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Electronic feed stations for feeding concentrates to pregnant ewes on commercial sheep farms

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Abstract (< 150 words)

The aim of this study was to investigate the use and capacity of electronic feed stations (EFS) on commercial sheep farms. The study was conducted on four commercial farms and the number of pregnant ewes per EFS were 36, 70, 72 and 80 respectively. Each farm was visited once and behavioural observations were carried out. In addition the date and time for both entering and leaving the EFS and the amount of concentrates dispensed at each visit for extracted. The vast majority of the ewes used the EFS regularly. The number of rewarded visits per ewe per day varied from 3.2 to 5.9, whereas the number of unrewarded visits ranged from 6.0 to 21.5 per ewe per day. We conclude that feeding concentrates to groups of pregnant ewes in electronic feed stations function satisfactory, but the design of the entrance and exit gate still have to be improved considerably.

Key words: electronic feeding stations, ewes, behaviour

Introduction

In Norway, sheep are usually kept inside for 7 – 8 months during winter and the majority of the ewes are kept in pens with slatted flooring, in groups of 11 – 20 animals and with a feed barrier where all the animals can eat simultaneously (Simensen et al., 2014). After lambing, usually in April and May, the ewes and their lambs are turned out on pasture. The general Norwegian recommendation for feeding of pregnant ewes is to provide free access to good quality roughage and supply some concentrates depending on stage of pregnancy (Nedkvitne, 1998). On some sheep farms, however, the roughage is provided in big bale feeders (Simensen et al., 2014) and hence another system for administering concentrates is needed. In recent years, electronic feed stations (EFS) have become an interesting alternative. The EFS was developed for dairy cows already in the 1960-ties (Harshbarger et al., 1968) and are now commonly used in commercial dairy herds and for group-housed dry sows (e.g. Olsson et al., 2011). Initial experiments with electronic feed stations for pregnant ewes (Jørgensen and Bøe, 2014) suggests/indicates that this system for providing concentrates can be used for sheep, but that both the design of the entrance and exit gates has to be improved. Currently, several commercial sheep farms in Norway have started to use EFS for pregnant ewes.

Not all ewes visit the EFS voluntarily, and the most appropriate method for teaching the older ewes was found to gently push the ewe into the feed station for one or more occasions (Jørgensen & Bøe, 2014). For younger ewes, a procedure including separating these individuals in a smaller area with the EFS for some hours and adding small amounts of concentrates on the feed station floor was successful.

A high capacity (a large number of individuals per feed station) is desirable because this will eventually reduce the investment costs per animal. For dry sows, the number of sows per EFS are reported to vary from 35 – 60 (Jensen et al., 2000; Olsson et al., 2011; Li & Gonyou, 2013) and in Danish herds up to 80 (Hansen et al., 2009). Whereas dry sows normally are fed a daily ration of concentrates of around 2.5 kg (NRC, 2012), the normal daily ration of concentrates for pregnant ewes is only 100 – 300 g in early pregnancy, increasing to 600 – 800 g in late pregnancy (Nedkvitne, 1998). Vik et al. (2017) found that the concentrate consumption rate was around 180 g/min and hence a ewe should be able to consume the complete daily ration of 400 g nearly within two minutes. In theory, one could, therefore anticipate that the maximum number of ewes per EFS are considerably higher than for dry sows.

The aim of this study was to investigate the use and capacity of electronic feed stations for feeding concentrates to pregnant ewes on commercial sheep farms.

Materials and methods

Animals, housing and feeding

Four commercial sheep farms in Norway using EFS (electronic feed stations) for pregnant ewes were contacted and responded positively to be included in the study. Each herd were visited once by a trained observer in the last part of February and first part of March. Herd A had two electronic feed stations with 36 and 38 ewes for each feed station respectively, but only the group with 36 ewes was included in the study. The number of pregnant ewes in the group on the other farms using EFS was 70, 72 and 80 in herd B, C and D respectively (Table 1). The ewes had at least two months of experience with the EFS. In herd C, however, a group of about 20 inexperienced ewes had been added to the main group just one week before the observations.

