International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(9): 1881-1883
www.biochemjournal.com
Received: 19-08-2025
Accepted: 20-09-2025

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Effectiveness of artificial insemination programs on livestock productivity in district Aligarh (U.P.)

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DOI: https://www.doi.org/10.33545/26174693.2025.v9.i9Sx.5785

Abstract
Artificial insemination (AI) is a key reproductive technology that enhances genetic quality and livestock productivity. This study evaluates the effectiveness of AI programs in District Aligarh, Uttar Pradesh, focusing on conception rates, milk yield, and reproductive efficiency. Data were collected from 150 dairy farms (450 insemination events) through a cross-sectional survey. Statistical analysis using descriptive statistics, chi-square tests, and regression models revealed a conception rate of 68% and a 12% increase in milk yield on AI farms compared to non-AI farms. Reproductive efficiency also improved significantly ($p<0.05$), with shorter calving intervals and more regular estrus cycles. Despite these benefits, challenges such as insufficient farmer training and poor semen handling practices limited outcomes in some cases. The findings underscore AI as a low-cost, scalable intervention for improving dairy productivity and highlight the need for capacity building and better program implementation.

Keywords: Artificial insemination, livestock productivity, reproductive efficiency, dairy farming, Aligarh

Introduction
Livestock farming sustains rural livelihoods in India by providing income, food security and employment. Improving livestock productivity is critical to meeting rising dairy demand, yet traditional breeding methods often result in low genetic gain and reproductive inefficiencies (Kumar *et al.*, 2017) [5]. Artificial insemination (AI) offers a reliable alternative, enhancing genetic potential, reducing disease transmission, and improving productivity. AI is extensively applied in cattle, buffalo, sheep, goats, pigs, horses and even in poultry species *viz.*, turkey, contributing to sustainable livestock production, genetic diversity, and improved productivity (Prasad and Kumar, 2022) [7]. Despite AI being promoted by government and private agencies, livestock productivity in Aligarh remains below potential. This indicates gaps in program efficiency and operational delivery (Cardoso *et al.*, 2021) [2]. exotic and crossbred animals generally exhibit higher productivity, they also require better feeding, management, and health care, which can limit the benefits if not addressed in parallel (Singh & Chauhan, 2021) [9]. Identifying these weak links is essential for improving reproductive performance and genetic quality in local herds.
This study provides empirical evidence on the effectiveness of AI in Aligarh. Its findings can guide policymakers, extension workers, and farmers in refining AI strategies, improving genetic programs, and strengthening rural livelihoods (Boettcher *et al.*, 2021) [1].

Materials and Methods
Study Design
A cross-sectional observational study was conducted to assess AI effectiveness under real-world rural conditions in Aligarh. Data were collected using structured questionnaires, direct farm observations, and veterinary record reviews. Parameters included conception rate, milk yield, calving interval, and estrus cycle regularity.

Sampling and Dataset
A stratified random sample of 150 farms was selected across herd sizes and breed types. A total of 450 insemination events were recorded across cattle and buffalo herds.

Data collection included semen handling practices, estrus detection, inseminator training, and farm management factors.

Data Analysis

Data were analyzed using SPSS v26. Descriptive statistics summarized productivity measures, while chi-square tests examined differences across breeds and farm types. Regression models estimated the impact of AI adoption while controlling for confounders such as breed, farm size, and feeding systems. Significance was tested at $p<0.05$.

Results and Discussion

The comparative performance of AI and non AI farms is presented in table and figure 1.

