

## **Effect of Automatic Feeding Station use on fattening performance in lambs and intake activity periods**

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**Abstract.** Implementation of precise farming technology is very important for productivity increasing of livestock. One of the highest components of the production costs is feeding expenses. An automatic concentrate feeding stations (AFS) can ensure economic feed distribution and intake registration for animals individually. The aim of this research was to study the possibility and benefits of using AFS in fattening of lambs. Results show that during all the research average number of daily visits to AFS per lamb were  $13 \pm 0.2$  visits, average daily live weight gain per lamb was  $254 \pm 15.7$  g. For 1 kg lamb live weight gain 5.35 kg concentrate was used. More intensively activity periods of lambs was noted during following hours of day time: 02:00–02:59, 08:00–09:59 and 19:00–20:59. Significant ( $P \leq 0.05$ ) moderate positive correlation ( $r = 0.470$ ) was found between average daily number of visits to the AFS per lamb and total amount of concentrate consumed during the research per lamb. Significant ( $P \leq 0.05$ ) strong negative correlation ( $r = -0.806$ ) was found between average daily number of visits to the AFS per lamb and average amount of concentrate consumed during one visit.

**Key words:** sheep, feed intake, live weight gain, feeding station.

### **INTRODUCTION**

Behaviour of animals is relevant to the welfare requirements and has influence on the productivity traits (Konig von Borstel et al., 2011; Dodd et al., 2012; Jogman et al., 2017). Although the animals would stay in the pasture most of the time (Shepley et al., 2017), but it is not always possible to provide under the production circumstances. Therefore the total periods of daily activity (eating, walking, sleeping, drinking) and intake speed have been analysed in various research studies (Silva et al., 2015; Simeonov et al., 2015; Rahman et al., 2017) as well as behaviour of the animals by daily hours (Tobler et al., 1991; Refinetti et al., 2016), to improve as much as possible the feeling of comfort of animals also in the barn.

Ruminants, allowed in the pasture, consume first major part of the daily food intake already in the morning, which means by 09:00, and the maximal daily food intake has been consumed till 20:00 (Thompson et al., 1985). During the two major feeding times the animals consume daily the 60%–80% from the total daily food quantity, thus the total quantity of daily intake closely correlates with the quantity of food taken in the major feeding times (Jarrige et al., 1995). Intake speed under limited food distribution to

animals is higher than in cases, when animals have unlimited access to food. Should there be unlimited access to food, the animals themselves determinate intervals and eating times, wherein the food intake occurs considerably more slowly (Zorrilla et al., 2005). Moreover, the pH level in rumen depends significantly ( $P < 0.001$ ) on the feeding time. Animals, having continuous access to the food, can remain constant pH level during the whole 24 hours (Felix et al., 2017).

The aim of this research was to study the possibility and benefits of using automatic concentrate feeding stations (AFS) in fattening of lambs. The following tasks were set: 1) to analyze frequency of visits to automatic feeding station daily and during the lamb activity; 2) to analyze the amount of concentrate intake during the one visit in the automatic feeding station in fattening periods; 3) to analyze the lamb live weight changes and daily live weight gain during fattening.

## MATERIALS AND METHODS

The study about lamb fattening effect and behaviour using AFS was carried out on the farm 'Mežoki' located in Latvia (57.016996, 21.632202). The study was carried out in production conditions. In total the research was carried out from 16 July 2017 to 10 September 2017.

Ten male 50% Romanov  $\times$  50% Dorper (RD) and twelve (seven female and five male) unknown crossbreed (XX) lambs were used. Lambs were born in the period from 3 March 2017 to 15 May 2017. The characterizations of both groups of lambs are enclosed below (Table 1).

