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Artificial Insemination in Pigs: Current Trends and Future Prospects

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Pig is one of the efficient feed converting animals amongst the domestic livestock and can play an important role in improving economic status of the weaker section of the society. Pig is one of the most important livestock reared by rural people specially the tribal mass of India. Pork is the most preferred meat consumed North East India but there is huge gap between the demand and supply of the pork. This is because the pig population is declining due to more consumption and lack of superior males for breeding to multiply the population. Low pork yield /indigenous pig, unavailability of semen/males at farmers' door step, lack of multiplier farms/farmers and tendency to rear on zero input basis are major hurdles in the pig production in the country. The goals and solution for augmenting pig production should be maximized number of live piglets per litter, optimizes piglet birth weight, maximizes litters per year, reducing weaning to oestrus interval, optimizes longevity & lifetime productivity. In such a situation, Artificial insemination provides the best solution. The technique is first generation and oldest reproductive biotechnology for fastest genetic improvement which has reached to the farmer's door step. A.I. is used worldwide across the world, for which the status of A.I. is described ahead in the present paper. However, A.I. in pigs is still in infancy stage. As per recent livestock censuses, consecutive decline trends have been observed in pig population across the country. But a rise in pig population has been observed in Assam state that is mainly use of A.I. in this state as compare to others. Performing artificial insemination in pig is very simple as compare to cattle and buffalo. Artificial insemination in pigs is mainly done using liquid semen while A.I. with frozen-thawed semen is still in infancy stage. Currently, more than 99% of inseminations conducted worldwide are made with liquid stored semen at 15-

20ºC for 0-5 days, where more than 85% of all inseminations are carried out on the day of collection or on the following day (within 24 hr. of semen collection) for meat production market. Less than 1% of all inseminations are made with cryopreserved semen for upgrading the genetic nucleus in a particular country or herd. In the present article, AI in pig will be mainly focused using liquid semen.

History of AI in Pig:

The first attempts on artificial insemination (A.I.) of pigs were made in 1926–1927 by Ivanov, which were continued between 1930 and 1936 by Milovanov et al. cited by Serdiuk, 1970. In 1957, First piglet born from frozen thawed semen by Hess E.A. in 1975, Beltsville-TS, one of the most commonly used extenders was developed.

Advantages of Artificial Insemination in Pig

The cost of one piglet is around Rs. 3000-4000/-. Hence on an average, a farmer can earn around Rs. 15000-20000/- per farrowing. Moreover, keeping male/Boar for natural service is a costly affair for them. Further, after a particular age of around more than 3-4 years, the boar (used for natural service) meat gives unpleasant smell which is not acceptable by meat consumers and the market value of that male become very low. Then such boars become burden for the farmers. In such situation, A.I. holds very good solution for them by reducing keeping cost of males/boars. Further, it is a source of employment also.

- Fastest genetic improvement can be achieved through A.I. technique because being a polytocous species in pig, inbreeding depression affect reproduction, production, carcass traits and feed conversion efficiency resulting economic loss can be eliminated using AI technique. Further, upgrading of finishing weight and production performances of indigenous pigs (small size) can be done with large sized boar from exotic breed of pigs in lesser time. Crossbreeding is possible in large scale for synthetic breed development programme.
- AI can be done at distant places using semen from superior quality boar. Further, import cost of live animals can be minimized by importing semen and using that semen for A.I.
- Sexually transmissible disease can be prevented.
- A.I. overcomes the size differences between male and female while mating.
- Record keeping for production and pedigree sheet gets improved, therefore dam and sire lines can be maintained very well.
- For small and marginal farmer, A.I. is highly cost-effective method of reproduction, because it eliminates the cost of feeding and management of a breeding boar it allows unusable piglets to go for castration and adds more profit in farm income. Because,

keeping a greater number of intact males after finishing age produces boar taint in meat of those males. Therefore, selecting superior males for A.I. programme, the castrating remains males, the economic losses due to boar taint minimized. The intact males after finishing age fetch fewer prices than castrated one. • It minimizes the managemental cost in conjunction with synchronization technique for induction of estrus /heat, where a group/ number of sows can be bred at a predetermined, therefore resulting farrowing in more synchronous way.

- Semen evaluation in A.I. allows investigation of sub fertility in boars if suffered after service for identification of etiology and remedial measures.
- A.I. provides breakthrough or essentional for further reproductive technologies such in vitro fertilization, sperm sexing, transgenic embryo production etc.

