Research Article

Artificial Insemination (AI) Innovation Adoption Rate on Buffalo Farm Business in Padang Pariaman Regency, West Sumatra

Ediset[1*], Jaswandi[2], Fuad Madarisa[1], Amrizal Anas[1], Rizqan[2]

[1]Department of Development and Livestock Business, Faculty of Animal Science, Andalas University, Padang, West Sumatra, Indonesia; [2]Department of Technology and Animal Production, Faculty of Animal Science, Andalas University Padang, West Sumatra, Indonesia.

Abstract | The availability of animal protein from buffalo can only be maintained by relying on an innovation-based maintenance system. This study aims to determine the level of adoption of Artificial Insemination (A.I.) innovations and the success rate of A.I. innovations in the buffalo farming business. This study uses a survey method and a secondary data analysis approach. The population is 100 buffalo breeders who have adopted the AI. innovation. In comparison, the number of samples determined by the Proportional Sampling technique is 50 breeders from 5 sub-districts in Padang Pariaman Regency. Data analysis was carried out in a quantitative descriptive manner, namely the adoption rate of A.I. was measured by the percentage of adoption, and the success rate of A.I. was measured by calculating Service PerConception (S/C), Conception Rate (C.R.), and Calving Rate (CvR). The result shows the adoption rate of A.I. innovations in terms of speed, area, and quality has an average percentage of implementation of 78.54%. In addition, the success rate of A.I. implementation is seen from the level of pregnancy (Service PerConception) with a value of S/C ± 1.67, the percentage of cattle pregnant. The first insemination (Conception Rate) with a C.R. value is 57.9%, and the percentage of birth rate (Calving Rate) with a CvR value is 47.9%. The study concludes that the adoption rate of A.I. in the buffalo breeding business in Padang Pariaman Regency, West Sumatra Province is in the moderate category. However, the success rate of its implementation is good.

Keywords | Innovation adoption, Adoption rate, Pregnancy rate, Success rate, Birth rate, Padang pariaman

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***Correspondence** | Ediset, Department of Development and Livestock Business, Faculty of Animal Science, Andalas University, Padang, West Sumatra, Indonesia; **Email:** ediset@ansci.unand.ac.id
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INTRODUCTION

West Sumatra is one of the areas that has become the center for the development of the buffalo farming business in Indonesia. When it is related to its history, this area is mostly inhabited by people from the Minang tribe, where the word Minang itself is withdrawn from the term "Minang Kabau," when translated into Indonesian, means Minang and Buffalo, this is similar to India and cows, China and pandas, Australia and kangaroos, and Russia and bears, because buffaloes in Minang society have at least become cultural objects. This linkage proves that the people Minang of West Sumatra Province are passionate about their buffalo farming business. The Central Statistics Agency of West Sumatra recorded a population of 795.64 buffalo in 2022. Still, this population continues to experience a downward trend from year to year. For example, in 2020, the total population was 85.242, then dropped to 83,821 in 2021. This statistical data shows that in the last three years, there has been a decrease in the buffalo livestock population by ± 6.7%.

The population decline has adversely affected the Minang culture in West Sumatra, due to the reduction of cultural

symbols such as traditional Minang women's clothing in the form of "tingkuluak" (resembling buffalo horns) and food "dadiah" which comes from buffalo milk. Equally important, the population decline has had a negative impact on the fulfillment of animal protein needs for the wider community. The situation is because, in a decrease in the availability of animal protein sourced from livestock meat, there has been an increase in demand for animal protein from time to time. The Ministry of Agriculture of the Republic of Indonesia in 2022 said that per capita animal protein consumption has increased to 62.21 grams from the previous 61.98 grams.

Improving maintenance management based on innovation, especially innovations related to reproduction, can prevent a decline in the buffalo livestock population. The innovation of buffalo livestock reproduction that has been introduced and adopted by breeders is the Artificial Insemination (A.I.) innovation. The A.I. program is a powerful way ever created by humans to increase livestock population and livestock production quantitatively and qualitatively (Tolihere, 1993). Technically, the A.I. innovation as the first generation of reproductive biotechnology is carried out through the process of collecting the semen of a superior male, dilution, freezing, storage, and artificially inserting semen using insemination equipment into the reproductive tract of a female to produce fertilization (Shehu et al., 2011). Eklundh (2013) argues that mating livestock with A.I. will make livestock healthier and increase the ability of animals to produce cattle, improving the livelihood status of breeders.

