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Scope of Artificial Insemination and its Application in Cattle: Farmers Perspectives

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Abstract
The public livestock department is playing an important role in the growth and development of the dairy sector. It is working to improve dairy production by providing livestock extension services. Artificial insemination (AI) is the technique in which semen with living sperms is collected from the male and introduced into the female reproductive tract at the proper time with the help of instruments. Adopting artificial insemination would considerably reduce genital and non-genital diseases in the farm stock. With the changing time, livestock farmers need to be well aware about the latest innovations and strategies for successful livestock farming. The public sector plays a major role in the livestock sector improvements. The current study was conducted in the District of Hafizabad. Data were collected using a multistage sampling strategy. There were two tehsils such as Tehsil Hafizabad and Tehsil Pandi Bhatian. One of the two tehsils (Tehsil Hafizabad) was chosen conveniently in the first stage. The sample

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size consists of 118 AI users that was drawn through www.surveysystem.com. For the purpose of data collection, a well-developed interview schedule was designed. The collected information was analyzed by SPSS. It was found that the educated (83.1%) young generation utilized artificial insemination. Majority of the farmers (68.6%) adopted AI technology exclusively. However, around one-third employed both insemination techniques i.e. natural and artificial. Slightly more than half (55.1%) of the farmers mentioned that AI is a very important service for dairy development. All respondents reported that the government provides AI services in their area. It was found that artificial insemination is essential for dairy production (WS = 551, mean = 4.67), higher conception rate (WS = 366, mean = 3.62), genetic improvement (WS = 343, mean = 4.182) and sex semen (WS = 326, mean = 3.88). Study findings declared that fraud in semen quality (WS = 499, mean = 4.23), high cost of the semen (WS = 434, mean = 3.68) and dishonest technician (WS = 427, mean = 3.62) were the major issues associated with artificial insemination. It is concluded that farmers with higher education levels, higher incomes, and more years of experience observed less issues associated with artificial insemination. The artificial insemination method might be rather expensive. Therefore, the government needs to work toward lowering the rate of artificial insemination. Fraud was observed in semen quality, there should be appropriate monitoring to detect the linked difficulties causing a barrier to adopting artificial insemination technology.
Key Words: Livestock, Artificial Insemination, cattle, problems.

Introduction

Over the year's livestock has emerged as the largest sub-sector in agriculture. The sector contributed more than sixty percent (61.89%) to the agriculture value addition and 14.04% to the GDP during the financial year 2021-22. The government has re-emphasized the livestock sector as an engine of economic growth, poverty reduction and food security in the country. The overall livestock development strategy aims to promote "private sector-led development with the public sector providing an enabling environment through policy interventions." The regulatory measures aim to increase per unit animal productivity by improving health coverage, management practices, animal breeding practices, artificial insemination services, the use of balanced rations for animal feeding, and the control of livestock diseases (Govt. of Pakistan, 2022).

The public sector is playing an important role in the growth and development of the dairy sector. It is working to improve dairy production by providing livestock extension services such as seminars, conferences, farmers' days, awareness campaigns, and field training programs, all of them are vital for improving and illuminating livestock production capacity. Improved livestock developments have great demand for consumers in the animal husbandry sector, especially in breeding, dairy feed production, health care, management practices, marketing, and livestock extension services. As a result, through extension education and training programs, extension services can provide farmers with the required technical know-how and skills (Khan *et al.,* 2018). Livestock plays a crucial part in the global economy, accounting for around 40% of the agricultural GDP (FAO, 2009). The livestock industry is significantly contributing to poverty eradication, particularly in rural communities. Additionally, it serves as a vital source of both food and revenue (Sharon, 2011).