A.I. in Pig in India

Pig production is an important secondary occupation for livelihood and nutritional security of the rural people, especially in North-Eastern region of India. Approximately 80% of tribal population in North Eastern India is involved in raising pigs on a small scale which are mostly reared under semi-intensive system of management. Pigs are concentrated in the North-Eastern Region where almost 40% of the country's total pig population exists. As per the latest livestock census, the pig population is 8.3 million and is presently showing a decline trend. One of the reasons behind declining pig population is lack of breedable males for multiplying the population. Only 3-4 or very few males are reared in a village, subsequent to which mating doesn't occur at the time of heat. The cycle of the female goes waste leading a loss of around Rs. 2000/- per estrous cycle. The artificial insemination is the technology by which this problem is solved because the semen for service can be provided at any time and at any place at farmers' door step. The technology aims in reduction of cost of keeping & feeding males, genetic improvement, overcoming the size of male & female and it can be done at farmers door step. ICAR-NRC on Pig, Rani (Guwahati) is a pioneer institute to develop artificial insemination (A.I.) in pig.

Boar Semen collection

Semen is collected by gloved (nitrile & vinyl; never use spermicidal gloves) hand method form a trained male on artificial dummy. Semen is collected twice a week in a in pre warmed thermos flask. Usually, it takes minimum of 6-8 minutes for collecting the semen. Semen comes in three fractions as shown in table below:

Pre-sperm	20-25ml	Watery + few gelatin	Discard
Sperm-rich	40 to 100 ml	viscous-chalky, milky-white	collected
Sperm poor	70 to 400 ml	opaque, chalky-gray	collected
Gelatinous	20 to 40 m	sticky substance	filtered

Preliminary semen evaluation

The semen is evaluated using standard protocols. Some of the preliminary test's range is indicated below.

Parameter	Range
• Ejaculate volume	200-400 mL
• Sperm rich volume	100-200 mL
• Sperm/ejaculate	60-130 billion
• Normal sperm	85-90%
• Progressively Motile sperm	80%
• Live sperm	90%
• Acrosome Abnormalities	< 5 %
• Cytoplasmic Droplets	< 5 %
• Curled Tails	1-2 %
• Clumping	0-10 %
• Concentration	150-200million/ml
• HOST +	70-80%
• Microbiology	< 1 CFU/mL

Processing /extension

Semen is processed within 30 minutes of collection. After preliminary examination, semen is kept at 22ºC for 4 hrs and then it is extended with extender as per type of extender and manufacture's guidelines. Usually an extension rate of 1: 3 is used with minimum of 3 billion sperm per dose of total volume 80-100ml. Different types of extenders are used as shown below

Short-term (1-3 days)
Beltsville Liquid (BL-1)
Beltsville thawing Solution (BTS)
Illinois Variable temperature (IVT)
Kiev
Vital(R)
Reading
X-cell(R); Zorlesco; ZORPVA

Long-term (over 4 days)
Acromax(R)
Androhep(R)
Modena
MR-A(R)
MULBERRY III(R)

Packing and preservation

Extended semen may be packed in packets or bottles and stored/ preserved at 17 ºC.

Performing AI in Pig using liquid semen

It is very easy as compared to cattle and buffalo. The timings for performing AI are given

below. The time interval between two inseminations and between the last insemination and ovulation, respectively, should not exceed 12 to 18 h.

Frequency of oestrus detection	Best time to inseminate relative to the first detection of standing oestrus	
	Gilts	Sows
Once daily	0 and 24 hours	0 and 24 hours
Twice daily (12 hr apart)	12 and 24 hours	24 and 36 hours

