Current Level of Reproductive Performances in Japanese Black Cows

Hiroshi Uchida*, Jin Kobayasi, Tatsushi Inoue, Keiichi Suzuki[1] and Takuro Oikawa[2]
Miyagi Agricultural College, Taihaku-ku, Sendai-shi 982-0215, Japan

ABSTRACT : A set of 313,169 reproduction records of Japanese Black cows calving between 1987 and 1996 were collected in nation widely Japan to investigate the current level of reproductive performances and the factors influencing the performances such as calving interval, first calving age, services per conception, calving difficulty, non-gestation period and gestation length. All the records of reproductive performances are outcome of artificial insemination. The means of first calving age, calving interval, non-gestation period and gestation length were 25.0 months, 389.9, 101.9 and 287.5 days, respectively. Services per conception were 1.41 and degree of calving difficulty was 1.07, which suggests most of the calving, did not need assistance. There were chronological tendencies that first calving age became younger while calving interval became longer. Differences in reproductive performance were found for seasons and calving numbers. Calving interval became shorter towards the fourth calving but became longer afterwards. The cows calving in May had the shortest calving interval followed by those in April and June and first calving age had a similar tendency. The cows with the standard body condition score showed more favourable reproductive performances compare with those with rather fatty or thin body condition scores. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 8 : 1098-1102)***

Key Words : Reproductive Performances, Effects on Performances, Japanese Black Cows

INTRODUCTION

Japanese Black, one of the four native beef cattle breeds called Wagyu is the largest breed among the four and kept widely in Japan. Only this breed can produce the delicately sweet, mouth-wateringly tender, Kobe beef for which Japan is famous (Longworth, 1983).

The circumstances of Japanese domestic beef production, distribution and consumption have greatly changed because of increased beef import and beef consumption since the liberalisation of beef import has taken place in April 1991. The liberalisation has challenged the Japanese beef producers, particularly, breeding farmers of Japanese Black which produce premium quality beef, to improve reproductive efficiency, to retrench the production costs and to have better management overall. Since those farmers commonly aim at an annual calving for cow, reproductive ability of breeding cattle is one of the most critical traits to achieve this target. While reproductive ability is basically attributed to endocrinal function for individual animal, reproductive performances of breeding farms vary mainly by environmental effects such as differences in climate, farm location, nutritional management and timing of insemination etc. Although several reports on reproductive performances of Japanese Black cows have been published, most of them dealt with records kept at certain experimental stations operated by the government (Okano et al., 1984; Okano, 1994) or records collected within limited areas (Moriya et al., 1991), in fact, there are very few reports available on the subject of a nation wide and current basis. Since substantial influence on reproductive performances was caused by environmental factors on a farm, investigations should be focused on environmental factors influencing reproductive performances.

The present study aims to investigate the current level of reproductive performances of Japanese Black cows and the effects of calving year and month, calving number and body condition of cows on reproductive performances.

MATERIALS AND METHODS

A set of 313,169 reproduction records of Japanese Black cows calving between 1987 and 1996, which were collected in the Production, Management and Technical Improvement Project of Beef Cattle undertaken by the Japan Livestock Industry Association, was used for analyses for calving interval, first calving age, services per conception, calving difficulty, non-gestation period and gestation length. The calving difficulty was classified into three degrees of 1, 2 and 3 representing not assisted, slightly assisted and heavily assisted, respectively. A length of gestation was defined as subtracting a non-gestation period in day from calving interval in days. Data exceeding more than three times of the standard deviations were considered to be outliers and excluded from the analyses. All the records of reproductive performances are outcome of artificial insemination. Most of farms joining the project operate in comparatively larger scale. Statistical models used in this analyses consisted of effects of prefecture, calving number, calving month and

* Address reprint request to Hiroshi Uchida. Tel: +81-22-245-2211, Fax: +81-22-245-1534, E-mail: uchida@miyanou.ac.jp
[1] Miyagi Prefectural Animal Industry Experimental Station, Iwadeyama-cho, Miyagi-ken 989-6445, Japan.
[2] Faculty of Agriculture, Okayama University, Okayama-shi 700-8530, Japan.
Received January 22, 2002; Accepted April 11, 2002

