

PROBLEMS OF COW FEEDING IN ROBOTIC MILKING AND LOOSE HANDLING CONDITIONS

Jānis Latvietis¹, Juris Priekulis², Indra Eihvalde³

Latvia University of Agriculture ¹Faculty of Agriculture,
²Faculty of Engineering, ³Research and Training Farm „Vecauce”
Jurs.Priekulis@llu.lv

Abstract. The research has been carried out on the training and research farm (MPS) of the LUA „Vecauce” in a milk cow barn where two robots are used for milking of cows. The cows receive silage and hay as well as a part of concentrated feed as a total feed mixture (TMR) that is freely fed at the feeding table but the animals receive the mixed concentrated feed programmed according to the milk yield in the milking stand and the feeding stand. The research describes rationing of nutrients according to the productivity of cows, the choice of the structure of the most suitable feed rations, the choice of the most economically profitable composition of feed mixture and concentrated feed distribution as well as the limiting norms for dosing of concentrated feed in the milking and feeding stands. The research results are used for improvement of the cow feeding and handling technology on the LUA MPS “Vecauce”.

Key words: feeding of cows, animal feed, robotic milking, loose handling, productivity of cows.

Introduction

In the new milk farming technologies cow milking robots and feeding stands occupy an important place. Since June, 2007 they have been introduced in the newly built milk farm on the MPS “Vecauce”. This farm is meant for 530 milk cows but at present there are a little more than 300 cows, including approximately 80 cows that are in the section where they are milked by means of robots. The application of the up-dated technology essentially reduces the necessary number of people on the farm and improves the quality of milk. Besides, supervision of cows becomes easier as all data are stored in the robot control computer.

Nevertheless, there are many unclear issues in the implementation of the new technology that are related to the problems of feeding cows. For instance, how to ensure the need of cows of different productivity level and physiological condition for feed dry matter, energy and main nutrients; how to choose the structure of feed rations and the kind of feeding suitable to a definite farm and peculiarities of handling cows; what limiting norms to determine for receiving concentrated feed in cow milking and feeding stands for cows of different productivity; what the economic profitability could be if the content of the total feed mixture and the concentrated feed feeding technology are changed. In the present research it is started to explain these issues.

Materials and methods

The research was carried out in the MPS “Vecauce” milk cow complex “Līgotnes” in the section of the newly built farm where robotic milking and cow loose handling system are introduced. The origin of the cows is Latvian browns, Holstein black and white as well as crossbreeds of Switzerland and some other breeds. Their age varied from the first to the fourth lactation but the productivity level during the experiment was 10-47 kg of milk per day with the average content of fat 4.4 %. The cows consumed grass and corn silage, perennial grass hay, self-produced concentrated feed (barley and other grain), common salt and some other feed admixtures that were fed as total feed mixture (TMR) and mixed concentrated feed. TMR was fed freely at the feeding tables but the concentrated feed – depending on the milk yield at milking and feeding stands.

In the research the parameters registered in the robot software were used: the frequency of milking every cow and the milk yield as well as the amount of concentrated feed consumed at the milking and feeding stands. Besides, the delivered and consumed amount of TMR was registered for every cow.

According to the obtained data the feed (TMR and concentrated feed) consumption activity was calculated for cows of five milk productivity levels (the milk yield of which is up to 10 kg, 11-20 kg, 21-30 kg, 31-40 kg and above 40 kg per day), the desired TMR content as well as the necessary concentrated feed feeding limitations (min., max.) at the cow milking and feeding stands were

determined and the economic profitability of including concentrated feed in the content of TMR was calculated.

The analyses of the chemical content of animal feed were made at the scientific laboratory of agrochemical analyses of the LUA and the biochemical laboratory of the joint stock company „Dobeles Dzirnavnieks”.

Results and discussion

Considering the recommendations of the National Research Center (NRC) and other scientific research organizations [2] the feed dry matter consumption limits and the necessity for the main feed nutrients of different productivity cows as well as the proportion of the rough forage (silage and hay) and concentrated feed in every feed ration were calculated.

Considering that in the new barn cows are handled loose and robotic milking is used the self-regulating principle dominates in feeding, that is, the animals can freely get to the feed mixture at the feeding table as well as get at the milking stand and feed station the programmed amount of mixed concentrated feed. Therefore, the content of the feed mixture (TMR) should satisfy the minimal requirements of the cows in the barn for energy (NEL), total protein, calcium (Ca), phosphorus (P), also common salt, but the needs of the most productive cows should be satisfied by feeding additional mixed concentrated feed at the milking and feeding stands.