**Table 1.** Characterizations of the groups of lambs before research start-up depending on breed

Characterizations	RD (n = 10) $\bar{x} \pm S_{\bar{x}}$	XX (n = 12)
Age, days	77 $\pm$ 2.2 <sup>a</sup>	89 $\pm$ 5.7 <sup>a</sup>
Live weight before the research, kg	21.1 $\pm$ 0.86 <sup>a</sup>	24.1 $\pm$ 0.92 <sup>b</sup>
Place of borth	Germany, imported in farm, Mežoki'on 15 July 2017	Latvia, farm, Mežoki'
Keeping conditions before weaning	on pasture	indoor
Concentrate consumption before the research	had not received	received unlimited in free access

<sup>ab</sup> – traits with different subscriptions are significantly different ( $P \leq 0.05$ ).

The study was started after lamb weaning, adapting period was not ensured. During the research lambs were kept apart in a separate pen and provided continuous access to an automatic concentrate feeding station. The lambs were given free access to water as well. At the automatic feeding station lambs were offered concentrate of the following content: 46% of cereals (barley (*Hordeum vulgare* L.), maize (*Zea mays*), wheat (*Triticum*), wheat (*Triticum*) bran), 36% plant-based protein sources (feed beans (*Vicia faba*), sunflower (*Helianthus annuus*) coarse meal, rapeseed (*Brassica napus*) meal) and 18% the remaining ingredients (oats (*Avena sativa*), lime flour, molasses – liquid, NaCl). Concentrate content: 84% of dry matter (DM), protein 20.4% in DM, crude fibre 8.2% in DM, metabolizable energy (ME) 10.48 MJ kg<sup>-1</sup> of DM, neutral detergent fibre (NDF)

24% in DM, acid detergent fibre (ADF) 11% in DM, P 0.59% in DM, Ca 1.66% in DM. Under the study the daily concentrate feed rations for one animal were determined steadily increasing from 1,510 g (17 July 2017) to 1,780 g (10 September 2017).

Live weight monitoring of lambs was organized with a New Zealand company's Tru-Test automatic weigh scales. Weighing accuracy is  $\pm 0.1$  kg for animals with live weight up to 50 kg and  $\pm 0.2$  kg for animals with live weight 50–100 kg. Live weight control dates: 16 July 2017, 30 July 2017, 13 August 2017, 27 August 2017, 10 September 2017.

Concentrate distribution was organized using BioControl Norway JSC compound concentrate feeding station for feeding of individual sheep, identically as for the research made in 2015 (Šenfelde & Kairiša, 2016; Šenfelde & Kairiša, 2017). The external measurements of the feeding station are  $2 \times 8 \times 1$  m, its mode of operation – continuous. Form of the concentrate feed – pellets. One standard dose dispensed in the feeding station – 25 g, entrance gates closes after the dispensing the dose and remains closed for 30 seconds or longer if the next dose dispenses within 30 seconds, maximum limit intake at one visit to the feeding station – 300 g. Using the concentrate feeding station the following data were recorded: electronic ID number of the animal visiting the feeding station, date and time of the visit to the feeding station for each lamb, the amount of concentrate dispensed per visit, the amount of concentrate dispensed per day for each lamb after each visit, total concentrate amount for each lamb per day. The data from the concentrate feeding station were collected from 17 July 2017 to 10 September 2017, except 9 August 2017 when there was a failure in power supply. The obtained data were analyzed in the periods between live weight controls: from 17 July 2017 to 30 July 2017 (1st period), from 31 July 2017 to 13 August 2017 (2nd period), from 14 August 2017 to 27 August 2017 (3rd period) and from 28 August 2017 to 10 September 2017 (4th period).

