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Institutional capacity of the artificial insemination service unit and the effectiveness of artificial insemination in beef cattle (Case study in Gorontalo regency)

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Abstract

This study aims to analyze the institutional capacity of the Artificial Insemination Service Unit (AISU) and the effectiveness of the implementation of the Artificial Insemination (AI) program in beef cattle in Gorontalo Regency. The method used is a case study with descriptive analysis using a semantic differential scale. Determination of the sample was carried out by purposive sampling or intentionally based on the consideration of having the largest, medium and low population of breeders and being an active acceptor of AI. Samples were taken from three selected sub-districts, such as Telaga Biru, Tibawa, and Tolangohula, with a total of 92 breeders as respondents calculated using the Slovin formula. The results showed that the institutional capacity of AISU was in the very good category, with an average value of 2.74 or 91% contributing to the effectiveness of AI. The lowest value, which was 2.35, is at the breeder level in detecting pregnancy, health maintenance and the highest value is 3 at the level of recording by officers. The effectiveness of IB services is also considered optimal based on the Service per Conception (S/C) indicator of 1.8, Calving Interval (CI) of 429 days, and Days Open (DO) for 90 days.

Keywords: Artificial insemination; Artificial insemination Service Unit; Beef cattle; Institutional capacity

1. Introduction

The livestock subsector plays an important role in supporting food security, especially through the provision of animal protein sources from beef. National demand for beef continues to increase along with population growth and changes in people's lifestyles. However, domestic beef production has not met national needs, making beef imports a necessary solution to address the shortage (Directorate General of Animal Husbandry, 2013). One of the causes of low beef production is low livestock productivity, especially in rural areas. This low productivity is influenced by suboptimal maintenance management factors, such as extensive maintenance systems, minimal attention to the selection of superior seeds, and the lack of adoption of modern reproductive technologies such as Artificial Insemination (AI) (Pawere et al., 2012). AI technology is considered one of the solutions to improve the genetic quality of livestock and accelerate the increase in the beef cattle population in Indonesia (Toelihere, 2005).

AI is a widely used reproductive technique, and in Gorontalo Regency, it has been designated as a government program of the Gorontalo Regency government as an effort to improve the genetic quality of livestock and increase production. The implementation of AI involves various parties, including breeders, inseminators, and institutions such as the AISU. The institutional role of AISU is crucial in ensuring the success of the AI program in the field (Directorate General of Animal Husbandry and Animal Health, 2012). This institution is responsible to provide AI services, estrus detection, and ensuring the reproductive health of livestock. However, the effectiveness of AI services is highly dependent on the institutional capacity of the AISU, including human resources, infrastructure, and a good recording and reporting system (Brinkehoof & Goldsmith, 1990).

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Gorontalo Regency has a fairly large beef cattle population, but its productivity is still relatively low. Therefore, strengthening the institutional capacity of AISU in this area is an urgent need to ensure that the AI program runs effectively and has a positive impact on increasing the livestock population (BPS Gorontalo, 2023). The general solution offered to increase the effectiveness of AI is to improve reproductive management, improve inseminator skills, and provide adequate equipment. Community-based livestock institutions can accelerate the adoption of AI technology among small breeders. Supriyanto (2016) In addition, the use of a good recording system is also important to monitor the effectiveness of the AI program and conduct regular performance evaluations (Mason & Buvanendran, 1982).

While the AI Program in Gorontalo Regency has been successfully implemented with the support of AISU, several obstacles remain. These include the limited number of inseminators and the uneven distribution of infrastructure across the region. To better understand how these challenges, impact the effectiveness of the AI program, this study investigates the institutional capacity of AISU and the implementation of AI services

2. Research Method

The research was conducted in Gorontalo Regency, whict located in the center of Gorontalo Province with an area of approximately 2,125.47 km^2. This area was chosen because it has a fairly large beef cattle population, reaching 101,685 or 38.16% of the total beef cattle population in Gorontalo Province (BPS Gorontalo, 2023). Gorontalo Regency is also one of the areas that actively implements the AI program as an effort to increase the productivity of beef cattle. The research was conducted during the period of December 2023 to February 2024 with a focus on three sub-districts, such as Telaga Biru, Tibawa, and Tolangohula. The selection of the research location was carried out by purposive sampling based on the consideration of having the largest, medium and low population of breeders in the area who are active acceptors of AI.

