Estrus Synchronization and Artificial Insemination for Productive Female Cattle through Feed Improvement

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ABSTRACT

Estrus synchronization and artificial insemination (AI) for productive female cattle through feed improvement aimed to increase the availability of seed quality. This study was conducted in July Kede Dua Village in July Subdistrict, Bireuen District. Nine cattle at the ages of 2 to 2.5 years old were used as samples. The design of the study was a Randomized Block Design (RBD) with 3 treatments and 3 replications. There were three ration treatments, namely: P = Sync+AI+natural grass+elephant grass, J = Sync+AI+50% rice straw+15% Gliricidia+35% (natural grass+elephant grass)+concentrate+mineral blocks, and S = Sync+AI+40% rice straw + 20% Gliricidia + 40% (natural grass + elephant grass) + concentrate + mineral blocks. The observed variables were the percentage of estrus, the percentage/rates of pregnancy, the weight of female cattle during pregnancy, feed intake and feed conversion. The results showed that hormonal injections of PGF2α on the first day of J treatment generated 100% of estrus while P and S treatments generated 33,33% of estrus. At the second injection, there was an increase up to 66,67% on the 12th day in P and S treatments. The average of feed consumption during the study in each treatment was J = 28.23 kg/cow/day, S = 27.08 kg/cow/day, P = 25.60 kg/cow/day. There was a significant difference in daily weight gain caused by the difference in ration quality in each treatment.

Keywords: Local Cattle, Percentage of Estrus, PGF2α, Pregnancy Rate.

INTRODUCTION

According to Central Bureau of Statistics (2011), the population of cattle in Indonesia reaches 14.8 million. However, Indonesia still has a shortage about 25% to fulfill beef consumption at 3.2 kg/capita/year. According to Directorate General of Livestock (2010), only 20.4% of local cows does meet the need of national beef consumption while 30% of which is imported from foreign countries.

Aceh province is one of the priority areas that serves as cattle contributor in the supply of beef. In a region with a population of 4.2 million people, the cattle population reaches 586.127 cows, with the level of demand up to 35.67%/year. However, the percentage of livestock growth has recently decreased about 1.25%. Therefore, Aceh government needs to find solutions by importing cattle or beef from foreign countries in order to meet the region's needs.

The total number of cattle owned by farmers in Indonesia is relatively large. If it is empowered properly, it can be a national force which contributes directly to Beef Self-Sufficiency Program as a national program in 2014 (Research and Development Center of Livestock, 2010).

As the number of human population keeps growing and the community's awareness of nutrient' is increasing, the national need for beef is getting higher as well. One way to overcome this problem is by increasing the supply of cattle to be fattened for thus to be slughtered in order to meet consumers' demand. This can merely be done through increasing the efficiency of cattle reproduction so that any productive female cattle can deliver at least one calf in one year.

Siregar (2010) stated that the attempts to develop local cattle can be done through the implementation of reproductive technologies namely Artificial Insemination (AI) and Embryo Transfer (ET). The applications of these technologies require information concerning on the reproductive cycle in cattle. The key to the success in implementating AI and ET is the accuracy in detecting female cows' estrus. This can be done through estrus synchronization to get simultaneous estrus that will save a lot of time and cost.

Artificial insemination (AI) is an artificial way of placing males' semen in females' reproductive organ. The semen can be in the form of frozen semen or fresh semen. (Inounu, 2014).

There are several methods in performing AI. One of them is by diluting a single male cow's semen for many females. Another one is by performing cross-breeding with males from areas which have different climate, as well as for cryopreservation (Thomassen & Farstad, 2009). Each method has different level of success because its applications have different level of difficulty.

Several major factors that play crucial roles in the success of Artificial Insemination (AI) are the quality of frozen semen, the state of females as AI acceptors, the accuracy of AI and the skill of inseminator.

