Original Article

Improvement of dairy cattle reproductive efficiency in Indonesia

Hozumi Tanaka[a*], Elizabeth Sanjaya[b], Tuty Sudartafi[c], Ida Royani[c], Herliantien[d], Enniek Herwiyanti[d], Oloan Parlindungan[d]

Abstract

The objective of this study was to propose the method to improve the reproductive efficiency of dairy cattle in a tropical region as the developing countries. The reproductive states of cattle were investigated in the dairy farms of East Java Island. They were examined genital organs by rectum palpation and the body condition scores at routine medical checkup, and were treated by four means. The pregnant cattle was needed that the duration of the cows' non-pregnant condition was 6.5±3.5 (means±SD) months after last parturition, and the conceived age of the heifers was 25.8±9.8 months. The body condition scores of the pregnant cattle were 2.0 or more. Over 82.7% of the non-pregnant cattle were found to be undernourished and in abnormal estrus. When the body condition score of less than 2.0 and non-pregnant cattle was increased by giving them only two kilograms of concentrated feed per day, 93.3% induction rate of estrus and a 73.3% conception rate were observed. In cattle with the body condition scores of more than 2.0, the means of iodine flushing, double PGF2α, and the synchronization of ovulation (OVSYNCH) result in significantly higher conception rates (59.4, 71.4, 64.2%, respectively) than in the control group (35%). These results demonstrate that the improvement of the body condition scores for undernourished cattle and iodine flushing lead them to the reproductive efficiecy of dairy cattle in a tropical region as the developing countries.

(Key words : induction of estrus, conception rate, body condition score, improvement of the body condition scores, iodine flushing)

Introduction

Genetic improvements in dairy cows have resulted in a markedly increased milk yield over the last three decades. This increased production has, however, been associated with a reduction in conception rates around the world[1,2]. Dairy farms need to maintain high conception

a Center for Experimental Medicine, Jichi Medical University, 3311-1 Yakushiji, Shimotuke-shi, Tochigi, 329-0498, Japan.
b KOP SAE Pujon, Jl Raya 11, Pujon, East Java, Indonesia.
c KAN Jabung, Jl Suropati 4-6, Ds. Kemantren-Jabung, East Java, Indonesia.
d Singosari Artificial Insemination Center, Kotak Pos 8, Singosari, East Java, Indonesia.
* Corresponding author. Present address : Center for Experimental Medicine, Jichi Medical University, 3311-1 Yakushiji, Shimotuke-shi, Tochigi, 329-0498, Japan.
Tel. : +81-285-58-7061 ; fax:+81-285-44-1069
E-mail address : htanaka@jichi.ac.jp (H. Tanaka)

rates for the continuation of high milk production, so it needs consideration that recent conception rates have been reported at less than 50% in USA, Japan and Europe[3,4]. It is reported that the reduction of conception rate has been caused by the decrease of heat-detection rate and anestrus[4]. In non-seasonal, year-round calving dairy herds, once a year calving is generally accepted as optimal to derive maximum economic benefit[5,6]. Thus, the synchronization of estrus and ovulation has been extensively used to improve the efficiency of estrus exhibition and the overall conception rate in the developed countries[7-13].

The body condition score (BCS) is a subjective measure of nutritional condition and supplied feed satisfaction[14,15]. The female BCS has been related to certain reproductive parameters such as the postpartum return to estrus, services per conception, conception rate, and calving interval[16-20]. The BCS is a numerical index representing the nutritive condition of dairy cattle set on a scale from 1 to 5 with 0.25 increments[17,21].

In Indonesia, dairy cattle are reared about 97% in Java Island highlands at altitudes from 200 to 1,500 m above sea level and atmospheric temperature from 15 to 31℃[22]. The scale of the dairy farms is small and the average farmer has about 3 heads of cattle.

Many dairy farmers own less than half a hectare of land, and they obtain most of their rough feed from riverside and the roadside locations during the two predominant (dry and rainy) tropical seasons. In the tropical climate, tropical plants as the roughages grow slowly in the dry season and the silage has not been produced for the storage in the rainy season.

The Indonesian dairy farms are still confronted with many problems. Wild roughage is the primary source of rough feed in the two tropical seasons here. Indonesian dairy cattle were given insufficient amounts of concentration feed and a large quantity of low quality roughage (30-50 kg). As most concentrated feeds cost up to half the selling price of milk in Indonesia, the main component (70-80%) is rice bran and the ratio of urea is high. This is a matter of farmer preference and needs further consideration. However, it is likely that Indonesia dairy cattle have adapted to their circumstances and maintain an energy balance with a low milk yield. In 2000, the average milk production was 10.7±2.28 (Mean±standard deviation; range 7.9 to 14.2) kg per day in the 15 Dairy Farm's Cooperative Union (DFCU). The peak lactation of most cows in Indonesia was between 10 to 20 kg per day, but generally remained flat (at about 10 kg per day with no peaks) in the 15 DFCU (total lactating cows : 59,375)[22].

