A decision support model simulating the vitamin supply over the year on a farm

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Abstract **– The aim of this new project is to develop a prototype of a decision support model simulating the feed and vitamin supply during a year to different groups of animals (calves, heifers, dry cows, cows in early and late lactation) on a farm self-sufficient with feed. The model takes into account that the content of vitamin depends on choice of crops, utilization method, cutting date, conservation method and duration of storage together with traditional optimizing the feeding scheme.**[1]

INTRODUCTION

Self-sufficiency and recirculation of nutrients within the farm are central elements in the organic principles (IFOAM, 2002). On the organic farm animal and crop production should exist in a harmonious balance supplying the animals with the full spectrum of nutrients. If supplements such as vitamins and micro minerals are necessary they should come from natural sources, if possible (IFOAM, 2002; CEC, 1999). However, the regulation of the Danish organic livestock production still allows for a number of exceptions from these principles, such as use of synthetic vitamins A, D and E for ruminants (Plantedirektoratet, 2005). Only recently Danish organic dairy herds changed to 100% organic feeding and most supplements of minerals and vitamins are still based on inorganic and synthetic products imported to the farm.

Our hypothesis is that self-sufficiency with vitamins could be obtained at farm level through optimization of the choice of forage crops and management and combination of feedstuffs used.

CONTENT OF VITAMINS IN FEEDSTUFFS

Fat-soluble vitamins are important for ruminants in respect to maintain an optimal immune function, reproduction traits and a high quality of the food products produced (Knudsen et al., 2001). The recommended level is shown in Table 1. In cattle feed the highest concentrations of pro-vitamin A (in the form of ß-carotene) and vitamin E (α-tocopherol) are found in the green leaves of grass, legumes and other green plants, while stem and seeds together with more mature crops as whole crop and corn silage only contain small amounts (Jensen, 2003). Grazing cattle normally have their requirements for fat-soluble vitamins met (Knudsen et al., 2001). However, during the indoor season, when conserved herbage are used instead of pasture, the content of fat-soluble vitamins may decrease to very low amounts depending on harvest time (in relation to plant development), harvest conditions, conservation method and storage conditions, (Kivimäe & Carpena, 1973). Knowledge about how to avoid this decrease is essential for obtaining self-sufficiency. Compared to the fresh crop the content of vitamin E in the ensiled crop was 33% lower, according to McDowell et al. (1996), but content of vitamin in ensiled feeds show a great variation and decrease with prolonged storage, high temperature and high moisture (Kivimäe & Carpena, 1973). The loss of vitamin in ensiled feed seems to be greater for whole crop than for grass silage, probably due to the higher risk to create heat (Knudsen et al., 2001). The extent to which vitamin E is destroyed during haymaking was found to be directly dependent on the method of drying, as natural drying in the sun can reduce the level to zero in four to five days whereas the loses are smaller with artificial drying (Kivimäe & Carpena, 1973).

DATA FOR THE MODEL

Another part of the project includes studies on the content of vitamins in fresh and ensiled forage crops including the role of harvest time and methods, preservation and effect of storage on the available amount of vitamins. Furthermore, the role of different species and seed mixtures (timothy, white clover, red clover, alfalfa, chicory, birds-foot trefoil) in pasture will be studied. These results will be used as input for the model.

THE MODEL

The model is a static, deterministic model that calculates the consequences of choosing different strategies for feed production: type of crop, use of herbs, harvest time, preservations methods, time of storage on the supply of vitamins for the different animal groups (calves, heifers, dry cows, early and late lactating cows) during the season.

To illustrate the variation in vitamin supply, some preliminary calculations have been made for vitamin

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E based on literature values (Table 2) for content of vitamin E in different crops and the variation in the content caused by type and quality of silage produced.

Table 1. Recommended level for supply of vitamin E in Denmark (Strudsholm et al., 1999)

	Vitamin E, mg/day
Milking cow	400-800
Dry cow 7-4 w.p.p	400
Dry cow 3 w.p.p - calving	800
Heifers	100-250

As shown in Table 2 the average content of vitamin E in fresh grass-clover has been found to be 150 mg/kg dry matter with a variation of +/- 33%. The level of vitamin E in grassland crops generally falls as development approaches seed-maturity (Kivimäe & Carpena, 1973). For lucerne and timothy content of vitamin E falls 20-65% depending on whether the crop is harvested at the grass-stage or at the full-flowering-stage (Kivimäe & Carpena, 1973). In silage Flye & Strudsholm (1994) found that variation in the digestibility of whole crop silage could explain 25-85% of the variation in content of vitamin E.

In the present calculation it was assumed that the level of vitamin E in grass clover silage was 62 mg/kg dry matter for silage of middle digestibility, 62 mg + 33% for grass-clover silage of high digestibility and 62 mg – 33% grass-clover silage of low digestibility.

Table 2. Content of vitamin E in different feedstuffs (Carlsson, 2000; Jensen, 2003)

	Variation, mg/kg dm	Average
Grass clover	100-200	150
Grass clover silage	10-150	62
Maize silage	5-55	26
Barley whole crop silage	10-35	17
Barley	5-15	12
Barley straw		5
Hay	15-65	30
Grass pellets	30-100	50

Three feeding strategies were defined with different type of silage (grass clover, barley whole crop or maize) and three feeding strategies were defined with different digestibility of grass clover silage (high, middle or low). For all strategies was assumed a fixed farm size of 200 (ha / pieces of cattle / ???.

RESULTS

As shown in Table 3 the level of vitamin E supply for cows in early lactation variates from 827 mg/day when the roughage consists of 50% whole crop silage, and up to 1,249 mg when the roughage consists of high digestible grass clover silage only. The vitamin E supply depends strongly on the digestibility of the grass clover silage: from 622 mg with low digestibility and 1,249 mg with the high digestibility.

Only with roughage consisting of high digestible grass clover silage the recommended level is reached for dry cows.

When growing grass clover for silage both financial considerations and considerations of supply of vitamin E indicate a preference for high digestibility, whereas a farmer with a high crop yield potential in maize had a conflict between an optimized economy and the vitamin E supply.

Table 3. Winter-feeding (kg dm/cow/day) of cows in early lactation and the resulting vitamin E supply from feed (mg)

Strategy	Clover grass silage			Maize	Whole crop
	High[1)]	Midd.	Low		
Barley	5.4	5.4	5.4	4.5	4.5
Grass pellets				1.6	1.6
Clover grass silage	14.4	13.9	13.3	10.3	7.1
Maize silage				3.3	
Whole crop silage					6.6
Barley straw				0.2	
Total vitamin E, mg	1,249	910	622	1,072	827

1) Digestibility of organic matter

CONCLUSION

When the project has generated more knowledge about content of vitamin E in organically grown crops the model will be more balanced including for example the effect of season and thereby taking into account the loss of vitamin E during storage.

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