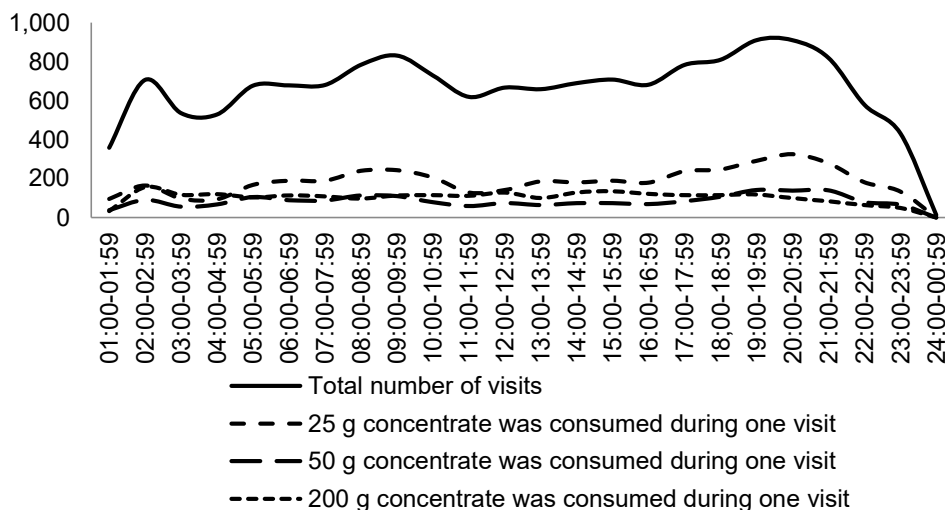
Data were analyzed within the framework of breed, regarding the total number of visits during the whole period of research, comparing results of lambs, visiting the AFS a less number of times (RD1 ( $n = 5$ ) and XX1 ( $n = 6$ )) with results of those lambs visiting the AFS more often during the whole period of research (RD2 ( $n = 5$ ) and XX2 ( $n = 6$ )).

The data were analyzed with mathematical processing methods, using software 'SPSS Statistics'. The number of visits, quantity of compound concentrate fed during one visit, live weight mean daily gain of lambs, standard error and the concentrate quantity necessary for 1 kg live weight gain were calculated. The amount of concentrate necessary for live weight gain of 1 kg was calculated dividing the total amount of concentrate (kg), which was fed, by the live weight gain (kg). The parameters obtained were compared between breeds, study periods and groups RD1-RD2, XX1-XX2 determining significance of their differences and designating with the upper-case alphabetical character; A, B,  $P \leq 0.05$  (between breeds) and lower-case alphabetical character; a, b, c  $P \leq 0.05$  (in other cases).

## RESULTS AND DISCUSSION

Dividing the total number of AFS visits by hours of the day several periods may be observed, during which the lambs visited the AFS more often (Figs 1, 2). Considering the total number of visits depending on hour of the day (Fig. 1) one can note that the AFS were visited by lambs more intensively in following hours of the day: 02:00–02:59,

08:00–09:59 and 19:00–20:59. These periods of activity of lambs do not match with the results stated in other research studies. Tobler et al. (1991) have shown that the active periods of sheep kept indoors occurs within time period from approximately 06:00 till 19:00, but according to article of Refinetti et al. (2016) the activity periods of sheep occur from approximately 08:00 till 20:00. In the same time the results of research of Nugroho et al. (2015) reveal increase of the eating activity at 06:00–06:29, 12:00–12:29, 18:00–18:29 and 00:00–00:29. Factors that could affect the results reported is the various feeding systems, sheep breed and age, air temperature, air humidity, lighting in barn or other.



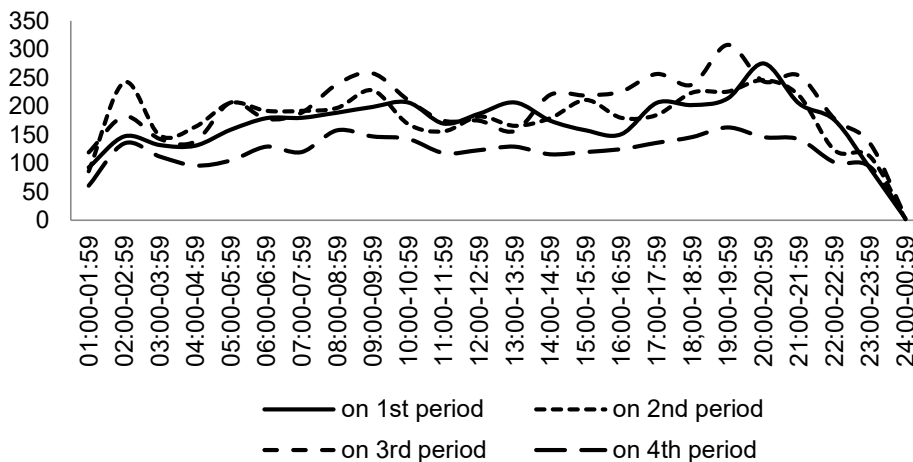
**Figure 1.** Number of visits to the AFS depending on concentrate consumed during one visit.