This situation indicates that dairy farming is managed under the most severe conditions in terms of using roughage, restricting farmers to low breeding rates. As they have confronted with numerous reproductive difficulties too, they have obtained an unstable profit from milk production and calf yield.

As the typical dairy farming of a tropical region has carried out the highlands, it is possible that data obtained in this study in Indonesia may represent dairy farms in tropical region of the developing countries.

The objective of this study was to propose the method to improve the reproductive efficiency of dairy cattle in a tropical region as the developing countries. We began with the BCS data as a basis for the clinical diagnosis of reproductive conditions among Indonesian dairy cattle. The reproductive states of the dairy cattle were investigated in East Java Island. Subsequently,

treatments were compared to improve reproductive efficiency for the cattle of reproductive difficulties in the field.

Materials and Methods

Three districts (designated as A, B and C) are located in the Java Island highlands at altitudes of 800, 900, and 600 m above sea level, with average temperatures of 23, 20, and 26℃, respectively. As these districts are participants in the Dairy Progeny Testing Program, implemented since 1986 with the cooperation of the government of Indonesia and the Japan International Cooperation Agency (JICA), bulls that had been previously tested were chosen for the study, as the resulting Holstein cattle were expected to have improved genetic merit[22]. The milk yield per one year had increased from a mean of 2,600 L/cow (in 1993) to 3,300 L/cow (in 2000) in Indonesia by this program. The climate is typical of tropical regions, rainy from October to March, and dry from April to September. The number of Holstein cattle bred in districts A, B, and C were 16,600, 13,000, and 1,900, respectively. We visited the districts, and the study was conducted with the guidance of the livestock technicians and veterinarians of each district's DFCU and the specialist of JICA. This study was carried out as a joint undertaking with these organizations.

As district B was high percentage of undernourished cattle among three districts, it may be that the by-product of agricultural products as cattle's feed is the difference in the three districts. District A, B and C were fruit culture district, the producing district of highlands vegetables and sugar cane, respectively.

In Experiment 1, we evaluated the BCS distribution of the pregnant cattle for one month. In Experiment 2, we evaluated the reproductive conditions and the BCS distribution of the identified non-pregnant cattle for two months. In experiment 3, four treatments were compared to improve reproductive efficiency on the defined non-pregnant cattle over the course of six months in the field.

Experiment 1

At forty days after artificial insemination (AI), 282 cattle were diagnosed as pregnant by rectum palpation. Furthermore, the BCS distribution and the reproductive histories of these cattle were then determined.

Experiment 2

The non-pregnant cattle chosen for this study included cows which had been non-pregnant for a voluntary waiting period (VWP) of two months post partum[6] and heifers that were non-pregnant for over fifteen months. The 220 selected non-pregnant cattle were divided into two groups, above and below the BCS of 2.0. Furthermore, the condition of the genital organs of all cattle in this study was examined twice by means of rectum palpation over a two-week interval. The conditions were classified as confirming that ovarian dysfunction did not existed in the functional corpus luteum (FCL) or antral follicle (AF), or that abnormal estrus existed in FCL and AF, and the signs of estrus were unclear or nothing[23].

Experiment 3

The identified non-pregnant cattle were examined by rectum palpation, and selectively

removed from the study if the existence of ovarian cysts, endometritis, or pregnancy was detected. The cattle were then divided into two groups at their BCS. The first (undernourished) group, with a BCS score of less than 2.0, was targeted for the BCS improvement. The second group, with scores between 2.0 and 3.5, was further divided into 3 groups. When estrus was induced in the cattle of all groups, AI was then performed. After 40 days of AI, pregnancy was diagnosed by palpation of the uterus per rectum. For this study, only cattle with a clear reproductive history (last parturition date, times and date of AI) were used. Cattle that had been sold or could not be subsequently observed were omitted from the data set. As the conception rate of the control group, we used the conception rate (35.0% : 260/742 heads) without the data of experiment 3 at routine medical checkup performed by the staffs of those three districts during the same time period.

