Danish Research Centre for
Organic Food and Farming

Progress Report 2008 and Application for Continuation in 2009

for research funding under the research programme:

Research in Organic Food and Farming
International Research Co-operation and Organic Integrity
(DARCOF III 2005-2010)

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1. Project title and acronym

Increased integrity in organic dairy production through natural sources of vitamins and minerals and non-antibiotic health control

Acronym: ECOVIT

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2. Project journal number

3304-FOJO-05-13-01

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3. Project period (month, year)

Start of project: **01/2007**
End of project: 12/2010

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4. Head of project

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Ilka C. Klaas has left the faculty. Her role in the wp5 has been taken over by T. W. Bennedsgaard ,Mette Vaarst and Lindsay Kay Whistance .

7. Midterm description of the project, its results and progress, and application for continuation in 2009

A. Project summary (from application)

The organic production is based on organic principles and objectives including naturalness, reduction in the use of resources and recirculation of nutrients.
Recently the requirements for the organic milk production have been strengthened. Today the feeding must be 100 percent organic, use of synthetic vitamins will soon be prohibited and alternatives to antibiotics must be used when their effect has been documented. These new requirements have made self-sufficiency or use of only Danish feedstuffs more relevant. Strategies with a higher degree of self-sufficiency will increase the importance of the feedstuffs being produced on the farm, conservation and storage of the feed and the composition of the ration. Our hypothesis is that the ration throughout the year can be balanced in a way that fulfils the requirements for vitamins and that on some soil types the requirements for micro minerals can also be fulfilled.

Vitamins and minerals are of great importance for the health and production of the animals, and they also affect the nutritional value of the products. The highest concentration of vitamins is found in the fresh green leaves of the crops. Some herbs and crops have especially high levels of one or more minerals. The increasing use of corn silage in Danish dairy herds has a drawback since corn is low in both vitamins and minerals compared to grass and legumes. The content of vitamins and minerals will depend on the season, the production and the content of minerals in the soil. Knowledge about these aspects could be used to control the level of vitamins and minerals in the forage. A large number of Danish organic herds are located on sandy soils, characterized by a low content of minerals. Thus self-sufficiency with all minerals in herds raised on these soils might by impossible. In wintertime dairy cows might have problems with sufficient supply of the fat-soluble vitamins A, D and E, especially from conserved feedstuff. In this project the role of the choice of forage crops will be examined by controlled field experiments and by studies on selected farms with different soil types. In a PhD. study running parallel with this project, the role of sunlight for the supply of vitamin D to dairy cows will be examined.
Whereas the minerals will normally not be lost during storage, the vitamins will undergo continuous degradation. In the project the role of the conservation method, the conditions at harvest and choice of crops will be studied. The results obtained will be used to conduct controlled experiments with two different rations with the first optimised to supply the cow with the best possible amount of vitamins and minerals from natural sources and the other ration optimised for the best possible production economy.
The complex interactions between forage crops, growing conditions and the availability of vitamins and minerals are one of the reasons that inorganic supplements of minerals and synthetic vitamins are used to a large extent in organic dairy farming today. However, in a few cases indication of mineral or vitamin-deficiency can be found. In the project the micro mineral status will be assessed in a number of dairy herds that have already been presented with some of the possibilities for an integrated supply of vitamins and minerals. The level of minerals will be compared to the health of the animals (mastitis-indicators). In a controlled experiment the possibilities for and effect of an integrated vitamin and mineral supply including the strategic choice of forage crops and feed management in a dairy herd will be evaluated.
Changes in forage crops and the ration affects many aspect on the organic farm. In the project the consequences of an integrated approach to vitamin- and mineral supply will be accessed by system analysis based on information from a number of farms. Based on the results from the other part of the project and the farmers experiences tools for decision support and simulation of the consequences will be developed.
According to the EU-regulations for organic livestock production, alternatives to antibiotics should be chosen if they have a documented effect. In the USA the use of antibiotics for organic animals is not allowed; treated animals lose their organic status forever. A central element in both regulations is to prevent disease by promoting healthy and robust animals. The consequences of these strategies are not fully described and the choice of alternatives to antibiotics is almost only based on the farmers' own experience. The documentation for most of the products used, primarily based on plants like Aloe

vera and garlic, and improvement of the mineral status by e.g. seaweed and stone dust as well as other kinds of alternative treatment like acupuncture and homeopathy is very limited. This means that the restrictions in the EU-regulation do not have any real impact today. In the project information on common practices in the USA and a number of European countries will be collected and the most promising treatment protocol will be examined through controlled experiments.

Table A.1: Work package list (from application)

WP No.	WP title	Responsible scientist	Budget DKK	Start	End	Deliverable No.
1	Project coordination and communication	TWB	232	01/ 2007	12/2010	D1.1-D1.3
2	Minerals and vitamins in fodder crops	KAS	3733	01/2007	12/2010	D2.1-D2.9
3	Integrated vitamin and mineral supply	SKJ	1932	1/2007	12/2010	D3.1-D3.6
4	Micro mineral status and relation to health	TLA	1437	1/2007	9/2010	D4.1-D4.3
5	Health promotion and effect of selected non-antibiotic disease treatments	TWB	2333	1/2007	9/2010	D5.1-D5.7
6	System analysis and perspectives for integrated vitamin and mineral supply at farm level	TKR	1533	1/2007	12/2009	D6.1-D6.4
Total			11200			

B. Objectives and expected achievements

The main objectives of the project are:

- To improve the integrity of organic dairy farming by evaluating strategies for an adequate supply of vitamins and minerals to dairy cows and calves from organic feedstuffs and to improve the health of organic dairy cows without use of allopathic treatments.
- To describe the role of the choice of crops, time of harvest, conservation and storage as well as soil type and the composition of the ration with regard to the supplementation of primarily Zn, Cu and Se and vitamin A, D and E.
- To evaluate strategies for supply of minerals and vitamins in organic dairy herds by the animals mineral- vitamin- and health status.
- To describe and develop tools for modelling the consequences of an integrated supply of vitamins and minerals on herd level through system analysis.
- To evaluate international and national experience on handling of diseases without antibiotics and conduct controlled studies on the most promising disease treatments with natural medicine.