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In addition to this, it suggests that the expansion of the dairy industry has the potential to reduce the degree of poverty. On the other hand, the dairy setup is steadily growing more important, and it has tremendously helped the rural lives (Quddus, 2012). The production of dairy products may be considered a cash crop and is regarded as the "white gold" of the rural economy. Milk is a crucial source of income and gives relatively quick returns for farmers working on a modest scale. Therefore, in order to raise milk output and improve its quality, small-scale dairy farmers operating out of their homes need to use dairy technology. A greater degree of technological adoption in the dairy industry is closely related with improved milk protein production, the reduction of poverty, and eventually higher revenue generation. Dairy development is an essential approach for securing one's livelihood (Uddin et al., 2010). The use of enhanced feed technology, the keeping of animals of mixed breeds, and management that is improved are all examples of dairy technologies (Mohammed et al., 2004).

The use of artificial insemination in animals was first established for the purpose of controlling the transmission of illness. This was accomplished by preventing the transportation of animals that may carry infections to other animal units for the purpose of mating and by reducing or eliminating the amount of direct physical contact that occurred between individuals. The use of sperm enhancers that include antibiotics was another factor that contributed to the reduction in the spread of bacterial infections (Morrell, 2011).

The cattle industry plays a significant role in Pakistan's agricultural economy. The nation's annual milk production amounts to 59 billion liters, sourced from a population of 49 million cows. Local cows have an average milk yield of only 1,100 liters per lactation, in contrast to Australian cows with 7,000 liters and American cows with 11,000 liters. The Government of Pakistan plans to implement a significant transformation in the dairy industry by extensively utilizing imported semen for artificial insemination. This initiative aims to eliminate local resilient cow varieties that have the capacity to produce up to 40 liters of milk each day (Hasan, 2021).

Artificial Insemination is a very vital technology for improving dairy and beef production. Therefore, analyzing factors that hinder its adoption is a worthwhile venture. This information is useful to breeders to develop cattle breeds that suit the needs of the farmers. The need for Artificial Insemination provided by livestock department in Punjab has been acknowledged for a few years. Agriculture and livestock departments have been formed to help farmers to improve their farming practices by guiding and teaching them. In the last few decades' livestock department took over the extension system, which had undergone various modifications to improve its performance and efficiency.

The initiative, however, is inspired by the creation of a full-fledged Livestock and Dairy Development Department. The average per head output of milk and meat is much lower in comparison to regional and industrialized countries, indicating the performing activities of livestock research and extension stakeholders responsible for the livestock department. The problem needs a comprehensive investigation of the various factors that influence animal development. The present research focused on assessment of artificial insemination application in cattle in district Hafizabad, Punjab, Pakistan.

Methodology

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This section outlines the practices and procedures adopted for conducting the study, collecting the data, and the methods used for analyzing it.

Study area

Geographical location

District Hafiz Abad was chosen conveniently for the study purpose, it is situated at a latitude of 32.20° N and a longitude range of 73.12° to 73.46° E. It is approximately 300 kilometers from the Federal Capital, Islamabad. Covering a total area of 2367 square kilometers, Hafizabad is one of the districts within the Gujranwala division. The climate of Hafizabad is characterized by extreme temperatures, with hot summers and cold winters. The region experiences its highest rainfall during the monsoon months of July and August (Riaz, and Javaid, 2007).

Livestock department overview

Hafizabad is a district with a richly diverse livestock population. According to the latest Cattle Census, there are 57,321 buffaloes, 210,033 cattle, 25,112 sheep, 122,215 goats, 2,885 horses, 47,197 donkeys, 2,806 mules, 346 camels, and 456,865 domestic poultry. To support this substantial livestock population, the district has two Artificial Insemination Centers located in Tehsil Hafizabad and Tehsil Pindi Bhattian. Additionally, there are six Civil Veterinary Hospitals in Hafizabad. Furthermore, nine Civil Veterinary Dispensaries are operational along with village-level Civil Veterinary Centers. There are also two Mobile Veterinary Dispensaries. The District Livestock Department is headed by a District Officer Livestock, supported by two Deputy Livestock Officers specializing in Breed Improvement and Animal Health, two Additional Principal Veterinary Officers, one Senior Veterinary Officer, and eighteen Veterinary Officers (Govt. of Punjab, 2024).

