Reproductive Performance of Beef Cattle Raised Under SPR Program in Tegal Regency

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ABSTRACT

The purpose of this research was to assess the reproductive performance of beef cattle based on different production systems. Survey research was carried out in Margasari Subdistrict, Tegal Regency, Central Java Province, in 13 farmer groups (a total of 188 breeders and 557 beef cattle) who took shelter in the SPR Program The qualitative and quantitative design framework is used to obtain comprehensive data. The questionnaire was used to get data and respondents determined by census method. SPSS software is used to analyze data. The results showed that 38.46% of farmer groups implemented a crop-livestock-system (CLS), 30.77% of farmer groups implemented a livestock-forestry system (LFS), and 30.77% of farmer groups implemented a crop-livestock-forestry-system (CLFS) in producing beef cattle. The results of the present study were significantly (P<0.05) there were differences in each reproductive performance parameter (BCS, S / C, CR, CI, and CC), which was observed in each beef production system (CLFS, CLS, and LFS). The results of this study also provide an overview of the simultaneous effects on the application of the production system to the reproductive performance of beef cattle. Although there has been certain variation between the production systems, the reproductive performance of the observed beef cattle has not been satisfactory. Improving nutrition management in cattle is needed to realize successful reproductive performance.

Keywords: Beef cattle production system, Reproductive performance, Smallholder beef cattle, The SPR program

Introduction

Ninety percent of beef cattle enterprise in Indonesia is dominated by smallholder, both in the number of operations and production (Widi *et al.*, 2015; Smith *et al.*, 2018). Although smallholder is the backbone in terms of providing meat beef in Indonesia, the ownership of beef cattle raised by an individual farmer is still low, ranging from 2-6 head (Rohyan *et al.*, 2016; Ekowati *et al.*, 2018). Beef cattle are usually operated by farmers and aim for cow-calf operation or fattening (Agus and Widi, 2018; Ekowati *et al.*, 2018). Some studies have informed that the productivity (reproductive aspect) of beef cattle kept by smallholder farmers is still relatively low, especially in the reproductive aspect (Antari *et al.*, 2014; Dahlanuddin *et al.*, 2016; Agus and Widi, 2018).

Beef cattle development approach, recently carried out by regional-based development namely SPR's Program or in Bahasa = Sentra Peternakan Rakyat which aims as a learning vehicle for farmers in increasing production, reproduction, increasing birth rates, etc. (Directorate General of Livestock and Animal Health (DGLAH), Ministry of Agriculture, 2015). One of the regions in Indonesia that has implementing the SPR Program is Tegal Regency,

Central Java Province. The SPR Program has been implemented in Tegal Regency since 2015. Most beef cattle raised by farmers are local cattle (cows and bull) such as Ongole crossbreeds cattle (PO), Bali Cattle, and Jabres Cattle. Beef cattle are traditionally run by farmers with less optimal conditions and appearance.

Most of the information available relating to the reproductive performance of Indonesian beef cattle is based on on-farm conditions (Pribadi *et al.*, 2015; Rohyan *et al.*, 2016; Panjono *et al.*, 2017) and only a few ware conducted under station or institutional herds. However, a study that is conducted under the SPR Program condition has never been reported. Therefore, studies aiming at assessing the reproductive performance of these breed of cattle in production systems in SPR of Tegal Regency are vital as an alternative strategy in the development of beef cattle enterprise.

Materials and Methods

Description of the study area

The study was conducted from Mei 12th 2017 to April 13th 2018, in Margasari Subdistrict Tegal Regency, Central Java Province. Margasari Subdistrict has 13 villages, but the distribution of farmer groups is found in seven villages, namely

Dukuh Tengah, Kalisalak, Pakulaut, Jatilaba, Marga Ayu, Jembayat and Prupuk Utara Village (Figure 1). Margasari Subdistrict width is 9.88% (8.684 ha) of the total area of Tegal Regency which is 87.879 ha and it has an agroecosystem of food crop and forest (Central Bureau of Statistics Tegal Regency, 2018).