C. Midterm results and progress

C.1 Description (summary) of main results and conclusions for each year

WP 1 Project coordination and communication

A project webpage has been established on www.ecovit.elr.dk and www.ecovit.elr.dk/uk . The pages are continuously updated.

Wp 2 Minerals and vitamins in fodder crops

Plots on Foulumgård

Nine different seed mixtures for a cutting management were established in 2006 with four replicates at Foulumgård. The growth, competitiveness and herbage quality are examined during spring growth and 3rd regrowth (May and August). The dry matter yield in the second harvest year 2008 is shown in table 1. Birds-foot trefoil is normally not used in DK. The yield level seems no to be sufficient compared to other legumes (Tables 1).

Table 1. Dry matter yield in 2008. Cut 4 will be harvested in October.

Grass	**Legume**	**Cut 1**	**Cut 2**	**Cut 3**	**Cut 4**	**Total**
Perennial ryegrass	White clover	3750	3595	2899		10245
Perennial ryegrass	Red clover	5118	5061	4374		14552
Perennial ryegrass	Birds-foot trefoil	3425	2930	2738		9093
Perennial ryegrass	Lucerne	3957	3847	4201		12005
Meadow fescue	White clover	4877	3467	3236		11581
Timothy	White clover	3706	3585	2839		10130
Hybrid ryegrass	White clover	4644	3661	2675		10980
Perennial ryegrass		2665	2699	2028		7392

Hybrid ryegrass had a surprisingly high feeding value, a high digestibility organic matter and a low content of cell wall and lignin. Birds-foot trefoil had a surprising low feeding value considering the relative low yield. Analysis of vitamins and minerals are not finished.

Table 2. Herbage quality in the single species. Mean over the season 2007.

	IVOMD[1)]	Cell wall[2)]	Hemicellulose[3)]	Cellulose[4)]	Lignin[5)]	Crude protein
Perennial ryegrass	81.6	45.2	19.2	24.3	2.0	15.5
Meadow fescue	79.2	49.7	20.6	26.9	2.3	14.1
Timothy	79.3	52.5	22.5	22.5	2.8	14.7
Hybrid ryegrass	82.6	42.5	17.7	17.7	1.8	13.3
White clover leaves	82.0	21.8	2.8	16.2	2.8	24.2
White clover flowers	62.0	39.1	2.4	26.4	10.3	19.6
Red clover	76.8	26.5	5.0	18.6	3.0	21.4
Birds-foot trefoil	72.4	26.3	5.5	16.1	4.6	21.8
Lucerne	69.4	36.0	6.2	23.9	5.8	21.6

[1)] IVOMD: in vitro organic matter digestibility, [2)] Cell wall: NDF, [3)] Hemicellulose: NDF-ADF, [4)] Cellulose: ADF-ADL and [5)] Lignin: ADL

All mixtures are ensiled at cut 1 and cut 4. A method was developed for standardization the pre wilting. The samples are dried in an oven without heating to 32 % $\pm$ 2 dry matter. In that way all samples can be pre wilted to the same dry matter level. The samples are ensiled in plastic bags and air is removed by vacuum at the beginning of ensiling. The samples will be analysed for vitamins, silage acids and feeding value.

Lucerne in August is wilted for hay and stored. The concentration of vitamin D2, alfa-tocopherol and beta-carotene decreased strongly during wilting and continued to decrease during storage. The concentration of fatty acids decreased slightly both during wilting and storage.