Research Design

This study employed a descriptive cross-sectional survey research design. Due to limited time and resources, data were collected once within a limited period to assess the application of artificial insemination in cattle in the district of Hafizabad.

Population of the study

All Artificial Insemination (AI) users were included in the population of the current study. The veterinary department's records showed that 297 farmers relied on the department's Insemination facilities. These farmers constituted the population of the study.

Sampling techniques

Multi stage sampling technique was employed for the selection of sample from the population. There were two tehsils such as Tehsil Hafizabad and Tehsil Pandi Bhatian. One of the two tehsils (Tehsil Hafizabad) was chosen conveniently in the first stage. There were 19 veterinary health centres. In the second stage, four veterinary centres i.e. Kaleki mandi, Sajjada, Burjdara and Kassoki were selected randomly.

Sample size

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The sample size was calculated by using online sample size calculator www.surveysytem.com. by keeping the confidence level 95% and a confidence interval of 7 during the calculation of sample size. The sample size was 118 farmers.

Construction of data Collection Tool

For the purpose of data collection, a well-developed interview schedule was designed by the while keeping in view the objectives of the study. The reliability and validity of the instrument were ensured through the following methods:

Reliability

The reliability of the interview schedule was tested and improved through pre-testing on ten farmers by using Cronbach's Alpha. The result, with a Cronbach's Alpha of 0.735 for questions of tools, indicated good reliability. Uncertainty and complexity of items were eliminated after pre-testing to enhance clarity and reliability.

Validity

To ensure content and face validity, a panel of experts, including one Assistant Professor, one Professor, and one Associate Professor from the University of Agriculture, Faisalabad, reviewed the survey instrument. They concluded it was representative of the study's objectives and suggested improvements, which were incorporated into the final version.

Data analysis

The data were analyzed using computer-operated statistical software called the Statistical Package for the Social Sciences (SPSS). Various statistical values were computed, including descriptive analysis approaches such as frequency, percentage, weighted score, mean, and standard deviation. **Chi-square and gamma statistical** values were also computed.

Additionally, **Multiple Regression analysis** was also performed to examine the relationship between the independent variables (age, education, income, and experience) and the dependent variable (importance of artificial insemination).

Where

B is the Un-standardized

- This coefficient represents the amount of change in the dependent variable i.e. for once unit change in the predictor variable, while holding all other variables constantan

β is the Standardized Coefficients

- It allows the comparison in the relative strength of each predictor

t-values and its significance

- This value test the null hypothesis

p-value

- Represent the significance level, it indicates the probability that the relationship occurred by chance or not, the values are given below
- If p < .001: Highly significant.
- If p < .01: Very significant.
- If p < .05: Moderately significant.

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Null Hypothesis

In the Multiple Regression analysis of the study following are the null hypothesis Ho

Ho: β_Age = 0
Ho: β_Education = 0
Ho: β_Income = 0
Ho: β_Experience = 0

It means

The age, education, income and the experience has no effect on the importance placed on the artificial insemination