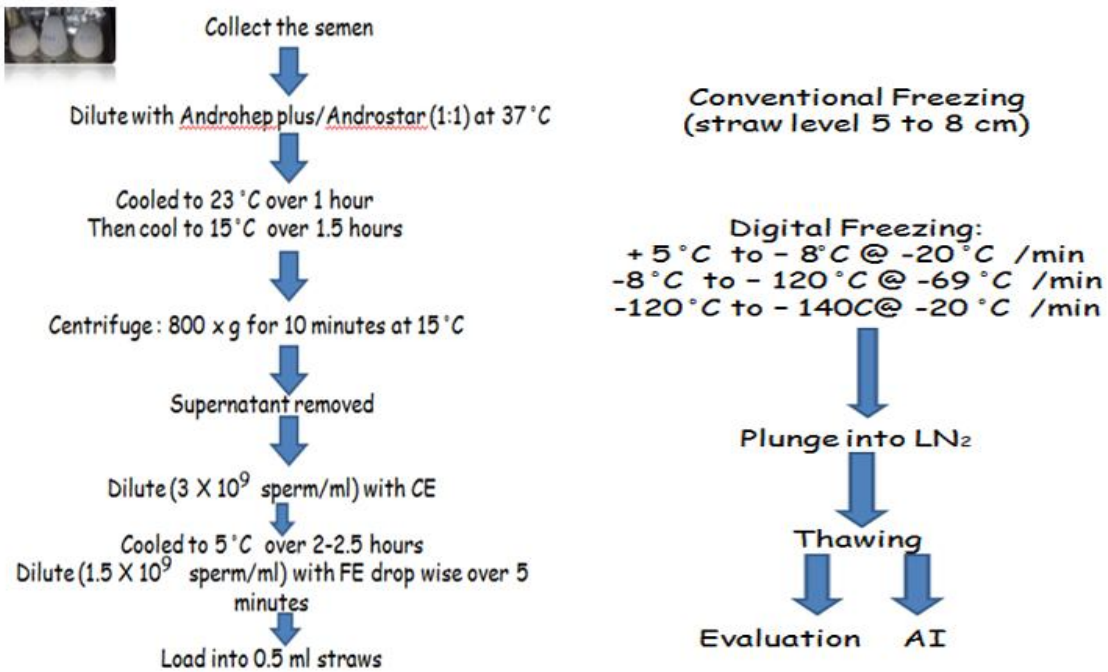
Procedure of AI

- Before inseminating the female, use a paper towel to clean the vulva.
- Lubricate the tip of the spirette or catheter using any non-spermicidal lubricant Avoid getting lubricant in the opening of the spirette/catheter.
- Gently guide the spirette/catheter at an angle of 45°, with the tip pointed up, through the vagina to the cervix. The bottle/packet of diluted semen is not attached to the spirette/catheter at this point. Keep the tip pointed up to reduce the chance of coming into contact with the bladder, which could cause a backflow of urine into the spirette/catheter. If this happens, use a new spirette/catheter because urine kills sperm. This is the primary reason the bottle of diluted semen should not be connected to the spirette/catheter until the cervix has been entered. Not connecting the bottle at this point also avoids exposing the semen unnecessarily to extremes of light or temperature.
- After inserting with an angle, make the catheter straight, and make forward till it stops to go further.
- Now, use a counter clockwise rotation to insert the spirette/catheter into the cervix. Resistance can be felt by gently pulling back on the spirette. A foam tipped catheter is not always inserted into the cervix, but usually is positioned up against the cervix.
- Gently invert the bottle/packet of diluted semen two or three times to mix the semen.
- Attach the bottle/packet to the end of the spirette and discharge the semen slowly.
- A gentle squeeze to start the process may be needed, but after that the semen should be allowed to be taken up by uterine contractions. This process takes at least 3-4 minutes. Because of the variation in intensity of uterine contractions, gilts often take longer to inseminate than sows. Depositing the semen too rapidly will cause a backflow of semen out of the vulva. Obviously, semen that flows out onto the ground is wasted.

- A small amount of semen backflow is expected. If an excessive amount of backflow occurs, stop the insemination. Either the semen is being deposited too rapidly or the spirette is not fitted properly into the cervix. A quarter-turn of the spirette might correct this. If semen flow stops, reposition the spirette by a quarter-turn or move the catheter back and forth a bit to reinitiate semen flow. Also, cut a small hole in the semen bottle if flow has stopped because of a vacuum build up.
- If there is a great deal of resistance to the flow of semen, reposition the spirette because the tip may be lodged against a cervical fold.
- When all of the semen has been deposited into the female, remove the spirette by rotating it clockwise while gently pulling.
- A new spirette/catheter should be used for each insemination to eliminate the possibility of
- Transmission of disease or infection from one female to another.
- Keep the female in quiet surroundings for 20 to 30 minutes. Distress at this time may still
- Disrupt semen transport and fertilization.

Boar semen cryopreservation

The current status of boar semen cryopreservation is still considered poor to-fair (Mazur et al., 2008). Most problematic is that we still do not know, conclusively, the reasons for these sub optimal results. As already mentioned, compared with freshly collected or extended counterpart spermatozoa, many, if not most, cells subjected to a cooling-freezing



thawing process have a short lifespan. This is presumably due to damage in the plasma membrane, caused, in turn, by differences in water efflux during freezing (dehydration) and the reverse rehydrating process during thawing (Rodríguez-Martínez, 2000). Boar sperm is very fragile as compared to other species. The different types of extenders, different rates of egg yolk and glycerol are used. A simplified flow chart for boar semen cryopreservation is shown. However, protocols, ingredients used vary. Extensive research in this area is going on across the world; however, results are still suboptimal.

Main constraints for A.I. in developing countries like India

1. Lack of suitable transportation system for maintaining the semen preservation temperature till at the site of insemination
2. Lack of sufficient number of A.I. laboratory/centres across the country to supply the liquid semen doses.

Limitations of A.I.

1. Improper cleaning of the instruments and unhygienic conditions may lead to lower fertility. 2. The market for the boars is reduced while that for the superior germplasm is increased.
2. The selection of the sire should be very rigid in all respect.
3. Preservation and transportation of semen is difficult under severe climatic conditions like those prevailing in most parts of India.
4. Initial investments are more and require infrastructure facilities.

Future Challenges for A.I. in Pig

1. Reducing the number of sperms per insemination
2. Standardization of synchronization protocols for A.I. in pigs
3. Development of low-cost preservation and transportation equipment's for boar semen for effective use.
4. Cryopreservation of boar semen.
5. Early detection of fertility in males.

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