The area of forest is used for *Tectona grandis*, *Swietenia mahogany*, *Dalbergia latifolia* and *Albizia chinensis*. The area in Margasari Subdistrict is also used for planting rice, maize, and peanuts. In 2017, the area of rice harvest of 5504 ha and produce of 33599 tons of rice per year. Maize harvesting area of 490 ha and producing corn as much as 3923 tons/year. Next on, peanut has a harvest area of 1 ha and produces peanuts as much as 2 tons/year (Central Bureau of Statistics Tegal Regency, 2018).

Overview of the methodological framework

This study was based on social research methods and how they were implemented using surveys. The combination of qualitative and quantitative approaches was used as a technique for obtaining data and this commonly called mixed methods research (Leppink, 2017; Taguchi, 2018) and it can be designed as a framework for getting comprehensive facts and understanding (Taguchi, 2018). The qualitative approach was used to know the type and trends of beef cattle production systems used. The quantitative approach was used to find out and compare the reproductive performance of beef cattle based on the livestock production system applied.

Data collection

The questionnaire set was used to obtain data by visiting every farmer in each group and cooperate to gather detailed information on the beef cattle production system used and measure the reproductive performance of beef cattle. Respondent was determined by the census method. The census method allows researchers to dig deep information on all population units and produce high-quality statistical and specific data (Neuman, 2014).

The beef cattle production system. The thing that needs to be done is to categorize the whole group of farmers based on the beef production system applied. A total of 13 groups of farmers are categorized into 3 clusters which refer to the beef cattle production system used. These are crop-livestock-system (CLS) i.e. system that includes beef cattle with grains dan grasses; livestock-forestry-system (LFS) i.e. system that includes beef cattle with grasses and trees; and crop-livestock-forestry-system (CLFS) i.e. system that includes beef cattle with trees, grains, grasses (Gil *et al.*, 2015). There were three major systems of beef cattle production in Margasari Subdistrict, Tegal Regency. A total of 5 groups of farmers (total 75 respondents) enter the cluster CLS, while the LFS as many as four groups of farmers (total 62 respondents) and four groups of farmers (total 51 respondents) belong in CLFS (Table 1).

Reproductive performance of beef cattle. The aim of the study was to measure the reproductive performances of beef cattle based on the production system used. A total of 13
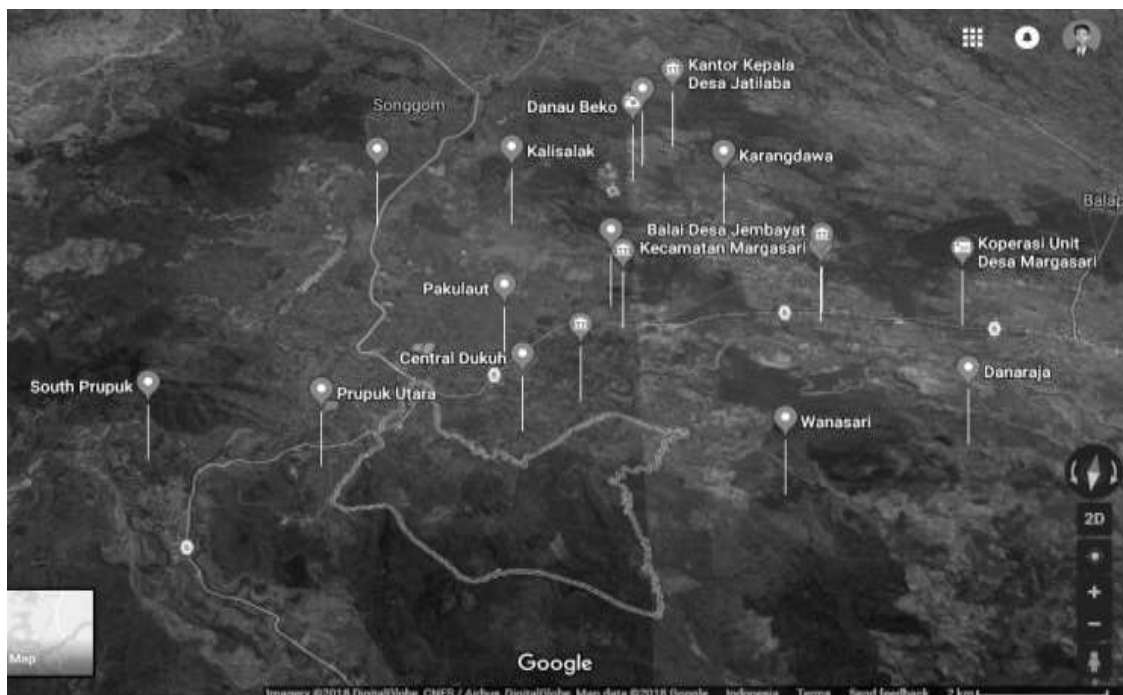

