Reproductive performance of female swamp buffalo in West Sumatra

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Abstract. The swamp buffalo population in West Sumatra Province decline continuously due to the low female reproductive performance. This research was conducted to identify female buffalo reproductive performance, which could be used as baseline data to enhance its population growth. A survey research method was conducted in two subdistricts, namely Lubuk Basung and Matur, located at different altitudes. Data were collected by interviewing farmers and observing their farms. The parameters observed were age at first mating, age at first calving, calving interval, service per conception, and buffalo farming practices. Significant differences in reproductive performances of female buffalo were observed. Age at first mating 39.04 ± 9.91 and 33.67 ± 5.3 mo., age at first calving 51.61 ± 9.95 and 45.71 ± 5.58 mo., calving interval 27.26 ± 8.84 and 24.17 ± 7.06 mo., and services per conception 1.82 ± 0.82 and 1.55 ± 0.78 were represented buffalo in Lubuk Basung and Matur, respectively. The buffalo reproductive performances in both locations were not optimal; however, Matur's buffalo reproductive performances were better than those in Lubuk Basung due to its better farming practices and more comfort climatic conditions. Therefore, improving farming practice is essential to enhance buffalo's reproductive performance and population growth.

Keywords: swamp buffalo, age at first mating, age at first calving, calving interval, service per conception

1. Introduction
The high demand for meat in Indonesia requires the availability of sufficient and sustainable meat-producer livestock. Swamp buffalo is one of the local livestock of Indonesia, which is a potential meat producer. This domestic animal spread out of 32 provinces in Indonesia, which West Sumatra is one of the centers of buffalo production. However, its population decreased every year. Statistical data from BPS [1] showed that the buffalo population in West Sumatra decreased by 58.48% during the 2009-
2019 time period. In 2009, the buffalo population was recorded up to 202,997 heads, while in 2019 left 84,289 heads. Its population growth rate was lower than the market demand for meat due to female buffaloes' low reproductive performance.

The government has launched some acceleration programs to increase the population of cattle and buffalo, i.e., Program Swasembada Daging Sapi dan Kerbau (PSDSK), Gertak Berahi dan Inseminasi Buatan (GBIB), Upaya Khusus Sapi Indukan Wajib Bunting (UPSIWAB), and Sapi Kerbau Komoditi Andalan Negeri (SIKOMANDAN). In general, the programs focused on reproduction management through Artificial Insemination (AI) and natural service (mating), reproduction disorder treatment, livestock and feed aids for farmer groups, and other activities to support the acceleration of enhancing cattle and buffalo population in Indonesia. The farmer contribution and support are required and determined the success of these programs. The farmers could give support by applying appropriate livestock farming practices. Therefore, the government programs could synergize with farmer efforts to enhance the buffalo's reproductive performance. It is hoped it could improve the buffalo population's growth and play an essential role in fulfilling Indonesia's meat demand.

Reproductive performances of female buffaloes, including age at first mating, age at first calving, calving interval, and service per conception, are influenced by genetic and non-genetic factors such as nutrition, management, and climatic factors [2]. Buffalo can reach puberty at the age of 20–24 mo. [3], first mating at the age of 30–36 mo., the gestation period of 305-318 days [4], first calving at the age of 40-45 mo., and calving interval of 13-14 mo. [5]. However, these reproductive traits vary in each area and location of the farms [6] due to the differences in rearing management, nutrition, and climatic conditions. Buffaloes in East Java Province-Indonesia get first mating at the age of 31.83 mo., the first calving at the age of 43.12 mo., calving interval of 14.45 mo., and service per conception of 1.79 [7]. In South Sumatra Province, buffaloes get first mating at the age of 2.3 years (27.6 mo.), first calving at the age of 3.23 years (38.76 mo.), and the calving interval of 14 mo. [8]. Age at first calving of Assamese buffaloes in India is 52.28 mo. and calving interval is 15.25 mo. [9]. Improving farming practices such as breed selection, reproductive management, feeding, rearing management, animal housing, and health handling can improve buffaloes' reproductive performance.