Similarly, it is very important to be aware of the feed intake as it has profound effect on the weight of cattle. Despite of high genetic potential, high percentage in cattle production will not be achieved if the feeding does not meet the nutritional requirements in both quantity and quality. According to Bamualim (2011), the strategy for the success in cattle business requires appropriate technology, the empowerment of the management, and the aspect of breeding cattle. However, the most important factor in improving cattle weight gain realistically is by providing feed intake which is consistent both in quantity and quality. Furthermore, the problem of feed insufficiency due to limited land must be solved together in order to get a solution (Murgueitioa *et al*., 2011; Janzen, 2011; Ukanwoko and Igwe, 2012).

Giving fodder to cattle often leads them to consume more (Sari, 2010). This is due to the level of their palatability; the more frequent fodder is given, the higher cattle palatability gets as they prefer new and fresh forage instead of dry and old one.

Beside feed improvement, estrus synchronization and artificial insemination are also performed to improve the productivity of female cattle. Estrus synchronization aims to manipulate the estrus cycle in order to generate simultaneous estrus and ovulation thus improving the efficiency in the use of artificial insemination (AI) as well as to obtain an increase in pregnancy rate and in the birth of the calf.

MATERIALS AND METHODS

This study was conducted from February to December 2013 in Bireuen on Paya Sakti Livestock Group which preserved productive female cattle. This group consisted of 20 people with a total cattle population of 58.

Materials used in this study were rice straw, natural grass, elephant grass, Gliricidia, rice bran, coconut cake, sago, mineral blocks, herbs, Reprodine hormones and frozen semen.

Nine productive female cows at the ages of 2 to 2.5 years old were used as samples. The design used a Randomized Block Design (RBD) with 3 treatments and 3 replications as follows;

P = Sync + AI + natural grass + elephant grass;

J = Sync + AI + 50% rice straw + 15% Gliricidia + 35% (natural grass + elephant grass) + concentrate + mineral blocks;

S = Sync + AI + 40% rice straw + 20% Gliricidia + 40% (natural grass + elephant grass) + concentrate + mineral blocks.

The measured variables were the percentage of estrus, the percentage of pregnancy, the weight of the females during pregnancy, feed intake and feed conversion.

Estrus percentage was calculated by using the following formula:

% Estrus Response = (Number of cows in estrus/ Number of tested cows) X100 %

The collected data was analyzed by analysis of variance followed by Duncan's multiple range test (Steel and Torrie, 1993).

RESULT AND DISCUSSION

Identification of Location for the Study

Keude Dua July is one of the villages located in July subdistrict, Bireuen district, with an area of 207 hectares and distance of 3.5 Km to the capital of subdistrict and 5.5 Km to the capital of district. It is accessible because of the availability of transportation and communication system. This village

shares land borders with Meunasah Teungoh, Blang Keutumb, Bate Raya, Peuraden and Seunebok Gunci.

Artificial Insemination (AI)

Adult females which are ready to breed naturally or artificially must be at the age of 32 months old because it is the appropriate age to conduct the inclusion. After they start showing estrus signs, they will be ready for the insemination. The most important factor in performing AI is female fertility. Generally, female fertility occurs at the time of ovulation, which is 18 hours after estrus signs. Ovulation usually takes place after the end of estrus period which is indicated by continous and thick cervical mucus from the vulva of the females. The right time to do the insemination process is usually 8 to 9 hours after estrus because the cervix starts to widely open.

The artificial insemination in Paya Sakti Group was done to avoid the females in the state of estrus again. In this case, all the inseminated females were observed and not released into the group in order to keep them to not be in estrus again which might cause cervical mucus along with injected spermatozoa to come out again. The insemination can be done after 9 to 18 hours after the signs of estrus but it will probably experience a little difficulty because the cervix begins to close. After 18 hours, it will completely be closed which makes the gun impenetrable.