Applying A.I. innovation in breeding buffaloes has various advantages compared to natural mating using males. The advantage of using A.I. that buffalo farmers can enjoy is better buffaloes pregnancy and birth rates. Donaldson (1976) revealed that a well-managed A.I. program's overall effectiveness will produce a pregnancy rate of 63% in 29 days of insemination. In contrast, according to Singh (2016), through A.I services, the overall conception rate in cattle and buffalo is 35%. Toelihere (1981) added that the success rate of using A.I. can be measured by the number of matings (insemination) on female livestock that was carried out until pregnancy occurred (Service per conception), the percentage of female cattle that became pregnant at the first insemination (Conception Rate) and the ratio of birth rates (Calving Rate).

Based on the situation mentioned above, several problems are formulated that must be answered, like: what is the level of adoption of Artificial Insemination (A.I.) innovations in terms of speed, area and quality in buffalo farming and what is the story of success in implementing Artificial Insemination (A.I.) innovations in look at reproductive performance such as Service perConception (S/C), Conception Rate (C.R.) and Calving Rate (CvR) in buffalo farming. The aim is to determine the level of adoption of Artificial Insemination (A.I.) innovations and the level of success in implementing A.I on buffalo farming business.

RESEARCH METHODS

Research sites

This research was conducted in 5 districts in Padang Pariaman Regency, West Sumatra Province, namely in V Koto Kampung Dalam, VII Koto Sungai Sarik, 2 x11 Kayu Tanam, Batang Gasan, and Ulakan Tapakis. These 5 (five) Districts are places where Artificial Insemination (A.I.) innovations have been adopted, and there have been results from their implementation.

Data collection

The data collected in this study are primary and secondary data according to research needs. Preliminary data were obtained from direct interviews with respondent breeders at the research location and from in-depth interviews with key informants who knew the issues being studied. The primary data collected was the adoption rate of A.I. innovations, such as speed, the extent of adoption, and the quality of adoption. Furthermore, the data for the success rate of A.I. implementation collected were the number of inseminations, the number of pregnancies, and the number of births. Meanwhile, secondary data for support was obtained from literature reviews, the Central Bureau of Statistics, the Animal Husbandry Office, the Technical Implementation Unit for Artificial Insemination Service Centers, and other agencies.

Population and Research Sample

The population of this study was 100 buffalo breeders who had adopted the Artificial Insemination (A.I.) innovation. Determination of the number of samples was determined using the Taro Yamane formula (Riduwan, 2015), and obtained a total sample of 50 breeders. The distribution of the number of research samples can be seen in the following table:

Table 1: Population distribution and sample of buffalo breeders applying AI in Padang Pariaman District

No	District	Number of Breeders	Number of Samples
1	VII Koto Sungai Sarik	30	15
2	Ulakan Tapakis	15	7
3	2x 11 Kayu Tanam	20	10
4	Batang Gasan	15	8
5	V Koto Kampung Dalam	20	10
	Total	100	50

Source: Secondary Data Processing Results for 2022

Data Processing and Analysis Methods

Data analysis was carried out in a quantitative descriptive manner in the form of numbers and percentages as described below:

1) The level of innovation adoption (speed, area, and quality) of Artificial Insemination (A.I.) in the buffalo farming business is analyzed using the formula:

% implementation level =

$$\frac{\text{total respond implementation}}{\text{totally agregate respond implementation}} \times 100\%$$

Furthermore, the percentage of adoption rates is compared with the implementation category in the opinion of Narimawati (2008) as follows:

a. Application Rate 20.00% - 52.00%, Slow/Narrow/Poor category

b. Application Rate 52.01% - 84.00%, Medium/Medium/Medium Category

c. Application Rate 84.01% - 100%, Category Fast/Broad/Good

2) The success rate of Artificial Insemination (A.I.) in buffalo cattle was analyzed using Toelihere's calculations (1981) :