Problems arise in the proportions of rough forage and concentrated feed in TMR and the amount of mixed concentrated feed that a cow should consume at the milking and feeding stands. On the one hand, the amount of concentrated feed in TMR should be enough for a cow to receive the amount of energy necessary for minimal productivity (10-15 kg milk yield) and it should be tasty enough that would stimulate the cow to consume the full planned amount. On the other hand – the amount of concentrated feed should not be too large, unsuitable for the productivity of cows and should not cause fattening. In turn, a possibility should be ensured for more productive cows to receive additionally to TMR the amount of mixed concentrated feed adequate to the productivity.

According to the research of scientific establishments [4] the cow consumes one kilogram of concentrated feed in approximately 3 minutes. So, in one milking time being in the robot stand for 5-8 minutes a cow can consume 1.5-2.5 kg of concentrated feed or 3-5 kg per day. The rest amount of concentrated feed (for a high productivity cow even up to 10 kg) should be fed in the feeding stands.

Considering the above mentioned requirements of feeding norms as well as the chemical composition of animal feed it is desirable to include in TMR (percentage of mass): silage of two kinds (grass and corn) 83-85 %, hay 5 %, concentrated feed (barley or other grain + mineral feed and other additives) – 10-12 %. The amount of concentrated feed to be fed to every cow including TMR is given in Table 1.

Table 1

**Feed consumption limits for a cow with body mass 600 kg
depending on the milk yield**

Milk yield, kg	Rough forage, kg		Concentrated feed, kg			
	Silage	Hay	In feed mixture	At milking stand	At feeding stand	Total
10	28.0	2.0	2.8	0.3	0.0	3.1
20	30.0	2.1	3.5	0.9	1.4	5.8
30	32.0	2.2	3.7	2.0	3.9	9.6
40	34.0	2.3	4.0	3.2	5.9	13.1
50	36.0	2.4	4.2	4.4	7.9	16.5

In order to determine the compliance of the feeding technology and the consumed feed ration to the recommendations elaborated at scientific establishments the compliance of the content of the main feed nutrients with the requirements of the NRC were compared. A cow with the body mass 600 kg, milk yield 20 kg per day and 4.4 % of fat content in milk was assumed as the relative average.

The characterisation of the feed ration and comparison with the requirements recommended by the NRC using robotic milking system at the MPS “Vecauce” are given in Table 2.

Table 2

Characterisation of the feed ration for a cow with the body mass 600 kg, milk yield 20 kg per day and 4.4 % of fat content in milk

Feed	kg	Dry matter, kg	Total protein, g	NEL, MJ	Ca, g	P, g
Silage, grass	16.00	5.7	825	32.5	49	16
Silage, corn	16.00	4.2	420	21.7	21	9
Hay, perennial grass	2.00	1.8	214	9.5	19	5
Barley	3.50	3.1	396	24.9	5	7
Mixed concentrated feed	2.30	2.0	449	15.9	15	14
Common salt	0.10	0.1	x	x	x	x
Mineral premix	0.13	0.1	x	x	13	14
Total	40.00	17.0	2304	104.5	122	65
Need (for NCR)	x	17.4	2296	105.4	92	58

As it is seen from the table the “relative average” cow will consume a sufficient amount of dry matter, NEL, total protein and minerals. So, also in the conditions of the new technology in planning of cow feed rations it is possible to orient according to the traditional recommendations of the scientific research establishments for rationing of feed nutrients. Feeding of five feed nutrients: grass silage, corn silage, hay, flattered barley grain and common salt with admix in TMR turned out to be profitable as it gave a possibility not to use equipment necessary for feeding every feed nutrient separately. Besides, high consumption of feed was ensured (97 %). It coincides with the investigations carried out earlier by our and Great Britain scientists [5].

In order to specify the limiting regulations for dosing of concentrated feed at the milking and feeding stands we calculated the amounts of concentrated feed delivered at these stands. They were quite variable. For instance, the cows with the average milk yield 23 kg additionally to TMR at the milking stand consumed in the average 2.2 kg of concentrated feed (lim. 1.0-3.4 kg), but at the feeding stands 4.5 kg of concentrated feed (lim. 0.9-8.8 kg). The total amount of concentrated feed delivered for one cow at the feeding stands varied from 2.7 to 11.7 kg or in the average 6.7 kg per day.