Table 1: Comparative performance of AI and Non AI farms

Parameter	AI Farms (n=150)	Non-AI Farms (n=50)	% Change
Number of Insemination Events	450	150	
Conception Rate (%)	68	56	+12
Milk Yield (Liters/Day)	10.5-12.0	7.8-8.7	+12
Calving Interval (Days)	430	480	-50
Estrus Cycle Regularity (%)	78	62	+16

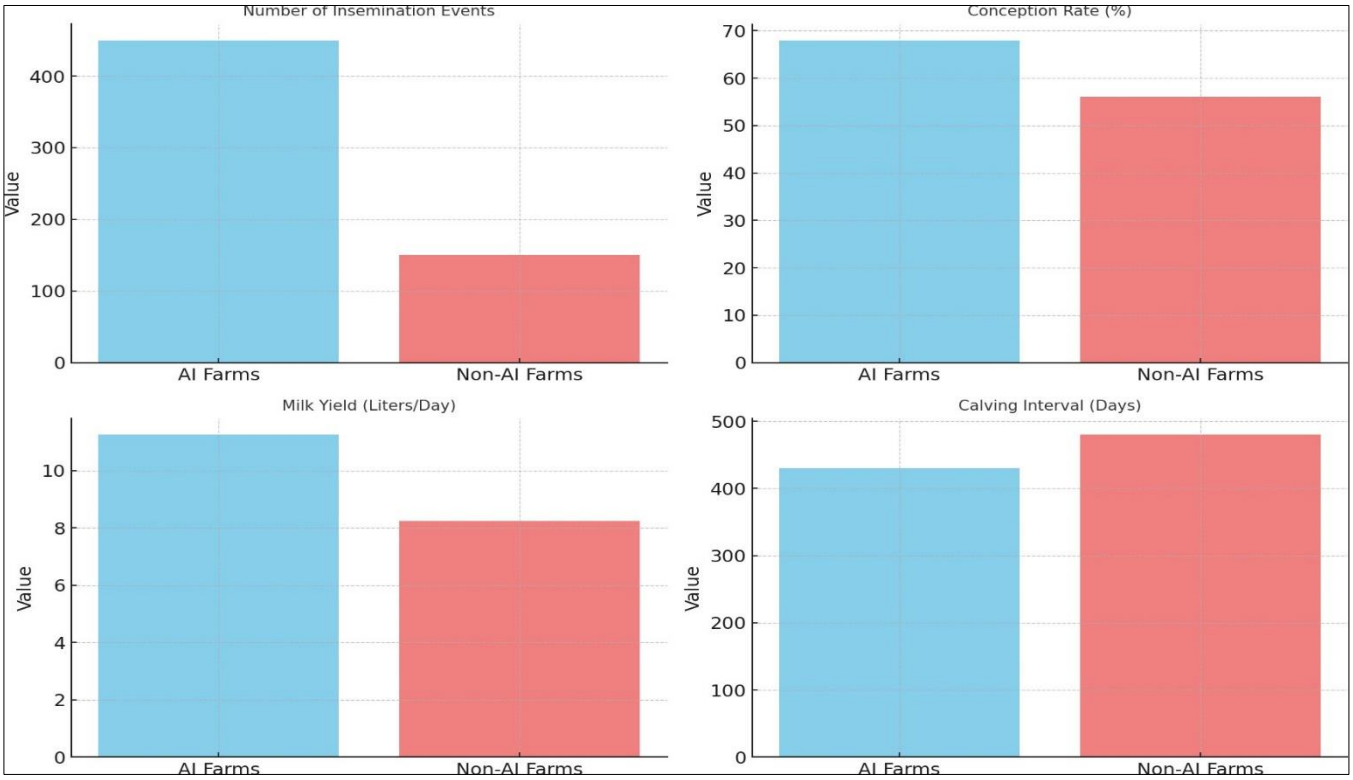

Fig 1: Comparative performance of AI and Non-AI farms

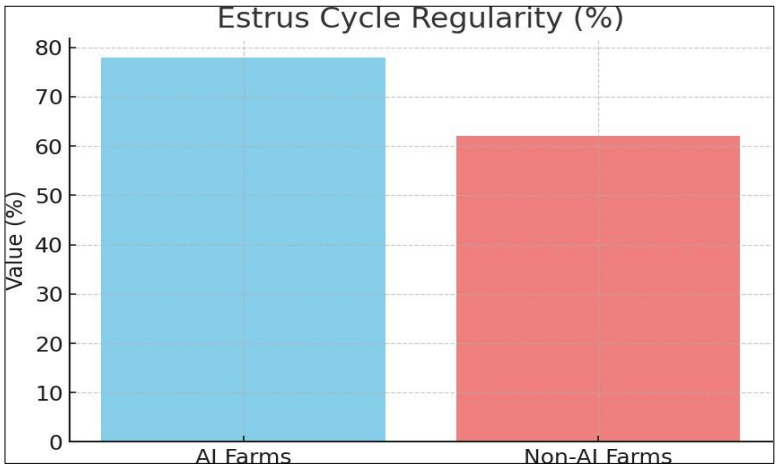

Fig 2: Estrus cycle regularity (%)