calving year, whereas calving number was not included for first calving age. In addition to the reproductive traits, an assessment was also undertaken for body condition score, which was classified into three degrees of 1, 2 and 3 representing respective rather fatty, standard and rather thin, on reproductive performances. Analyses of variance were carried out to investigate the effects on reproductive traits using GLM procedure of Statistical Analysis System (SAS, 1994) and the Fisher's least significant difference test (Steel and Torrie, 1980) was applied to the comparisons of the effect means except for calving difficulty. Chi-square test was carried out to investigate the effects of calving number on calving difficulty using CATMOD procedure of SAS (SAS, 1994). A statistical model for an analysis variance was as follows;

$$Y_{ijklmn}=\mu+L_i+M_j+N_k+O_l+P_m+e_{ijklmn}$$

where, Y_{ijklmn}=the n^{th} observation in the $ijklm^{th}$ subgryoup, μ=an overall mean, L_i=the effect of i^{th} urban and rural prefectures, M_j=the effect of j^{th} calving number, N_k=the effect of k^{th} calving month, O_l=the effect of l^{th} calving year, P_m=the effect of m^{th} body condition and e_{ijklmn}=random residual effects.

The model included the only effects which were found to be significant by analysis of variance.

RESULTS AND DISCUSSION

Basic statistics of reproductive performances

Table 1 shows the basic statistics of the data used in the present study. Mean first calving age was 24.98 months old which was 5 months younger than the age (30.36months) reported by Okano et al. (1984) and Okano (1994). Okano et al. (1984) studied reproductive performances of Japanese Black cows in the Chugoku Agricultural Experimental Station from 1938 through 1982 and reported that calving interval and non-gestation period were 417.5 and 125.5 days while the results of the present study were 389.9 and 101.9 days and these are 28.2 and 23.8 days shorter than the report, respectively. Based on the records of farms in Miyazaki prefecture, Moriya et al. (1991) reported those as 400.9 and 118.8 days, which are more than 10 days longer than the results found in the present study while they found gestation length almost the same (287.8 vs 287.5 days). Uchida, one of the authors, found that calving interval of Japanese Black cows was shorter in the farmers keeping larger numbers of cows (unpublished). Most of farms involved in the analysis kept cows at comparatively larger scales. In addition to this, data exceeding more than three times of the standard deviations were excluded from the analyses as described in the section of materials and methods. These are considered to be the main reasons for the average calving interval found in this study is shorter than those in other reports (Moriya, 1991; Okano et al., 1984). The gestation length at calving male (number of animals, mean±standard deviation; 125,269, 287.7±4.8 days) is significantly longer than female (111,596, 287.2±4.8 days) in Japanese Black cows as well as the common description (Iritani et al., 1987). Okano et al. (1984) also reported services per conception as 2.3 whereas 1.41 in the present study. Degree of calving difficulty was 1.069 and this indicates most of the calving did not need assistance if at all.

Table 2 indicates that 38.8% of cows had their first calving at less than 23.9 months of age. Similarly, table 3 shows that 42.6% of calving intervals were under 365 days and the rest failed to achieve 'calving every year'.

The results of the present study on Japanese Black cattle showed much shorter calving interval and much earlier age at first calving in comparison with those of native breeds and their cross bred in Malaysia (Japri et al., 1997), Sri Lanka (Ibranhim and Jyatileka, 2000) and Bangladesh (Islam et al., 2000).

Effects of calving year, calving month and calving number on reproductive performances

Changes with year in first calving age and calving interval : Table 4 shows changes with year in reproductive performances. First calving age was 25.76 months old in 1987 but this became a month younger, 24.98 months old in 1991 and stayed on afterwards with occasional slight increases. These results suggest that the mean age at the first mating in Japanese Black cows would have been between 14 and 15 months old since gestation periods ranged between 280 and 290 days. Contrary to this, calving

Table 1. Basic statistics of reproductive performances in Japanese Black cows

Trait (unit)	N	Mean	SD	Minimum	Maximum
First calving age (months)	36,204	24.98	2.47	16.6	33.8
Calving interval (days)	255,377	389.9	57.4	286	604
Non-gestation period (days)	236,865	101.9	57.5	21	319
Gestation length (days)	236,865	287.5	4.8	267	297
Services per conception	235,382	1.41	0.82	1	10
Calving difficulty (classes)*	271,958	1.069	0.263	1	3

N: Number of records, SD: Standard deviation, * 1: Not assisted, 2: Slightly assisted, 3: Seriously assisted.