Nutrition is a factor that has significant implications for livestock reproductive performance [10]. Nutritional balance and good rearing management can increase productivity [11], including buffaloes' reproductive performances [6,10,12]. Supplementation of fats, minerals, and vitamins in feed can increase reproductive efficiency in livestock [10]. The buffaloes group receiving high feed intakes showed better ovarian activity, ovulation rate, service per conception, pregnancy rate, as well as progesterone and estrogen concentrations. Meanwhile, increasing the age at first mating and reducing pregnancy rates were found in the buffaloes group receiving restricted feed [12]. Another research [13] reported that buffaloes supplemented with Ca and P seven days before and after calving needed 38.14 days for uterine involution and 63.57 days for postpartum estrous. Meanwhile, buffaloes without supplementation needed 41.71 days for uterine involution and 69.86 days for postpartum estrous.

The microclimate factors such as ambient temperature, relative humidity, solar radiation, and wind speed influenced livestock productivity [14]. Even though buffalo could adapt to varying environmental conditions from dry, wet, and muddy, this livestock is not bear to direct sunlight or to work during hot day conditions. This condition is due to their dark skin, which absorbs more heat than cattle, and their fewer and deep sweat glands [15]. This condition interferes with heat dissipation from buffalo's body that affects heat stress, and can even cause death [16]. Heat stress leads to decreased feed intake, milk production, growth rate, reproductive efficiency [16], and less noticeable estrous symptoms [17]. It causes low productive and reproductive performance. Less noticeable estrous symptoms effects difficulties in determining the right time for AI or natural mating, resulting in a longer calving interval or delaying the age at first mating on heifers.

Temperature Humidity Index (THI) is a value of a combined effect between ambient temperature and relative humidity [18]. When THI of environment ≤ 74 provides comfortable livestock conditions, THI 75-78 is on alert, THI 79-83 causes a significant weight loss, THI ≥84 can cause death if livestock does not appropriately handle [19]. Increasing temperatures due to climate change negatively affect
livestock physiology, health, welfare, and reproduction. The oocyte and embryo are directly influenced by heat stress due to heat shock on cellular function [18]. A high THI harms livestock reproductive performance, such as reducing the pregnancy rate at the first AI in female buffalo [20], testicular degeneration, decreasing the percentage of normal spermatozoa per ejaculation a bull, and reducing the ability to fertilize ovum of the female buffalo [21]. Therefore, buffalo must be provided with a comfortable environment or cooling medium to reduce the stress of their body heat, such as wallow, river, pond, or shade.

Swamp buffalo is commonly reared traditionally in the rural area and generally used as side work for farmers. The farmers had less attention to appropriate livestock farming practices such as management of breeding/reproduction, feeding, rearing management, house availability, and limited knowledge of buffalo disease and health. Poor livestock farming practices caused low productive and reproductive performances [22]. The low reproductive performance includes late puberty age, long postpartum anestrous, unobvious estrous symptoms, low pregnancy rate, and long calving interval [23]. If these conditions continue, Indonesia's buffalo population will decrease and might lead to the endangered. Therefore, the buffalo population must be increased by improving its reproductive performance. This research was designed to study female buffaloes' reproductive performance and the problems that cause their low reproductive performance. The data resulting from this research are expected could be used in concepts and methods preparing to enhance the buffalo population in West Sumatra Province. Therefore, it can contribute to fulfilling the meat demand in Indonesia.

2. Method

This research was conducted in two subdistricts, namely Lubuk Basung and Matur, in Agam District, West Sumatra Province. Lubuk Basung Subdistrict is located in the lowlands with altitude ranging from 25 to 200 m asl, while Matur Subdistrict is in the highlands, ranging from 810 to 1126 m asl [24]. A survey method was used in this research, while data collection was conducted by interviewing the farmers and conducting direct observations on their farming areas. The female buffaloes used as samples were selected using a purposive sampling method with the specification, i.e., adult female buffalo have given birth at least twice. The numbers of female buffalo samples were 169 heads, consisting of 91 heads in Lubuk Basung Subdistrict and 78 heads in Matur Subdistrict. Standard identification guideline of technical buffalo farming from the Directorate General of Animal Husbandry, Agricultural Ministry of Republic Indonesia (1992), was used to evaluate farmers' buffalo farming practices. The guideline standard consisted of 30 evaluation points which the total scores are 1000, consisting of breed/reproduction (score 300-6 points), feeding (score 300-8 points), rearing management (score 100-5 points), animal housing (score 100-5 points), and disease/health (score 200-6 points).

