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Nakanishi, Yoshitaka
Kuju Agricultural Research Center, Faculty of Agriculture, Kyushu University

Mutoh, Yoshihiro
Kuju Agricultural Research Center, Faculty of Agriculture, Kyushu University

Umetsu, Raizaburo
Kuju Agricultural Research Center, Faculty of Agriculture, Kyushu University

https://doi.org/10.5109/24012

出版情報：九州大学大学院農学研究院紀要. 37 (3/4), pp.209-218, 1993-03. Kyushu University
バージョン：
権利関係：

J. Fac. Agr., Kyushu Univ., 37 (3•4), 209-218 (1993)

Interrelationships among Maintenance Behaviour, Agonistic Behaviour and Live Weight Change in a Beef Cattle Herd after Introducing a Strange Cow

Yoshitaka Nakanishi, Yoshihiro Mutoh* and Raizaburo Umetsu

Kuju Agricultural Research Center, Faculty of Agriculture,
Kyushu University 46-10, Oita 878-02, Japan

(Received August 1, 1992)

To examine the changes over time in maintenance behaviour of 9 horned Japanese Black Cattle in a herd subsequent to the introduction of a stranger and the relationships of maintenance behaviour to agonistic interactions and live weight change in the herd after introduction, incidents of eating, lying, standing and locomotion of each animal and agonistic encounters occurring in the herd were recorded in a dry-lot (225 m^2) during the observation period (2 pre- and 5 post-introduction days). On the day of introduction, the cattle showed large increases of both standing and locomotion time at the expense of both eating and lying time, however little difference in maintenance behaviour occurred between Day +6 and pre-introduction (Days -3 and -2). During the observation period of post-introduction, the percentage of time spent lying was negatively correlated with the frequency of agonistic interactions, especially it had the highest significant correlation with the frequency of actively aggressive behaviours (fighting, butting and threatening) of the introduced cow who was most dominant in her previous group (r = -0.993, $P < 0.001$). In the posttintroduction herd, the introduced cow spent more time in locomotion than other herdmates, which might partly lead to her larger reduction in live weight.

INTRODUCTION

In large-scale cattle farms, exchanging animals between groups, mixing unfamiliar animals and/or introducing strangers into an established group are routinely carried out by herdsmen. Such social disruption causes an increase in aggression within the herd (Hafez and Bouissou, 1975; Kiley-Worthington, 1977; Fraser and Rushen, 1987) and in some cases it results in a drop in productive performance (Schein and Fohrman, 1955; Brake1 and Leis, 1976; Arave and Albright 1976; Clark et al., 1977; Krohn and Konggaard, 1980). In particular, adding strangers to an established group in a given space is a social alteration accompanied with both increase in group size and decrease in space available per animal, which is extremely important in the management of group-fed cattle. Nakanishi *et al.* (1991), who observed a small herd of Japanese Black Cattle kept in a dry-lot, reported that introducing a strange cow into the herd caused a 4 - fold increase in total agonistic interactions on introduction day. Thereafter, the frequency of agonistic behaviours decreased gradually and in about a week became similar to that before introduction. In addition, they found the introduced

* Present address: Meijiya Sangyo Co., LTD., Nougata-shi, Fukuoka 822, Japan.

cow had the greatest reduction in live weight and suggested the reduction was induced by social stress associated with changed group structure. It may be expected that such a marked increase in aggression immediately after introducing a strange cow will exert an influence on maintenance behaviour of cattle within the herd, however the relationship between agonistic behaviour and lying behaviour in the post-introduction herd has not been elucidated. Moreover, the reason why the introduced cow suffered the greatest reduction in live weight within the herd is not confirmed.

This paper reports changes over time in daily maintenance behaviour (eating, lying, standing and locomotion) of a Japanese Black Cattle herd as affected by introducing a strange cow and describes the relationships between agonistic interactions and lying behaviour of cattle and between maintenance behaviour and live weight change for each animal in the herd after introduction.