The calculation of S/C is the ratio of the amount of straw used for AI with the total number of the inseminated females that become pregnant. In this study, the pregnancy pecentage of cows being kept intensively in a pen reached 100%. AI is usually conducted by the inseminator at different times from day to night which causes estrus to rise at different times as well but still in the same day. The success of AI for cattle which are kept in a pen all day long may reach above 80% because the observation of estrus can be controlled entirely from day to night, whereas the success of AI for those kept in a pen only at night (individual maintenance) only reaches 32%. This is due to the inaccurate estrus detection because it cannot be controlled completely which makes the implementation of AI is not timely.

In this study, the inseminator performing AI was from the nearest Paya Sakti village, and the straw used was from the Livestock Department of Aceh province with Bali-cow type. AI was done in 2 stages. The first stage was done after 9 hours of estrus as a result of PGF2α hormonal injection and the second was 11 days later after the injection of PGF2α.

Percentage of Estrus

Estrus synchronization is an attempt to make a herd of female cattle be in the state of estrus simultaneously, which is by manipulating the processes of reproduction. It has several advantages as follows:

1. Saving a lot of time as cattle are in the state of estrus in the predetermined scheduled.
2. Providing convenient time to conduct artificial insemination, especially on a herd of cattle by treating them in groups, in relation to the current procedure at the time of ovulation in order to carry out insemination based on a predetermined schedule.
3. Allowing farmers to feed cattle in a homogenous group, especially when it involves the changes in the consumed ration adjusting to the phases of females' pregnancy.
4. As a continuation of the simultaneous breeding.
5. Limiting the overall period of births on a herd of cattle.
6. Enabling birth control with the aim of reducing the mortality of newborn and care arrangements of the calf on the other parents.
7. Allowing to perform weaning, fattening, marketing cattle and facilitating the use of embryo transfer after mating control is successfully carried out.

The application of PGF2α intramuscularly must be carried out directly in the field with a dose of 2 ml/cow to the target organ CL. This is applied to the whole group of cattle so that they will be in the state of estrus simultaneously. After PGF2α hormonal injection, in one or three days, the injected females will show the signs of estrus such as acting nervous, trying to climb the other cows, raising tails, kissing the back of the other cows, red swollen vulva, producing cervical mucus, approaching the males, being passive when climbed up by males and having a decrease in appetite. Estrus synchronization on two ruminants with different size of body (scale 1-5) showed different results which confirms that small and thin females have lower response than those with medium body size (Vatankhah *et al*., 2012)

The highest percentage of AI success is obtained in 6-9 hours after the rise of estrus. Estrus observation accuracy will determine the insemination time accuracy. This was proven in this study that the percentage of estrus response 3 days later after estrus synchronization were different (see Table 1).

The results of hormonal injections (PGF2α) on the first day of all 9 cows were visible in the treatment of J (Sync + AI + 50% rice straw + 15% Gliricidia + 35% (natural turf grass + elephant grass) + concentrate + mineral blocks). The first injection caused estrus to rise up to 100% while in the treatment of P and S, the rise was only 33.33%. However, the second injection on day 12 of the treatment P and S increased the percentage up to 66.67%.

Table 1. The percentage of productive females after the first and second PGF2α injections

Treatments	Number of Females	Females in Estrus			
		First Injection		Second Injection	
		Number of Females	Percentage (%)	Number of Females	Percentage (%)
J	3	3	100	0	0
P	3	1	33,33	2	66,67
S	3	1	33,33	2	66,67

Note: J = Sync + AI + 50% rice straw + 15% Gliricidia + 35% (natural grass+elephant grass) + concentrate + mineral blocks, P = Sync + AI + natural grass, S = Sync + AI + 40% rice straw + 20% Gliricidia + 40% (natural grass + elephant grass) + concentrate + mineral blocks

On the first PGF2α injection, the females which were initially not in the state of estrus were in the follicular phase where follicle developed by the rise in estrogen. On the second PGF2α injection, all cattle (100%) showed the signs of estrus in two days after injection. This was due to all females were in the luteal phase where the corpus luteum began to function. The second injection was repeated at the interval of 11 days after the first one with the expectation that all the cows would be in the same phase.