Reproductive parameters measured were age at first mating, age at first calving, calving interval, and service per conception. Supporting parameters were a score of technical aspects application according to the standard identification guideline of technical buffalo farming by Directorate General of Animal Husbandry (1992), i.e., breeding/reproduction, feeding, rearing management, animal housing, and disease/healthy. The age at first mating and the age at first calving data were analyzed using the Mann Whitney test, while data of calving interval and service per conception were analyzed using the T-test using SPSS software. The evaluation score of buffalo farming practices by farmers was analyzed using descriptive statistics in percentage. The score obtained was calculated by comparing it with the standard score to get the percentage of buffalo farming practices implementation, which was categorized into three categories, i.e., good (81-100%), medium (60-80%), and low (<60%).

3. Results and discussions

The research was started by interviewing 264 farmers consisting of 116 farmers in Lubuk Basung Subdistrict and 148 farmers in Matur Subdistrict to obtain data about their buffalo number and criteria. However, only 85 (73.28%) farmers in Lubuk Basung Subdistrict and 76 (51.35%) farmers in Matur Subdistrict owned buffalo with the specified defined criteria. Data of respondents and sample buffalo are shown in Table 1. The sample buffalo were 169 heads consisting of 91 and 78 heads in Lubuk
Basung Subdistrict and Matur Subdistrict. The table showed that the number of respondents, the number of buffalo ownership, and the number of sample buffalo in Matur Subdistrict were fewer than those in Lubuk Basung Subdistrict. This result is related to the condition that farmers in Matur Subdistrict preferred to raise young male buffalo for the fattening program or used as worker buffalo in sugarcane refineries or field plowing.

Table 1. Recapitulation of Respondents data in Lubuk Basung Subdistrict and Matur Subdistrict.

| Parameters                                      | Lubuk Basung Subdistrict | Matur Subdistrict |
|-------------------------------------------------|--------------------------|-------------------|
| Numbers of Respondent (farmers)                 | 85                       | 76                |
| Numbers of buffalo ownership (heads):           |                          |                   |
| - Total                                         | 282                      | 175               |
| - Average of buffalo ownership                  | 3.32 ± 2.87              | 2.3 ± 0.95        |
| Numbers of sample buffalo (heads)               | 91                       | 78                |

The reproductive performances of female buffaloes in two research locations are shown in Table 2. The results showed that the reproductive performances of buffaloes in Lubuk Basung Subdistrict were un-optimal. The older age at first mating (39.04 ± 9.91 mo.) and age at the first calving (51.61 ± 9.95 mo.), long calving interval (27.26 ± 8.84 mo.), and higher service per conception (1.82 ± 0.82) than references described its un-optimal condition. While the age at first mating (33.67 ± 5.3 mo.) and the ages at first calving (45.71 ± 5.58 mo.) of buffaloes in Matur Subdistrict were optimal, but the calving interval was longer (24.17 ± 7.06 mo.) and service per conception (1.55 ± 0.78) was higher than references. Mann Whitney and T-Test exhibited a significant difference between female buffalo's reproductive performance in two research locations. Buffaloes in Matur Subdistrict showed better reproductive performance than buffaloes in Lubuk Basung Subdistrict. In general, however, the reproductive performances of buffaloes in the two research locations were not optimal.

Table 2. Reproductive performance of female swamp buffalo in Lubuk Basung Subdistrict and Matur Subdistrict.

| Parameters                                      | Lubuk Basung Subdistrict | Matur Subdistrict | Optimal rate/Reference |
|-------------------------------------------------|--------------------------|-------------------|-------------------------|
| Age at first mating (mo.)                        | 39.04 ± 9.91a            | 33.67 ± 5.3b       | 30-36[4]                |
| Age at first calving (mo.)                       | 51.61 ± 9.95a            | 45.71 ± 5.58b      | 40-45 [5]               |
| Calving interval (mo.)                           | 27.26 ± 8.84a            | 24.17 ± 7.06b      | 13-14 [5]               |
| Service per Conception (times)                   | 1.82 ± 0.82a             | 1.55 ± 0.78b       | 1.4 [25]                |

Different superscript letters in the same row indicate a significant difference (P < 0.05)

The un-optimal buffalo reproductive performance causes economic losses for farmers and consequently hamper the national buffalo population growth. The delay in the first-mating age results in a delay in calving age, while a high number of services per conception causes a longer calving interval. The longer calving interval of 24.17 to 27.26 mo. in buffaloes at these two locations resulted in their low population growth. Meanwhile, high meat demands required the availability of sustainable ready-to-slaughter livestock. This condition causes Indonesia's buffalo population to decline yearly due to lower population growth than the number of buffalo slaughtered.