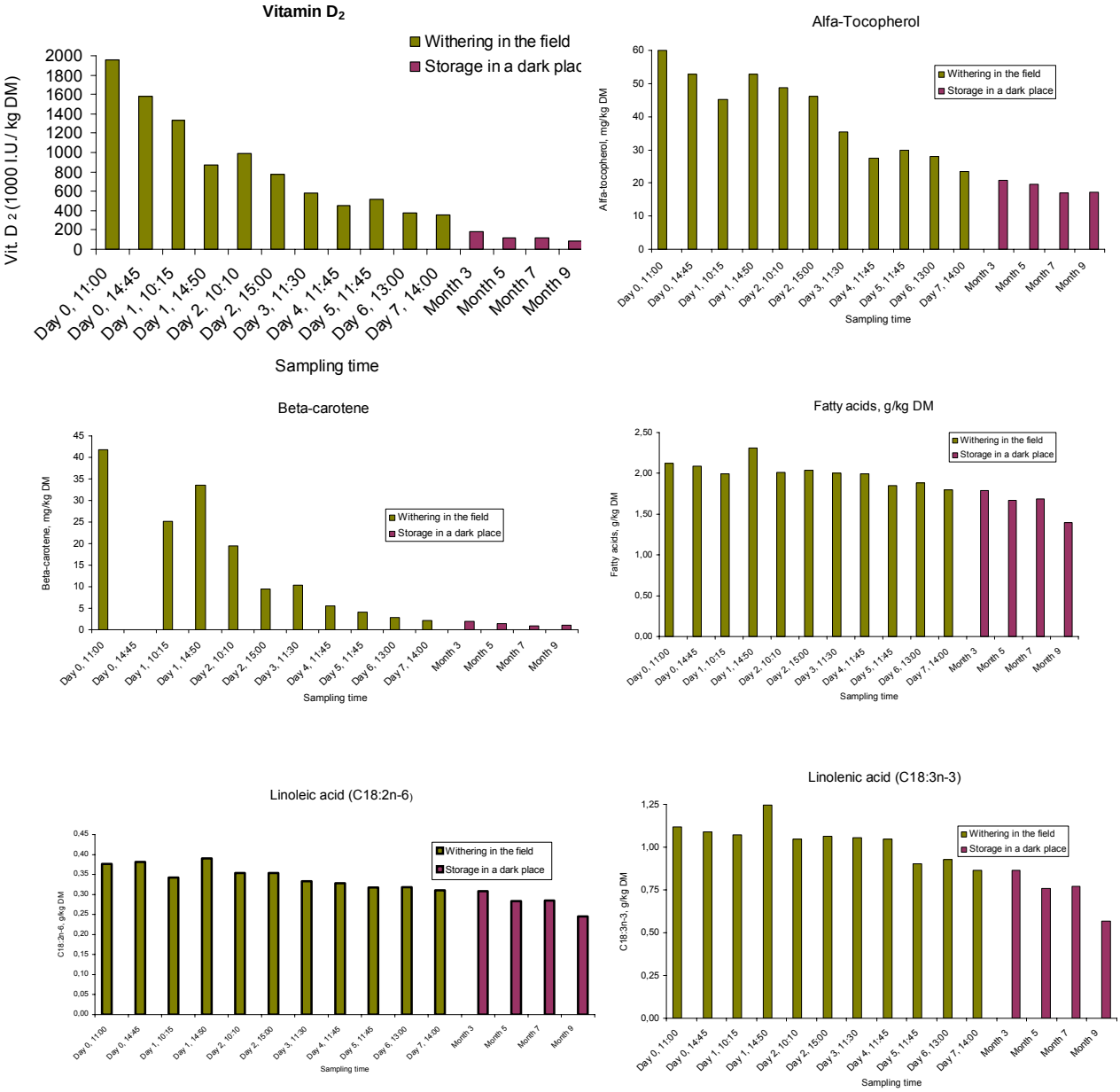


Figure 1. Content of vitamins and fatty acids in Lucerne during wilting and storage.2007.

In 2008 it has been possible to extend this part of the project (the plot experiment) with some studies on N-fixation without any additional expense for the project. One of the subplots has been unfertilized and N-fixation and N-transfer are measured in all treatments under fertilized and unfertilized conditions. This work is done by post doc. Jim Rasmussen, Institute of Agroecology and Environment, DJF.

Herbs in pastures on farms

Herbage was established in pastures grazed by dairy cows on 6 farms in 2006, cf. WP 6. The herbs

were broadcasted together with a traditional seed mixture of perennial ryegrass and white clover. Unfortunately one farm has stopped due to bad establishment of grass/clover. The botanical composition in 2008 is shown in table 3 for each farm. There are great differences between the farms, which can be due to different parameters as soil type, grazing management etc. Chicory and plantain have competed well with the main species perennial ryegrass and white clover. Bird's-foot trefoil and caraway constitute only a small part, but the number of plants is quite high on some farms. Establishment of sainfoin and chervil did not succeed on any of the farms. Compared to 2007 the proportions of plantain and great burnet have decreased and the proportion of caraway has increased. Sampling has been done in June both under grazing and cutting and in August under grazing. The species will be analysed for feeding quality and content of macro and micro minerals. In table 1 some results from 2007 concerning feeding quality parameters are shown. The difference between species are much higher than between farms. Caraway, plantain and chicory had a high content of ash, which indicates a higher content of minerals. Caraway had an extremely high digestibility of organic matter. On the other hand plantain and great burnet had a low digestibility. The feeding value thus varied very much between species.

Table 3. Proportion of seed sown in spring 2006 of the different species (in total 26 kg seed/ha) and the botanical composition on the single farms. Mean of June and August 2008. Results of some herbage quality parameters from 2007 are further shown.

	% of seed	**Farm % of dry matter**					**IVOMD***	**Crude ash**	**FE/kgDM***
		1	**2**	**3**	**4**	**5**			
Per. ryegrass	66.2	52.2	44.8	26.6	61.2	48.1	75.2	8.1	0.82
White clover	11.9	28.1	25.3	40.2	24.5	37.3	76.2	9.6	0.92
Red clover	3.1	9.2	12.3	1.1	3.7	4.1	74.1	9.6	0.87
Chicory	2.7	4.9	9.5	14.7	4.6	3.9	72.0	14.2	0.73
Plantain	3.1	4.3	70	11.7	1.5	3.3	66.3	12.8	0.66
Birds foot trefoil	1.9	0.2	0	0.1	0	0.7	72.8	8.0	0.90
Caraway	3.1	0.9	0.9	5.3	3.7	1.6	82.8	14.6	0.92
Great burnet	3.1	0	0	0	0	0.1	59.2	9.8	0.54
Sainfoin	3.1	0	0	0	0	0			
Chervil	2.3	0	0	0	0	0			
Unsown sp.		0.3	0.1	0.2	0.2	0.7			

*: in vitro organic matter digestibility
**: Foderenheder (feed units) per kg dry matter

Measurements of selection under grazing indicate that plantain was rejected both in June and August (Figure 2). Grass, white clover and red clover were grazed in the same way. Chicory was rejected a little in August (Figure 2).