Figure 1. The study areas in Margasari Subdistrict, Tegal Regency, Central Java Province.

Table 1. Differences of reproductive performance of beef cattle based on production system in SPR Program, Tegal Regency

Names of Village	Name of cattle farmer group	Number of farmers as respondent	Beef cattle production system	BCS (1-9 scale)	S/C	CI (months)	Number of cows	Pregnant cows	Annual calf crop production	CR (%)	CC (%)
Dukuh Tengah	Lembu Jaya Nusantara	12		3.42±0.51[a]	1.29±0.16[a]	12.79±0.42[a]	19	15	12	79	80
Jatilaba	Suka Maju	26	Crop-Livestock System (CLS)	4.04±0.81[b]	1.39±0.13[b]	13.75±1.32[b]	93	75	58	81	77
Marga Ayu	Rimba Jaya	17		3.83±0.79[c]	1.35±0.10[c]	13.69±1.47[c]	72	59	45	82	76
Marga Ayu	Dadi Makmur	10		4.04±0.92[d]	1.39±0.11[d]	13.15±0.54[d]	26	19	15	73	79
Jembayat	Bhakti Raharja	10		3.76±0.72[e]	1.36±0.12[e]	13.44±0.71[e]	25	18	14	72	78
	Sub-Total			3.90±0.80[a]	1.37±0.12[a]	13.56±1.24[a]	235	186	144	79	77
Prupuk Utara	Sida Makmur	8		4.14±0.77[a]	1.49±0.16[a]	14.23±0.43[a]	22	16	12	73	75
Dukuh Tengah	Kebantingan	12	Livestock-Forestry System (LFS)	4.27±1.31[b]	1.39±0.13[b]	13.95±1.25[b]	59	49	38	83	78
Kalisalak	Wirajaya	26		3.93±0.81[c]	1.37±0.20[c]	13.34±1.01[c]	56	42	34	75	81
Kalisalak	Lembu Sehat Sejahtera	16		4.12±1.01[d]	1.41±0.13[d]	14.12±1.18[d]	32	23	18	72	78
	Sub-Total			4.01±1.05[b]	1.40±0.16[b]	13.82±1.13[b]	169	130	102	77	78
Dukuh Tengah	Krajan	19		4.35±1.13[a]	1.23±0.13[a]	12.19±0.39[a]	62	54	45	87	83
Dukuh Tengah	Banteng Jaya	14	Crop-Livestock-Forestry System (CLFS)	3.79±0.71[b]	1.26±0.14[b]	12.38±0.60[b]	34	28	23	82	82
Dukuh Tengah	Banteng Mulya	9		4.90±0.86[c]	1.29±0.19[c]	12.52±0.51[c]	29	25	21	86	84
Pakulaut	Sida Mulya	9		4.14±0.76[c]	1.31±0.25[d]	12.68±0.48[d]	28	20	15	71	75
	Sub-Total			4.29±0.99[c]	1.26±0.17[c]	12.38±0.51[c]	153	127	104	83	82
	Grand Total	**188**		**4.04±0.95**	**1.35±0.16**	**13.31±1.20**	**557**	**443**	**350**	**80**	**79**