The un-optimal female buffalo reproductive performance in these two locations might be due to the poor implementation of technical aspects in buffalo farming practices, such as breed/reproduction, feeding, rearing management, animal housing, and disease/health. Figure 1 illustrated the evaluation of those implementations based on the Guidelines for the Identification of Livestock Technical Aspects established by the Directorate General of Animal Husbandry (1992). The total implementation percentage of technical aspects of buffalo farming practices in Lubuk Basung Subdistrict and Matur Subdistrict was 34.4% and 42.6% of the standard. Its implementation in Matur Subdistrict in all technical aspects was higher than in Lubuk Basung Subdistrict. It showed that the buffalo farming practice in
Matur Subdistrict was better than that of Lubuk Basung Subdistrict. It impacts better buffalo reproductive performance significantly in this location, as previously described. However, in general, the buffalo farming implementation in these two locations was low because the total percentage was less than 60%, also low in each technical aspect. Table 3 showed the technical aspects that might affect the reproductive performance of buffaloes in both locations.

![Figure 1. Implementation of technical aspects of buffalo farming practices in Lubuk Basung Subdistrict and Matur Subdistrict.](image)

Breed quality is one factor that significantly affects livestock productivity. Quality buffalo breed supported by the appropriate livestock farming practices would perform optimal productivity. Selection is one way to obtain the quality buffalo breed as practiced by farmers in the research location. The farmers in the two research locations commonly buy local buffalo breeds at the local livestock market or other farms. To get the right breed, farmers selected buffalo breed based on physical characteristics. Farmers in both locations have almost the same criteria in determining a good quality buffalo, including large feet, large and long body frame, big stomach, good appetite, short jaws, and agile. But farmers could not select breed based on the pedigree because they did not know the parent stocks of buffaloes sold in the market.

Some farmers could not practice the buffalo selection because they raised buffalo with joint ownership. The farmers usually accept the buffalo from the owner directly in their farm location, so the buffalo they got not always fulfilled the criteria they expected. Table 3 showed that 51.76% of farmers in Lubuk Basung Subdistrict and 50% of farmers in Matur Subdistrict reared buffaloes with joint ownership, while the rest raised their buffaloes themselves. Farmers who bought buffaloes at the market did not always get quality buffalo breeds because of their limited funds. As a result, buffaloes' productivity was not as optimal as expected. Optimal buffalo productivity would be achieved if the breed is qualified and supported by appropriate farming practices.

Apart from the quality of the breed, reproduction management also positively affects the productivity of buffalo. Without proper reproduction management, buffalo will not reproduce as they should be. The mating system of 97.65% of buffaloes in Lubuk Basung Subdistrict and 96.05% of buffaloes in Matur Subdistrict were carried out using the natural mating system. Not all of the farmers have bulls to use as a stud, so they dominantly borrowed them from other farms around their locations. Only 18.29% of farmers in Lubuk Basung Subdistrict and 15.07% of farmers in Matur Subdistrict had their bulls, while 81.71% and 84.93%, respectively, borrowed it from other farmers. They could not select the bulls to use due to the limitation of its availability. As a result, the quality of offspring was comparable to their parent stocks.
Table 3. Technical factors that influence the reproductive performances of female swamp buffaloes in Lubuk Basung Subdistrict and Matur Subdistrict.