MATERIALS AND METHODS

Animals and management

A total of 9 horned Japanese Black Cattle (3-10 years old) at the Kuju Agricultural Research Center of Kyushu University, located in Oita (alt. 950 m) was used for this study. The herd comprising 7 cows and a heifer had been fed in a dry-lot (225 m^2) over 2 weeks and then a separately-fed cow, who had been most dominant in her previous cow-calf group, was introduced into the herd immediately after her calf's weaning (90 d postpartum) in the morning (at 0900 h). During the observation period, the cattle were given lucerne hay cubes at a stanchion manger at 0900 h and were allowed free access to rice straw at hay racks in the lot (supplied at 1530 h). Water and salt were given *ad libitum*. Profile of the experimental cattle and scheme of the dry-lot were described in detail in a previous paper (Nakanishi *et al.*, 1991).

Observations

Individual identifications were made by dyed numbers on both sides of the cattle. Herd behaviour was observed between 0930 and 1730 h during 2 pre- (Days -3 and -2) and 5 post- (Days 0, +2, +3, +5 and +6) introdution days. Behavioural observation was not made on Days -1, +1 and +4 because of rainy weather. During the observation days, the weather was fine or cloudy and the mean maximum temp., minimum temp. and relative humidity were 26.8°C, 19.0°C and 76.3%, respectively. During the observation period, the following behaviours were recorded for each animal at 10-min intervals: eating, lying (rest and rumination), standing (rest and rumination), locomotion and others (drinking, salt licking and social interactions). Agonistic behaviour (fighting, butting, threatening and avoiding) as defined by Hafez and Bouissou (1975) was also recorded whenever it occurred and then it was categorized into total (fighting, butting, threatening and avoiding), physical aggression (fighting and butting), non-physical aggression (threatening) and actively aggressive behaviour (fighting, butting and threatening) toward other herdmates of an introduced cow. The cattle were weighed at the start (Day -4) and the end (Day +7) of the study (both at 0900 h) and the live weight change for each animal was calculated from the difference. The feeding condition of the cattle was the same for both weighing days.

Data analyses

The relationship between agonistic interactions and lying behaviour of cattle in the post-introduction herd was analysed by regression analysis. In order to examine the relationship between maintenance behaviour and live weight change, relative live weight change: (live weight change/initial body weight) × 100, was calculated for each animal and the relationships between proportion of each maintenance behaviour and relative live weight change were analysed using rank correlation (Siegel, 1956).

RESULTS

Effect of introducing a strange cow into a stable herd on daily maintenance behaviour

Changes over days in eating, lying, standing and locomotion of cattle are shown in Fig. 1. During the pre-introduction period (Days -3 and -2), there was little change in the frequency of eating (16-19%), lying (34-40%), standing (35-40%) and locomotion (3-4%). However, after introducing a strange cow (Day 0) the incidences of eating and lying decreased drastically, whereas those of standing and locomotion increased. Thereafter, the proportion of time spent on each maintenance behaviour tended to approach that of pre-introduction days by Day +5. Thus, the introduction of the strange cow into the established herd had a considerable impact on the frequency distribution of maintenance behaviour. Diurnal pattern of eating behaviour of cattle before and after introduction showed an overall tendency of lower eating frequency and no eating peak between 0930 and 1530 h (Fig. 2). On the day of introduction there was almost no incidence of eating between 0930 and 1530 h.

Relationship between agonistic interactions and lying behaviour in the herd after introducing a strange cow

Table 1 shows total agonistic encounters, physical aggressive encounters, non physical aggressive encounters, frequency of actively aggressive behaviours of the introduced cow and proportion of daily lying behaviour in the herd during the observation period after introduction. Total agonistic interactions, physical and non-physical aggressive interactions in the herd tended to decline from Day 0 to Day +6 and the

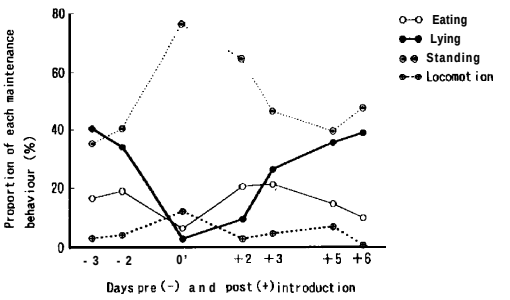

Fig. 1. Proportion of eating, lying, standing and locomotion time of cattle before and after introducing a strange cow.
*Introduction day.