1. Pregnancy Rate / *Service per Conception (S/C)*

$$S/C = \frac{\Sigma \text{ I.B. until pregnancy occurs}}{\Sigma \text{ pregnant acceptor}}$$

2. Percentage of pregnant cattle at first insemination /*Conception Rate* (C.R.)

$$CR = \frac{\Sigma \text{ pregnant cattle}}{\Sigma \text{ cattle in I.B.}} \times 100\%$$

3. Percentage of Birth Rate / *Calving Rate (CvR)*

$$CvR = \frac{\Sigma \text{ birth cattle}}{\Sigma \text{ cattle in IB}} \times 100\%$$

RESULTS AND DISCUSSION

Adoption Rate of Artificial Insemination Innovations

Innovation Adoption Speed: The research showed that buffalo breeders in Pariaman Regency adopted Artificial Insemination (A.I.) innovation at a moderate pace, with an implementation percentage of 72.80%. The cause of the speed of adopting A.I. innovations in the medium category is the low knowledge of breeders about how to detect heat in buffalo because they do not show the same symptoms as cattle when in heat. Siregar (2008) said that the symptoms of estrus in buffalo are generally not as obvious as in cows, both changes in the external genitalia, vulvar discharge, and sexual behavior. Jainudeen and Hafez (1987) added that around 70-80% of buffalo experience symptoms of silent estrus.

Another factor that causes breeders to be less quick to adopt A.I. innovations is the reproductive nature of buffaloes which have rather long intervals, be it the time of heat after calving, spacing of calving, and the age of first calving. The low knowledge of breeders about signs of lust and reproductive characteristics should be improved by optimizing the role of extension agents. Therefore according to Tripathi (2021), to address the information needs felt by farmers, it will be very helpful if policymakers can formulate strategies for extension systems and information delivery systems using Computer Information Technology to deliver extension services, mobile applications, and training.

Area of Application of Innovation: The application of Artificial Insemination (A.I.) to buffaloes in Padang Pariaman Regency, seen from the size of the area, is in the medium category with an application area percentage of 82.09%. Narimawati (2008) says that the application area is 52.01% - 84.00%, indicating that the application is in the moderate category. The adoption of A.I. innovations that are less widespread in Padang Pariaman Regency, West Sumatra, may be different for different regions or countries because the area of application of A.I. is also determined by the calving interval of buffaloes, as reported by Kanloung (2021) that the calving interval for Murrah buffaloes in India ranged from 559.6 days while the calving gap for Murrah buffalo in Sabah Malaysia was around 740 days.

The less extensive application of A.I is also due to the limited number of resources (inseminators) available at the Animal Husbandry Office of the Padang Pariaman Regency, where only 35 inseminator officers are available for this area. This number is disproportionate to the site and type of work. In addition to the large working area, inseminator officers also have additional duties as A.I. officers for cattle. Siregar et al. (1997) said that inseminators could only inseminate ten heads of cattle per day or 300 tails in one month if they were not burdened with other additional tasks.

These results also need support from extension officers so that buffalo farmers in the study area change their thought that A.I. innovation is not only intended for cattle but can also be applied to buffalo. Ediset (2013) concluded that extension workers had little role in implementing the technology package for groups of buffalo breeders, even though it was mostly based on experience as breeders.

Quality Intensification of Innovation: The studies show that the quality of implementing A.I. innovations is still in the medium category, where the percentage of A.I.

Table 2: Adoption Rate of Artificial Insemination (AI) Innovations in Buffalo Farming Business

No	District	Adoption Size			
		Speed (%)	Area (%)	Quality (%)	Average(%)
		Category	Category	Category	Category
1	VII Koto Sungai Sarik	79.41 medium	88.10 wide	82.93 medium	83.48 medium
2	V Koto Kampung Dalam	75.00 medium	78.46 medium	83.08 medium	78.85 medium
3	Ulakan Tapakis	71.64 medium	86.75 wide	85.18 wide	81.19 medium
4	Batang Gasan	65.22 medium	73.59 medium	70.59 medium	69.80 medium
5	2x 11 Kayu Tanam	72.73 medium	83.54 medium	81.82 medium	79.36 medium
	Padang Pariaman	72.80 medium	82.09 medium	80.72 medium	78.54 medium

of A.I. implementation that follows the concept or theory conveyed by extension agents is 80.72%. The quality of implementing A.I., which is not optimal, is influenced by the nature of A.I. innovation, such as the level of profit, suitability for business conditions, ease of trying, and simplicity. Palacpac (2022) argues that the level of relative gain for the livestock business largely determines technology adoption by breeders. The buffalo, suitable and practical for business, can be tried easily and simply.