|                                | Lubuk Basung Subdistrict | Matur Subdistrict |
|--------------------------------|--------------------------|-------------------|
| Buffalo ownership status (%)   |                          |                   |
| - Farmer’s own                 | 48.24                    | 50.00             |
| - Joint ownership              | 51.76                    | 50.00             |
| Breeding system (%)            |                          |                   |
| - Natural mating               | 97.65                    | 96.05             |
| - AI                          | 2.35                     | 3.95              |
| The source of the stud/bull (%)|                          |                   |
| - Own stud/bull                | 18.29                    | 15.07             |
| - Other farmers’ stud/bull     | 81.71                    | 84.93             |
| Inbreeding incidence (%)       | 20.73                    | 16.44             |
| Paid stud (%)                  | 20.90                    | 51.61             |
| Fee for the stud/bull (IDR)    | 20,000-80,000            | 20,000-300,000    |
| Kind of buffalo feed (%)       |                          |                   |
| - Forage                       | 94.12                    | 68.42             |
| - Forage + additional feed     | 5.88                     | 31.58             |
| Grassland availability (%)     | 27.06                    | 88.16             |
| Kind of buffalo forage (%)     |                          |                   |
| Nature grass                   | 71.76                    | 14.47             |
| Nature grass + Napier grass + King grass | 23.53 | 73.68 |
| Nature grass + agricultural by-products | 4.71 | 11.85 |
| Animal house availability (%)  | 1.18                     | 21.05             |
| Calf weaning time (month)      | 12.92                    | 10.54             |

The limited number of bulls caused a high incidence of inbreeding in the buffaloes in research locations. It was also happened because of the communal rearing of bull and their heifers. There were 20.73% and 16.44% of farmers in Lubuk Basung Subdistrict and Matur Subdistrict stated that there were inbreeding cases in their buffaloes mating, either intentionally or not. Inbreeding negatively affects livestock productivity, such as milk production, calving interval, service per conception, reproductive efficiency [26], and adverse effects on qualitative traits [27]. If this happens continuously for a long time, it will be detrimental to farmers' economies because it will reduce buffalo breeds quality [28]. As a result, buffalos' productivity, including reproductive performance, will be lower.

Difficulty in getting a bull also resulted in a delaying or unsuccessful mating of female buffalo in the estrous period. Sometimes, the owner does not allow their bulls to mate with other female buffaloes as they think it would cause adverse effects on the bull growth. They worried that after mating, the bull would get agitated and lost its appetite. It would cause a disadvantage due to the decrease in the bodyweight of the bull. Farmers will delay their female buffaloes' mating until the next estrous period if they do not get a stud. It is detrimental because it causes the late age of the first mating and calving in heifers or the female buffalos' long calving interval.

Some farmers explained that they should pay for bull used to mate their female buffaloes. Farmers in Lubuk Basung Subdistrict (20.90%) paid 20,000-80,000 IDR per mating while farmers in Matur Subdistrict (51.61%) paid 20,000-300,000 IDR per mating. The higher payment for bulls in Matur Subdistrict due to fewer bulls than in Lubuk Basung Subdistrict. The amount was paid by barter system with grass, rope, cigarette, or cash. Low price payment might not burden the farmers, but high price payment was burdensome for them. Difficulty in getting bull and the high price of mating cost led the farmers to choose to rear youth male buffalo or fatten their female buffalo as meat producers. This condition led to its lower population growth.
AI is one way to improve livestock's genetic quality [29], reduce disease transmission risk [30], reduce the inbreeding rate, and overcome bull limitations [31]. However, only 2.35% of Lubuk Basung Subdistrict farmers and 3.95% of Matur Subdistrict farmers applied it. The obstacle faced in implementing AI was handling buffalo accustomed to living freely without a pen or housing and rarely met strangers. Using a restraining pen to facilitate AI application and inseminator safety caused buffalo more stress, which led to difficulties in its application. As a result, the AI application was low in both locations.

Inaccurate in detecting appear time and estrous symptoms were also an obstacle in implementing natural mating or AI in buffaloes. This obstacle was because buffaloes are primarily placed in fields far from the farmers' house. The farmer comes to the location 2-3 times a day, in the morning, afternoon, or evening to move the grazing area or deliver the grass. Estrous symptoms that usually appear at night would be unnoticed by the farmer [17]. It resulted in the wrong time in AI applications or natural mating. It affected the high service per conception rate, resulting in the late age at first calving or the long calving interval, causing farmers' losses. Sometimes, the buffaloes' tethered location was formidable to access by vehicle, so it needed more time for the inseminator to reach the place.