Note: S/C= service per conception, CI=calving interval, BCS=body condition score, CR=conception rates, CC=calf crop percentages. Superscript letters within the same column indicate statistical differences between group means (P<0.05).

groups of farmers containing 557 cattle (local-breed such as as PO, Bali Cows, Jabres Cows) that is cluster CLS=235 head, cluster LFS=169 head, cluster CLFS=153 (Table 1) were measured; 1) body condition score (BCS) measured by the American method, scale 1-9 (1, emaciated; 9, obese) (Gutierrez *et al.*, 2014; Díaz *et al.*, 2017); 2) service per conception or S/C, i.e. the number of insemination performed on cattle to be pregnant (Hassan *et al.*, 2017); 3) calving interval or CI, i.e. the number of days that have passed between parturition 1 and parturition 2 (Titterington *et al.*, 2017); 4) conception rates or CR is the number of cows that become pregnant after insemination divided by the number of cows inseminated in units of percent (El-tarabany and El-bayoumi, 2015); and 5) calf crop percentage or CC (number of born calves divided by number of cows in percentage) (Gebrekidan *et al.*, 2016).

This research uses the triangulation method and data collection. The triangulation method combines the method between a qualitative and quantitative approach. Furthermore, in the triangulation of data collection, the data obtained is a combination of qualitative data and quantitative data. The triangulation of data collection is used in calculating the reproductive performance of beef cattle as measured by service per conception, calving interval, and cow ages. This is because farmers do not have records of beef cattle performance. The study was conducted with the SPR program Manager to get assurance that the findings were the correct data.

Statistical analysis

The data were analyzed using the IBM®-SPSS® software (Andreß, 2015) version 22. The description statistic used is a measure of central tendency and standard deviation (Neuman, 2014) to know the average of S/C, CI, and BCS on beef cattle in each farmer's group. The next performance elements are CC and CR using the frequency distribution by category of data in percentage form (Neuman, 2014). Comparative statistics ($\chi 2$ test) were used to analyze the differences in the average of S/C, CI, and BCS variables between; 1) between groups but still within the same cattle production systems; and 2) differences between group means among three production systems used pooled data (sub-total means).

Result and Discussion

Farmer background and a brief description of the application of the production system

Background of all farmers in each group does not have crop enterprise, because they do not have lands. According to the interviewees, 65,43% farmers into farm labors (planting, plowing and weeding) as a second profession after rearing cattle. There are also farmers who work as elementary school teachers (4,26%), sand diggers (12,77%), motorcycle drivers (7,45%), and traders (10,11%). The majority of beef cattle farming is efforted on a smallholder with average livestock ownership of 8.23 ± 2.18 AU. Animal Unit (AU) is a standard for categorizing cattle. 1 AU is equivalent to 1 cow (Kannan *et al.*, 2017).

In general, the characteristics of beef cattle production systems in the SPR Program are rural landless farms, with small beef cattle ownership, and integrated with food crops and forests. A number of farmers groups who implement CLS as much as 5 groups (38.46%). The LFS was applied in 4 groups (30.77%), while for the CLFS implemented by 4 groups (30.77%). The types and trends of the beef cattle production system can be observed in Table 1. The next finding is that the production system carried out in each group then extended to form patterns of integration, namely; 1) CLS pattern formed Beef Cattle-Rice-Maize-Peanuts-Grass; 2) LFS pattern formed Beef Cattle-Grass-Tree, and 3) CLFS pattern formed Beef Cattle-Rice-Maize-Peanut-Grass-Tree.