Percentage of Gestation

Pregnancy detection was carried out by rectal palpation at the age of 2 months old after AI and by looking at the profile of progesterone from the blood plasma. When the concentration was above 2 nmol/mL the females was suspected to be pregnant. Table 2 shows that the pregnancy rate in J treatment (Sync + AI + 50% rice straw + 15% Gliricidia + 35% (natural grass + elephant grass) + concentrate + mineral blocks), P (Sync + AI + natural grass + elephant grass) and S (Sync + AI + 40% rice straw + 20% Gliricidia + 40% (natural grass + elephant grass) + concentrate + mineral blocks) resulted in 100% of pregnancy rate. This percentage indicated a very good result despite the synchronization was conducted up to twice.

Table 2. The pregnancy rate of productive female cattle in aceh after artifical insemination

Treatments	Number of females	Artificial Insemination	
		Pregnant females	Percentage (%)
J	3	3	100
P	3	3	100
S	3	3	100

According to Sujono (2011), the success of conception rates in cattle PO reaches 50% from all parents that receive artificial insemination. High pregnancy rate is expected to result in one time of mating process. Based on a study result conducted by IHSAN (2011), the pregnancy rate of beef cattle can reach up to 64%. This is likely due to local beef cattle are originally from Indonesia so they do not have difficulties in adapting with the environment. In addition, they also have a good ability in digesting poor quality feed but still have higher fertility rate.

Based on the study of all these treatments, the result gave pregnancy rate at 100%. This is due the fact that to Bali's cattle are native from Indonesia which make the achievement of fertilization and the endurance of cows' embryo excellent. Besides, they are well-adapted to the climate of Indonesia which result in high pregnancy rate. The low pregnancy rate is not caused by the inseminator nor

semen used when doing AI. The inseminator with good skill and the used semen have 70% of motility which is caused by the predetermined scheduled of AI.

The schedule of AI can also cause low pregnancy rate due to different responses of females after treatments. Estrus which rises at different times will result in different ovulation times as well. This may be caused by the implementation of AI carried out not at climax point of estrus which then results in low pregnancy rate.

Weight of Females during Gestation

Reproductive performance will be more apparent in females which are in good condition. Therefore, a proper additional and economical feeding will be required to improve the reproductive performance of the females. The highest pregnancy rate according to USG at day 30 of gestation (Hafizuddin *et al*., 2011) was 100% obtained from five small inseminated ruminants.

Table 3. Weight gain rates in local female cattle during the study

Treatments	Groups			Total	Rates
	1	2	3		
P	10.50	10.38	9.88	30.75	10.25[a]
J	11.43	12.28	12.95	36.65	12.22[b]
S	11.65	11.58	10.95	34.18	11.39[ab]
Total	33.58	34.23	33.78	101.58	

Note: The result of the study shows that the treatment of P and J are significantly different (P> 0.05)

In the treatment of J and S, it showed a very significant difference (P <0.05). The difference in daily weight gain of females may be caused by the differences in feed quality. In the treatment of J, the weight gain reached 12.22 kg per month. Viewed from the feed aspect, the treatment of J contained additional provision of concentrate as much as 1 kg/cow/day as well as additional Gliricidia leaves which resulted in weight gain up to 350- 450 grams. This study shows that an increase in body weight is largely determined by additional Gliricidia leaves (*Gliricidia sepium*) with rice straw as basic feed. Gliricidia is one of legumes containing higher nutritional value than natural grass as crude protein content within it reaches 25.2% (Puger, 2008)

Feed consumption

At the beginning of the study, all females were given helmintic to make them sterile from worms, so the growth that occured later was due to the treatments. The average consumption of feed during the study for J treatment (Sync + AI + 50% rice straw + 15% Gliricidia + 35% (natural grass + elephant grass) + concentrate + mineral blocks) was 28.23 kg/cow/day, S treatment (Sync + AI + 40% rice straw + 20% Gliricidia + 40% (natural grass + elephant grass) + concentrate + mineral blocks) was 27.08 kg/cow/day, and P treatment (Sync + AI + natural grass + elephant grass) was 25.60 kg /cow/day.

