Indian Journal of Animal Sciences **88** (3): 339–343, March 2018/Article

Behavioural adaptation of crossbred cows in automatic concentrate feeding station

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Received: 17 August 2017; Accepted: 18 October 2017

ABSTRACT

The present study evaluated the adaptation behaviour of crossbred cows (46) in Automatic Concentrate Feeding Station (ACFS). The adaptation behaviour was studied over a period of 6 weeks. The percentage of adaptation was calculated based on the average concentrate allotted divided by average number of rewarded visits. After adaptation, duration of rewarded and unrewarded visits under three feeding windows (FW1: 12.01 AM - 7.59 AM; FW2: 8.00 AM - 3.59 PM; FW3: 4.00 PM -11.59 PM) in 2 ACFS (FS_1 & FS_2) was studied over a period of 72 h using software. Significant difference in the duration of rewarded visits was observed between stations (FS_1 and FS_2) and between feeding windows (FW1 and FW3 differed with FW2). The average duration of rewarded visit was 247.3±7.97 sec, 192.46±7.29 sec and 239.47±8.21 sec during FW1, FW2 and FW3, respectively, while the corresponding values for unrewarded visits were 44.49±3.77 sec, 46.73±2.9 sec and 59.84±3.32 sec, respectively. Overall mean duration of time spent for a single visit in rewarded and unrewarded visits was 218.56±3.82 sec and 49.93±1.85 sec, respectively, for 72 h irrespective of feeding stations and feeding windows. It was concluded that adaptation period of crossbred cows with automatic concentrate feeding station was shorter for older animals than younger ones, and the duration of unrewarded visits influenced the learning behaviour of animals.

Key words: Automatic feeding system, Behavioural adaptation, Crossbred cows, Feeding behaviour

In dairy farms, feed costs constitute more than 50 to 60% of the total cost of milk production. Dairy cows have traditionally been fed concentrates as they are milked to supplement nutritional requirements not supplied by the forages (Pritchard *et al.* 1999). Although concentrate can be provided at the manger or inside the parlour while milking, the latter is commonly practiced as it is believed to cause more efficient udder emptying, a higher peak flow and thus higher milk production. On farms, where concentrate is fed in milking parlours, the opportunity for individual feeding varies considerably, depending on type of equipment and milking management practices (Pritchard *et al.* 1999). If concentrates are provided outside parlour in groups, it causes competition resulting in aggression during feeding, which may reduce feed intake and milk production, and compromises animal welfare (Herlin and Frank 2007). Moreover, large amounts of concentrates if consumed in a single meal, decrease the ruminal pH resulting in rumen acidosis leading to reduced milk production (Gibb *et al.* 1998, Schwartzkopf-Genswein *et al.* 2003) and negative welfare implications such as sudden death (Glock and DeGroot 1998). Therefore, feeding concentrate several times in small amounts throughout the day is a better practice to maintain rumen health although, it is time consuming. In order to achieve maximum output with minimum wastage, each cow should receive a controlled amount of concentrate (Collis 1980). Automatic computerized feeding system (ACFS) provides facility for better control over feeding of cows as individuals in a group housing system, especially in herds ranging in size from 50 to 150 cows (Pritchard *et al.* 1999). The use of computerized feeding stations is beneficial in meeting individual cow's nutritional needs by reducing feeding errors and monitoring feed intake as an indicator of cow health (Shultz 1989).

The number and duration of daily visits to the feeding station depend upon the amount of concentrate allotted and behavioural adaptation of dairy cows to the feeding station. Individual cows were able to adapt to computerized feeding stations (Cassel *et al.* 1984, Wierenga and Hopster 1990) but the variability was great among cows (Cassel *et al.* 1984, Metz-Stefanovska and Spahr 1989, Pirkelmann 1992). The

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behavioural adaptation of visiting activity in the feeding station depends upon biological factors (age, weight, and parity), psychological factors (temperament and social behaviour) and technical factors like number and layout of feeding stations (Tennessen 1989, Wierenga and Hopster 1990).

Few studies investigated the period of adaptation and behaviour of dairy cows with respect to layout of feeding stations in computerized ACFS but there is no literature on how the adaptation was framed. The aim of the present study was to evaluate the adaptation of crossbred cows to the ACFS and the factors influencing behavioural adaptation in relation to rewarded and unrewarded visits to the feeding systems.