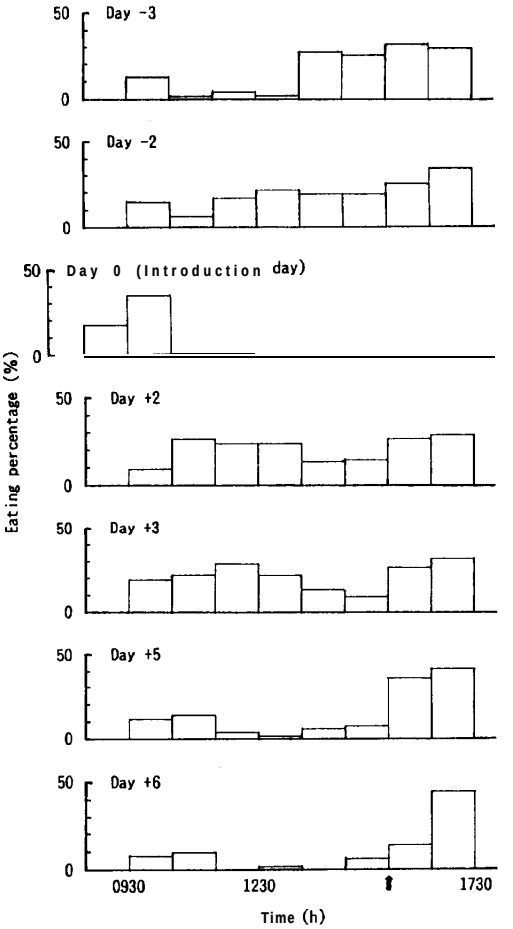

Fig. 2. Diurnal pattern of eating behaviour of cattle during the observation days before and after introducing a strange cow.
⬆ Supply of rice straw.

Table 1. Frequencies of categorized agonistic interactions[1]) and percentage of time spent lying during daily 8 h observation periods.

Item	Days after introduction				
	0	+2	+3	+5	+6
Total agonistic interactions (no.)[2])	610	343	484	339	129
Physical aggressive interactions (no.)[3])	29	12	16	9	5
Non-physical aggressive interactions (no.)[4])	114	87	50	57	17
Number of aggressive behaviours toward other herdmates of an introduced cow (no.)[5])	50	44	25	9	2
Lying behaviour (%)[6])	3.2	9.7	26.2	35.4	38.7

1) Adopted from Nakanishi *et al.* (1991).
2) Fighting, butting, threatening and avoiding.
3) Fighting and butting.
4) Threatening.
5) Fighting, butting and threatening.
6) Expressed as percentage of total number of observations during the day.