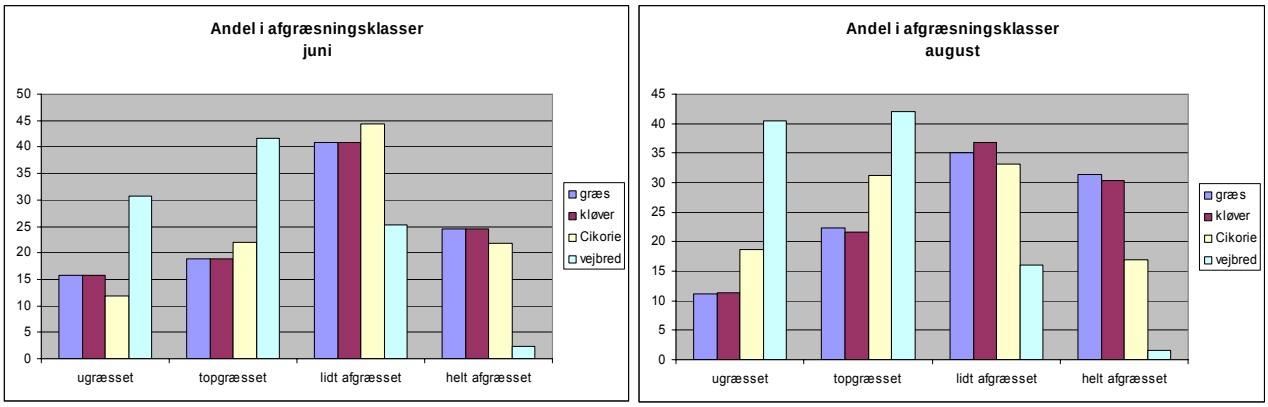


Figure 2. The proportion of the registrations, which are ungrazed, top grazed, little grazed or totally grazed. Results from the domineering species; grass (blue), clover (red), chicory (yellow) and plantain (light blue). Mean of farms in 2007.

WP 3 Integrated vitamin and mineral supply on farm level

The overall objective of this project is to investigate how the mineral and vitamin supply of the herd is affected depending on whether the feed production is optimised in order to maximise output of milk per ha (group 1) or optimised in order to meet the requirement for an integrated vitamin and mineral supply (group 2).

In spring 2007 the fodder crops for the two different strategies were selected and clover grass and clover grass with herbs as well as Lucerne were sown out with barley as cover crop.

In 2008 corn for production of corn silage for group 1 were sown out as well. The corn silage will be cut and ensiled primo October 2008.

During 2008 the clover grass for group 1 were harvested May 19, July 22. In June the fields were only trimmed due to severe drought.

For group 2 clover grass with herbs and alfalfa were cut first time May 12 and ensiled in the same bunker silo.

Second cut of alfalfa was harvested June 20, wilted and wrapped into round bales, while the other fields were trimmed.

Third cut was taken on July 22 and ensiled on top of first cut. Fourth cut was taken primo September and ensiled on top of third cut.

Alfalfa was cut on July 31 and primo September and wrapped into round bales.

In addition oat and triticale grain was harvested and rapeseed cake was bought as protein supplement.

The feeding experiment is scheduled to begin 15 November with 56 cows with expected calving from 19 October – the end of March 2009.

The feed for the two feeding groups are:

Group 1

Corn silage, 6 FE
Whole crop silage barley/pea 6 FE
Clover grass silage 6 FE
Oat 2 FE
Triticale 4 FE
Type 3 minerals

Group 2

Clover grass mixed with herbs silage 12 FE
Alfalfa wrapped silage 6 FE
Oat 1,5 FE
Triticale 2,5 FE
Rapeseed cake 2 FE

The feeding experiment will last until May 2009 and during this period cows and calves will be monitored with respect plasma and milk levels of vitamin A, E, and carotenoids. In addition some samples will be analysed for vitamin D status, and some samples will also be analysed for fatty acid composi-

tion as part of the CORE Organic project “PhytoMilk”.

Wp 4 Micro mineral status and relation to health

Methods for analyzing mineral status in blood and milk have been established as well as methods for analysis of health status based on milk samples. The project plan has been changed, due to difficulties in finding farms suitable for and interested in the test setup. The studies are now carried out as part of the experiment in wp3 – see revised project plan.

Wp 5 Health promotion and effect of selected non-antibiotic disease treatments

Data analysis on central data on a large group of Danish organic dairy herds has been performed, and a group of ten herds has been selected based on no or very limited use of antibiotics for dairy cows in the last 5 years. Herd studies have not started yet.

17 US dairy farmers have been visited and interviewed and information on the use of non-antibiotic treatments of infectious diseases have been extracted from the interviews. The US farmers will be visited again in 2009.
The information from the interviews is being combined with literature studies of the active ingredients and will form the basis for the selection of the treatments for the two planned experiments.

Wp 6 System analysis and perspectives for integrated vitamin and mineral supply at farm level

Farm reports for the five case study farms for summer of 2007 have been made for each farm. Focus was on roughage quality, sward composition, methods of harvest and feed supply, including use of mineral and vitamin, The report has been presented for the farmer as part of the validation of the data and as part of the dissemination of the preliminary results and ideas behind the project.