MATERIALS AND METHODS

The present study was conducted at the Livestock Research Centre, National Dairy Research Institute, Karnal. The mean temperature and relative humidity during the experimental period ranged from 8.47ºC (minimum) to 21.52ºC (maximum), and from 51.7% (minimum) to 93.2% (maximum), respectively. Experimental crossbred (Karan Fries - Holestein Friesian × Tharparkar) cows (46) were selected randomly irrespective of parity and stage of lactation. A week before experiment, experimental cows were tied with neck belt holding the transponder, activity meter and number tags for individual animal identification. These cows had no previous experience in computerized ACFS. All the experiment procedures were duly approved by the Institute Animal Ethics Committee.

Experimental shed and automatic feeding station: The experimental cows were maintained in modernized loose housing system under group management practices where ACFS and video cameras were fixed. The FSC400 (premium) type of concentrate feeding station fixed in the experiment shed had feed manger, funnel and front plate made of stainless steel. Manger with fence line feeding system was used for roughage and dry fodder feeding. Water trough and automatic groomer were placed opposite side of the manger. The feeding station was installed on a slightly elevated plane on the shed for better visual identification. The feeding stations had two bins (1×1) and were coded as FS_1 and FS_2. Each station was controlled by a station controller and a system controller. Above the feeding station, an antenna is fixed, from which data's were sent to ALPRO® software through wire. Dimensions of the shed with AFS are depicted in Fig. 1.

Feeding: The daily feeding was split into 3-times in a day. Cows were fed with *ad lib.* green fodder (berseem, oat, mustard, turnip and maize) during morning hours at 8.30–9.00 AM, then 10.00–11.00 AM and 2.00–2.30 PM in afternoon, along with dry fodder. The residual green fodder was given to the animals in the remaining hours and during night hours. The concentrate to the experiment animals were fed individually based on her daily concentrate allotment through computerized ACFS with regular frequency throughout a day based on their weekly average milk yield. The concentrate was fed @ 1.5 kg to 2.0 kg/animal for body maintenance in general. Milking cows (yielding above 5.0 kg) were given additional concentrate at the rate of 1.0 kg for every 2.5 kg milk production. Concentrate mixture had 20% CP and 70% TDN consisted of 33% maize, 21% groundnut cake, 12% mustard cake, 20% wheat bran, 11% de-oiled rice bran, 2% mineral mixture and 1% common salt. The concentrate ration was given per the NRC recommendations (2001).

ALPRO® software data entry: In the system software, individual cow neck belt tag number, transponder number, activity number were entered to validate the cow in the software database and these numbers were specific to individual cows. Based on individual cow date of birth, date of calving, parity number and amount of basic ration were entered before activation of transponder. The time interval of concentrate dispensing was calibrated as per fixed time feeding routine of 8 h 3 equal feeding windows (FW's) FW_1 from 12.01 AM to 7.59 AM; FW_2 from 8.00

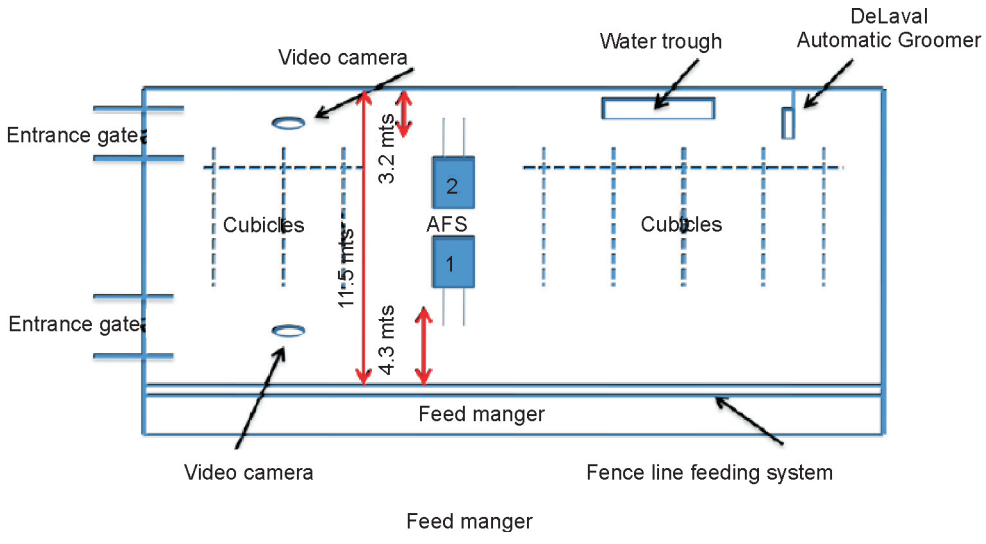

Fig. 1. A bird's-eye view of experiment shed.