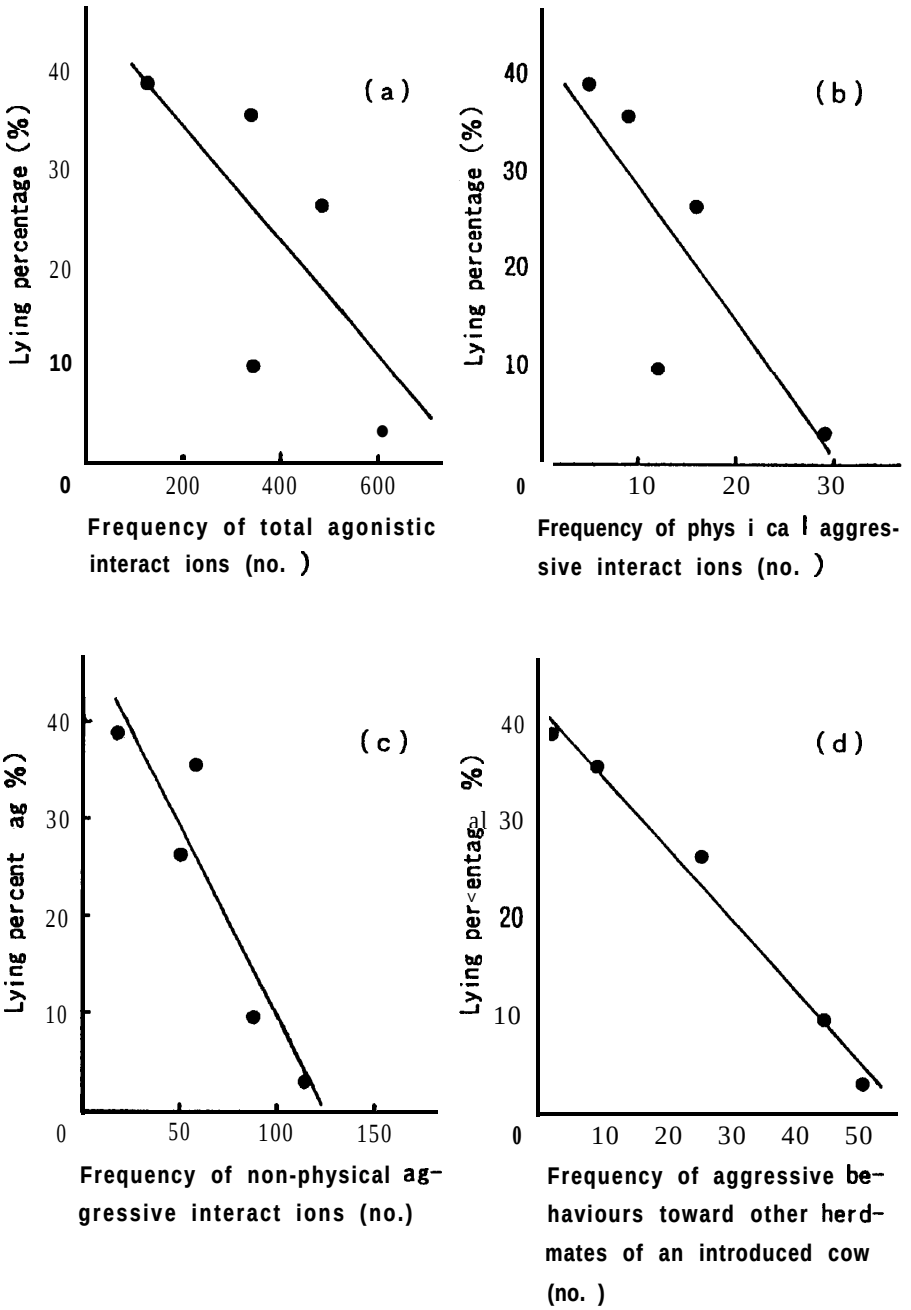

Fig. 3. Relationships between (a) frequency of total agonistic interactions, (b) frequency of physical aggressive interactions, (c) frequency of non-physical aggressive interactions and (d) frequency of actively aggressive behaviours toward other herd-mates of an introduced cow, and percentage of time spent lying during daily 8 h observation periods after introducing a strange cow.

frequency of actively aggressive behaviours of the introduced cow decreased obviously. In contrast, the percentage of time spent lying by cattle increased from Day 0 to Day +6. Total agonistic interactions, physical aggressive interactions, non-physical aggressive interactions or frequency of actively aggressive behaviours of the introduced cow had an adverse relation to lying behaviour. Although those relationships may not continue for any length of time, they were presented in the following 4 regression equations as far as were known during the observation period (Fig. 3);