Statistically, there was a significant difference (P<0.05) between J and P treatment where feed consumption in P treatment (Sync + AI + natural grass + elephant grass) was very low. Nevertheless, as the local cattle have adapted well to natural feed, they were still able to digest it optimally even in a poor condition. Meanwhile, J treatment (2.5 kg of natural grass + 2.5 kg of elephant grass + 9 kg of rice straw + 1.5 kg of Gliricidia + 1 kg Concentrate) and S treatment (1.5 kg of natural grass + 6 kg elephant grass + 4.5 kg of rice straw + 3 kg of Gliricidia) had greatly affected the palatability of cattle because the more complete the formulated feed the better the quality of the feed which thus resulting in positive effect on the cattle weight gain.

The result of the study on J treatment (Sync + AI + 50% rice straw + 15% Gliricidia + 35% (Natural Grass + Elephant Grass) + Concentrate + Mineral blocks) showed that there was an increase in feed consumption due to the addition in Gliricidia and concentrate with high digestibility which further could be utilized optimally by cattle for the metabolism of the body, reproduction, and production. It was also found that the increase in consumption level may be due to good digestibility of the straw. In overall treatments, there was a decline in consumption power because the appetite of synchronized cattle feed had reduced.

Table 4. The average feed consumption of cattle during the study (kg/cow/day).

Treatments	Groups			Total	Rates
	1	2	3		
P	24.60	26.08	26.13	76.80	25.60[a]
J	28.85	27.78	28.05	84.68	28.23[b]
S	26.20	27.33	27.73	81.25	27.08[ab]
Total	79.65	81.18	81.90	242.72	

Note: The result of the study shows that P and J treatments are significantly different (P>0.05)

Feed conversion

Feed conversion is a ratio of the amount of feed consumption with the weight gain during a specific time or during the study. The higher the value of feed conversion, the more feed needed to raise the weight. In this study, an average conversion was 28.09 kg for P treatment, 34.83 kg for J treatment and 31.91 kg for S treatment.

Statistically, there was a significant difference (P<0.01) of feed conversion among P, J, and S treatments. From the result of the study, the best feed conversion was found in P treatment which had low conversion value. The conversion itself means consumed ration is divided by weight gain in the same period.

Table 5**.** Feed conversion rate of local females in Aceh/day in 4 months

Treatments	Groups			Total	Rates
	1	2	3		
P	28.53	28.76	26.99	84.28	28.09[a]
J	33.35	34.54	36.60	104.49	34.83[b]
S	32.39	32.42	30.93	95.74	31.91[b]
Total	94.27	95.72	94.52	284.51	

Note : The result of the study shows that P treatment is significantly different from J and S treatments (P<0,01)

From the Table 5, it can be concluded that feed conversion in P treatment (Sync + AI + natural grass + elephant grass) was low compared to J treatment (Sync + AI + 50% rice straw + 15% Gliricidia + 35% (natural grass + elephant grass) + concentrate + mineral blocks) and S treatment (Sync + AI + 40% rice straw + 20% Gliricidia + 40% (natural grass + elephant grass) + concentrate + mineral blocks). Low feed conversion can reduce production costs. Nonetheless, if it is associated with increasing weight loss in P treatment (Sync + AI + natural grass + elephant grass), it can be concluded that the consumed feed did not meet the nutritional requirement of the cattle.

CONCLUSION

It can be concluded that estrus synchronization technique using prostaglandin hormone in the submucosa of the vulva may cause cattle to be in the state of estrus with the pregnancy rate reaches 100% after having artificial insemination with frozen semen.

Feed improvement prior to the implementation of AI resulted in high pregnancy rate while giving local feed during pregnancy resulted in high percentage of weight gain.

The injection of prostaglandin hormone by 2 ml with the interval of 11 days from the first injection resulted in better estrus responses than prostaglandin hormone injected only one time.

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