AM to 3.59 PM and FW_3 from 4.00 PM to 11.59 PM.

Feeding station visiting data: Each visit of individual cow to the feeding station was recorded in system software database as rewarded and unrewarded visits. The visit was considered as rewarded when the cows successfully entered into the feeding station and received their allotted amount of concentrate in the scheduled feeding window while the visit was considered as unrewarded when the cows successfully entered into the feeding station but the concentrate was not dispensed to her by the machine. The number of visiting pattern (rewarded and unrewarded) was detected by individual cow visits and stored in the ALPRO® software database. The percentage of adaptation was calculated based on the average number of rewarded visits by average concentrate allotted.

Behaviour monitoring and recording: For behavioural observation, individual cows were identified by ear tags and also by neck belt number tags. More specifically, for easy identification, all the cows were marked by white paint spray before a day of video recording. Individual animal behaviour was monitored using 2 infrared sensitive video cameras (1/3" Sony Super Colour HAD CCD camera, model: HSW-72E, TVS, India, with an F1.2/3.6 mm lens, auto focusing) fixed in the animal shed (8 feet above the ground) focusing on the feeding station bins (FS_1 and FS_2) and recorded by digital video recorder (model number KDM-6553, model name - MEPEG4/H.264, Shenzhen kadyMay technology Co. Ltd., China) with 1 and 4 channel digital time lapse (25 frames per second) video visuals of 720×576 pixels with 1-terabyte internal hard disk was used for storage of 72 h recording. Motion pictures were saved in the computer system attached with the DVR. Video cameras were connected to DVR by cable wire. Sufficient numbers of lights were placed under the roof of the shed for adequate lighting to facilitate day and night video recording. Continuous observation methods were used to record the experiment cows visiting pattern in the ACFS and it was recorded and saved in DVR. Time duration of visiting pattern in the feeding station was studied by video observation of individual animals. Recorded video data were used for analysis of how long a cow spent in the feeding station. Later on duration of visits were classified as rewarded and unrewarded visits based on video recording and it was substantiated with ALPRO® software feeding data.

Behaviour analysis: All video recordings were analyzed by continuous observation and multiple observers were used to collect the behavioural information. Inter-observer reliability, as measured at percentage agreement was between 98 and 99%. All visiting patterns of each cows were read by 2× to 32× speed depending on the activities of cows. The start and end point of each feeding activity was observed by both forward and backward replay. The duration of each activity was the difference between start and end point of that activity.

Statistical analysis: Data were analyzed statistically by using statistical software SigmaPlot version 11.0, Systat Software Inc., USA. Data's on visiting pattern of individual crossbred cows (46) were classified and analyzed between the parity subclasses, viz. first, second and ≥3rd parity by using the tabular test (for descriptive statistics) and two-way analysis of variance (ANOVA) for parity, concentrate allotted, number of rewarded visits with interaction and for correlating the parameters Pearson coefficient of correlation was used.

RESULTS AND DISCUSSION

Based on the parity group, the percentage of adaptation based on the weekly mean concentrate allotted and numbers of rewarded visits attempted in the ACFS along with duration of visiting pattern were studied.

Concentrate ration allotted and number of rewarded visits attempted: The results pertaining to the weekly mean concentrate ration allotted during the study period (6 weeks) are presented in Table 1. The overall mean concentrate was allotted based on their average weekly milk yield. The minimum to maximum amount of concentrate allotted were 4.29±0.29, 5.05±0.08, 4.34±0.39 kg and 5.86±0.34, 6.94±0.46, 6.29±0.63 kg to 1st, 2nd and ≥3rd parity cows, respectively.