The first group was given an additional two kilograms of concentrated feed per day for induction of estrus by way of an improvement in BCS. As vermicide had been administered by each DFCU periodically, parasitic diseases were removed from the possible causes of undernourishment. When estrus was introduced within one month and AI was successfully performed, this method was judged to be effective.

The second group was treated with prostaglandin (PG) F2α, the synchronization of ovulation (OVSYNCH) and iodine flushing. The cattle selected for these treatments were chosen randomly, with the exception of cattle with regular estrus cycles.

Experimental design

(a) Double PGF2α injection

PGF2α injections consisted of 25 mg of Dinoprost Trometamol (Lutalyse : Pharmacia & Upjohn, USA) per dose. The cattle were treated twice with PGF2α at an interval of 14 days. When estrus was induced within one week after the last treatment and AI was successfully performed, this method was judged to be effective.

(b) OVSYNCH

Treatment protocols are shown in Figure 1. PGF2α treatments consisted of 25 mg of Dinoprost Trometamol per one dose. Gonadotropin-releasing hormone (GnRH) was administered in dosages of 100μg (Cystorelin : Rhone Merieux Inc., Athens, GA. USA 30601). Cattle received GnRH i.m. on Day 0 (start of the protocol), followed by PGF2α i.m. on Day 7 and GnRH i.m. on Day 9. Timed-AI was performed on Day 10, 16-20 hours after the second GnRH treatment.

All cattle were performed AI between 16 and 20 hours after GnRH treatment.

(c) Iodine flushing

For the treatment, 10 to 50 ml of povidone iodine (2%) (Iodine povidone 2% : Kimia Farm, Surabaya, Indonesia) was flushed into the uterus of the cattle. When estrus was induced within 3 weeks and AI was successfully implemented in the cattle, this method was judged to be effective.

GnRH		PGF2α	GnRH	AI
↓		↓ 30~36h	↓ 16~20h	↓
Day 0		Day 7	Day 9	Day 10

Fig. 1 Protocol of hormonal treatments for OVSYNCH

Statistical analysis

Data were analyzed using Chi-square (Table1, 2 and 4) and one-way ANOVA with Fisher PLSD (Table 3).

Result

Experiment 1

The results are presented in Table 1. One hundred and ten pregnant cattle were diagnosed as pregnant from three districts among 282 cattle test for pregnancy after AI (conception rate : 39%). The BCS of the pregnant cattle were measured to be at least 2.0, with 87% of the scores ranging from 2.0 to 2.75. The average BCS was 2.3±0.27 (means±SD). The duration of non-pregnancy was 6.5±3.50 (means±SD) months in cows and the conceived moon's age of the heifers was 25.8±9.80 (means±SD) months. No significant differences were observed between the three districts studied.

Experiment 2

The distribution of the non-pregnant cattle on reproductive failure in the three districts is shown in Table 2. The cattle with BCS of less than 2.0 comprised 26.8% of all cattle, almost all of which were diagnosed as ovarian dysfunction without FCL and AF. District B had a significantly higher percentage of undernourished cattle than district A ($p<0.05$). In the cattle

Table 1 The distribution of BCS on the pregnant cattle[a]

	BCS									
	<2.00	2.00	2.25	2.50	2.75	3.00	3.25	3.50	Total	BCS[b]
A	0	12	7	14	4	2	0	1	40	2.4±0.34
B	0	20	18	10	7	0	0	0	55	2.3±0.26
C	0	10	3	2	0	0	0	0	15	2.1±0.19
	0	42	28	26	11	2	0	1	110	2.3±0.27

a : The conception rate was 39% (110/282).

b : Values are mean±SD.

Table 2 The distribution of reproductive failurea on the non-pregnant cattle in three districts

	BCS<2.0	2.0≦BCS					
	O-dys (%)	O-dys (%)	Abn-E (%)	End. (%)	FC (%)	Ab (%)	Total
A	13(16.3)[b]	9(11.3)[d]	55(68.8)[f]	2(2.5)	1(1.3)	0	80
B	32(34.8)[c]	9(09.7)[d]	48(52.2)[f]	1(1.1)	1(1.1)	1(1.1)	92
C	14(29.2)	12(25.0)[e]	20(41.7)[g]	1(2.1)	0	1(2.1)	48
	59(26.8)	30(13.6)	123(55.9)	4(1.8)	2(0.9)	2(0.9)	220

a : O-sub is ovarian dysfunction. Abn-E- is abnormal estrus. End is endometritis. FC is follicular cyst. Ab is abortion.

b-c, d-e, f-g : Values with different superscripts are significantly different ($P<0.05$).

with higher BCS than 2.0, the incidence of abnormal estrus was the highest in all three districts. Ovarian dysfunction and abnormal estrus accounted for 95% (153/161) of the cattle with higher BCS than 2.0. District C had a significantly higher incidence of ovarian dysfunction and had a significantly lower incidence of abnormal estrus than the other districts ($p<0.05$).