Table 1 here

The ewes in herd A, B and D were Norwegian White crossbreed sheep whereas the ewes in herd C was of the Spæl breed. Lambing was scheduled to the first part of April. The space allowance varied from 0.71 to 2.85 m^2/ewe. In three herds there were slatted flooring and in one herd there was deep straw bedding.

In all the four herds, the ewes had free access to good quality grass silage in round bale feeders located in the middle of the pen. Drinking water was provided using water nipples in one herd and water bowls in the three other herds.

Electronic feed stations

All ewes had a standard RFID-ISO (International Organiztion for Standardization) transponder earmark. The electronic feed stations were made by the Norwegian company A-K Maskiner. The EFS was a walk through- model with an air pressure- operated entrance gate, which was programmed to close when concentrates were released into the trough (see figure 1). The front (exit) gate was oneway, spring-operated with two independent doors which the ewes could easily pass through. The actual feed unit, originally designed for goats, was produced by GEA Farm Technologies – Westfalia Surge and controlled by the data programme Dairyplan DMS 21. An antenna surrounding the feed trough of the feeding unit identified the individual ewe.

Figure 1 here.

In all the herds, standard pelleted concentrates for sheep was provided in the EFS. The mean daily ration of concentrate varied from 265 g/day to 440 g/day (Table 1). The daily ration for each ewe was split into 3 to 10 portions (Table 1), distributed over the whole 24 h period. Approximately 40 g of concentrates were provided per pulse and the interval between pulses were 10 sec in herd A and 20 sec in herd B, C, and D, giving an output rate of 240 g/min and 120 g/min respectively. The entrance gate was shut during a rewarded visit and was set to open again 60 sec after the last feed portion was distributed.

Behavioural observations

Each sheep farm was visited once and then behavioural observations were carried out from 07:00 to 10:00 and from 12:00 to 15:00 by a trained observer (in total 6 hours). The following behaviours were scored using instantaneous sampling at 5 minutes intervals:

- Queuing behind the EFS; number of ewes standing with the head oriented towards the entrance gate, within 1 meter from the gate
- Lying behind the EFS; number of ewes lying within 1 m distance of the entrance gate
- Blocking the EFS; a ewe is standing in the feed station without being assigned concentrates, the entrance gate is open

In addition, all events of displacements were scored continuously:

- Displacement by front exit; ewe B manage to open the front exit gate and tries to displace ewe A that is currently in the feed station consuming concentrates.
- Displacement from behind; first ewe A and then ewe B enter the EFS before the entrance gate closes, and ewe B displaces ewe A through the front exit and consumes the concentrate ration assigned for ewe A (only rewarded visits).

Visits to the EFS

The computer programme Dairy Plan, controlling the EFS, was used to extract the following data for 3 days (72 h) after the visit to the herd:

- Identity of the ewe
- Date and time for both entering and leaving the EFS
- Amount of concentrates dispensed at each visit

Based on these data, number of rewarded visits (visits where concentrates were dispensed), unrewarded visits (visits where no concentrates were dispensed) and total number of visits for each ewe per 24 h period was calculated.

Occupation time of the EFS was calculated as time from a ewe entered the station (identified by the antenna surrounding the feed trough) and until she left the EFS. Even if the entrance gate was set to open again 60 sec after the last feed portion was distributed, it is the real occupation time that is presented here.