The general activities on the five case study farms in 2008 follow the same registrations manual as in 2007. More intensive focus has been set on vitamin and mineral supply.

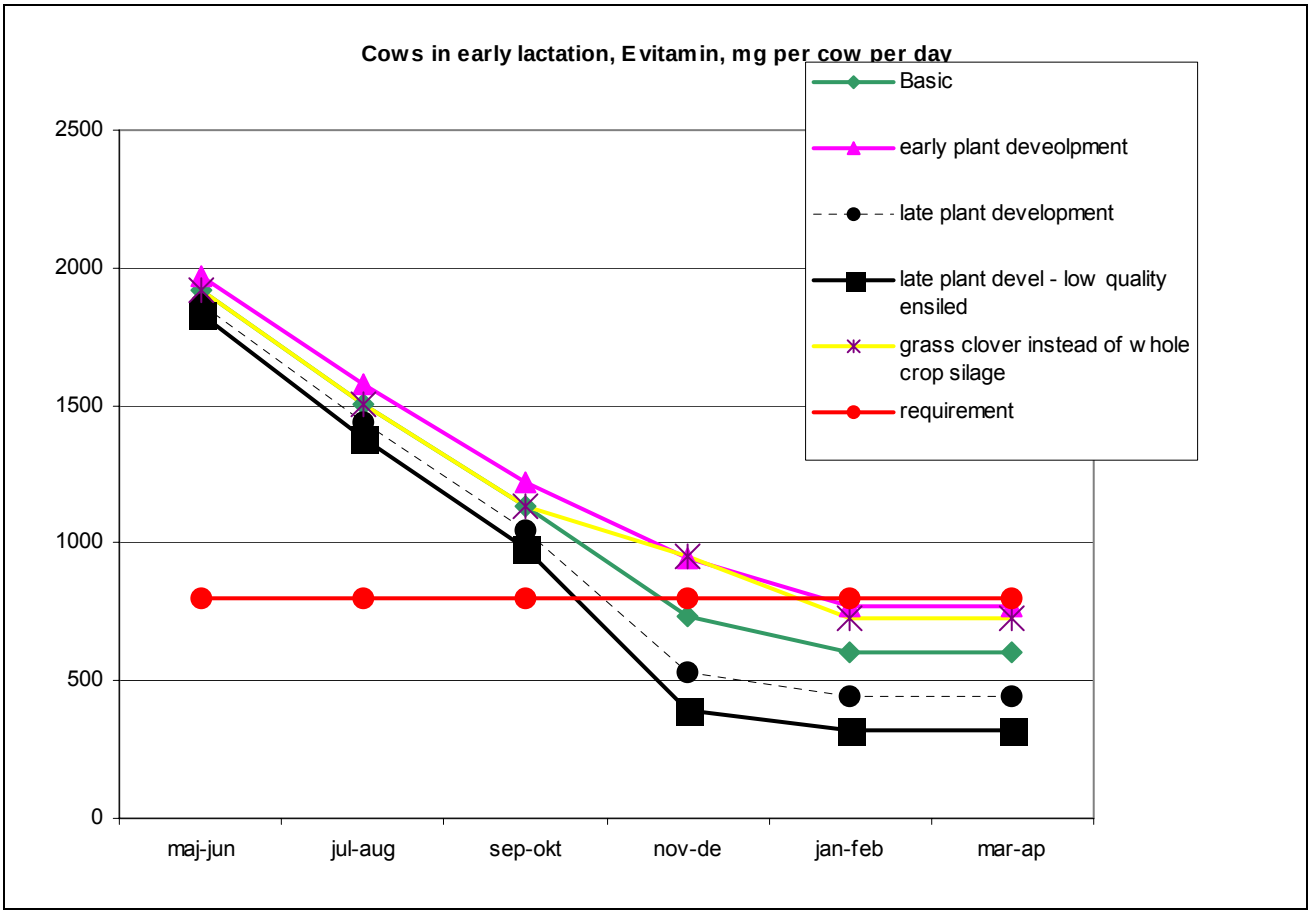
From all farms samples of roughage from the two most important crops in terms of dry matter per cow during winter 07/08 have been collected during harvest and samples had been taken 2 to 4 times during the winter feeding season. These samples will be analysed for vitamin content (WP1) together with bulk milk samples taken 6 times during the year. For all samples, the crops were described before it was harvested, as well as the process of harvesting was described. Furthermore the samples was analysed for feeding value.

The decision support model for simulating the feed and vitamin supply during a year was further developed and presented at the Second Scientific Conference of the International Society of Organic Agriculture Research (ISOFAR), held at the 16th IFOAM Organic World Congress (Mogensen et al, 2008) and at a field day about ”Grass clover fields with herbs in the crop rotation at organic dairy farms” for organic farm advisers and the private case study farmers included in the project. The model takes into account that the content of vitamin and minerals depends on choice of crops, conservation method, season, plant development at harvest, quality of the silage production, and duration of storage together with traditional optimizing of the feeding scheme. In the model, focus is primarily on the supplementation of zinc (Zn), copper (Cu) and selenium (Se) and vitamin A and E. The present model includes the crops traditionally grown on organic dairy farms: barley, oats, wheat, maize, peas, blue lupines, perennial ryegrass, white and red clover, and lucerne. Furthermore some new crops and herbs are included: timothy, chicory, plantain, caraway, bird’s-foot trefoil, sainfoin, chervil and salad burnet. In the model, grasses and legumes can be grazed, ensiled, harvested as hay or produced as pellets. The vitamin content is calculated as a function of the content in the fresh crop and the used conservation method. The effect of season on vitamin and mineral content is included as a function of

the month in which the crop is harvested. The effect of plant development on vitamin and mineral content is defined as a relative effect of early or late development compared to middle. The loss of vitamin in ensiled feed is a function of number of number of months in storage. All the present relations and values are based on information from literature, and therefore need to be updated as new information is obtained in the project.