The quality of A.I. innovation adoption will be categorized as good if extension officers always carry out intensive extension activities to educate buffalo breeders to understand the level of importance of the nature of the innovation and the technicalities of the livestock business. In line with the opinion of Dehinenet (2014) that the availability of technical service assistance will increase technology adoption by breeders. Lamarang (2017) added that the contribution of extension services influences the decision-maker of breeders in adopting livestock technology innovations.

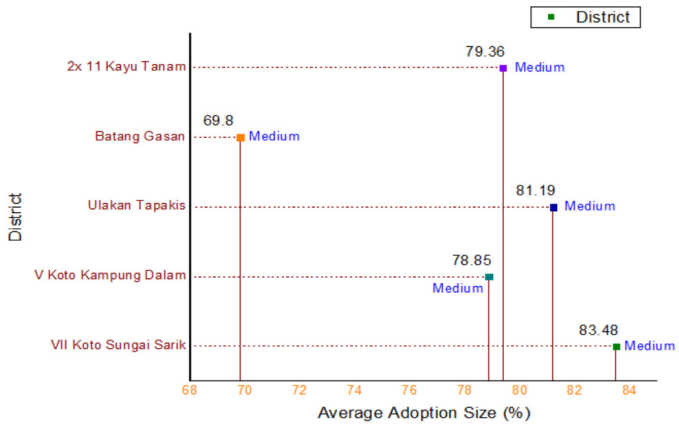

Figure 1: Adoption Rate of Artificial Insemination (AI) Innovations in Buffalo Farming Business

II. Success Rate of Artificial Insemination Innovation

Pregnancy Rate (Service per Conception (S/C)

Table 3: Pregnancy rate for buffalo after insemination

No	District	Service / S (tail)	Conception / C (tail)	S/C
1	VII Koto Sungai Sarik	8	5	1.60
2	V Koto Kampung Dalam	15	9	1.67
3	Ulakan Tapakis	10	6	1.67
4	Batang Gasan	7	4	1.75
5	2x 11 Kayu Tanam	10	6	1.67
	Padang Pariaman	50	30	1.67

The study showed that the pregnancy rate of buffaloes after insemination was in a good category, where the S/C value obtained was 1.67. This good pregnancy rate is inseparable from the fertility of the buffalo, with a good fertility rate also having a high lust intensity. Siregar (2008) said that the intensity of estrus determines 55.3% of pregnancy success. Particularly in buffalo, several studies have shown that the low success of A.I. is due to the difficulty in detecting the peak of estrus due to low estrus intensity (Situmorang, 1997). Even the results of statistical analysis through the Student test conducted by Lumbantoruan (2018) showed that the S/C value in the natural mating method was not significantly different from the A.I method, provided that the semen used was of the same quality.

The S/C value obtained illustrates that buffaloes kept by breeders in Padang Pariaman Regency have a fertility level that supports cultivation needs. Toelihere (1981) said that a good S/C value is in the range of 1.6 - 2.0. If S/C is greater than this range, it indicates low fertility. Additionally, the S/C value can be determined by breeder factors, insemi-

nator staff factors, genetic factors, the nation of the buffaloes, and the availability of artificial insemination facilities. Rajadurai (2018) reports that the lack of A.I. facilities for buffaloes and the low conception rate through artificial insemination are the main obstacles to raising buffaloes.