Table 2. Distribution of first calving age in Japanese Black cows

First calving age (month)	Number of records	Rate (%)
16.6-20.9	421	1.2
21.0-21.9	1,516	4.2
22.0-22.9	4,427	12.2
23.0-23.9	7,672	21.2
24.0-24.9	7,310	20.2
25.0-25.9	5,070	14.0
26.0-26.9	3,434	9.5
27.0-27.9	2,104	5.8
28.0-28.9	1,405	3.9
29.0-29.9	951	2.6
30.0-30.9	641	1.8
31.0-31.9	516	1.4
32.0-32.9	392	1.1
33.0-33.8	345	0.9

Table 3. Distribution of calving interval in Japanese Black cows

Calving interval (day)	Number of records	Rate (%)
286-305	315	0.1
306-335	30,913	12.1
336-365	77,672	30.4
366-395	57,153	22.4
396-425	34,076	13.4
426-455	21,263	8.3
456-485	133,16	5.2
486-515	8,710	3.4
516-545	5,583	2.2
546-575	3,839	1.5
575-604	2,537	1.0

interval showed steady increases, by nearly one month for 10 years, from 371.0 days in 1987 to 398.9 days in 1996. While improving feeding management for heifers would lead to an advance of the first calving, prolonged calving intervals were attributed mainly to failure to achieve insemination at appropriate time, unskilful feeding and poor management. In the current situation, establishing a standardised feeding method will play a major role to achieve a further shortened calving interval. Breeding farmers should approach strategically to accomplish'calving every year' as well as improve reproductive and maternal performance of cows.

Comparisons of reproductive performances for calving number : Results of reproductive performance for calving number are shown in table 5. Calving interval was 392.4 days for the second calving and it became as short as 389.7 days towards the fourth calving. After the fifth calving, however, it turned around to be longer and for the tenth calving, it became 397.5 days which was more than one week longer compared with that for the fourth calving. Almost the same tendency was found in services per conception. The results show that cows which have had more than ten calves could at least be a cause of deterioration of calving interval and if it is the case the animals should be culled. Okano et al. (1984) similarly suggested reasonable culling ages to be 9 to 10 years old after 7th to 8th calving. It is known that gestation length of older cows become one or two days longer than younger cows (Iritani et al., 1987). Our investigation of Japanese Black cows indicated the same result, that is, gestation length became longer as calving number advanced. On the other hand, calving difficulty became easier with an advance of calving number.

Comparison of reproductive performances for calving month : Table 6 compares reproductive performances for calving month. Calving intervals for cows calving between March and July were less than 390 days and they were shorter than those for cows calving in other months. The shortest calving interval was found to be for cows calving in May and the intervals gradually increased to reach the longest in November, then declined afterwards. This change almost coincides with the change in first calving age with month, having the youngest 24.86 old in April and tending to get older towards November. It is commonly said that although cattle have no breeding season, the calving intervals for cows calving in spring tended to be shorter than autumn in the northern hemisphere (Iritani et al., 1987). The result of this study indicates that this is also true in Japanese Black cows.

The differences of reproductive performances among urban and rural prefectures were significant. The difference for the highest and lowest calving intervals was almost 39 days and other parameters showed similar tendencies to calving interval. These large differences were due mainly to differences in feeding and overall management. To reduce differences in performances among the prefectures, a standardised feeding system management have to be urgently established.

Effects of body condition score on reproductive performances

As Suzuki et al. (1976) and Suzuki and Sato (1984, 1985) reported that nutritional condition influenced the reproductive performance in Japanese Black cattle, effects of body condition, which generally reflects the nutritional status of the animals, on reproductive performances were also analysed as shown in table 7. Calving intervals for body condition score 2 (standard), 3 (rather fatty), and 1 (rather thin) were respective 393.8, 398.5 and 401.3 days and there is a ten-day difference between the body condition score 1 and 2. The mean first calving age for the cows with body condition score 1 was much older than those for the cows with body condition score 2 or 3 and the difference

Table 4. Changes with years in reproductive performances of Japanese Black cows

Calving year	Calving interval (days)	First calving age (months)	Services per conception
1987	371.0±0.7^{a}	25.76±0.07^{a}	1.26±0.02^{a}
1988	391.4±0.4^{b}	25.48±0.07^{b}	1.46±0.02^{c}
1989	393.5±0.4^{fe}	25.28±0.07^{c}	1.48±0.02^{d}
1990	392.5±0.4^{cd}	25.07±0.07^{eghj}	1.46±0.02^{c}
1991	393.0±0.5^{cf}	24.98±0.07^{hk}	1.41±0.02^{b}
1992	394.2±0.4^{ge}	24.96±0.07^{ih}	1.46±0.02^{c}
1993	394.5±0.4^{g}	25.01±0.07^{aek}	1.46±0.02^{c}
1994	396.6±0.4^{h}	24.90±0.07^{k}	1.43±0.02^{b}
1995	399.1±0.5^{i}	25.00±0.07^{fgk}	1.42±0.02^{b}
1996	398.9±0.5^{i}	25.07±0.08^{dfhij}	1.41±0.02^{b}

Values are least squares means±standard errors.
Least squares means in same column with different superscript letters differ significantly ($p<0.05$).