In figure 1 is shown results from scenario calculation from one of the private case study farms in the project. The decision support model was used to simulate how different strategies can affect vitamin E supply during a year. Basic illustrates the present situation. If the grass clover silage is harvest at an earlier plant development stage or more grass clover silage is used instead of barley whole crop during the winter feeding period it is possible to improve the supply of vitamin E of the high yielding cows.

Figure 1 Example of scenario calculation using the decision support model from one of the case study farms



C.2 Fulfilment of deliverables and milestones

(To be completed for each work package)

Deliverables list (from application)

Workpackage 1						
Delive-rable No	**Deliverable title**	**Lead scien-tist**	**Delivery date**	**Allocated scientific person moths**	**Type of de-liver-able**	**Fulfilled (ok) or devia-tions (d)***
D1.1	Field day, presentation of forage crop produc-tion	KAS	6/2008	0.5	O	OK
D1.2	Workshop for farmers regarding handling of disease	TWB	9/2009	0.9	C, P	
D1.3	Open project conference on integrated supply of vitamins and minerals and health promotion without antibiotics	TWB	9/2010	0.9	C, P	
D1.4	Final status report	TWB	1/2011	0.6	R	

Workpackage 2						
Delive-rable No	**Deliverable title**	**Lead scien-tist**	**Deliv-ery date**	**Allocated scientific person moths**	**Type of de-liver-able**	**Fulfilled (ok) or devia-tions (d)***
D2.1	Present preliminary results at General Meeting of European Grassland Federation	KAS	6/2008	1	C	d 2010
D2.2	Presentation of results at Plantekongres or Økologikongres	KAS	2009	1	C, P	
D2.3	Scientific paper on vitamins and minerals in fresh forage crops	SKJ, *KAS, JAS*	3/2010	11	S	
D2.4	Popular paper on vitamins and minerals in fresh crops	KAS	4/2010	2	P	
D2.5	Scientific paper on selection of herbs on pas-tures	KAS, *SKJ, JAS, TKR*	5/2010	10.3	S	
D2.6	Popular paper on selection of herbs on pasture	KAS	6/2010	1.5	P	
D2.7	Popular paper on effects of ensiling on vitamins in forage crops	SKJ	10/2010	1.5	P	
D 2.8	Scientific paper on the effect of wilting of hay on the vitamin content	*LHY* SKJ	6/2010	6	S	
D 2.9	Guidelines on how to cure crops for silage or hay and how to preserve the natural vitamin content of the crop	*LHY*, SKJ	6/2010	2.5	P	
Workpackage 3						
Delive-rable No	**Deliverable title**	**Lead scien-tist**	**Deliv-ery date**	**Allocated scientific person moths**	**Type of de-liver-able**	**Fulfilled (ok) or devia-tions (d)***

D3.1	Presentation at field day	KAS	6/2008	0.5	O	OK
D3.2	Presentation at project conference	SKJ	9/2010	1	C, P	
D3.3	Popular paper with suggestions for integrated strategies for TMR's for dry cows and milking cows in order to fulfill the requirement for an integrated vitamin and mineral supply	SKJ	4/2011	4	P	
D3.4	Scientific paper describing the effects of an integrated vitamin and mineral supply at an experimental organic farm.	SKJ, *KAS, JAS, TKR*	4/2011	9	S	

Workpackage 4						
Deliverable No	**Deliverable title**	**Lead scientist**	**Delivery date**	**Allocated scientific person months**	**Type of deliverable**	**Fulfilled (ok) or deviations (d)***
D4.1	Trace element status in organic dairy herds situated on different quality soils.	TLA, *TWB*	7/2009	4	S	D Cancelled
D4.2	The association between cows trace element status and mastitis in organic herds	TLA, *TWB*	7/2009	7	S	D Cancelled
D4.3	Presentation at project conference	TLA	9/2010	0.5	C, P	
D4.4	Integrated mineral and vitamin supply for dairy cows and their milk fed calves and effect on physiological status and immune status and mastitis indicators in an organic herd.	TLA, *TWB*	9/2010	4	S	

Workpackage 5						
Deliverable No	**Deliverable title**	**Lead scientist**	**Delivery date**	**Allocated scientific person months**	**Type of deliverable**	**Fulfilled (ok) or deviations (d)***
D5.1	Strategies for health promotion and disease treatment in herds under the USDA national organic standards	TWB, *MVA*	7/ 2008	4	S, C	d 5/2009
D5.2	Effect of treatment no. 1 of XXX in organic dairy cattle	TWB, *MVA*	2/ 2009	5	S, C	11/2009
D5.3	Evaluation of the consequences of a long-term non-antibiotic herd strategy in Danish organic dairy herds	*MVA*	3/2009	7	S	12/2009
D5.4	Strategies and principles for health promotion in Danish organic dairy farms with very low usage of traditional veterinary medicine	MVA, *TWB*	4/2009	6	S	12/2009
D5.5	Workshop for farmers. Handling of disease and herd health promotion without antibiotics in organic diary herds	MVA	9/2009	1	C	
D5.6	Effect of treatment no. 2 of YYY in organic dairy cattle	TWB, *MVA*	1/2010	4.25	S	
D5.7	Presentation at project conference - Handling disease without antibiotics	TWB	9/2010	0.5	R,C	

