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Revolutionizing Swine Breeding: The Role of Artificial Insemination

Man Singh*, D.S. Bidhan, Vishal Sharma, Sandeep Kumar, Narender Singh, D.C. Yadav and Amandeep
Department of Livestock Production Management
Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar (Haryana)-125004
*Corresponding Author: drmansinghluvas@gmail.com

Abstract

In India, pig rearing remains largely traditional with low productivity. To ensure sustainability, efficiency, and competitiveness in pig production, it is essential to adopt advanced reproductive technologies. Artificial insemination (AI) stands out as the most effective method for achieving these goals. AI involves the collection of semen, laboratory processing, and packaging into 80 to 90 ml pouches containing two to three billion spermatozoa, followed by timely insemination of the sow. Globally, AI is widely used with freshly diluted semen, leading to significant improvements in swine populations. This technology not only enhances genetic quality but also streamlines farm management, reduces labor, and prevents disease transmission. However, the introduction of AI in northeast India has shown promising responses from various stakeholders. To replicate global successes, it is crucial to understand the technique, adapt it to local conditions, and establish appropriate regulations and support services. With proper implementation, AI can significantly boost the profitability and sustainability of pig farming. Achieving this requires coordinated efforts from all involved parties.

Introduction

Indian pig farming is a crucial livelihood source for rural poor communities, particularly those in the lowest socio-economic strata. Tribal farmers predominantly rear pigs under scavenging systems across much of India and backyard production systems in the northeastern regions. The majority of the pig population in India consists of indigenous breeds characterized by poor growth rates and low productivity. Despite these challenges, pig production has significant economic potential due to pigs' high fecundity, efficient feed conversion, early maturity, short generation intervals, and minimal space requirements. However, interest in pig breeding among farmers is limited due to the unavailability of breeding boars, high breeding costs, lack of field methods for pregnancy diagnosis, and limited awareness.

Artificial insemination (AI) addresses these challenges by improving local germplasm with minimal input costs. Compared to natural mating, AI is more effective for introducing superior genes into sow herds with a reduced risk of disease transmission. Genetic selection programs using AI have enhanced economic traits such as growth rate, feed conversion efficiency, carcass quality, mothering ability, and litter size. Initially, AI was focused on improving breeding management and preventing venereal diseases rather than accelerating genetic progress. AI, combined with estrus synchronization, facilitates planned and controlled breeding and prevents inbreeding by avoiding repeated use of the same boar. It eliminates the need for keeping boars at every farm, reducing production costs and improving record maintenance. Semen from a single ejaculate can be used to breed 10 to 20 females, and long-term extenders have enabled widespread AI adoption. AI also helps control venereal diseases and maintains a closed nucleus herd, preventing disease entry. Centralized semen production centers enhance boar management and health, housing, and feeding, while early semen collection allows for comprehensive laboratory examination and early culling of sub-fertile boars. Expanding AI technology in pig farming and spreading superior germplasm is essential for large-scale improvement. However, AI is not without challenges. Semen can carry diseases, with some pathogens like the porcine reproductive and respiratory syndrome virus causing significant economic losses. Microbial contamination of semen can result from infected boars or improper handling, leading to quality deterioration, embryonic or fetal death, endometritis, pyometra, repeat breeding, and systemic infections in recipient females. To prevent pathogen contamination, it is crucial to maintain specific pathogen-free boars and enforce strict biosecurity measures at AI stations. Adding antibiotic cocktails to extenders can reduce contamination during semen collection, processing, and storage. Boar Training for semen collection: Boar training is most important part in the whole process and many a time it may turn out in a frustration for the farm manager. Boar training is done in the morning hours before feeding. The young boars are introduced to the dummy and allowed to sniff the dummy which may be smeared with the saliva, urine or vaginal discharges of sows in heat. Otherwise, the saliva and semen of older boars may also be used. Dummy should be solid in construction (made up of wood or metal) without sharp edges, and located in a quiet designated semen collection room with a non-slippery floor or having provision of rubber mat. Prior to training, dummy mounting and semen collection of older boars may be done in view of the younger boars as this influences a positive response in faster mounting by the trainee boars. Generally, the boar should start mounting the dummy within 15 days and start donating ejaculates within 20 to 25 day. However, sometimes it may take four to five months depending upon the libido of the boar and experience of the trainer. Boar displaying low libido should be rejected from breeding programme. Semen should be collected at minimum intervals of at least 3 days for optimum semen fertility.

Semen collection

In boar, semen is collected by the gloved hand method in which the cork screw tip of the boar penis is grabbed and held by the hand of the collector using a polyvinyl glove (do not use latex gloves). In glove hand technique, applying pressure on the cork screw part of penis by hand is major reflex for boar to ejaculate. The semen is collected into a collection flask or thermos flask (maintained at 37°C) through a Buchner funnel fitted with milk filter to filter out the gel plug of the boar ejaculate. The pre-sperm fraction (about 10–20 ml) consisting of preputial fluid and urine accumulated in the prepuce is discarded and only the sperm rich fraction (100 to 400 mL) is collected. The ejaculation period generally last for five to ten minutes. The post-sperm rich part is watery and clear fluid which should be discarded. Also, filter along with gel should be discarded. The collected ejaculate is brought to laboratory within 15 min for processing and dilution. All the materials and equipment which comes into direct contact with semen must be sterile to avoid the bacterial contamination. During the whole process of semen collection and processing, the temperature of the semen collection flask, extender and other materials should be kept at 37ºC.

