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20 Exercise yards for dairy cows

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Introduction

In accordance with the guidelines in Finland the exercise yards have to have a dense surface layer if their area is less than 20 m² per cow. In larger exercise yards the area in front of doors to the barn and the area around feeding facilities have to be hardened. The demand for hardened area per cow is 5 m² with the total limit of 300 m². Whenever the surface layer of the yard is hardened, the runoff waters coming from there must be collected to a pit. The volume of this pit has to be 0,2 m³ per m² of yard. Very often these guidelines lead to quite expensive solutions.

It has been counted that in our country there are about 200 exercise yards and feedlots. The total area of these is about 20 000 m². The number of exercise yards is about to grow because of the legislation on animal welfare. The act on animal welfare provides that during summer period dairy cows and heifers have to have the possibility to go to pasture or it has to be arranged a space in accordance with the purpose for them to move around. The period of transition ends at the beginning of the year 2006.

Exercise yards in Finland are mainly used during warm periods instead of letting dairy cows go out to the pasture. But there are also farmers who want to use these yards all the year round especially those running an organic farm. The aim of this research project has been to find acceptable solutions for exercise yards, their structure, covering and also space allowance, and for the treatment of runoff waters when keeping in mind the animal welfare, the environmental impacts and last but not least the economy of farming.

Material and methods

Exercise yards

In the project two exercise yards have been designed. The first yard consists of two different parts, the total area about 10 m² per cow. The area beside the barn is hardened with asphalt, 5 m² per cow, and the more distant area is covered with bark up to 30 cm, 6 m² per cow. The layer under the bark is gravel (about 30 cm) and at the bottom there are drainage tubes with the distance of five meters to meet the case to collect all the water coming through the upper layers. The aim of this partial solution is that the cows will have more area in use for a reasonable price. But if the area covered with bark gets too wet because of rain or snow it can be cut off and the cows can still go out on the asphalt area. The yard has been fenced in with a simple timber fence with the height of 1,30 meters. The cows are observed to find out witch of these two areas they prefer. The estimated costs of the asphalt area are 18,5 €/m² and of the bark cover area 8,5 €/m².

The other exercise yard has an area of about 20 m² per cow. It is hardened with a 10 cm layer of stabilized slag. Two ways of mixing the slag with the cement have been tested. The slag has been mixed with a harrow or with a rotary cultivator and packed with tractor. A 20 cm layer of granulated slag is also used in the supporting structure because of its insulating properties. The yard has been fenced in with a timber fence with the height of 1,50 metres. The compactness of the surface structure is monitored by taking samples under the stabilized slag layer from three different depths; 0-10 cm, 10-20 cm and 20-30 cm below. The estimated costs of this yard are 11,3 €/m².

In both cases the runoff waters are collected and the amounts of these waters are measured. Samples from the runoff water have been taken regularly and the nutrient content (total N, NH_4-N, NO_3-N, total P, PO_4-P, dry matter, pH, total COD) and hygienic quality are analysed.

Filters for runoff water

Different kind of filters to purify the runoff waters from the exercise yards have been designed and tested in laboratory. The tests have been carried out in two steps; first with single materials and after that with mixtures of these materials. Materials used in these filters are straw, peat, sawdust and woodchips. The mixtures used are straw-peat and straw-woodchips. The temperature in the laboratory has varied between +16,4 °C and 16,6 °C and the relative humidity between 65 % and 77,5 %. The tests in laboratory have been done in three replicates.

The filters tested have been 30 cm thick with the surface area about 0,125 m². Diluted cow slurry with normal and reduced amount of dry matter was added to each filter seven times a day during 22 days. The total amount of added diluted slurry was 149 litres. The amount of runoff water coming through the filters was measured. Samples from the slurry and out coming water were taken daily. From the samples total N, NH_4-N, NO_3-N, total P, soluble P, dry matter, pH, total COD and soluble COD were analysed.

Results and discussion

Exercise yards

The first yard has been built during the years 1999 and 2000. Cows have been using the yard daily. During warm periods cows have been able to use the area freely but during winter time they have been let out in groups. Cows have preferred the bark surface even if they have had hay to eat on the other part of the yard. There was enough room for the cows also when giving them extra hay. The fence was too low. In winter snow heaped up beside the fence and cows were able to step over it. Now the fence has been made higher up to 160 cm.