Alternate Hypothesis

Alternate Hypothesis are

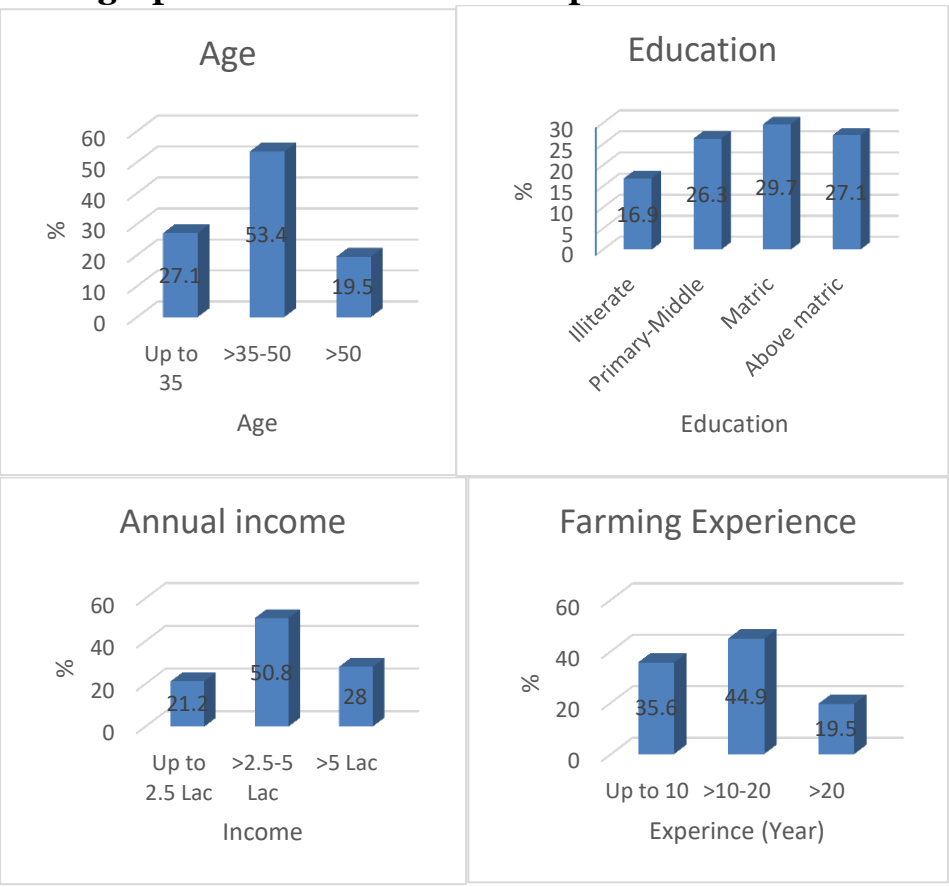
H_1: β _ Age ≠0
H_1: β _ Education ≠0
H_1: β _ Income ≠0
H_1: β_ Experience ≠0

It means

The age, education, income and the experience has an effect on the importance placed on artificial insemination.

Results and Discussion

Demographic Attributes of the Respondents



According to the data, more than one-fourth (27.1%) of the participants were up to 35 years of age, while the remaining 72.9% were above 35 years of age. This

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indicates that more mature farmers were handling and dealing with livestock. The results align with the findings of Muhammad et al. (2008), who found that about 65% of respondents were less than 50 years old. However, the results of Idrees et al. (2007) contradict the present study, as they reported that 45% of livestock farmers in their area were between 36 and 50 years old.

Almost 17% of the respondents were illiterate. However, around one-fourth (26.3%) had a primary to middle level of education. About 30% had education up to the matric level, and the remaining 27.1% had qualifications above matric. These results differ from those of Idrees et al. (2007), who found that 84% of livestock farmers were illiterate and only 16% were literate in a study conducted in Peshawar, Pakistan. This indicates that the literacy situation in the study area is significantly better than that of Peshawar.

In the study area, respondents were asked about their total income from all sources. About 21% of the participants had an annual household income of up to 2.5 lac PKRs, 50.8% had an income of 2.5 to 5 lac PKRs, and the remaining 28% had an annual income above 5 lac PKRs. Sirajuddin et al. (2018) reported that livestock farming is a significant source of increased household income.

The question regarding the livestock farming experience was inquired from the farmers. A significant part (44.9%) of the farmers had 11 to 20 years of experience, and 19.5% of the farmers had more than 20 years of experience. During the discussion with the farmers, it became clear that older individuals were highly involved in livestock farming and performed farming practices proficiently. This finding contradicted those of Khanal and Gillespie (2011), who found that farming experience is negatively associated with the adoption of artificial insemination. According to their research, younger farmers were more likely to adopt AI compared to older farmers.