$Y = 46.65 - 0.06X_1 (r = -0.726)$

$Y = 42.21 - 1.38X_2 (r = -0.811, P < 0.10)$

$Y = 48.31 - 0.39X_3 (r = -0.935, P < 0.02)$

$Y = 41.86 - 0.74X_4 (r = -0.993, P < 0.001)$

where the independent variables (X) and dependent variables (Y) were defined as follows: X_1 = total agonistic interactions (no.), X_2 = physical aggressive interactions (no.), X_3 =non-physical aggressive interactions in the herd (no.), X_4 = frequency of actively aggressive behaviours of the introduced cow (no.) and Y = proportion of daily lying behaviour of cattle (%), respectively. The results of regression analysis indicated that the higher the incidence of agonistic interactions, the lower the percentage of lying behaviour in the herd. In particular, lying behaviour of cattle reduced almost linearly as the frequency of actively aggressive behaviours of the introduced cow increased.

Relationship between maintenance behaviour and live weight change in the herd after introducing a strange cow

The percentage of time spent eating, lying, standing and locomotion and relative live weight change for each animal during the observation period are shown in Table 2. Cattle spent 4.6-27.1% of the observation time eating, 15.4-31.3% lying, 39.665.0% standing and 1.7-9.6% in locomotion. Eating frequency showed much greater variation amongst individuals than lying, standing and locomotion (CV: 66.2, 22.4, 15.7 and 54.0%, respectively). A newcomer (animal 9) spent more time in locomotion than other herdmates. Concerning relative live weight change, the nowcomer had the greatest reduction in its weight within the herd during the observation period. The coefficients of Spearman's rank correlation between 3 maintenance behaviour variates (eating, lying and standing) and relative live weight change suggested that those relationships were not very close (Table 3). However, the coefficient between locomotion time and relative live weight change was relatively high ($r_s = 0.538$, $P < 0.10$), indicating that the animals which spent more time in locomotion had a tendency of greater reduction in weight.

DISCUSSION

A comparison of maintenance behaviour before and after introducing a strange cow into a stable herd suggested that cattle showed large increases in both standing and locomotion time at the expense of both eating and lying time. The change in maintenance behaviour of cattle over time was in general consistent with the investigation of Krohn and Konggaard (1980) who observed that the time spent eating and lying was back to its normal level on the 8th day after moving cows from one group to another. The present findings were similar to social behaviour pattern in the previous

paper (Nakanishi et al., 1991; lying behaviour-social licking interactions, standing behaviour-agonistic interactions). Such changes in maintenance and agonistic behaviour over time, which was induced by the introduction of the strange cow, also resembled those in daily behavioural patterns of herds during pre- and post-estrous days reported by other workers (Hurnik *et al.*, 1975; Pollock and Hurnik, 1979; Phillips and Schofield, 1990).

For cattle, lying behaviour is considered to be of great importance for body rejuvenation (metabolic recovery and conservation of body energy) (Fraser, 1980; Wierenga and Hopster, 1990). It is also suggested that the amount of time spent lying is an indicator of animal comfort and well-being (Arave and Walters, 1980; Metz, 1985). Czakó (1977) found a decrease in lying time of loose housed cattle under high density conditions. Krohn and Konggaard (1980) also reported that lying time in a dairy herd was markedly decreased on the first day after group transfer. Subsequent-

Table 2. The time-budget of behavioural activities" and relative live weight change for each cattle over the observation period.

Item	Cattle No.								
	1	7	10	14	17	21	22	23	9'
Eating behaviour (%)	11.3	24.2	27.1	22.5	4.6	10.4	7.9	6.3	16.3
Lying behaviour (%)[2]	21.7	31.3	19.6	24.6	22.1	15.4	20.0	29.6	19.6
Standing behaviour (%)[2]	63.3	39.6	50.0	45.8	65.0	60.0	60.8	57.1	51.7
Locomotion (%)	3.7	2.5	1.7	4.2	7.1	9.6	8.8	4.2	9.6
Others (%)[3]	0	2.4	1.6	2.9	1.2	4.6	2.5	2.8	2.8
Relative live weight change (%)[4]	+1.0	+0.7	+0.4	-0.4	+1.5	-0.7	-1.0	-1.6	-2.5

"Expressed as percentage of total number of observations during 5 days (Days 0, +2, +3, +5 and +6).
"Including rest and rumination.
[3]Including drinking, salt licking and social interactions etc.
[4]Calculated from both difference in body weight between the initial (Day -4) and the final (Day +7) of the study and initial weight: (the difference in weight/initial weight) x 100.
*Introduced cow.