Nevertheless, determining the concentrated feed feeding limits not only the existing milk yield should be taken into account but also the lactation phase of the cow. Too large concentrated feed rations in the last third of lactation can result in fattening of the cow and other negative problems related to it. Therefore, the limits at the milking stand and especially at the feeding center feeders should be revised at least once a month.

The concentrated feed delivery limits that are obtained according to the results of our investigations are given in Table 3.

Table 3

Concentrated feed delivery limits for cows of different productivity

Milk yield per day, kg	Concentrated feed limit, kg		
	At the milking stand	At feed centers	Total
10 – 20	2.0 – 2.5	2.5 – 3.0	5.0
20 – 30	3.0	5.0	8.0
30 – 40	3.0 – 3.5	8.5 – 9.0	12.0
40 – 50	4.0	12.0	16.0

During the introduction of the new technology we faced several difficulties. The main of them – that a considerable part of cows are slow to attend the milking stand and a special person had to be hired to stimulate them. Although in literature [1, 3] facts are mentioned that in the robotic milking technology 97 % of cows adapt within a month’s time, in our observations even after three months 5-10 % of cows had to be driven to the milking stand.

In order to stimulate visiting of the milking stand starting from 24.09.2007 from TMR concentrated feed – barley flour – was excluded. After that in the next decade the consumption of concentrated feed reduced by 6.3 kg per day, including 3.3 kg of concentrates and 3 kg of rough forage calculating in the average per every cow and it remained the same also in the further period. Obviously, it has been influenced by worsening of the TMR taste qualities regardless of the high quality of silage and hay in the mixture. At the same time the consumption of the mixed concentrated feed at the cow milking stand has considerably increased – almost for 2 kg and at the feeding stands – by more than 3 kg. Comparing the periods of four decades before and after excluding of concentrates from TMR the total consumption of mixed concentrated feed has increased by 5.3 kg and it reached even 10.3 kg calculating in the average per cow per day (Fig. 1).

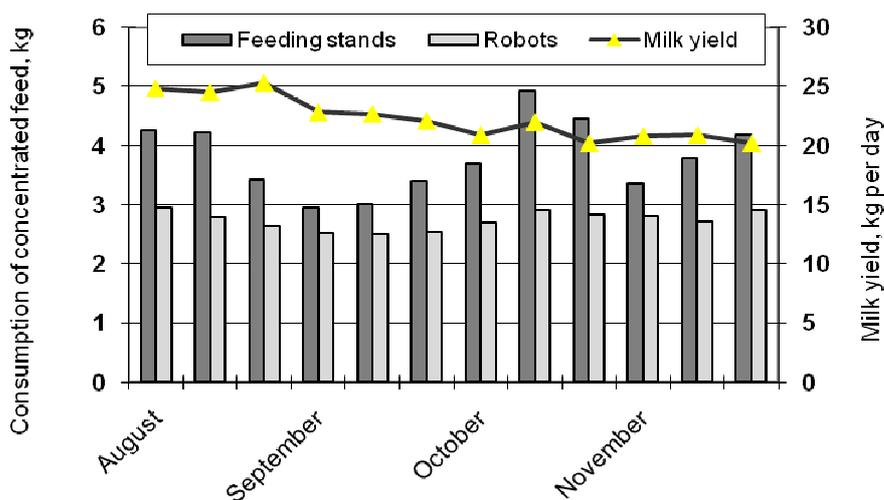


Fig. 1. Dynamics of concentrated feed consumption and milk yield changes in the period of time from 1.08. to 30.11. 2007

In the result the average milk yield during the first decade after excluding of concentrates from TMR reduced almost by 4 kg per cow per day and continued to reduce by 0.3 – to 1.1 kg during the decade. During four decades before and after exclusion of concentrates from TMR the average milk yield had reduced from 23.4 kg to 19.1 kg. It has been to some extent influenced by several objective reasons – a large part of the cows had passed into the last phases of lactation, 14 new cows have entered the barn that are not used to the new conditions, and also other reasons are possible.

The distribution of the amount of concentrated feed in TMR, milking and feeding stands for different productivity cows six decades before and after exclusion of concentrates from TMR is shown in Table 4.