Experiment3

The reproductive histories and the BCS of the identified non-pregnant cattle are shown in Table 3. The average of the BCS, post-parturition months (for cows) and AI times were 2.3±0.18, 6.7±0.99, and 2.0±1.51 (means±SD) respectively. Other than an improvement in the BCS, the duration of non-pregnancy and times of AI among the treatment groups did not change.

The examination results of the non-pregnant cattle are presented in Table 4. Iodine flushing resulted in a significantly lower rate of estrus induction than in the other two groups ($p<0.05$). Though the four treatment groups displayed a significantly higher conception rate than the control group (35% ; 260/742) ($p<0.05$), no significant differences were observed in the conception rates among the four treatment groups.

When fourteen cattle (93.3%) were performed AI in the improvement group of the BCS, they had raised two or more of BCS within one month and eleven cattle (73.3%) had become pregnant.

In the double PGF2α group, the rate of estrus induction was 66.7% (40/60) after the first

Table 3 Reproductive history and BCS on the cattle using experiment 3[a]

	No. of Cows	BCS	Post-parturition[b] (months)	Times of AI
Improv. of BCS[c]	15	1.8±0.23	4.2±1.07	0
S. & D. PGF2α[d]	60	2.6±0.34	6.1±2.94	1.6±1.69
OVSYNCH	30	2.5±0.35	8.2±4.38	2.9±1.97
Iodine flushing	57	2.4±0.36	8.4±3.05	3.3±1.73
	162	2.3±0.18	6.7±0.99	2.0±1.51

a : Values are mean±SD.
b : Months of post-parturition is only for cows.
c : Improvement of BCS.
d : Single and Double PGF2α.

Table 4 The effect of four treatments on the non-pregnant cattle

	No. of cattle	AI (%)		Conception (%)	
Control	742			260/742	(35.0)[c]
Improvement of BCS	15	14/15	(93.3)[a]	11/15	(73.3)[d]
Double PGF2α*	60	52/60	(86.7)[a]	25/35	(71.4)[d]
OVSYNCH	30	—		18/28	(64.2)[d]
Iodine flushing	57	27/41	(65.9)[b]	19/32	(59.4)[d]

* : Treatment of PGF2α was carried out at an interval of 14 days.
a-b, c-d : Values with different superscripts are significantly different ($P<0.05$, 0.01).

treatment and 86.7% (52/60) after the second treatment. In the iodine flushing group, the cattle with and without F-CL exhibited induced estrus at rates of 84.0% (21/25) and 37.5% (6/16), and conception rates of 75.0% (15/20) and 33.3% (4/12), respectively. Iodine flushing induced estrus at a rate of 65.9% (27/41) and resulted in a 59.4% (19/32) conception rate.

Discussion

The present result indicated that the BCS ≧ 2.0 was necessary for the cattle to get pregnant in tropical region of Indonesia. The resulting negative energy balance and rate of mobilization of body reserves appear to be related to the interval between postpartum and first ovulation, and to the lower conception rate. A past study indicated that a negative energy balance probably has a similar affect as undernourishment[24]. Lopez-Gatius et al.[19] reported that better pregnancy rate were obtained in cows in good condition (with scores higher than 3.5) at parturition and first AI in the developed countries. The pregnant cattle in tropical region as the developing countries have lower BCS (average ; 2.3±0.27), which may be related to the inadequate feed management and adaptation for the poor situation. All cattle with BCS of less than 2.0 were identified as having ovarian dysfunction. As the improvement group had raised two or more of BCS within one month and had the estrus, it is likely that the BCS of 2.0 may be a minimum value for normal reproductive activity in Indonesia as the developing countries. The conception rate, duration of non-pregnancy, and, conceived month's age of the heifer were 39%, 6.5±3.5 months and 25.8±9.8 months, respectively. To the best of our knowledge, this is the first report on the conception rate, duration of non-pregnancy of cows and conceived month's age of the heifer in the developing countries as Indonesia.

When the circumstances of reproductive failure among identified non-pregnant cattle were investigated in the three districts, there was a difference in the incidence of reproductive failure between the three districts. District C was high percentage of ovarian dysfunction and low percentage of abnormal estrus on the cattle with higher BCS than 2.0 among three districts. These results may have the cause-effect relationship that only district C was the newly-risen dairy farm district and the farmers had poor dairy farming skill. The present study has clarified concretely that Indonesian dairy farms are confronted with numerous reproductive difficulties.