Suppose breeders can anticipate the factors above. In that case, it will positively impact the size of A.I. innovation adoption in this area. Even though the A.I. adoption rate is currently in the moderate category, after seeing the success rate of its good S/C, it will certainly be able to change the breeders' attitude from not adopting to being adopters. Because according to Khoiron (2012), one that determines whether or not the main actors embrace technological innovation is determined by the farmer's attitude.

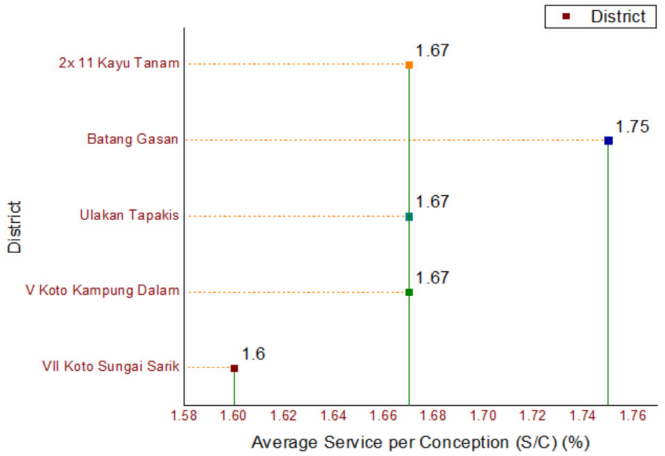

Figure 2: Average Pregnancy Rate (Service per Conception (S/C)

Pregnancy rate from the first insemination (Conception Rate / C.R.): Pregnancy of buffaloes from the results of the first insemination is already good results. This fact can be seen from 57.9% of buffaloes that were inseminated experienced pregnancy from the results of the first insemination. Even though this result has not yet reached the maximum pregnancy rate from the first insemination compared with conditions in Indonesia, this result is far above the existing pregnancy rate. Toelihere (1993) said that the Conception Rate (C.R.) the best can reach 60-70%, while for Indonesia taking into account natural conditions, management, and distribution of livestock, that spread is considered good if the Conception Rate (C.R.) value reaches 45-50%.

This finding is very important for the development of buffalo livestock towards industry because the economic indicator used as a benchmark for running this business is its reproductive performance. The better the reproductive performance, the better the business prospects are for development. Abdalla (2003) said that reproductive performance is among the most profitable keys for the buffalo livestock industry. One of the advantages of raising buffalo is to increase the breeders' income because, according to Karli (2021), buffalo farming activities play an important role in generating income among breeders.

This result will certainly provide a stimulant for breeders to apply A.I. to the buffaloes they raise because indirectly adopting this innovation will be able to improve their household economy. In order for this to be achieved, the various innovations that have been produced should have been introduced to breeders by extension workers. The application of innovation in rural areas of Indonesia is closely related to the implementation of extension services, where field extension workers play an important role in introducing agricultural technological innovations to farmers (Pranadji, 2016).

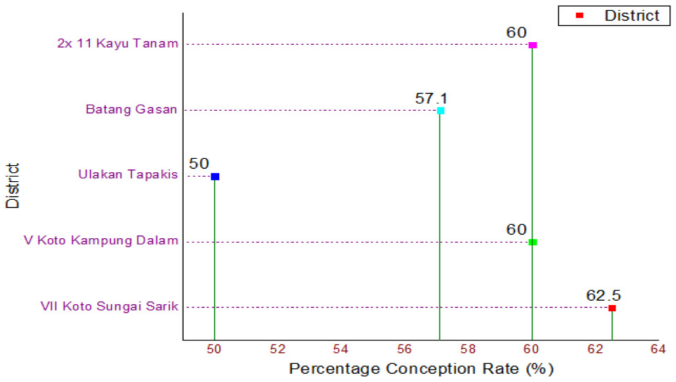

Figure 3: Percentage (%) Conception Rate

Cattle birth rate from first insemination (Calving Rate / CvR): The percentage of buffalo cattle born through artificial insemination (A.I.) in Padang Pariaman Regency is already at a good level, when compared to natural mating (using natural males). The results showed that by using the A.I. mating system, the birth of buffaloes reached 47.9%. Meanwhile, according to Samsuadi et al. (2016) the birth rate of calves with the application of natural (free natural) mating was 31.70% of the entire brood stock.