Analysing the number of AFS visits depending on the quantity of concentrate consumed per one visit, it may be concluded, that often (in 28% cases from the total number of visits) the lambs consumed 25 g of concentrate per one AFS visit. The most intensive eating periods during the day, when 25 g of the concentrate were consumed by lambs per one AFS visit conform to the intensity periods observed in the general curve of visits (02:00–02:59, 08:00–09:59 and 19:00–20:59). Amount of 50 g of concentrate were consumed by lambs per one AFS visit in 13% cases, but 200 g of concentrate – in 16% cases from the total number of AFS visits. Considering the number of visits depending on the quantity of concentrate consumed per one AFS visit (Fig. 1) it may be noted that the eating intensity within the above mentioned periods of the day is not typical for all other quantities of concentrate (except 25 g). It could be explained with the fact that should there be a queue formed in front of the AFS, the lambs consume 25 g per one AFS visit, because immediately after opening of the gate (30 s after dispensing out of the first portion) there comes the next lamb to the AFS and the previous one must leave the AFS. Should there be no queue at the AFS, the lamb can manage to require dispensing out of the next portion and consume higher dose per one visit (max 300 g).

Proportion of the rest quantity of concentrate consumed by lambs per one AFS visit from the total number of visits was as follows: 75 g – 9%, 175 g – 9%, 150 g – 7%,

225 g – 7%, 100 g – 6%, 125 g – 4.8%, 250 g, 275 g and 300 g was generally fixed in 0.2% of all cases.

Analyzing the number of AFS visits by research periods, numerically the largest number of AFS visits (4655 AFS visits) was achieved by lambs in the third research period (from 14 August 2017 to 27 August 2017), and the lowest number of AFS visits (2869 AFS visits) in the fourth research period (from 28 August 2017 to 10 September 2017). The eating activity increases in the same hours of the day, which were observed under the total number of AFS visits (at 02:00–02:59, 08:00–09:59 and 19:00–20:59, Fig. 2).



**Figure 2.** Number of visits to the AFS depending on research periods.

Among the breeds (Table 2) significantly different ( $P \leq 0.05$ ) results was observed in the average number of daily AFS visits per lamb (RD  $13 \pm 0.2$  visits, XX  $14 \pm 0.2$  visits,  $P = 0.000609$ ) and in the average quantity of concentrate consumed per one AFS visit (RD  $108 \pm 0.9$  g, XX  $105 \pm 0.8$  g,  $P = 0.026812$ ). The average increase of daily live weight gain per lamb among breeds does not differ significantly ( $P > 0.05$ ). The average daily live weight gain of RD lambs per day was less ( $246 \pm 26.3$  g) than average daily live weight gain of XX lambs ( $261 \pm 18.8$  g). In this research the average daily live weight gain of RD lambs was less than it could have been stated in the published results of other research studies (275 g – 388 g per day per lamb) of purebred Dorper sheep and their crossbreeds (Deng et al., 2012; Gallo et al., 2014; Gavojdian et al., 2015). The necessary quantity of concentrate for 1 kg live weight gain of RD lambs was higher (5.39 kg) than of XX lambs (5.32 kg).