Reproductive performance of beef cattle in different production systems

Beef cattle raised under SPR Program and the majority apply cow-calf operation system. An assessment of the reproductive performance of beef cattle is done to help provide an overview of the current situation regarding the condition of broodstock breeds. On the other hand, the goal of the SPR Program is a vehicle to increase the production and reproduction of beef cattle (Directorate General of Livestock and Animal Health (DGLAH), Ministry of Agriculture, 2015). This study can help in designing and planning intervention options for improving reproductive performance of beef cattle.

Observation of the reproductive performance of beef cattle using several parameters, such as S/C, CI, BCS, CR, and CC can be observed in Table 1. This research used triangulation in parameters service per conception, calving interval, and cow ages. Farmers who take shelter under the SPR program is a smallholder that has not implemented the recording of reproductive performance in beef cattle. Therefore this study involved the SPR program manager in ensuring the validation of the findings in the field with the actual reality. A total number of the cow in this study amounts 557 heads. The proportion consisted of 235 cows found in CLS, as many as 169 cows found in the LFS group, and as many as 153 cows found in CLFS. There are variations in the values of reproductive performance in 13 groups of farmers taking shelter in the SPR Program and showing significant differences (P<0.05).

The mean body condition scores of beef cattle were significantly (P<0.05) greater in the CLFS applied group (4.29 ± 0.99) than the CLS application group (3.90 ± 0.80) and LFS (4.01 ± 1.05) (Table 1). This study also shows that overall beef cattle raised under the SPR program are 4.04 ± 0.95. On the other hand, the condition of the beef cattle body observed in the three production systems applied was significantly different (P<0.05).

The results of reproductive performance studies of beef cattle in BCS parameters indicate that, there are significant differences in the CLS application group with the LFS application group and the CLFS group applicant. The group of farmers who implement the CLFS production system has a higher BCS value compared to the group of farmers who apply the production system CLS and LFS. In other words, the production system applied by each farmer can affect the reproductive performance of beef cattle. This is because the CLFS system allows farmers to get various types of forages originating from food crops and forests.

There are types of forages commonly used as cattle feed, including agricultural waste (rice, maize, and peanuts) and trees originating from forests (Tectona grandis, Dalbergia latifolia, and Albizia chinensis). Various grasses also can be found both in food crops and forests. The types of grass that can be found in the area of crops are; Paspalum vaginatum, Digitaria ciliaris, Eleusine indica, Seteria sphacelate, and Brachiaria eruciformis. On the other hand types of grass that can be found in forests, among others; Angeratum conyzoides, Pennisetum purpureum, Crynodon dactylon, Seteria sphacelate, Brachiaria decumbens, Chrisopogon ariculatus, and Pennisetum purpupoides.

Although there are limitations to the forage that comes from food crops, which depends on the harvest season, the availability of forages originating from the forest does not recognize the season. So that forages from the forest can be a buffer when crop failure or the dry season. This is in accordance with the state of the field that the perceived impact of farmers in implementing CLFS system that is easier for them to obtain forage every time (there is no session) for beef cattle.

It has been confirmed that the adequacy of cow nutrition has an impact on reproductive performance (Antari *et al.*, 2014; Mayberry *et al.*, 2014). Inadequate nutritional intake for cattle makes cattle body reserves run out and body condition decreases (Diskin and Kenny, 2016, 2014). deally cattle should have BCS values ranging from 5 (scale BCS = 1-9) (Dickinson *et al.*, 2019; Diskin and Kenny, 2014). However, if the beef has a value below the optimum (small / thin) makes the lack of good reproductive performance of beef cattle (Dickinson *et al.*, 2019; Manzoor *et al.*, 2018). This study shows that the observed body condition of beef cattle is less ideal for the three different production systems as well as the overall cattle maintained under the SPR program (Figure 2).