Successful reproduction programs also depend on nutrition management. Adequate feed intake could help improve livestock reproductive performance [12]. The low reproductive performance of buffaloes in research locations might be affected by the low quality of feed and nutrition given; thus, it did not fulfill the buffalo nutrient requirements. 94.12% of Lubuk Basung Subdistrict farmers and 68.42% of Matur Subdistrict farmers only provide grass without additional feed to their buffaloes. Previous research [32] showed that buffaloes treated with only grass reached puberty at 35.8 mo. In contrast, buffaloes treated with forage and concentrate as additional feed (1-1.5 kg per day) reached puberty at 23 mo.

Feed ingredients such as rice bran, soybean meal, coconut cake, tofu dregs, minerals, and others can be added to enrich feed quality. However, only 5.88% of farmers in Lubuk Basung Subdistrict and 31.58% of farmers in Matur Subdistrict provided supplemental feed such as bran, sago, boiled sugarcane juice, minerals, and salt. Due to economic conditions limitations, many farmers could not buy supplement feed for their buffaloes. Some farmers preferred to provide it for their male buffaloes in a fattening program to be fat and sold quickly. Farmers ignored supplement feed for female buffalos, although they also need quality feed for their growth, development, and reproductive health.

Limited land ownership was one of the obstacles to provide grass and grazing areas for buffalo in study locations. Only 27.06% of farmers in Lubuk Basung Subdistrict owned pasture land, while in Matur Subdistrict, 88.16% of farmers owned pasture land. The types of grass planted were varied, such as bede grass (*Brachiaria decumbens*) and bitter grass (*Axonopus compressus*), elephant grass (*Pennisetum purpureum*), king grass (*Pennisetum purpuroide*), Bengal grass (*Panicum maximum*), and other types of grasses. Farmers who did not have grassland would get forage difficulty during the dry season, so they searched for grass further afield. Limited family labor in getting forage was also an obstacle in providing feed for buffaloes. As a result, buffalo got less forage in the dry season, which will affect their productivity.

The type of forage given to buffaloes in Lubuk Basung Subdistrict was 71.26% natural grass, 23.53% a mixture of natural grass with elephant grass and king grass, 4.71% a mix of natural grass, agricultural by-product such as thatch leaves, and rice straw. The type of forage given to buffaloes in Matur Subdistrict was 14.47% natural grass, 73.68% a mixture of natural grass with elephant grass and king grass, and 11.84% mixture of natural grass with agricultural by-product such as corn leaves, sugar cane shoots, and rice straw. Data showed that most of the forage type given to buffaloes in Matur Subdistrict was better than in Lubuk Basung Subdistrict. As a result, buffalo nutrition requirements were more fulfilled and positively affected its productivity, which showed better reproductive performance.

The treatment of agricultural by-product uses ammonization, and the fermentation process can solve the problem of forage getting difficulty and limitation of grazing area and grassland for buffaloes. However, farmers in both locations did not apply it due to the less knowledge and busyness on their primary job as farmers, sales, entrepreneurship, and other works. The fields that far from the main road
were also an obstacle in transporting the agricultural by-product, so that farmers in these two locations rarely used it as animal feed or treated it as feed.

Another technical aspect that farmers need to pay attention to is buffalo housing. It will help farmers practice rearing management properly. It also prevents livestock from the effects of bad weather. However, only 1.18% of farmers in Lubuk Basung Subdistrict and 21.05% of farmers in Matur Subdistrict provided housing for their buffaloes. The farmers stated that they did not have enough money to build buffalo housing. Farmers explained that they chose buffalo because it was easier to keep and did not need a house, so they were not motivated to build it. Farmers in Matur Subdistrict prioritized the housing providing for male buffalo, which were kept intensively for the fattening program. The pen's unavailability made it hard to provide feed and drink properly, difficulty monitoring estrous symptoms and AI application, and negatively affected livestock’s health when exposed to heat and bad weather. Their dark and thick skins, sparse and deep of sweat glands, are not bear when exposed directly to the sun \[15\], so they need shade or shelter. Buffalo undergoes heat stress quickly, even causes death when they do not get sheltering, shading, or wallowing after exposure to the sunshine for a long time.