Table 1: Categorization of the participants concerning the type of insemination method they adopted and service provider

Insemination method	***f***	**%**
Natural	0	0.0
Artificial	81	68.6
Both	37	31.4
Total	118	100.0
AI service providers		
Government	118	100.0
NRSP or NGOs	23	19.5
Pvt. Companies	35	29.7

According to table 2, a significant number of the farmers (68.6 percent) said that they were practicing Artificial Insemination (AI) technique, and 31.4% of the farmers were adopting both methods (natural and artificial insemination). During the discussion with the farmers, it was revealed that famers were more incline towards insemination as according to them the success rate of insemination was higher and handling of the cattle was easy in insemination than that of natural mating. Foote (2001) states that AI, which stands for 'artificial insemination,' was the first significant biotechnology to be used to

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enhance the genetics of agricultural animals and their reproduction. It has had a significant influence on a global scale in relation to many different animals, notably dairy cattle.

The Government of Punjab and NRSP provide AI services in Punjab. Artificial insemination services are rendered by AI technicians and veterinarians, who offer these services for a fee. The cost includes expenses for semen doses and the service itself (Govt. of Punjab, 2012).

According to the above table, all respondents reported that government veterinarians provided AI services in their area. Additionally, 19.5% reported that NRSP or NGOs provided AI services, and 29.7% mentioned that private veterinarians rendered insemination services in their area. Khan et al. (2018) also reported that the public sector plays an important role in the growth and development of the dairy sector. The Government of Punjab and NGOs provide AI services.

Need of artificial insemination (AI)

The use of artificial insemination in animals was first developed with the intention of preventing the spread of disease. This was accomplished by preventing the movement of animals that could carry pathogens to other animal units for the purpose of mating and by eliminating direct contact between individuals. The use of sperm enhancers that include antibiotics was another factor that contributed to the reduction in the spread of bacterial infections (Morrell, 2011). Table 3 represents the farmers' opinions about the need of artificial insemination (AI)

Table 2: Ranking of the farmers' opinions about the need of artificial insemination (AI)

Need of artificial insemination	W.S.	Mean	S.D.	Rank
Dairy production	551	4.67	.30	1
Better conception rate	366	3.62	.98	2
Genetic improvement	343	4.18	.80	3
Sex semen	326	3.88	1.01	4
Control of venereal diseases	303	3.33	.65	5

Table 3 represent the reasons behind the farmers preference of Artificial Insemination. Results of the study show that the majority of the farmers favored AI, as according to them it is necessary for improving "dairy production". The factor "dairy production" ranked at the first position as it had the maximum value of weighted score. The mean value 4.67 indicates that the responses tended towards the 'very-high' category.

The AI is more reliable for 'better conception rate'. This ability is ranked 2nd with a mean value of 3.62, standard deviation of .98 and weighted score of 366. The mean value of 3.62 indicates that the responses tended towards the 'high' category.

The AI is more suitable for 'genetic improvement'. This capability is ranked 3rd with a mean value of 4.18, standard deviation of .80 and weighted score of 343.

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The mean value of 4.18 indicates that the responses tended towards the 'high' category.

The AI is more appropriate for 'sex semen'. This capability is ranked 4th with a mean value of 3.88, standard deviation of 1.01 and weighted score of 326. The mean value of 3.88 indicates that the responses tended towards the 'high' category.

Based on the comprehensive findings, it can be inferred that artificial insemination is indispensable for dairy production, since it leads to a greater conception rate and genetic enhancement. The International Atomic Energy Agency (IAEA) also said in 2007 that Artificial Insemination (AI) is widely acknowledged as a technology capable of facilitating swift genetic enhancement in cattle and buffaloes. Similarly, Fadl et al. (2021) found that the females who were inseminated with semen had high rates of conception and birth. However, the aforementioned conclusions differ depending on Ali et al. The year 2019.They noted that the livestock producers had technical, financial, and physical restrictions, such as a low conception rate of artificial insemination in buffaloes, high prices for concentrates, and high treatment costs.

Table 3: Ranking of the farmers' perceptions about the problems associated with artificial insemination

Problems	**W.S.**	**Mean**	**S.D.**	**Rank**
Fraud in semen quality	499	4.23	.80	1
High cost of the semen	434	3.68	.94	2
Dishonest technician	427	3.62	1.02	3
Unskilled technician	400	3.39	.95	4
Unavailability of a technician on time	393	3.33	1.08	6
Failed insemination	371	3.14	1.05	7
Time-consuming	348	2.95	1.10	8

Table 4 represents the farmers' problems related to artificial insemination. The fraud in semen quality is ranked first problem associated AI with a mean value of 4.23, standard deviation .80 and weighted score of 499. The mean value of 4.23 indicates that the responses tended towards the 'strongly agree' category.