Workpackage 6						
Deliverable No	**Deliverable title**	**Lead scientist**	**Delivery date**	**Allocated scientific person moths**	**Type of deliverable**	**Fulfilled (ok) or deviations (d)***
D6.1	Prototype of model	TKR	11/2007	2	O	ok
D6.2	Perspectives for integrated mineral and vitamin	TKR	11/2007	2	R	Ok

	supply at organic dairy farms					(I+S)
D6.3	Presentation at project conference	TKR	9/2010	1	C	
D6.4	Integrated mineral and vitamin supply at organic dairy farms	TKR, *SKJ*, *JAS*, *KAS*	11/2010	5.5	S	
D6.5	Sådan opnår du en integreret vitamin og mineral forsyning	TKR	12/2010	1	R	

** Deviations are to be further discussed in D*

Milestones list (from application)

Workpackage 1			
Mileston No	**Milestone title**	**Delivery date**	**Fulfilled (ok) or deviations (d)***
M 1.1	First project meeting	01/2007	OK
M 1.2	Last project meeting	12/2010	

Workpackage 2			
Mileston No	**Milestone title**	**Delivery date**	**Fulfilled (ok) or deviations (d)***
M 2.1	Establish plot at Foulumgård	2006	OK
M 2.2	Select organic dairy farms for experiments together with WP6	11/2006	OK
M 2.3	Co-ordinate sampling technique and analyses with research in Sweden	1/2007	OK
M 2.4	Describe the exact ensiling method	5/2007	OK
M 2.5	Set-up of Se-analyse	9/2007	11/2007
M 2.6	Data hand over to WP3	1/2008	12/2008
M 2.7	Evaluate the methods used in the ensiling	3/2008	12/2008
M 2.8	Discus results with farmers and advisors participating the experiment	4/2008	OK
M 2.9	Data hand over to WP6	9/2008	9/2009
M 2.10	Data hand over to WP3	4/2009	
M 2.11	Data hand over to WP6	2/2010	
M2.12	Crops harvested and samples collected for analysis of hay	6/2009	
M 2.13	Laboratory analyses of hay finished	1/2010	

Workpackage 3			
Mileston No	**Milestone title**	**Delivery date**	**Fulfilled (ok) or deviations (d)***
M 3.1	Fodder crops for the feeding experiment are selected	2/2007	OK
M 3.2	Harvest and storage strategy for the selected fodder crops are decided.	3/2008	OK
M 3.3	Formulation of TMR diets for dry cows and lactating cows according to	9/2008	OK

	the selected strategies		
M 3.4	Experiment with integrated vitamin and mineral supply begin at Rugbal-legaard	10/2008	OK
M 3.5	Experiment with integrated vitamin and mineral supply at Rugballegaard finished	5/2009	

Workpackage 4			
Mileston No	**Milestone title**	**Delivery date**	**Fulfilled (ok) or devia-tions (d)***
M 4.1	Select organic dairy farms for experiments	2/2007	changed
M 4.2	Laboratory analysis developed and selected.	5/2007	OK
M 4.3	Experimental feeding schemes decided based on preliminary results from WP 2 and WP6	9/2007	changed
M 4.4	Animal experiments at study herds initiated (Rugballegaard WP3)	10/2007	11/2008
M 4.5	Blood and milk sampling starts. Initiation of laboratory analysis	11/2007	11/2008
M 4.6	Blood and milk sampling finished	7/2008	4/2009
M 4.7	Laboratory analysis of samples finished	12/2008	1/2010

Workpackage 5			
Mileston No	**Milestone title**	**Delivery date**	**Fulfilled (ok) or devia-tions (d)***
M 5.1	Establishing contacts in USA	03/2007	OK
M 5.2	Identification of Danish study herds	10/2007	8/2008 OK
M 5.3	Initiation of survey and herd visits in organic dairy herds in USA	11/2007	OK
M 5.4	Treatment protocol for controlled treatment study I +II	3/2008	12/2008
M 5.5	Start of on-farm controlled treatment study I	3/2008	4/2009
M 5.6	End of study in Danish herds	2/2009	12/2009
M 5.7	Start of on-farm controlled treatment study II	3/2009	6/2009
M 5.8	End of on-farm controlled treatment studies	11/2009	3/2010

Workpackage 6			
Mileston No	**Milestone title**	**Delivery date**	**Fulfilled (ok) or devia-tions (d)***
M 6.1	Select organic dairy farms for experiments together with WP2	11/2006	OK
M 6.2	First round of farm visits – with system description	1/2007	OK
M 6.3	End of first year's registration	12/2007	OK
M 6.4	End of farm registration	4/2009	

(The nature of the deliverables must be indicated by S = publication in scientific journal with peer review; P = publication in journals without peer review; R = reports; C = presentation at meetings and congresses or O = other types of deliverables, e.g., prototypes, models, websites, etc.).