Health management determines reproduction success. Knowing the causes, symptoms, and ways of overcoming disease will help farmers maintain their livestock health so support its productivity. The farmers’ knowledge about the causes, symptoms, and treatment methods for several infectious diseases such as anthrax, \textit{Septicemia epizootica}, foot-and-mouth disease, and brucellosis were lacking. It was might because these diseases rarely occurred, so farmers knew less about them. However, they learned about several cases that had attacked their buffaloes, such as diarrhea, worms, or fever. Usually, farmers provided traditional medicines derived from plants. An animal husbandry instructor's role is vital in providing information and knowledge to farmers through extension activities.

Calving interval is influenced by the service period, which is affected by postpartum estrous, service per conception, and the age of the male used \[5\]. The longer calving interval of the buffaloes in the two locations, 27.26 mo. (Lubuk Basung Subdistrict) and 24.17 mo. (Matur Subdistrict) might be due to the late pregnancy of the female after giving birth. It might be due to 1) Delaying mating after calving, 2) late postpartum estrous, and 3) repeated mating. These three cases might occur due to the late calf weaning, namely at the age of 12.86 mo. (Lubuk Basung subdistrict) and 10.55 mo. (Matur Subdistrict), and the low quality of feed given to the mother buffalo. The calves were raised with their mothers until the weaning time, so they were free to suckle whenever needed. The farmer would put the head rope on the calf when the buffalo hard to handle and disturbs crops. Weaning would happen at that time because the calf would find it hard to suckle the mother.

The farmers in the two research locations deliberately weaned the calves for a long time to let them grow well. They worry that earlier weaning time would affect the calves' growth badly. Even though late weaning time is good for the calves, it will delay the mother's postpartum estrous reaching \[33\]. It results in a long calving interval because the female buffalo cannot mate immediately after calving. A previous study indicated that accelerating weaning time would accelerate ovarian activity resumption and increase the pregnancy rate \[35\]. Feeding with adequate nutritional and restricted breastfeeding can be recommended to reduce the prolonged postpartum un-estrous \[23\]. The research on river buffaloes \[34\] showed that buffaloes, whose calves weaned on the third day (early weaning) after calving, would re-estrous after 53.3 days, conception rate within 90 days after calving was 62.5%. Meanwhile, buffaloes that breastfeed their calves twice a day will re-estrous after 128 days, and the conception rate in 90 days after delivery was 0%.

Weaning was an effective way to enhance the pregnancy rate after calving, which may help optimize buffaloes' reproductive performance after calving \[34\]. Even though early weaning is rarely applied to swamp buffalo, the farmers can accelerate weaning time or restrict breastfeeding by putting the head rope earlier than usual and giving supplement feeding to help calves grow better. The mother can mate in a faster time after calving. Therefore, the calving interval could be accelerated that would provide benefits for farmers. Calving interval on buffalo in Matur Subdistrict was shorter because of the earlier weaning time (10.55 mo.) than in Lubuk Basung (12.86 mo.) and better feeding.
Microclimatic conditions were factors that might also support buffalo productivity in Matur Subdistrict. This subdistrict was located in highland with a temperature of 19.48° to 30.97° C and THI of 67.23 to 80.60 during the study. Temperatures of 25–30°C with lower THI were comfortable for buffalo [35] to naturally support its physiology mechanism. In contrast, Lubuk Basung Subdistrict is in lowland, where its temperature of 25.42° to 33.99° C and THI 77.12 to 86.96. THI value exceeds 80 was critical for buffalo [36]. High THI would cause a decreased buffalo feed intake [39], leading to unfulfilled nutritional requirements, exacerbated by low feed quality given to buffalo. It would affect the low growth and development of livestock, including reproductive performance. High temperatures also reduced bull fertility due to the high number of abnormal spermatozoa [37], significantly decreasing the live sperms and concentration of sperms [38], thus decreasing female buffaloes’ pregnancy rates. Using cooling systems during hot temperatures was recommended to minimize heat stress [36].

4. Conclusion
In Matur Subdistrict, buffaloes showed better reproductive performance than buffalo in Lubuk Basung Subdistrict due to better implementation of buffalo farming practices and more comfortable climatic conditions. However, buffaloes' reproductive performance in these two locations is not optimal yet, because the technical aspects of maintenance have not been optimally implemented. Improving the implementation of technical aspects in rearing management will enhance buffalo reproductive performance.

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