close to the sperm storage glands, while maintaining the health and welfare of the breeder hens to achieve optimal fertility. Typically, less than 0.1 ml of semen is required for insemination, containing a minimum of 100 to 200 million viable sperm, which is introduced into the hen's vagina (Gordon, 2005).

Fig 1-Semen collation

Fig-2 Artificial insemination

Interesting behaviour of spermatozoa in oviduct of hen

After semen is deposited in the oviduct, it enters the sperm storage gland, located at the junction of the vagina and shell gland. From this point, spermatozoa travel up the oviduct to another storage site at the junction of the magnum and infundibulum (Aisha and Zain, 2010). The arrival of an ovum in the infundibulum triggers sperm activity, leading to fertilization of the ovum by one sperm (Aisha and Zain, 2010).

Froman and Feltmann (2005) found that the hen's Sperm Storage Tubes (SST) are situated between the vagina and shell gland of the oviduct. Spermatozoa reach the SST within one day in hens and cockerel sperm remain motile at 41°C for days or weeks after ejaculation. However, how sperm enter, survive, and leave the SST remains unclear. Sperm movement through the oviduct occurs via smooth muscle contractions or ciliary action, accumulating in the mucosal folds and glands near the lower infundibulum (Hafez and Hafez, 2000). Unlike in mammals, where sperm spend a short time in the female tract, sperm in chickens and turkeys can remain in the oviduct for extended periods before fertilizing the ovum-up to 32 days in chickens and 70 days in turkeys (Hafez and Hafez, 2000).

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Mauldin (2000) explains that sperm are released from the SST at regular intervals to fertilize sequentially ovulated ova. Once released, sperm are carried to the ovum by oviduct contractions, and sperm motility becomes less critical. Within 5 to 10 minutes after ovulation, sperm reach the ovum's surface. Those that contact the perivitelline layer undergo an acrosome reaction, where enzymes, likely acrosin, help break down the perivitelline layer. While theoretically only one sperm fertilizes the ovum, polyspermy is common in hens, with many holes forming in the perivitelline layer (Hafez and Hafez, 2000).

Conclusion

India's poultry industry has evolved from traditional farming to advanced commercial production, significantly impacting the rural economy. Assisted Reproductive Technologies (ARTs), particularly Artificial Insemination (AI), have been key in increasing productivity by efficiently utilizing genetically superior cockerels. AI boosts fertility, resolves compatibility issues in broiler breeding, reduces male birds needed, and aids in disease control. Overall, the application of ARTs, combined with advancements in genetic selection and nutritional management, has boosted poultry production in India, although continuous research and technological improvements are necessary to overcome existing limitations.

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