The numbers of rewarded visits were determined based on their daily concentrate allotment. The weekly mean number of rewarded visits attempted is shown in the Table 1. The minimum number of visits attempted by cows belonging to 1st, 2nd and ≥3rd parity were 1.96±0.42, 1.74±0.59, 3.04±0.56, while the minimum number of visits

Table 1. Week and parity-wise observation on concentrate allotted (mean±SE) and number of rewarded visits (mean±SE) of crossbred dairy cows under automatic concentrate feeding station

Parameter	Parity	Weekly observation					
		1st	2nd	3rd	4th	5th	6th
Concentrate allotted (kg)	1	4.29 ± 0.29^{A}	5.74 ± 0.20^{AB}	5.50 ± 0.32^{AB}	5.67 ± 0.34^{AB}	5.87 ± 0.34^{AB}	5.86 ± 0.34^{AB}
	2	5.05 ± 0.08^{A}	5.96 ± 0.33^{AB}	6.65 ± 0.46^{AB}	6.85 ± 0.50^{AB}	6.91 ± 0.47^{AB}	6.94 ± 0.46^{AB}
	≥3	4.34 ± 0.39^{A}	5.91 ± 0.58^{AB}	6.76 ± 0.67^{BC}	7.06 ± 0.72^{BC}	7.25 ± 0.73^{BC}	6.29 ± 0.63^{ABC}
Number of rewarded visits	1	1.96 ± 0.42^{A}	4.43 ± 0.70^{AC}	7.57 ± 0.89^{ABC}	10.92 ± 1.09^{BC}	10.93 ± 1.29^{BC}	10.72 ± 1.30^{BC}
	2	1.74 ± 0.59^{A}	6.85 ± 1.40^{AB}	9.37 ± 1.67^{B}	10.55 ± 1.80^{B}	10.15 ± 1.61^{B}	10.61 ± 1.68^{B}
	≥3	3.04 ± 0.56^{A}	7.85 ± 1.32^{AB}	10.93 ± 2.32^{B}	12.00 ± 2.00^{B}	13.07 ± 2.30^{B}	11.95 ± 2.31^{B}

Values within a row bearing different superscript differ significantly ($P<0.05$). Values for specific parameter within a column bearing different superscript differ significantly ($P<0.05$).

were 10.72±1.30, 10.61±1.68, 11.95±2.31, respectively. There was no significant difference in the weekly mean number of rewarded visits attempted in the feeding station among cows of different parities.

The numbers of rewarded visits were totally dependent upon the allotted amount of concentrate. During initial weeks, cows made very less number of rewarded visits according to their allotted amount of concentrate in the feeding station. Once cows had adapted to the feeding system, the number of rewarded visits gradually increased both in case of primiparous and pleuriparous cows.

Percentage of adaptation: The percentage of adaptation in the feeding station was calculated based on average concentrate ration allotted to the mean number of rewarded visits attempted in the feeding station every week. The cows that made more than 100% rewarded visits in the feeding station were considered as adapted in the system. In the first week of observation, percentage of adaptation between the parity 1 (45.79%), parity 2 (34.55%) and parity ≥3 (70.13%) was less than the target of 100% of adaptation. By the week 2, all the cows irrespective of the parity have crossed the target of 100% adaptation in the ACFS. It clearly indicate that cows with lower parities (heifers and primiparous cows) were less acclimatized to the new system of feeding compared to pleuriparous cows in the early weeks of adaptation. Contrary to this report, Collis (1980) reported that the primiparous cows were more active than multiparous cows in the visiting pattern of feeding station. Ketelaar-de Lauwere *et al.* (1999) also reported that higher mean numbers of rewarded visits were recorded in heifers (11.3) than multiparous cows (8). It was observed that there was a high correlation between weekly average concentrate allotted and mean number of visits (r=0.722) in the feeding station. The coefficient of correlation between concentrate allotted and number of rewarded visits attempted was similar to findings of Wierenga and Hopster (1991), Pirkelmann (1992) and Livshin *et al.* (1995).

Duration of visits in the feeding station: The duration of time spent was compared between feeding stations 1 and 2 with three feeding windows for 72 h and the results are given in Table 2. Between the feeding stations the overall mean time spent for rewarded visits in FS_1 and FS_2 differed significantly (215.16±6.11 sec vs 237.66±6.67 sec). Between the feeding stations, in terms of rewarded visits, mean duration of time spent in FS_2 was higher compared to that in FS_1 irrespective of feeding windows. The distance between the feeding stations (1 and 2) had huge importance with respect to the rewarded visits. It clearly indicated that FS_1 had more competition and disturbances than FS_2. FS_1 was placed nearer to the feeding manger and entrance where as FS_2 was placed towards the side of water trough, but faced opposite to FS_1 and also to green feeding alley. Due to one way entrance into the experiment shed, cows had more chance to visit the FS_1 compared to FS_2. This could have created competition and butting behaviour during the visiting pattern in FS_1. Since there was less competition among the cows for FS_2, the cows had experienced fewer disturbances and took feed comfortably as indicated by long duration of visits.