Significantly different results for both breeds ( $P \leq 0.05$ ) were obtained in the fourth research period, in comparison with other research periods: the average daily number of AFS visits was significantly less (RD  $10 \pm 0.2$  visits, XX  $10 \pm 0.2$  visits), the average quantity of concentrate consumed per one AFS visit was significantly higher (RD  $140 \pm 2.0$  g, XX  $146 \pm 1.8$  g), the average daily live weight gain was significantly smaller (RD  $89 \pm 27.8$  g, XX  $113 \pm 22.8$  g) and the necessary quantity of concentrate for 1 kg live weight gain was the highest (RD 14.83 kg, XX 12.83 kg). In beginning of fourth research period the age of lambs were  $125 \pm 3.5$  days (RD  $119 \pm 2.2$  days, XX  $131 \pm 5.7$  days). Daily live weight gain reduction and concentrate consumption gain

in fourth period can be explained with peak productivity of lambs at the end of third research period (Šenfelde & Kairiša, 2017a).

**Table 2.** Daily number of visits to the AFS per lamb, concentrate consumed during one visit (g), daily live weight gain (g) per lamb and concentrate necessary for 1 kg live weight gain (kg)

Breed	Research period	Daily number of visits per lamb $\bar{x} \pm S_{\bar{x}}$	Concentrate consumed during one visit, g	Daily live weight gain per lamb, g	Concentrate necessary for 1 kg live weight gain, kg
RD	1	11 ± 0.5 <sup>a</sup>	103 ± 1.8 <sup>a</sup>	395 ± 44.5 <sup>a</sup>	2.95
	2	15 ± 0.4 <sup>b</sup>	97 ± 1.6 <sup>b</sup>	204 ± 44.9 <sup>b</sup>	6.56
	3	15 ± 0.4 <sup>b</sup>	100 ± 1.6 <sup>ab</sup>	297 ± 39.5 <sup>ab</sup>	5.00
	4	10 ± 0.2 <sup>a</sup>	140 ± 2.0 <sup>c</sup>	89 ± 27.8 <sup>c</sup>	14.83
	Total	13 ± 0.2 <sup>A</sup>	108 ± 0.9 <sup>A</sup>	246 ± 26.3 <sup>A</sup>	5.39
XX	1	15 ± 0.4 <sup>a</sup>	96 ± 1.4 <sup>a</sup>	367 ± 30.0 <sup>a</sup>	3.82
	2	15 ± 0.5 <sup>ab</sup>	95 ± 1.4 <sup>a</sup>	238 ± 25.8 <sup>b</sup>	7.28
	3	16 ± 0.4 <sup>b</sup>	99 ± 1.4 <sup>a</sup>	328 ± 22.2 <sup>a</sup>	4.30
	4	10 ± 0.2 <sup>c</sup>	146 ± 1.8 <sup>b</sup>	113 ± 22.8 <sup>c</sup>	12.83
	Total	14 ± 0.2 <sup>B</sup>	105 ± 0.8 <sup>B</sup>	261 ± 18.8 <sup>A</sup>	5.32
RD, XX	Total	13 ± 0.2	106 ± 0.6	254 ± 15.7	5.35

<sup>abc</sup> – traits with different subscriptions are significantly different ( $P \leq 0.05$ ) between research periods; <sup>AB</sup> – traits with different subscriptions are significantly different ( $P \leq 0.05$ ) between breeds; RD – 50% Romanov × 50% Dorper lambs; XX – unknown crossbreed lambs.