The high cost of semen is ranked 2nd with a mean value of 3.68, standard deviation .94 and weighted score of 434. The mean value of 3.68 indicates that the responses tended towards the 'agree' category. The dishonest technician is ranked 3rd with a mean value of 3.62, standard deviation 1.02 and weighted score of 427. The mean value of 3.62 indicates that the responses tended towards the 'agree' category. The unskilled technician is ranked 4th with a mean value of 3.39, standard deviation .95 and weighted score of 400. The mean value of 3.39 indicates that the responses tended towards the 'neutral' category.

Unavailability of a technician on time is ranked 5th problem with a mean value of 3.33, standard deviation 1.08 and weighted score of 393. The mean value of 3.33 indicates that the responses tended towards the 'neutral' category. The failed insemination is ranked 6th problem with a mean value of 3.14, standard deviation 1.05 and weighted score of 371. The mean value of 3.14 indicates that the responses tended towards the 'neutral' category. The time-consuming is ranked

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7th problem with a mean value of 2.95, standard deviation 1.10 and weighted score of 348. The mean value of 2.95 indicates that the responses tended towards the 'neutral' category.

The overall conclusion declared that fraud in semen quality, high cost of the semen and dishonest technician were problems associated with artificial insemination. There is need to improve the breeding services for the welfare of the farmers as reported by Mutenje et al., (2020), It is essential to offer affordable livestock breeding services by recruiting and training more artificial insemination providers. Strong and effective institutions that incentivize collective participation are crucial to the success of any community-based livestock breeding program. Additionally, promoting access to information and enhancing farmers' knowledge and skills in improved livestock management practices is vital. similarly, Ibrahim et al (2014) also reported the problems associated with insemination of animals, among smallholder dairy farmers, 41% had regular access to artificial insemination, while 59% faced issues like technician shortages and service interruptions. Major constraints included conception failure, technician unavailability, and disease.

Table 4: Relationship between livestock farmers' education level and their problems associated with artificial insemination

Education level	**Behavioral qualities**			**Total**
	Low	**Med.**	**High**	
Illiterate	5	5	10	20
	25.0 %	25.0 %	50.0 %	100%
Primary-Middle	5	5	21	31
	16.1%	16.1%	67.7 %	100%
Matric	5	7	23	35
	14.3 %	20.0 %	65.7 %	100%
Above matric	13	13	6	32
	40.6 %	40.6 %	18.8 %	100%
Total	28	30	60	118
	23.7 %	25.4 %	50.8 %	100.0 %

Chi-square = 20.05 d.f. = 6 P-value = .003**
Gamma (λ) = -0.307 P-value = .007**

** = Highly significant

Table 5 represents the relationship between livestock farmers' education level and their problems associated with artificial insemination. Statistics ($\chi 2$) display a significant ($\chi 2 = 20.05, p = .003$) relationship between livestock farmers' education level and their problems associated with artificial insemination.

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Gamma statistic (λ = -0.307, p = .007) showed significant and negative relation among the variables. It means highly illiterate farmers faced more problems (associated with artificial insemination) as compared to educated farmers.