In Experiment 3, the treatment subgroups targeted for BCS improvement, the administration of Double PGF2α group, the OVSYNCH group, and the iodine flushing group, displayed significantly higher conception rates than the control group. We confirmed that the treatment of cattle in abnormal estrus and undernourished cattle improved their reproductive efficiency. It seems reasonable to conclude that an improvement on the BCS was achieved in the undernourished cattle. The cattle with F-CL(+) in the subgroup of double PGF2α injections entered estrus at a rate of 66.7% (40/60) after the first injection of PGF2α. Our result was similar to previous reports[7,8,9]. We also obtained high conception rates by OVSYNCH, similar to some other earlier researchers[10-13]. Although iodine flushing showed lower induction rate of estrus than improvement of BCS and double PGF2α, there was no difference in the conception rate of the identified non-pregnant cattle among four methods. It had been reported that inflammatory changes in the endometrium transiently occurred with iodine flushing, and estrus was

induced after 6-11 days of intra-uterine infusion by the regression of the corpus luteum[25]. Iodine flushing has been one of the first choice treatments for reproductive failure in the veterinary clinic of Japan. Iodine flushing resulted in a low induced rate of estrus (37.5% ; 6/16) in the cattle without F-CL and became pregnant out of six induced estrus, and, a high induction rate of estrus (84.0% ; 21/25) in the cattle with F-CL. Furthermore, when cattle with regular estrus cycles that had been serviced at least three times were flushed with iodine one day after AI, the conception rate was 75.5% (12/16) (unpublished data). These results suggest that iodine flushing may promote pregnancy through a transient inflammatory change of the endometrium. It was confirmed that povidone iodine (2%) is effective in improving reproductive efficiency of developing countries. Iodine flushing is attainable at a reasonable price, whereas double PGF2 α and OVSYNCH are prohibitively expensive for developing countries.

As lactating cows are expected to increase their milk yield by bulls of genetic improvements in the world, dairy farming must continue considering the limited availability of feed and breeding management in developing countries. The key for dairy farm success is overcoming reproductive disorders and improving their feed management for highly productive cows. We recommend that the staff of most the DFCU, as well as the existing livestock technicians and veterinarians, be trained in the routine execution of enlightenment-diffusion-activity work on the strength of this examination in developing countries.

This study suggested that the improvement of BCS and the administration of iodine flushing, as well as the synchronization of estrus and ovulation improved the reproductive efficiency of Indonesian dairy cattle.

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インドネシアでの乳用牛の繁殖率向上の試み

田中　穂積[1)]　エリザベス・サンジャヤ[2)]　ツチィ・サダルタフィ[3)]
イダ・ロヤニ[3)]　ヘリアンティン[4)]　エニック・ヘルウィャンティ[4)]
オロワン・パルリンゾンガン[4)]

要　約

（目的）この研究の目的は，発展途上国の熱帯地域における乳用牛の繁殖効率を改善するための方法を提言することである。（方法）乳用牛の繁殖試験は，インドネシアのジャワ島東部で，定期的な生殖器の直腸検査とボディコンデションスコアー（BCS）を調べ，4治療法が実施された。（結果）経産牛は，空胎期間が6.5±3.5ヶ月，未経産牛の受胎月齢は25.8±9.8（means±SD）であった。妊娠牛はBCSが2.0以上で，非妊娠牛は82.7%が低栄養状態（<2.0）あるいは異常な発情を示した。低栄養状態の非妊娠牛に1日当り2 kgの濃厚飼料を追加給与すれば，93.3%で発情が誘起され，73.3%が受胎した。BCSが2.0以上の非妊娠牛では，イソジン子宮内注入法，2回のPGF2α投与，排卵同期化処置（OVSYNCH）を行った場合，対照群（35%）より有意な受胎率（各59.4，71.4，64.2%）が得られた。（結論）発展途上国の熱帯での酪農牛の繁殖効率の改善法に，低栄養状態牛へのBCSの改善と，BCS2.0以上の非妊娠牛へのイソジン子宮内注入法が効果的であることが示された。

1)　自治医科大学実験医学センター
2)　プジョン酪農組合，プジョン，東ジャワ州，インドネシア
3)　ジャブン農業組合，ジャブン，東ジャワ州，インドネシア
4)　国立シンゴサリ人工授精センター，シンゴサリ，東ジャワ州，インドネシア