The research method used is a case study, which aims to conduct an in-depth analysis of the institutional phenomenon of the AISU in supporting the effectiveness of the implementation of AI in Gorontalo Regency. The case study was chosen because it provides a comprehensive understanding of the dynamics of AISU institutions and their interactions with the beef cattle farming community (Arikunto, 2016). The approaches used in this study were qualitative and quantitative approaches. The qualitative approach is used to understand the institutional work process of AISU in processing inputs into outputs, while the quantitative approach is used to measure institutional capacity and IB effectiveness through descriptive statistical analysis with a semantic differential scale. The population in the study were all breeders registered as acceptors of the IB program in Gorontalo Regency, with a population of 13,661 breeders spread across 19 sub-districts (Department of Agriculture, 2023). The research sample was determined using the Slovin formula with an error tolerance level of 10% in three selected sub-districts, such as Telaga Biru, Tibawa, and Tolangohula with a total of 1,234 breeders. Based on these calculations, a sample of 92 breeders was obtained. The Slovin formula used in this study is as follows:

$$n = \frac{N}{1 + N.e^2}$$

Notes:

- n = Number of Sample
- N = Number of Population
- e = fault tolerance level (10%)

The population of the selected sub-district was 1,234 breeders, which the sample calculation was:

$$n = \frac{1.234}{1 + 1.234\ (0{,}1)^2} = 92 \text{ breeders}$$

The selection of villages in each sub-district was carried out with the criteria of the number of active acceptors and the availability of inseminator officers. Table 1 below shows the location and number of samples used in the study.

Table 1 Location and Number of Samples

No	Subdistrict	Viilage	Population	Sample
1	Telaga Biru	Tinelo, Ulapato A, Dumati	178	13
2	Tibawa	Reksonegoro, Dunggala, Molowahu	429	33
3	Tolangohula	Lakeya, Suka Makmur Utara, Gandasari	627	46
Total			1,234	92

Source: Gorontalo Provincial Agriculture Service, 2023

Data collection techniques in the study included observation, interviews, and documentation. The data obtained were analyzed using descriptive analysis with a semantic differential scale. This scale is used to measure the institutional capacity of AISU based on various indicators, such as the availability of acceptor livestock, completeness of AI equipment, estrus detection, and maintenance of the health of cattle and calves. The assessment was carried out on a scale of 1 to 3, where a value of 1 indicates the category "Not Good", a value of 2 indicates the category "Good", and a value of 3 indicates the category "Very Good" (Simamora, 2004).

The analysis of institutional capacity data on each question attribute:

$$Interval\ Scale = \frac{(3\ x\ 1) - (1\ x\ 1)}{3}$$

$$Interval\ Scale = \frac{(3) - (1)}{3}$$

$$Interval\ Scale = 0{,}67$$

Were indicated as:

Value: 1.00 – 1.67 = Not Good

Value: 1.68 – 2.35 = Good

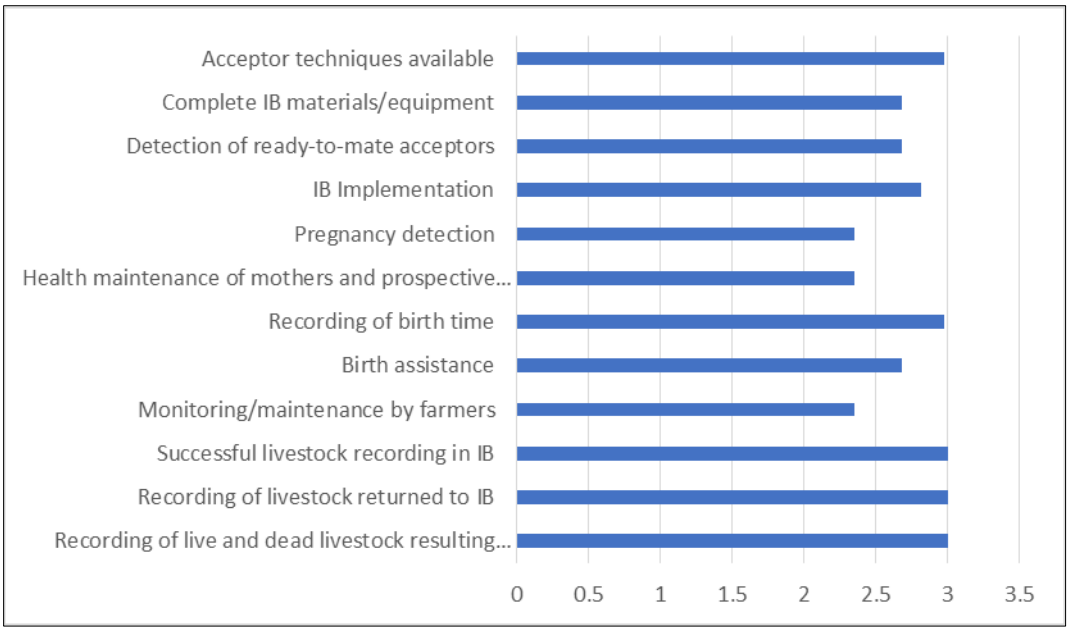
Value: 2.36 – 3.00 = Very Good

In addition to the institutional capacity analysis, this study also evaluated the effectiveness of the implementation of AI using three main indicators, such as Service per Conception (S/C), Calving Interval (CI), and Days Open (DO). S/C is calculated based on the number of insemination services required until pregnancy occurs, with an optimal value ranging from 1.6 to 2.0 (Toelihere, 2005). CI is measured from the time interval between two consecutive births, with an ideal value of 12 to 14 months. DO is calculated as the time between birth and the next pregnancy, with a normal value of 60 to 90 days (Smith, 2002).