The value of the Calving Rate depends on the efficiency of the inseminator, male fertility, female fertility at the time of insemination and the ability to care for the child in the womb until birth (Toelihere, 1981). intensive and supported by good qualifications of insemination officers, this is proven by the election of one of the insemination officers in this area to be the best national inseminator.

The birth rate of buffaloes in the study area is also much higher than the percentage of births of buffaloes nationally, which are the same as mating with the A.I. system.

Tambing (2020) says that the average birth rate for buffalo calves with the A.I marriage system is only 38.32%. This condition is also inseparable from the role of the local government through related agencies which seek to maintain the population and increase it through the launch of various relevant programs.

Table 4: Percentage of pregnancy of buffaloes after the first insemination.

No	District	Number of Insemination (Tail)	Number of Births (tail)	Percentage (%)
1	VII Koto Sungai Sarik	8	5	62.5
2	V Koto Kampung Dalam	15	9	60.0
3	Ulakan Tapakis	10	5	50.0
4	Batang Gasan	7	4	57.1
5	2x 11 Kayu Tanam	10	6	60.0
	Padang Pariaman	50	30	57.9

Table 5: Percentage of buffalo cattle born after the first insemination

No	District	Service / S (tail)	Conception / C (tail)	Percentage (%)
1	VII Koto Sungai Sarik	8	4	50.0
2	V Koto Kampung Dalam	15	7	46.7
3	Ulakan Tapakis	10	5	50.0
4	Batang Gasan	7	3	42.9
5	2x 11 Kayu Tanam	10	5	50.0
	Padang Pariaman	50	24	47.9

The birth rate of buffalo from the first insemination has decreased by 10% when compared to the pregnancy rate from the first insemination, this proves that not all pregnant buffalo mothers will be able to give birth to children. Failure of pregnant mothers to give birth to children can be caused by several factors and especially of course caused by reproductive disorders, Rasyid (2017) said that reproductive disorders in buffaloes are generally caused by reproductive diseases, poor maintenance systems and pregnancy failure rates. The results of field research indeed show that the failure of buffalo cattle to give birth to children is caused by the discovery of dystocia or what is known as difficulty in giving birth, abortion (miscarriage) and premature birth.

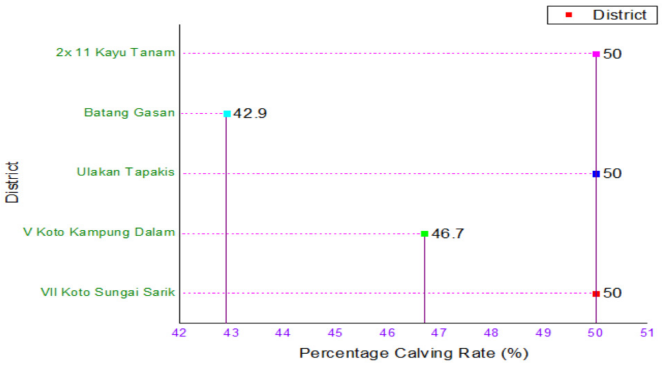

Figure 4: Perscentage (%) Calving Rate

CONCLUSION

The adoption rate of A.I innovations in buffalo farming business seen from the speed, area and quality is in the medium category with an average percentage of adoption of 78.54%, but even so the success rate has been well implemented, especially in terms of the level of pregnancy (Service per Concept) with value of S/C ± 1.67, percentage of pregnant cattle at first insemination (Conception Rate) with C.R. value = 57.9% and percentage of birth rate (Calving Rate) with CvR value = 47.9%. Seeing these results, it is recommended that all livestock stakeholders carry out a program to increase A.I. adoption on an ongoing basis, especially through extension activities for breeders and training for inseminators in a planned and systematic manner.

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CONFLICT OF INTEREST

The authors have declared no conflict of interest.

NOVELTY STATEMENT

The study's results identified the level of adoption-innovations and the success rate of AI innovations in buffalo farming in West Sumatra, which so far has tended to be measured only in cattle farming.

AUTHORS' CONTRIBUTIONS

All authors contributed equally to the manuscript.

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