The average service per conception in beef cattle in the LFS application group (1.40±0.16) was significantly greater (P<0.05) than the CLS implementing group (1.37±0.12) and CLFS (1.26±0.17) (Table 1). In addition, this study also shows that overall service per conception of beef cattle has a value of 1.35±0.16. This study shows that there are significant differences in service per conception of beef cattle (P<0.05) from the three production systems used.

Figure 2. The appearance of the body condition of beef cattle.

The results of the research on service per conception (S/C) parameters indicate that, the S/C values in the LFS application group are significantly higher than those in the CLS and CLFS application groups. This is caused by the simultaneous effect of the appearance of the body condition of beef cattle in each group of farmers. Appearance body condition refers to the BCS beef triggered the intensity of the S/C, in other words if the value of the ideal BCS can express the value of the S/C is ideal anyway. As with the beef cattle whose body appearance is small or thin, the S/C value is higher.

As discussed above, thin cows can reduce reproductive performance. That is because nutrition plays a role delays postpartum estrus, silent estrus, ovulation is delayed (Ibrahim and Seid, 2017; Richardson *et al.*, 2016), thus triggering the dynamics of the number S/C (Vinothraj *et al.*, 2016). Some studies report at least an ideal range of S/C values of less than 2 (Ibrahim and Seid, 2017; Manzi *et al.*, 2018; Siatka *et al.*, 2017).

Even though the three production systems used and the whole cows maintained under the SPR program show ideal S/C values, but still found that thin cows tend to be slower estrus. Not only late estrus, the observed state of the field are farmers had difficulty in detecting estrus in cattle breeders group that implement CLS and LFS production systems. It has been reported that good reproductive performance of cattle is indicated by the emergence of estrus immediately after childbirth, then pregnancy occurs with minimal insemination services (Muller *et al.*, 2018). Factors that affect the S/C consists of state of the reproductive system of a cow, estrus detection efficiency, quality of cement, timing of insemination, inseminator skill, and other management factors (Vinothraj *et al.*, 2016).

The average conception rate of beef cattle in the CLFS production system (83%) is greater than the CLS production system (79%) and LFS (77%) (Table 1). Overall the level of conception of

beef cattle maintained under the SPR program is 80%. This study showed that the level of conception in the production system of CLFS, CLS and LFS had a significant difference (P<0.05).

The next reproductive cattle parameter performance is conception rates or CR. There were significant differences in the percentage of conception rates in each implementing group of each production system, namely that the CLFS was significantly different than the CLS and LFS. We can conclude that the best percentage of pregnancy for beef cattle is in the group of farmers who implement the CLFS production system. It has been reported that the ideal pregnancy rate of beef cattle in cow-calf operations is more than 85% (Abdullah *et al.*, 2017).

Unfortunately the beef cattle reared using three different production systems and the whole cattle that are under the SPR program shows the percentage that is not optimal conception rates (below 85%). The success of conception rates reflected optimal mating process (Manzi *et al.*, 2018), in this case is the ideal value of services per conception. At least semen is deposited into the reproductive tract of female cattle around 6-12 hours before the ovulation process takes place (Diskin, 2018) and it is certain that pregnancy should not be more than 80-85 days after giving birth (Ibrahim and Seid, 2017).

The reality in the field observed was that farmers had difficulty detecting estrus (silent estrus) and estrus delay in farmers who applied the CLS and LFS systems. This causes a decrease in conception rates of the mating process. Beef contained in CLFS implementers group showed clear expression of estrus compared with CLS and CLFS implementers group, so that the mating can take place optimally and it has an effect on the percentage of cow pregnancy rate.

The average calving interval of beef cattle in the LFS system (13.82 ± 1.13 months) was significantly longer than that of beef cattle found in

the CLS system (13.56 ± 1.24 months) and CLFS (12.38 ± 0.51 months) (Table 1). Overall the calving interval of beef cattle in the SPR program was 13.31 ± 1.20 months. This study showed that there was a significant difference in the calving distance of beef cattle in the three systems used (P<0.05).