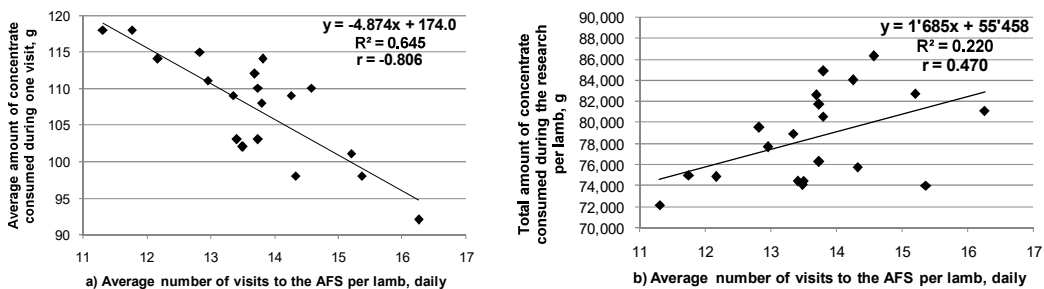
Analysing data depending on the number of AFS visits (Table 3), it may be noticed, that the average quantity of concentrate consumed by lambs, who visited the AFS less times (RD1 and XX1 group) was significantly ( $P \leq 0.05$ ) higher (RD1 112 ± 1.3 g, XX1 108 ± 1.1 g), in comparison with lambs visiting the AFS more often (RD2 104 ± 1.2 g, XX2 103 ± 1.1 g). The average daily live weight gain among groups within the framework of one breed does not differ significantly ( $P > 0.05$ ).

**Table 3.** Concentrate consumption during one visit (g) and live weight gain (g) depending on number of visits to the AFS

Group	Concentrate consumed during one visit, g $\bar{x} \pm S_{\bar{x}}$	Daily live weight gain per lamb, g	Concentrate necessary for 1 kg live weight gain, kg
RD1	112 ± 1.3 <sup>a</sup>	256 ± 42.9 <sup>a</sup>	4.99
RD2	104 ± 1.2 <sup>b</sup>	236 ± 31.6 <sup>a</sup>	5.83
XX1	108 ± 1.1 <sup>a</sup>	245 ± 24.7 <sup>a</sup>	5.41
XX2	103 ± 1.1 <sup>b</sup>	277 ± 28.4 <sup>a</sup>	5.25

<sup>ab</sup> – traits with different subscriptions are significantly different ( $P \leq 0.05$ ) between groups within breed; RD1 and XX1 – groups of lambs, visiting the AFS a less number of times, RD2 and XX2 – groups of lambs, visiting the AFS more often during the research.

The correlation was calculated for average daily number of visits to the AFS per lamb and average amount of concentrate consumed during one visit to the AFS (Fig. 3, a). The results showed the strong negative correlation ( $r = -0.806$ ) between mentioned factors, also the correlation was significant ( $P \leq 0.05$ ).



**Figure 3.** Correlation between average daily number of visits to the AFS and: a) average amount of concentrate consumed during one visit, g; b) total amount of concentrate consumed during the research, g.

Significant ( $P \leq 0.05$ ) moderate positive correlation ( $r = 0.470$ ) results showed between average daily number of visits to the AFS per lamb and total amount of concentrate consumed during the research per lamb (Fig. 3, b). Regarding both graphs (Fig. 3, a, b) one can note that lambs during all the research totally consumed more concentrate in case if they visited AFS more often and during one visit to the AFS consumed less concentrate.

## CONCLUSIONS

By using AFS it is possible to ensure continuous access (24 hour per day) to the concentrate for lambs during fattening with reduced human participation and costs. The average daily number of visits to the AFS per lamb achieved  $13 \pm 0.2$ . Generally, in the research following periods of the day may be noted, when the eating activity of lambs was increased: at 02:00–02:59, 08:00–09:59 and 19:00–20:59.

During one visit the lambs most often consumed 25 g, 50 g and 200 g of concentrate, which was fixed respectively in 28%, 13% un 16% of the cases from the total number of visits. If the lambs visited AFS more often, they consumed less concentrate during one visit to the AFS, but it did not affect the live weight gain.

The average daily live weight gain per lamb was  $254 \pm 15.7$  g in the whole research and the necessary quantity of concentrate for 1 kg live weight gain was 5.35 kg. Continuous access to the AFS for food consumption reduces the level of stress of the lambs and ensures better food conversion after intake.

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