Table 5: Relationship between livestock farmers' total household income and their problems associated with artificial insemination

Income (PKR)	**Problems associated with artificial insemination**			**Total**
	Low	**Medium**	**High**	
Up to 2.5 Lac	5	7	13	25
	20.0%	28.0%	52.0%	100.0%
>2.5-5 Lac	7	15	38	60
	11.7%	25.0%	63.3%	100.0%
>5 Lac	16	8	9	33
	48.5%	24.2%	27.3%	100.0%
Total	28	30	60	118
	23.7%	25.4%	50.8%	100.0%

Chi-square = 17.89 d.f. = 4 P-value = .001**
Gamma (λ) = -0.344 P-value = .009**
** = Highly significant

Table 6 represents the relationship between livestock farmers' total household income and their problems associated with artificial insemination. Statistics ($\chi 2$) display a significant ($\chi 2$ = 17.789, p = .001) relationship between livestock farmers' total household income and their problems associated with artificial insemination. Gamma statistic (λ = -0.344, p = .009) showed significant and negative relation among the variables. It means highly lower income farmers faced more problems (associated with artificial insemination) as compared to high income farmers.

Table 6: Multiple Regression Analysis

Variable	Un-standardized Coefficients		Standardized Coefficients	t	Sig.
	B	S.E.			
(Constant)	2.215	.180			.00**
Age	-.403	.199	-.370	-2.02	.05*
Education	.414	.092	.589	4.48	.00**
Income	.376	.145	.355	2.58	.01*
Experience	-.502	.185	-.493	-2.71	.01**

Dependent Variable: Importance of Artificial Insemination
R^2 = .38 Adjust R^2 = .36 F-value = 17.29 p-value = .000

The R2 result indicates that around 36% of the variation in the importance of AI can be accounted for by four explanatory variables: Age, Education, Income, and Experience. Based on the data in the result table, it can be inferred and calculated that the entire model exhibits a high degree of reliability. The F-test value also represents this. This model also indicates that the independent factors

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included in the model effectively account for the dependent variables.
All null hypothesis is rejected and alternate hypothesis are accepted. The impacts of two explanatory variables such as education and household income are positive while the other two variables such as age and experience were negative and significant. It means, educated and high income farmers felt more importance of artificial insemination. On the other side young and less experienced farmers felt more importance of AI.
Similar findings were reported by Chaudhry and Miranda (2015), who noted that high-income farmers predominantly rely on new breeding methods for their animals. This concept aligns with Rogers' model of adoption of innovation. As Lee (2004) stated, high-income individuals are risk-takers and are among the earliest adopters of innovative technology. similarly, education also effects the adoption of innovative method and technology of farming. as reported by Mutenje et al., (2020), access to education and income influenced these preferences. Education enabled farmers to make informed decisions, while higher income increased their likelihood of investing in livestock breeding technologies.

Conclusions

It was concluded that educated young generation used artificial insemination. AI users had a handsome earning from livestock. A significant number of the farmers accepted only Artificial Insemination (AI) technique, however around one-third used both insemination methods (natural and artificial). A majority of the farmers mentioned that the AI is very important service for dairy development. All of the respondents reported that the government are provided AI services in their area. Majority of the livestock farmers were aware that the livestock department offered the farms services that included local (un sexed), imported (un sexed) and local (sexed) semen. It was found that artificial insemination is essential for dairy production, higher conception rate, genetic improvement and for sex semen, It was found that most of the livestock farmers were satisfied with the livestock services related to animal health (Vaccine), improved breeds (Cross-breeds) and Artificial Insemination. Study findings declared that fraud in semen quality, high cost of the semen and dishonest technician were problems associated with artificial insemination. A bivariate analysis revealed that farmers with higher education levels, higher incomes, and more years of experience had less issues associated with artificial insemination.

Recommendations/Suggestions

- It was discovered that the artificial insemination method might be rather expensive. Therefore, the government need to work toward lowering the rate of artificial insemination.
- It was noticed that the majority of livestock producers were not informed of the need of the AI as well as the advantages that it offers. Therefore, the government need to organise a seminar, workshop, or farmers day in order to offer comprehensive information on artificial insemination.
- It is recommended that the government's livestock department provide assistance for the dissemination of dairy technologies and make it possible for them to make better use of the technology.

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- It was observed fraud in semen quality. There should be appropriate monitoring to detect the linked difficulties causing a barrier to adopting artificial insemination technology.
- Extension agents working at the village level need to visit dairy producers' farms and houses on a regular basis.
- There is dire need for training related to innovation technology in the field of livestock.

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