Results

Visits to the EFS

Total daily number of visits (per 24 h) to the EFS varied from 739 to 1428 (Table 2). Mean number of visits per ewe were highest in Herd A (25.6 visits/24 h) and lowest in herd D (9.1 visits/24 h) whereas mean number of rewarded visits were highest in Herd B (5.9 visits/24 h) and lowest in herd D (3.2 visits/24 h). The majority of the visits were actually unrewarded (65 – 82 %), and also here the differences between herds were large. Interestingly, the number of visits per ewe were actually lowest in the herd with the largest group size (herd D) and highest in the herd with the smallest group size (herd A). It is also interesting to notice that number of rewarded and unrewarded visits and total occupation time was apparently not differ in group C compared to the other herds even if 20 inexperienced ewes had been added only one week before the observations.

Table 2 here.

Maximum number of visits per ewe ranged from 35 in herd D to 64 in herd C. Both in herd C and D there were some individuals that did not visit the EFS within a 24 h period (Table 2). In general, the ewes visited the EFS all around the 24 h period.

Occupation time

The EFS was occupied for 09:17 (h:min) in herd A and 16:51 (h:min) in herd C (Table 2). Occupation time during rewarded visits however, involved only a small part of this, especially in herd A with the smallest group size.

Queuing and displacements

Mean number of ewes queuing varied from 2.8 in herd B to 4.5 in herd C (Table 3) whereas the maximum proportion of ewes queuing occurred in herd A (9 % of the ewes in the group). In herd C, there was always some ewes queuing but in the other herds, there were periods where no ewes were observed queuing. In herd C and D, ewes were almost never lying in the area behind the entrance gate, while this was quite common in herd A (Table 3). Occupation of the EFS without consuming concentrates was very common in all herds, but most prominent in herd C (Table 3).

Table 3 here.

Displacement by front exit was almost negligible in herd A and B and rather common in herd D (Table 3). Displacements from behind were observed in all four herds (Table 3) varying from 9 to 26 within the 6 h observation period.

Discussion

The vast majority of the ewes visited the EFS regularly. Only three ewes in herd C and two ewes did not visit the EFS within a 24 h period. However,these ewes entered the EFS during the 72 h period. Unfortunately, we do not have data over an extended period and hence cannot estimate the magnitude of this. Kjæstad & Myren (2001) indicate that 8 % of heifers did not use the feed station regularly. Hunter et al. (1988) point out that this also happens in groups of dry sows, but do not indicate numbers.

Displacements by front exit was not observed in herd B, but was quite frequent in herd D. Feed stations with a front exit is not used for dairy cows, but generally recommended for dry sows (Jensen et al., 2000; Olsson et al., 2011), as one-way traffic increases the capacity of the feed station (Edwards et al., 1988a). In order to avoid these displacements, the design of the front exit must be improved. Displacements from behind during rewarded visits was quite frequent in all herds, which imply that two ewes have actually managed to enter the feed station simultaneously. It is thus necessary to change the design of the entrance gate. Possibly, all the displacements may have caused some individuals not to visit the feed station regularly, but we have no data that supports this. Both the design of the exit and entrance gate on the new models of the feeding station have been further improved according to the feedback from these studies.

Installation of an EFS involves a high investment cost, and it is therefore interesting to consider the maximum number of ewes one EFS can serve. The output rate of concentrates in the present study was 120 or 240 g/min, which is slightly below or above the mean consumption rate for ewes (Vik et al., 2017). Hence, increasing the output rate further would probably not have decreased the actual occupation time during rewarded visits. The entrance gate was set to open 60 seconds after the last feed portion was distributed. This is obviously too long when considering the mean consumption rate for ewes (Vik et al., 2017), and shortening this interval could possibly increase the capacity of the EFS.

Another factor that is important for the capacity of the EFS is the number of unrewarded visits. Even though the occupation time per ewe was not affected, both the number of rewarded visits and total number of visits were lowest in the herd with only three daily rations of concentrates.