The asphalt area has been easy to clean and collect the manure. Also the runoff waters have been easy to collect except on late autumn and early spring when the wells were frozen. The asphalt surface became slippery during winter; especially areas sloping between 5 and 7 % caused problems.

The bark covered area was blocked a couple of times after heavy rain and snow fall. After a few days it was taken into use again. After one year in use the bark had worn out and gone into pieces so that it had to be removed. The bark was transferred to the field.

It was not possible to measure the exact amount of runoff waters coming from the asphalt area because of the blockages in the pump and tube used. Samples taken from the runoff water on asphalt area showed very high nutrient concentrations while the ones taken from the tubes under the bark and gravel layers showed lower levels, table 1. In the samples taken from the bark covered area the phosphor values were on the same level as in the runoff

waters from arable land. The hygienic quality of these runoff waters is shown in table 2. The concentrations in samples taken from the asphalt area were on the same level than those of slurry and municipal waste water. Although the concentrations in samples taken from the bark covered area were significantly lower than those from the asphalt area they didn't fulfil the limiting values given for swimming waters in EU.

Table 1. The nutrient concentrations of runoff water samples taken from the exercise yard 6.4.–12.11.2001. 40 samples from the asphalt area and 30 samples from the bark covered area. (Uusi-Kämppä & al. 2002)

	The asphalt area			The bark covered area		
	Median	Maximum	Minimum	Median	Maximum	Minimum
PO_4-P (mg/l)	24,3	49,7	6,7	0,1	1,8	0,0
Tot-.P (mg/l)	48,6	113	15,2	4,3	14,2	1,2
NO_3-N (mg/l)	0,07	1,24	0,02	0,01	0,88	0,0
NH_4-N (mg/l)	77,9	486	1,9	29,2	47,2	6,2
Tot-N (mg/l)	179	907	16,2	43,3	84,1	6,7
COD (mg/l)	3000	11 300	544	2900	4900	1900
Dry m. (g/l)	3,4	9,6	0,6	2,9	4,3	2,0
pH	7,7	8,3	7,2	6,0	8,4	5,4

Table 2. The hygienic quality of runoff water samples taken from the exercise yard (pieces/100 ml). (Uusi-Kämppä & al. 2002)

	The asphalt area	The bark covered area	The limiting value for swimming water in EU
Faecal coliform	700 000 – 120 000 000	130 000	< 500
DNA- coliphages	100 000 – 4 000 000	18 000	< 10 000

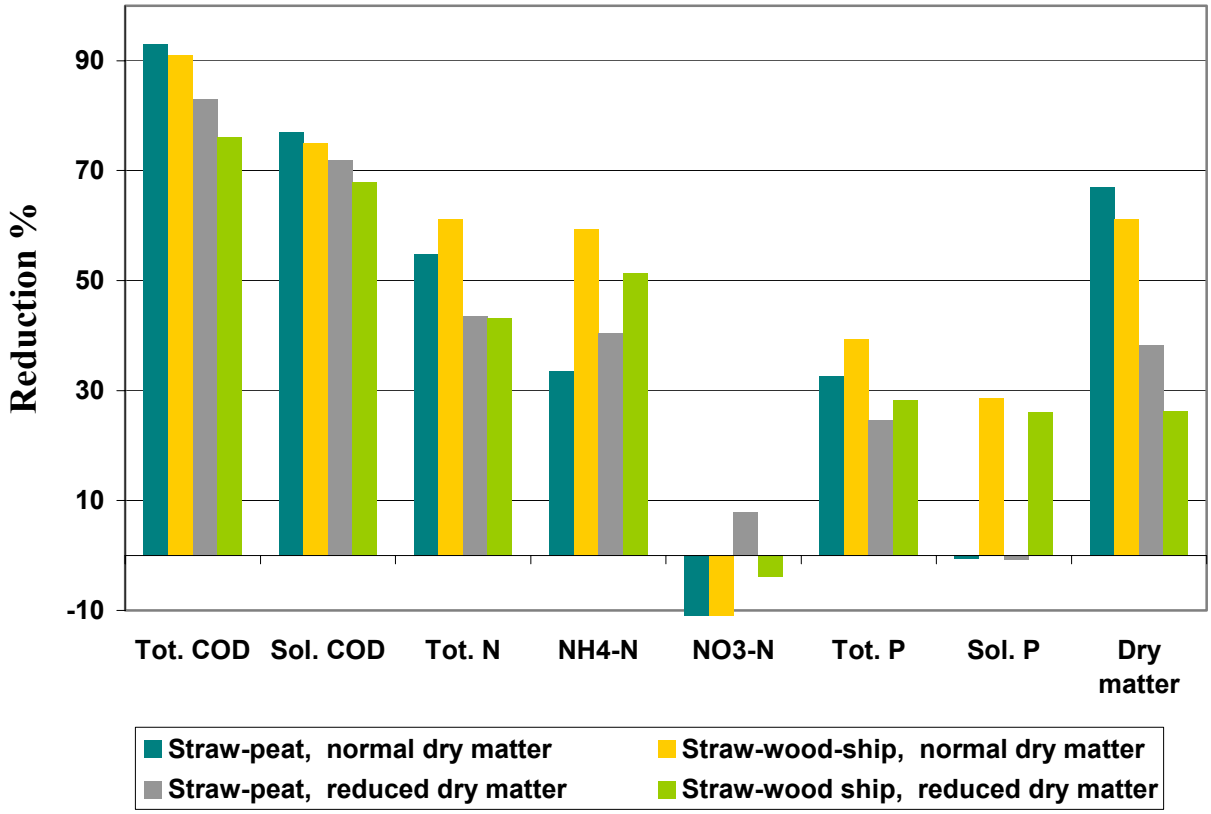
The second yard was built during the autumn 2001. The work was performed by the farmer himself with the machinery available on the farm. Cows have not yet been using the yard. The surface of the yard seemed to be quite rough. It has been recommended that fine slag or sand is spread to the surface before cows are taken to the yard, to prevent damages to their hooks.