Table 5. Changes with calving number in reproductive performances of Japanese Black cows

Calving number	Calving interval (days)	Services per conception	Gestation length (days)	Calving difficulty (classes*)
1	-	1.35±0.02^{a}	-	1.114±0.006^{a}
2	392.4±0.4^{c}	1.42±0.02^{bc}	286.3±0.04^{a}	1.086±0.006^{b}
3	390.8±0.4^{b}	1.41±0.02^{b}	286.5±0.04^{b}	1.083±0.006^{bc}
4	389.7±0.4^{a}	1.41±0.02^{b}	286.7±0.04^{c}	1.081±0.006^{c}
5	389.9±0.4^{a}	1.41±0.02^{b}	286.8±0.04^{d}	1.079±0.006^{c}
6	391.2±0.4^{bd}	1.42±0.02^{bc}	286.9±0.04^{de}	1.075±0.006^{cd}
7	391.8±0.5^{cd}	1.43±0.02^{cd}	287.0±0.04^{f}	1.071±0.006^{e}
8	393.8±0.5^{e}	1.46±0.02^{e}	287.0±0.04^{ef}	1.072±0.006^{de}
9	394.9±0.5^{e}	1.45±0.02^{e}	287.1±0.04^{g}	1.070±0.006^{e}
10 or more	397.5±0.4^{f}	1.49±0.02^{f}	287.1±0.03^{g}	1.073±0.006^{de}

Values are least squares means ± standard errors. * Difficulty is defined in table1. Chi-square test was carried out for calving difficulty.
Least squares means in same column with different superscript letters differ significantly ($p<0.05$).

Table 6. Monthly changes in reproductive performances of Japanese Black cows

Calving months	Calving interval (days)	First calving age (months)	Services per conception
Jan	392.7±0.5^{d}	25.26±0.07^{e}	1.42±0.02^{bc}
Feb	392.6±0.5^{d}	25.07±0.07^{d}	1.43±0.02^{c}
Mar	389.3±0.5^{c}	24.93±0.07^{abc}	1.41±0.02^{b}
Apr	385.7±0.5^{b}	24.86±0.07^{c}	1.38±0.02^{a}
May	384.7±0.5^{a}	24.88±0.07^{c}	1.38±0.02^{a}
Jun	386.4±0.5^{b}	24.99±0.07^{ad}	1.39±0.02^{a}
Jul	389.9±0.5^{fc}	25.05±0.07^{bd}	1.40±0.02^{b}
Aug	392.7±0.5^{d}	25.20±0.07^{e}	1.44±0.02^{c}
Sep	396.7±0.5^{e}	25.43±0.07^{f}	1.46±0.02^{d}
Oct	399.0±0.5^{fg}	25.44±0.08^{f}	1.46±0.02^{d}
Nov	400.4±0.5^{h}	25.41±0.07^{f}	1.47±0.02^{d}
Dec	399.4±0.5^{fh}	25.26±0.07^{e}	1.47±0.02^{d}

Values are least squares means±standard errors.
Least squares means in same column with different superscript letters differ significantly ($p<0.05$).

between body condition 2 and 3 was not statistically significant since both were around 26.0 months. In a long term, cows having late first calving age will eventually end up with unfavourable reproductive performances that lead to a considerable loss of profit in breeding farm business (Uchida and Yamamoto, 1992).

Table 7. Reproductive performances of Japanese Black cows according to body condition scores

Body condition	Calving interval (days)	First calving age (months)	Services per conception
Rather thin	401.3±1.9[a]	26.06±0.16[a]	1.75±0.02[a]
Standard	393.8±1.5[b]	25.52±0.06[b]	1.53±0.01[b]
Rather fatty	398.5±1.8[a]	25.79±0.19[ab]	1.59±0.02[c]

Values are least squares means±standard errors.
Least squares means in same column with different superscript letters differ significantly ($p<0.05$).