Conception Rates

The investigation of 450 artificial insemination (AI) episodes in 150 District Aligarh dairy farms reported a common conception rate of 68%. Among the farms, highly performing farms, where there were trained inseminators, proper semen handling, and frequent estrus detection, had conception rates above 75%. Studies in different parts of India have reported first-service conception rates ranging from 35% to 55%, with significant variation based on breed, season, and management practices (Patel *et al.*, 2023) [6]. Those with compromised AI assistance, inadequate infrastructure, or irregular checking had conception rates less than 60%. These reveal that operational factors in nature greatly influence reproductive success in AI schemes (Hailay *et al.*, 2021) [3]. Secondary stratification of the conception rate by type of breed revealed that the conception efficiency of crossbred females, with an average of 71%, was higher than indigenous breeds at 63%. This disparity indicates the role of genetic elements towards AI outcomes and also highlights the importance of adequate management principles for obtaining peak reproductive performance across several breeds (Table1).

Milk Yield

Milk yield was significantly affected through the implementation of AI. Milk production improved by 12% on an average daily basis in AI package farms in comparison to natural breeding farms. Specifically, crossbred cows benefited most, with average yields improving from 10.5 liters to 12.0 liters per day, while indigenous cows had a smaller, yet considerable, improvement from 7.8 liters to 8.7 litters per day (Rahmat *et al.*, 2021) [8]. The time trend of milk production indicated that the improvement was most pronounced in the initial three months after effective AI, consistent with best calving intervals and enhanced reproductive health. Seasonal variations were also observed; milk yield increased more during winter months, perhaps due to favourable environmental conditions and less heat stress on cow metabolism. These results are a testament to the fact that AI programs, in addition to increasing reproductive efficiency, also have immediate economic benefits through increased milk production (Table 1 and Figure 1).

Reproductive Efficiency

Reproductive efficiency measures were considerably improved among AI-operated farms. Calving interval shortened, from 480 days in non-AI farms to 430 days in AI program-adopting farms, indicating shorter periods between successive calvings and higher intensification of lactation cycles (Hambisa *et al.*, 2021) [4]. The improvement crossed farm sizes, although smallholder farms recorded slightly longer intervals due to gaps in estrus detection and veterinary services. Regularity of oestrus cycles also rose significantly, with 78% of AI cows exhibiting regular oestrus activity against only 62% in non-AI cows. This is critical to ongoing regular breeding calendars, effective labour scheduling, and overall increased herd productivity. The study also indicated that the ratio of repeat inseminations that had to be performed in order to achieve conception went down on AI farms, meaning more efficiency and reduced reproductive wastage (Table 1 and Figure 1).

Summary and Conclusion

Artificial insemination programs in Aligarh significantly improved livestock productivity as shown by higher conception rates, increased milk yield, and better reproductive efficiency. AI farms achieved a 68% conception rate, 12 points higher than non-AI farms. Crossbred cows outperformed indigenous breeds, highlighting genetic and management influences. AI farms recorded a 12% increase in daily milk yield, particularly among crossbreds. Seasonal variations indicated higher yields during winter, reflecting environmental effects. Calving intervals were reduced by 50 days, and estrus cycle regularity improved by 16 percentage points. This contributed to more efficient breeding and lactation cycles. Poor farmer training, improper semen handling (15% of cases), and delayed estrus detection constrained success in some farms. Operational success requires strong farmer training, proper semen handling, and adherence to veterinary protocols. Strengthening extension services and institutional support can maximize AI's role as a sustainable strategy for livestock development.

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