Filters for runoff water

The diluted slurry including normal amount of dry matter blocked quite soon the surface of the filters so that the diluted slurry flew much slower through the filters than the slurry with reduced amount of dry matter. This deceleration led to better results in reduction of both total and soluble COD, total N and P and dry matter. The reduction in both total and soluble COD were very good (70 – 90 %) with both filter mixtures. The reduction of total N and NH_4-N were between 35 and 55 %. But the reduction of NO_3-N was mainly negative. The

reduction on total P and soluble P were modest. The reduction in dry matter was much better with diluted slurry including the normal amount of dry matter. This resulted in the fact that the dry matter in runoff water from these filters was lower than that of filters where diluted slurry with reduced dry matter was added. The results are shown in figure 1.

The pH measured from the samples was at the beginning near 7 and rose to about 8 towards



the end of the laboratory test.

Figure 1. The total reduction of COD, nutrients and dry matter with different filter mixtures

Conclusions

The required area per cow depends on the use of the exercise yard. If all the cows are forced to go out at a certain time and if they are fed in there, an area between 5 and 10 m² per cow is needed. But if there is no feeding and the cows have free access to the yard only 4 - 5 m² per cow is needed. The fences have to bee high enough, height of 150 –160 cm is recommended.

The structure of exercise yards depends mainly on how much area there is per cow. When the space allowance is small it is recommended to have yards with hardened surfaces. If there is more room, then part of the yard can be covered with soft material, which cows find comfortable. It is recommended to design the yard so that the area covered with soft material

can be blockaded when ever it gets too wet. Always, the area around doors and feeding equipment should be hardened.

Surfaces of exercise yards stabilized with slag or cement can be mixed with machinery available on the farm. But it is recommendable to pack the yard with a roller in order to achieve a smoother surface.

The design of sloping has to be very careful. There has to be enough sloping to ensure the runoff waters to flow to their collection wells. But during winter time, as the yards get frozen and slippery, sloping over 5 % can cause serious problems. If this kind of sloping is not to be avoid it is recommendable to use electricity or some other system to maintain the sloped area unfrozen.

The laboratory tests have shown that with filters consisting of straw, peat or woodchips it is possible to significantly lower the nutrient content of runoff waters. The problem with the filters is that the dry matter content of runoff water must be lowered before entering the filter. If that is not done the filter will quite soon be blocked and the whole filter material has to be changed. Although the filters can be designed so that they can easily be refilled, it is reasonable to settle the dry matter in runoff waters. The materials in the filters should be selected so that the spent filter material can be spread to the field.

Runoff waters coming through this kind of filters include still so much nutrients and COD that it is recommendable to lead the waters to some kind of land treatment system; wetland, reed-bed system, treatment system with willows.

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