3. Result and Discussion

3.1. AISU Institutional Capacity

Institutional capacity of the AISU in Gorontalo Regency with a focus on 12 main aspects. The results show that AISU has a very good capacity to support the implementation of AI. The Institutional Capacity of AISU Gorontalo Regency is presented in Figure 1.



Source: Processed Primary Data

Figure 1 The Institutional Capacity of AISU Gorontalo Regency

AI acceptor livestock are productive female livestock that are used for AI. Gorontalo Regency has an average age of beef cattle as acceptors of 2 years. This is in accordance with what Hoesni (2017) stated that to be used as acceptors, the cattle must be at least two years old and no more than ten years old. If the cattle are still too young, it is feared that their body development will not be perfect, and they are at risk of experiencing dystocia (Febrianila et al., 2018). The availability of acceptor livestock is one of the main factors in the success of the AI program. In Gorontalo Regency, there are 101,685 beef cattle, with 16,740 of them as active AI acceptors. Most of the acceptor livestock are productive females that have successfully become pregnant, with an average value of 2.97 (very good category). These results support the opinion of Toelihere (1993) who emphasized that the success of AI depends on the availability of productive female livestock as acceptors..

3.1.1. AI Equipment

AI equipment is a tool that used in the AI process. AI equipment such as insemination guns, plastic sheaths, and plastic gloves are considered adequate with a score of 2.68 (very good category). This support comes from the Gorontalo Regency Animal Husbandry Service which routinely supplies inseminator needs. According to Pasino (2020), good equipment quality increases the efficiency of AI implementation.

3.1.2. Breeder

Breeders in Gorontalo Regency conduct estrus detection twice a day (morning and evening). Accurate information from breeders allows inseminators to conduct AI at the right time. The acceptor detection value reached 2.68 (very good category), indicating good coordination between breeders and inseminators. Timely estrus detection increases the chance of pregnancy (Toelihere, 1985)

3.1.3. AI Implementation

The implementation of AI was carried out by 31 inseminators spread across 19 sub-districts. The average value of 2.81 (very good category), indicating very good implementation. Procedures such as thawing frozen semen, rectal manipulation, and semen deposition were carried out carefully according to the Guidelines for the Development of IB Service Institutions (Directorate General of Animal Husbandry and Animal Health,2012). Other factors such as semen quality also contribute to the effectiveness of AI.

3.1.4. Pregnancy detection

Pregnancy detection was performed through rectal palpation by trained personnel, with 12 of the 31 inseminators having pregnancy examination certificates (PKB). The pregnancy detection results reached a score of 2.35 (good category). According to Pemayun et al. (2014), the rectal palpation method is the best standard for ensuring pregnancy.

3.1.5. Livestock health

Livestock health is checked regularly, including giving vitamins, deworming drugs, and vaccinations. The score for this aspect is 2.35 (good category). This examination reduces the risk of diseases such as neonatal diarrhea in calves, which is often an obstacle to productivity (Siti, 2012).

3.1.6. Time recording

The recording of the time of birth was very accurate with a score of 2.97.00 (very good category). This information is used to prepare for birth and prevent complications. Susilowati (2013) stated that good recording facilitates the management of livestock reproduction.

3.1.7. Birth Assistance

Breeders together with inseminators and livestock health officers actively accompany the birth process. The assistance score reached 2.68 (very good category). A well-supervised normal birth process increases calf survival and maternal health (Paputungan et al., 2019).

3.1.8. Livestock Maintenance Monitoring

Breeders in Gorontalo showed a high commitment in monitoring and maintaining livestock. The average score of 2.35 (good category) reflects breeders' compliance with technical maintenance guidelines. Routine monitoring helps early detection of reproductive and health problems (Bella et al., 2020).

3.1.9. Recording of successful AI livestock

Recording of successful AI livestock showed high accuracy with a score of 3.00 (very good category). This data includes birth and offspring information, supporting the evaluation of IB success. This recording is relevant to the opinion of Mason & Buvanendran (1982), who emphasized the importance of recording for breeding analysis. This is supported by Fioretti's statement (2010) that the benefit of recording is to provide opportunities for genetic improvement for the resulting production and reproductive traits.