Semen quality

The success of artificial insemination (AI) programs is largely attributed to the ability to evaluate boar ejaculates in the laboratory for quality. Ideally, semen should be creamy white and free of debris and blood. The opacity of the ejaculate provides a rough indication of spermatozoa concentration. Ejaculate volumes range from 100 to 400 mL, depending on breed, climate, and season. Sperm motility is essential for successful fertilization. Initial sperm motility in b oars is assessed either subjectively at 400X magnification under a light or phase contrast microscope, or objectively using computer-assisted sperm analysis (CASA), with equipment maintained at 37ºC. Typically, fresh boar semen exhibits 70-90% initial sperm motility, although this decreases over time in storage depending on the extender used. Microscopic examination of spermatozoa provides insights into morphological abnormalities, cell membrane integrity, and the acrosome. These parameters are routinely used to monitor semen quality. While other in vitro and in vivo tests for comprehensive semen evaluation exist, they are not commonly used. Ultimately, the most reliable test for predicting fertility is pregnancy.

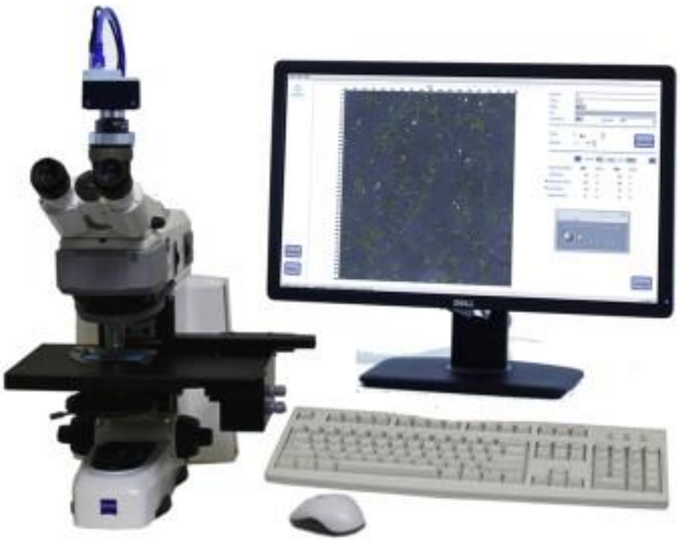

Fig. 1 computer-assisted sperm analysis (CASA)

Oestrus detection and insemination

After the successful collection and processing of semen, timely insemination of the sow or gilt is crucial for maximizing the benefits of artificial insemination (AI). Proper understanding of estrus duration, its control, timing and number of inseminations, AI procedures, on-farm semen storage, and the use of new AI technologies necessitates thorough knowledge of pig reproductive physiology.

Regular estrus detection on the farm, assisted by a boar, is essential for accurate heat detection. The aim is to identify when the sow or gilt reaches standing heat, a period during which the female stands still and rigid when pressure is applied to her loin. Signs of standing heat (lordosis) include swelling and reddening of the vulva, vulvar discharge, vocalization, inappetence, boar-seeking behavior, ear popping, and standing for back pressure. Estrus in sows lasts from 48 to 72 hours, with sows typically returning to heat 4-6 days post-weaning. In gilts, estrus lasts 40-48 hours. The preferred strategy involves two inseminations during standing estrus at 12-hour intervals. Gilts should be inseminated 12-24 hours after heat detection, and again 12 hours later. Sows should be inseminated 24-36 hours after heat detection, followed by a second insemination 12 hours after the first. Ovulation in pigs occurs during the latter two-thirds of the estrus period. The site of semen deposition, typically at the outer end of the cervix during natural mating and conventional AI, influences survivability, litter size, and conception rates.

Fig. 2 Back Pressure Test

Conclusion

AI in pig is used widely in the world with the use of freshly diluted semen. The use of AI has allowed significant improvement in swine population over the world. Besides genetic improvement, it allows for better maintenance of farm record, saving farm labor and prevents disease transmission. Artificial insemination in northeast India was introduced only recently but the response from the farmers is quite favorable. It has already taken off in parts of Nagaland, Assam, Meghalaya and in Mizoram with enormous success. In Nagaland, ICAR has introduced this technology and is getting popular among farmers. In order to replicate the successes achieved in different countries, a proper understanding of the technique, its adaptability to local conditions and the regulations that need to be put in place. The establishment of support services is vital to achieve success. The technology has the potential for enhancing the profitability of pig farming in sustainable way. To reap the full potential of this technology, concerted efforts are needed from all stakeholders.

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