The cows with body condition score 2 showed favourable reproductive performances. Careful nutritional management is required for breeding cows, especially, pre- and post-natal periods to maintain good reproductive condition to achieve a high conception rate and 'calving every year'. By contrast, cows with unfavourable body condition scores generally have poor reproductive performances because of fatness and often retarded oestrus or nutritional insufficiency during pre- and post-natal periods.

Breeding farmers are urged to promote faster recovery of the reproductive function of cows by appropriate nutritional management during pre- and post-natal periods and, if it is necessary, by restricting calves from suckling in order to calve once a year (Suzuki and Sato, 1985). At the same time, continuous improvement of breeding characteristics such as reproductive performances and maternal ability (Shimada et al., 1995; Shimada et al., 1996; Shimada et al., 1998) are also required.

ACKNOWLEDGEMENTS

We greatly appreciate the support of the Japan Livestock Industry Association for providing the data.

REFFERENCES

Ibrahim, M. N. M. and T. N. Jayatileka. 2000. Livestock production under coconut plantations in Sri Lanka: cattle and buffalo production systems. Asia-Aus. J. Anim. Sci. 13:60-67.

Iritani, A., T. Sugie, K. Tanaka, T. Nakahara, J. Masaki and A. Yokoyama. 1987. Reproduction in livestock. 2nd edn. Yokendo, Tokyo.

Islam, S. S., A. Ashraf and A. B. M. M. Islam. 2000. A study of the milking and reproduction performances of grazing indigenous cattle at a semi urban area of Bangladesh. Asia-Aus. J. Anim. Sci. 13:837-841.

Japri, B. M., A. M. Majid, H. E. Fauziah and K. R. Adrien. 1997. Effects of breed of sire, percentage of *Bos Taurus* inheritance and season of birth on calving performance of crossbred dairy cattle. Asia-Aus. J. Anim. Sci. 10:313-317.

Longworth, J. W. 1983. Beef in Japan, University of Queensland Press, Queensland.

Moriya, K., R. Fukuhara, Y. Oshikawa, Y. Harada and H. Harada. 1991. Analysis of field records on the reproductive traits of Japanese Black cows. Anim. Sci. Technol. (Jpn.). 62:357-361.

Okano, A., K. Shimada, Y. Izaike and T. Oishi. 1984. Reproductive performance of Japanese black cows in their lifetimes. Jpn. J. Zootec. Sci. 55:458-464.

Okano, A. 1994. Life reproductive performance and fetal development in Japanese Black cows. J. Reprod. Dev.(Jpn.). 40:117-129.

SAS lnstitute lnc. 1994. SAS/STAT User's Guide: Version 6. 4th edn. SAS Institute Inc., Cary, North Carolina.

Shimada, K., N. Takenouchi, K. Ohshima and M. Takahashi. 1995. Maternal effects on calf growth in Japanese Black cattle(Wagyu). Jpn. J. Zootec. Sci. 66:167-169.

Shimada, K., C. Lin, K. Ohshima, N. Takenouchi and M. Takahashi. 1996. Relationship between breeding value of maternal genetic effect on calf growth and actual milk yield in Japanese Black cattle (Wagyu). Anim. Sci. Technol.(Jpn.). 67:175-180.

Shimada, K., C. Kitamura, T. Noumura and T. Hayashi. 1998. Maternal effects on carcass traits in Japanese Black cattle(Wagyu). Anim. Sci. Technol. (Jpn.). 69:365-369.

Steel, R. G. D. and J. H. Torrie. 1980. Principles and procedures of statistics, 2nd edn. McGraw-Hill Book Co., New York.

Suzuki, O., M. Sato and Y. Sakai. 1976. The influences of level of nutrition during rearing on puberty and reproductive performance in Japanese Black cattle heifers. Bull. Natl. Grassl. Res. Inst. 8:33-41.

Suzuki, O. and M. Sato. 1984. Effects of underfeeding during pregnancy on postpartum reproductive performance of beef cows and growth of their calves: III. Effects of underfeeding extending over two consecutive pregnancies on serum progesterone concentration, parturition and postpartum reproduction. Bull. Natl. Grassl. Res. Inst. 27:62-69.

Suzuki, O. and M. Sato. 1985.Effect of short-term restricted suckling on postpartum reproductive performance of beef cows and growth of their calves. Jpn. J. Zootec. Sci. 56:384-390.

Uchida, H. and K. Yamamoto. 1992. The analysis of reproductive records for last five years. Japan Livestock Industry Association. Production, Management and Technical Improvement Project of Beef Cattle Report. pp. 38-60.