Dairy cows in full lactation are offered large amounts of concentrates, and spreading out the supply of concentrates over the whole 24 h period is therefore recommended. For the ewes in the present experiment, the daily concentrate allowance made up only a small part of the total daily feed allowance and hence splitting the concentrate into several daily rations has actually no purpose. Interestingly, studies in dry sows (Edwards et al., 1988b) showed that sows that obtained their daily ration in one visit were more settled and made fewer visits to the EFS than sows having to feed twice daily. It is recommended to feed dry sows on electronic sow feeders only once per day (e.g. Jensen et al., 2000). Hence, also for pregnant ewes in the EFS the option of feeding concentrates only once daily seem interesting. The fact that the number of visits per ewe were lowest in herd D, the herd with the largest group, could indicate that the low number of rations per day affected the number of visits, and also that the sows probably had learnt that there was no use to visit the EFS more often. In order to further decrease the number of unrewarded visits and occupation time, modern electronic sow feeders retract the feed trough and only make it accessible if the sow has ration remaining (e.g. Big Dutchman).

In Danish commercial herds, up to 80 dry sows per EFS are used. Data suggest that when number of sows is higher than 65, the number of sows not consuming their daily ration increase (Hansen et al., 2009). Hence, the Danish recommendation for maximum number of sows per EFS is 65. In the present study both in herd C and D with 72 and 80 ewes respectively, the occupation time for rewarded visits was only 04:51 and 07:36. Even if the daily allowance of concentrates will be increased in late pregnancy, it is possible that the number ewes per feed station could be increased to more than 80, given that the gates are redesigned and function properly. Factors like access to the feed trough only when allowed to feed and reducing the number of daily rations to one or two could potentially increase the capacity further. Regardsless this should be tested in future experiments.

Conclusion

We conclude that feeding concentrates to groups of pregnant ewes in electronic feed stations function satisfactory, but the design of the entrance and exit gate still have to be improved considerably. Concentrates could probably be fed only once daily to pregnant ewes.

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Table 1. Number of ewes, number of daily rations and daily allowance of concentrates in the four herds.

	Herd A	Herd B	Herd C	Herd D
Number of ewes in the group	36	70	72	80
Number of rations of concentrates per day	6	10	10	3
Mean daily allowance of concentrates (g/ewe)	440	301	341	265
Pen flooring	Slatted	Slatted	Slatted	Straw bedding

Table 2. Data on number of rewarded and unrewarded visits and occupation time in the four herds.

	Herd A	Herd B	Herd C	Herd D
Total number of visits in the EFS (visits/24 h)	944 ± 68	1428 ± 67	1044 ± 10	739 ± 4
Number of visits in the EFS per ewe (visits/24 h)	25.6 ± 1.0	20.4 ± 2.0	14.5 ± 0.6	9.1 ± 0.3
Number of rewarded visits per ewe (visits/24 h)	4.2 ± 0.0	5.7 ± 0.8	3.7 ± 0.08	3.2 ± 0.04
Number of unrewarded visits per ewe (visits/24 h)	20.4 ± 0.6	14.7 ± 2.3	10.8 ± 0.7	5.9 ± 0.2
Maximum number of visits per ewe (visits/24 h)	47	58	64	35
Minimum number of visits per ewe (visits/24 h)	8	5	0	0
Number of ewes not visiting the EFS within a 24 h period	0	0	3	2
Total occupation time (hour:min per 24h)	09:17	13:32	16:51	13:59
Occupation time, rewarded visits (hour:min per 24 h)	01:30	03:45	04:51	07:36

Table 3. Queing and displacements during the 6 h observation period in the four herds.

	Herd A	Herd B	Herd C	Herd D
Queuing behind the EFS (mean number of ewes and range)	3.1 (0 – 8)	2.8 (0 – 8)	4.5 (2 – 7)	3.5 (0 – 7)
Lying behind the EFS (mean number of ewes)	1.2	0.3	0.0	0.0
Blocking the EFS (% of observations)	72	64	85	49
Displacement by front exit (number per observation period, 6h)	4	0	10	70
Displacement from behind (number per observation period, 6h)	9	19	22	26

Figure 1. Picture of the feeding station used in one of the herds.