The overall mean time spent for rewarded visits within the feeding windows, also showed significant differences among FW_1 (247.30±7.97 sec) and FW_3 (239.47±8.21 sec) with FW_2 (192.46±7.29 sec). The overall mean time spent for unrewarded visits showed a significant differences among the three FW_S; however the time spent in FW_3 (59.84±3.32) was significantly ($P<0.05$) higher than FW_1 (44.49±3.77 sec) and FW_2 (46.73±2.90 sec). Within unrewarded visits, FS_1 (45.02±4.29 sec) showed significant difference between FW_2 (42.47±3.14 sec) and FW_3 (59.58±4.45 sec).

In the duration of visiting pattern in rewarded visits, within the feeding station, the overall mean of individual feeding windows 1 and 3 showed a significant difference with FW_2 in both the stations. Duration of time spent on FW_2 (8.00 AM to 3.59 PM) by the cows was less compared to FW_1 (12.00 AM to 7.59 AM) and FW_3 (4.00 AM to 11.59 PM). The major farm routine activities like cleaning of shed, health checkup, heat detection and supply of green fodder were followed during 8.00 AM to 3.59 PM. The disturbances caused by these activities could be the reason behind less duration of time spent by the cows in FW_2. The mean duration of time spent by cows in FW_3 was more compared to FW_1 and FW_2. As the timing of FW_3 was from evening 4.00 PM upto night 11.59 PM, therefore, in this duration of time cows might not have experienced any disturbances due to farm activities and thereby they could spend more

Table 2. Time spent (mean±SE; sec) of crossbred dairy cows in different feeding stations and feeding windows under automatic concentrate feeding station

Visit Time spent	Station	Feeding window-1 (12.00 AM to 7.59 AM)	Feeding window-2 (8.00 AM to 3.59 PM)	Feeding window-3 (4.00 PM to 11.59 PM)	Overall mean
Rewarded (sec)	Feeding station -1	230.71±10.83^{a}	178.58±7.59^{b}	224.84±10.03^{a}	215.16±6.11^{A}
	Feeding station –2	252.55±12.22^{a}	206.33±9.36^{b}	254.11±11.58^{a}	237.66±6.67^{B}
	Overall mean	247.30±7.97^{a}	192.46±7.29^{b}	239.47±8.21^{a}	–
Unrewarded (sec)	Feeding station -1	45.02±4.29^{ab}	42.47±3.14^{a}	59.58±4.45^{b}	49.03±2.48
	Feeding station –2	43.95±3.64	50.99±4.73	60.10±7.17	51.68±2.96
	Overall mean	44.49±3.77^{a}	46.73±2.90^{a}	59.84±3.32^{b}	–

Values within a row bearing different superscript differ significantly ($P<0.05$). Values for specific parameter within a column bearing different superscript differ significantly ($P<0.05$).

time on AFS. Irrespective of feeding stations and feeding windows, overall mean duration of time spent for single visit in rewarded and unrewarded visits as 218.56±3.82 sec and 49.93±1.85 sec, respectively for 72 h. Collectively our findings revealed that the duration of time spent for unrewarded visits as lower than rewarded visits in the feeding station and it was similar to the findings of Wierenga and Hopster (1991).

From the above experiment, it was concluded that adaptation period of crossbred cows with automatic concentrate feeding station was shorter for older animals than younger ones, and the duration of unrewarded visits influenced the learning behaviour of animals.

ACKNOWLEDGEMENTS

The authors express their sincere gratitude to Dr A. K. Srivastava, Formerly Director and Vice Chancellor, National Dairy Research Institute, Karnal. The first author is a recipient of NDRI -Institute Fellowship. The authors are also thankful to Dr Nitin Tyagi, Dr Archana Verma, Dr Kaushal Kumar and Dr Ahmad Fahim for their scientific assistance during the study. Thanks are also due to Mr Gurpreet Singh and his team (DeLaval) for providing technical support during the course of the study.

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