3.1.10. Recording of Livestock Returned to AI

Recording of livestock returning to AI includes livestock that failed to become pregnant in the previous cycle. A recording score of 3.00 (very good category) indicates that AISU has anticipated risks such as inbreeding and insemination failure. Kusumawati. (2014) stated that good recording helps evaluate and improve IB programs. Without a recording system, the implementation of IB cannot be evaluated and its level of success measured.

3.1.11. Livestock that Die and Live as a Result of AI

Officers who are members of the AISU institution always monitor and record every incident that occurs to livestock that is in AI both live and dead livestock. This is in accordance with the statement (Hakim et al., 2010) that the livestock recording process includes all activities and events carried out in a livestock business. The population of livestock from IB shows a significant increase. In 2023, from 9,250 active IB acceptors, 13,964 calves were born, with a birth rate of 66%.

3.2. Effectiveness of AI

Table 2 Results of IB Reproductive Parameters

No	Reproductive Parameters	Average	Value	Category
1	S/C (Service per conception)	1.6 - 2	1.8 ds	Normal
2	CI (Calving Interval)	365 - 450	429 days	Normal
3	DO (Day open)	85 - 115	90 days	Normal

Source: Processed primary data.2024

In the research variables, the effectiveness of AI is measured through three main parameters, such as Service per Conception (S/C), Calving Interval (CI), and Days Open (DO). The research results show that the three parameters are included in the normal category as presented in Table 2.

3.3. Service per Conception (S/C)

The Service per Conception (S/C) value in Gorontalo Regency reached an average of 1.8 inseminations to achieve pregnancy. This value is within the optimal range recommended by Toelihere (2005), which is between 1.6 and 2.0. The low S/C value reflects a good level of reproductive efficiency, supported by estrus detection punctually by breeders and implementation of AI by trained inseminators. However, several cases of insemination failure still occur, which are associated with late detection of estrus or less than optimal livestock reproductive conditions.

3.4. Calving Interval (CI)

The average Calving Interval (CI) in beef cattle in Gorontalo was 429 days, meeting the ideal standard of 365-450. These results indicate that the AI program has succeeded in maintaining birth spacing within an efficient range, which is important for increasing livestock productivity. This success is related to good reproductive management, including providing quality feed and accurate reproductive recording by AISU.

3.5. Day Open (DO)

The average Day Open (DO) in Gorontalo Regency is 90 days, in accordance with the normal value of 85-115 days, as mentioned by Smith (2002). This value indicates high efficiency in managing the time interval between birth and the next pregnancy. The controlled DO length reflects the inseminator's skill in determining the right insemination time based on the livestock's estrus cycle.

The institutional capacity of AISU in Gorontalo Regency plays an important role in the success of the AI program. Previous research by Brinkehoof and Goldsmith (1990) emphasized the importance of institutional capacity in ensuring the sustainability of service programs in the livestock sector. Good institutional capacity will increase the adoption of modern reproductive technology by breeders and accelerate the increase in livestock population. However, several challenges are still found in the implementation of the AI program in Gorontalo Regency. One of the main challenges is the delay in estrus detection in female cattle. Untimely detection of estrus will affect the success of AI and can lead to higher S/C values. According to Toelihere (1985), accurate estrus detection is very important to ensure the right insemination time and increase the chances of pregnancy. In this context, continuous training is needed for breeders and inseminators to improve their ability to detect signs of estrus in livestock.

Completeness of facilities and infrastructure is also a factor that influences the effectiveness of the AI program. According to research by Argus (2023), equipment such as insemination guns, plastic sheaths, and liquid nitrogen storage containers are very important to support effective AI implementation. In Gorontalo Regency, the availability of AI equipment is still a challenge in several areas, especially in villages far from the AISU service center. Provision of adequate facilities and infrastructure must be a priority to ensure that AI services can be accessed by all breeders in the area.

The implication of the results of this study is the importance of strengthening the institutional capacity of AISU to increase the effectiveness of the AI program in Gorontalo Regency. The government and related parties need to improve training for breeders and inseminators, provide adequate facilities and infrastructure, and strengthen the recording and reporting system for livestock reproduction results. A good recording system will make it easier for livestock breeders and AISU officers to monitor pregnancy results, determine birth times, and manage livestock reproduction effectively (Mason & Buvanendran, 1982). The results of this study indicate that strengthening institutions in the livestock sector is an effective strategy to increase livestock production and support national food security.

4. Conclusion

The institutional capacity of the AISU in Gorontalo Regency is in the very good category, with an average value of 2.74, or 91% contributing to the success of AI. The effectiveness of the implementation of Artificial Insemination (AI) is measured through three main indicators, such as Service per Conception (S/C) of 1.8, Calving Interval (CI) of 429 days, and Days Open (DO) for 90 days. This shows that the AI services provided by AISU have been running optimally in supporting increased productivity and genetic quality of beef cattle.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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