Subsequent reproductive performance observations are calving intervals (CI). There were significant differences in the mean CI values between groups of farmers in three different production systems. CI values in LFS-applied groups are longer than those for CLS and CLFS groups. This study shows that the fastest calving interval for beef cattle can be observed in the CLFS production system. Ideally, calving intervals of no more than 365 days (12 months) in order to maximize the productivity of sires (Ibrahim and Seid, 2017; Walmsley *et al.*, 2018).

Calving interval of beef cattle observed in three different production systems as a whole as under the SPR program is classified as still exceeding the ideal standard set at 12 months. That is because the CI value is more than 12 months. Several studies have reported that the parameters of the S/C at the smallholder in Indonesia more than 12 months (Agus and Widi, 2018; Priyanti *et al.*, 2015; Rohyan *et al.*, 2016). Some factors that can cause the length of CI include; production system (Gebrekidan *et al.*, 2016), lack of feed availability in the dry period phase (Wario *et al.*, 2017), the length of postpartum estrus (Manzi *et al.*, 2018), number of services per conception (Vinothraj *et al.*, 2016).

The fact that observed in the field that there is a problem that is not ideal body condition that causes difficulty detecting estrus so the impact on calving interval. Calving interval can be achieved ideally, at least it should be ensured pregnant cows no more than 80-85 days after giving birth (Ibrahim and Seid, 2017). Improved maintenance management is key and contributes greatly to the reproductive performance of cattle (Manzi *et al.*, 2018).

The average percentage of calf crop in the CLFS production system is greater (82%) compared to the CLS production system (77%) and LFS (78%) (Table 1). Overall the percentage of calf crop in the SPR program is 79%. This study shows that there is a significant difference in the percentage of calf crop in the three production systems applied (P<0.05).

Further beef cattle reproductive parameters observed in this study is the calf crop percentage, where the production system is significantly greater CLFS significantly different from the LFS and the CLS. Ideally calf crop percentage should be more than 85% (Andreini *et al.*, 2018; Troxel *et al.*, 2015), but in reality the calf crop percentage contained in three different production systems as well as overall program SPR is less than the ideal value.

Factors that can affect the high and low calf crop percentage, namely cattle failing to become pregnant and calving intervals are too long (Ibrahim and Seid, 2017). Factors that can affect the high and low calf crop percentage, namely cattle failing to become pregnant and calving intervals are too long (Ibrahim and Seid, 2017). This is in accordance with the conditions in the field that the conception rates and calving interval of beef cattle are not ideal, thus causing the acquisition of calves in each production system is also not ideal. The causal factors are not ideally the conception rates and calving intervals of beef cattle described above, but have a major impact on the final yield of calves.

The results of this study provide an overview of the simultaneous effects on the application of the production system to the reproductive performance of beef cattle. The production system applied by each farmer has an impact on the nutritional adequacy of beef cattle which is manifested in the appearance of body conditions (BCS). The less ideal appearance of beef cattle triggers a delay in estrus, silent estrus, ovulation, and other reproductive disorders so that service per conception increases, and vice versa if the BCS is ideal, the mating process takes place optimally. Ideally, cows should be pregnant no more than 80-85 days after giving birth to maintain the ideal calving interval (365 days/12 months) so that the maximum calf crop yield is obtained.

Conclusions

The reproductive performance of beef cattle has not been satisfactory, although it has been ensured that there are variations between the production systems. Improving nutrition management in cattle is needed to realize successful reproductive performance. Improved nutrition of cows can utilize the potential of existing agroecosystems until the cows show the appearance of ideal body conditions (BCS = 5). Though farmers both individually and in groups have utilized local agroecosystems that are realized by the application of various types of production systems (CLFS, CLS and LFS). Although the reproductive performance of beef cattle is not optimal for each parameter (in each production system), but still in the production system CLFS shows the superiority of each parameter compared to other production systems.

Acknowledgment

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