Table 3. Spearman's rank correlation coefficients of percentage of time spent in each maintenance behaviour with relative live weight change for cattle.

	Relative live weight change
Eating behaviour	-0.070
Lying behaviour	-0.276
Standing behaviour	-0.233
Locomotion	0.538 +

Animal with the greatest reduction in body weight, which spent most time in each maintenance behaviour within the herd, was ranked as 1.
$^{+}P < 0.10$.

ly, several problems concerning deprivation of such maintenance behaviour in modern intensive farm animal husbandry systems were discussed (Fraser, 1985). Therefore, a lack of free opportunity for lying appears to be undesirable from the viewpoint of animal health and productivity. In this study, the introduction of a strange cow into a stable herd elicited a large increase in agonistic encounters, resulting in decreased lying time. Especially, an increase in aggression of the introduced cow is likely to impinge upon lying time of herdmates. Krohn and Konggaard (1982) showed that based on blood cortisol levels, deprivation of lying time (a decrease to 25% of the normal lying time) was stressful to cattle. As shown in Fig. 1, on the introduction day cattle revealed marked decrease to less than 10% of the lying time before introduction (decrease from 34-40% to 3%). This indicates that adding a strange cow to a stable herd is considerably stressful to the cattle. The stressful condition was probably caused by increase in group size (increased confrontations with group members), reduction in space allowance per animal and weaning (separation of dam and her offspring).

Although it might be generally expected that eating time in cattle would affect their body weight gain, no high correlation was found between time spent eating and live weight change. This may reflect the lower eating frequency in the daytime (observation period), which is probably induced by both increased agonistic interactions and possible eating events during the non-observation period due to late feed supply in the afternoon (1530 h) as presented in Fig. 2. A relatively higher correlation between the amount of time spent in locomotion and the extent of reduction in body weight, implied largely that the introduced cow spent more time in locomotion than others in attempts to avoid the socio-spatial stressful1 condition (psychological and physical stress, including bullying by dominants) and to seek her offspring (which was weaned by the stockperson) with vocalizing as mentioned above, so that she impaired her body weight gain.

CONCLUSION

From both the present findings and the results of a previous report (Nakanishi et *al.*, 1991), it was concluded that under a dry-lot feeding system with limited space (25.0 m^2 per animal) introducing a strange cow into an established herd influenced not only the incidence of the various maintenance behaviours but also social interactions in the herd. Especially, a large reduction in lying time of herdmates and large increase in aggressive interactions were evident on the day of introduction. In the post-introduction herd, lying incidence of cattle was greatly reduced by the increase in aggression of the introduced cow who was most dominant in her previous group, however she herself was also subjected to greater psychological and physical stress and could not avoid reducing her weight due to the increased locomotion time. This study focused on behaviour in a herd of beef cattle, however the effects of introducing strangers into established groups on social and maintenance behaviour may be modified by different social tensions between strangers varying in social experience within the previous group and their herdmates (Bouissou, 1981). Therefore, further behavioural observations of various types of herds should be made as fundamentals of effective herd management, and related information is needed.

ACKNOWLEDGEMENTS

The authors wish to express thanks to Mr. T. Etoh of Kuju Agricultural Research Center, Kyushu University for the care of experimental animals and his skilled technical assistance in this study. Thanks are also due to Dr. Y. Masuda, Associate Professor at the Department of Animal Science, Faculty of Agriculture, Kyushu University for extensive and valuable discussions on this manuscript. Special appreciation is expressed to Dr. G. W. Arnold, Division of Wildlife and Ecology, CSIRO and Dr. C. W. Arave, Department of Animal, Dairy and Veterinary Sciences, Utah State University for their kind reviewing of the manuscript.

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