Table 4

Average consumption of concentrated feed of different productivity cows

Period	Productivity group	Average milk yield, kg	Consumed concentrated feed, kg per day			
			TMR	At milking stands	At feeding stands	Total
Before exclusion of concentrated feed from TMR	10-20 kg	18.2	3.0	1.8	1.0	5.8
	21-30 kg	26.6	3.2	2.0	2.9	8.1
	> 30 kg	34.4	3.4	2.2	5.5	11.1
After exclusion of concentrated feed from TMR	10-20 kg	18.3	-	2.4	3.4	5.8
	21-30 kg	24.6	-	2.9	4.9	7.8
	> 30 kg	31.1	-	3.1	7.2	10.3

Considering that the proportion of concentrates included in TMR for all cows was equal – 10 % of the feed mass, the amount of concentrated feed consumed with it depended on the amount of the

consumed feed mixture that was a little bigger for high productivity cows. In turn, the amount of concentrated feed delivered at the milking stand was limited in the frame of 2-3 kg. Therefore, the biggest difference in the consumed amounts of concentrated feed occurred at the feeding stands that were accordingly bigger for high productivity cows.

After exclusion of concentrates from TMR the amount of mixed concentrated feed delivered at the milking and feeding stands adequately increased. Though the total amount of the consumed concentrated feed for the productive cows reduced: in the 21-30 kg milk yield group in the average by 0.3 kg but in the group above 30 kg – by 0.8 kg per day. With this also the average productivity of the cows from this group was lower compared to the period before exclusion of concentrates from TMR.

Evaluating the economic efficiency of TMR exclusion we must draw a conclusion that the difference from the point of view of money was approximately in the frame of 1.0 Lats calculating per cow per day in the favour of self produced and cheaper feeding of concentrates in TMR compared to feeding of expensive granulated mixed concentrated feed at the milking and feeding stands. At the same time the cows started to attend the milking stand more often and it was possible to reduce the number of the serving personnel by 1 person (cow driver).

Nevertheless, it will be possible to judge about the usefulness of feeding concentrates in TMR or silage machines not sooner than after a year when the cows after calving will return in the barn and will get used to the new technology.

It must be considered that the robotic milking and handling technology is still only in the stage of implementation. It is necessary to continue the research in cow feed consumption activities in different times during twenty four hours and in different microclimatic conditions depending on their productivity genetic parameters (breed, origin) and other conditions.

Conclusions

1. For determination of the cow feed rations in the conditions of the new technology it is possible to use the traditional feed rationing systems.
2. Usage of the total feed mixtures (TMR) in feeding of cows is profitable as it gives a possibility not to use the equipment necessary for delivery of every separate feed nutrient and high consumption of feed is ensured (about 97 %).
3. The amount of mixed concentrated feed delivered at the milking and feeding stands is quite variable: at the milking stand 1.0-3.4 kg (in the average 2.2 kg), at the feeding stands 0.9-8.8 kg (in the average 4.5 kg) per day.
4. Limitations of concentrated feed delivery at the cow milking and feeding stands have to be revised at least once a month and corrected for every cow considering the milk yield, lactation phase and the physiological condition of the cow.
5. Exclusion of concentrates from the total feed mixture increased the consumption of mixed concentrated feed at the milking and feeding stands, reduced the amount of the consumed rough forage, reduced the milk yield but stimulated more often attendance of the milking stands that allowed for reduction of the serving personnel by one person.
6. To improve and successfully implement the new technology it is necessary to continue the research in feed, including rough forage, consumption activities depending on the cow productivity and genetic parameters or other conditions.

References

1. Füberer A.; Kowalewsky H. – H. (2005). Praxiserfahrung mit automatischer Melksystemen. Kapitel 4.2. KTBL: Darmstadt. 47p.
2. Hillman D. (1993). Dietary nutrient allowances of dairy cattle./ Dairy Nutrition. Feedstuffs. July, 1993. pp. 54 – 66.
3. Laurs A. (2007). Robotic milking in Latvia: situation and perspective./ Proceedings of the 6th International Scientific Conference. – Jelgava. pp.377 –381.
4. Osītis U. (2005). Dzīvnieku ēdināšana kompleksā skatījumā – LLU. Jelgava. 320 lpp.
5. Ramane I., Latvietis J. (1999). Atgādinājums par barības maisījumiem./ Latvijas Lauksaimnieks, Nr.5, 1999. 20. lpp.