D. Description of deviations and subsequent adjustments of plans

In WP2 the analysis of samples has been partly delayed. Minor corrections in the budget have been made. The delay will only have minor influence of the time schedule.
Deliverable 2.1 was delayed since the chemical analyses were not completed before the deadline. Instead it will be presented at a corresponding meeting in 2010

WP4 has been delayed due to difficulties in finding herds with a feeding system that allows the feeding of different mineral mixtures in a practical and controllable way.
As a consequence the project group is interested in changing the project plan. The main aim of wp4 to evaluate different sources of minerals by measuring indicators for health is integrated into the feeding experiment in wp3 (see revised project description). The budget for the new project plan is reduced by 710.000 kr. A proposal for a study of the effects of different principles for hay production for the contents for vitamins has been prepared and is also included titled “wp2+”.

The activities in WP5 have been delayed to allow for the full integration of a PhD student in the project. It is still expected that the planned workshop for farmers can be carried out according to the plan. The treatment experiments are delayed but are expected to be carried out in parallel to reduce the delay (see C2)

E. Project publications and other products

[Produkter under 1 skal kopieres fra Organic Eprints. Dette gælder også for produkter, som kun delvist er finansieret af FØJO. Listen fra Organic Eprints kan findes på hjemmesiden http://www.okoforsk.dk/projekt/index.html under "Project publications" på de enkelte projekter.]

[Produkter under 2 er mundtlige præsentationer og andet, som ikke skal kunne findes i Organic Eprints]

1. Products from Organic Eprints archive

Mogensen, L.; Kristensen, T.; Søegaard, K. and Jensen, S.K. (2008) How can the organic dairy farmer be self-sufficient with vitamins and minerals?. Poster presented at Cultivating the Future Based on Science: 2nd Conference of the International Society of Organic Agriculture Research ISOFAR, Modena, Italy, June 18-20, 2008.

Mogensen, L. (2008) Vitaminer og mineraler i økologisk mælkeproduktion. In *Ny Kvægforskning*, Volume 4, No 6, page pp. 1-2.

Mogensen, Lisbeth; Kristensen, Troels and Jensen, Søren K. (2006) A decision support model simulating the vitamin supply over the year on a farm. Paper presented at Joint Organic Congress, Odense, Denmark, May 30-31, 2006..

Søegaard, Karen (2008) Urter i græsmarken [Herbs in the pasture]. In *Økologisk Jordbrug*, February, No 403.

Bennedsgaard, Torben (2008) Mindre antibiotika med samme celletal In Kvæginfo nr 1908.

2. Other products (oral presentations, public meetings, field days, etc.)

Field day (Emnedag vedr. græsmarker i økologiske kvægbrugssædskifter herunder anvendelse af urter) at Foulum 22 May 2008 for the farmers, on which farms the project has activities, their advisers and other collaborators. In total 23 participants. Arranged together with ORGGRASS (ICROFS-III pro-

ject).

Presentation at the field day ”Grass clover fields with herbs in the crop rotation at organic dairy farms”. For farm advisers and the private case study farmers. Mogensen, L. 2008. Vitaminer og mineraler – beregningsmodel for foderrationen. Foulum d. 22. maj.

K. Søegaard presented the ECOVIT project in the experimental field at Foulum to the board for seed mixtures October 31 2007 and August 26 2008 and to the board for organic research (Skejby-DJF) June 25 2008.

* 25-75% financed by DARCOF
** 5-25% financed by DARCOF

F. Scientific education

Compared to the original plan a position as ph.d. student has been established. The Ph.d. student will be involved in WP 5 and in another research project ANIPLAN (CoreOrganic). The study has been financed by these two projects and AU, Dept. of animal health, welfare and nutrition in coorporation with Thise Mejeri.The ph.d. student Lindsay Kay Whistance started April 2008.

G. National and international cooperation

Cooperation with two new projects under the Coreorganic program has been established. In wp5 cooperation with ANIPLAN will take place including the involvement of a new Ph.D. student in both projects. Wp2 and WP3 are working together with PhytoMilk.

Through the FØSU network called “tailor-made milk” milk from the experiment at Rugballegaard (wp3) will be used in an intervention study involving older women to test the hypothesis “Green feed improves the nutritional properties of the milk-fat fraction “ with the b*asic hypothesis:* Milk fat from cows fed green plant material has a positive impact on metabolic syndrome, partly due to the presence of the highly active PPAR-α and RXR agonists derived from the chlorophyll molecule (phytanic acid and phytol).”

H. Critical reflection on the project

The activities in WP2, WP3 and WP6 have been started according to the time schedule and the cooperation with the involved farms is fulfilling the expectations. During the project period an increasing number of cooperations and supplemental funding have been established which in the end is expected to enable the project participants to address several new scientific questions related to the main purpose of the project.
The activities in WP5 have been delayed due to the decision to include a PhD. Student in the project. The deadlines in WP5 have been postponed to allow for a better planning of the activities in the PhD study. It is expected that the PhD study, which will deal with animal health in organic herds on a full time basis and the cooperation with AniPlan will strengthen the project, especially by having more resources to evaluate the influence of low antibiotics usage on animal welfare.

In wp4 the project group has faced serious problems recruiting farms for the intervention study. As a result the project plan has been changed. The focus of the work package has been changed from different sources of micro minerals to the evaluation of differences in immune status of cows and calves fed a traditional ration with supplementation of minerals and vitamins with cows fed a ration optimized for minerals and vitamins in the roughage without supplementation – the feeding experiment is the

experiment carried out in WP3 with supplemental sampling of blood and milk and analysis of indicators of metabolic status and immune status.

The changes in WP4 has the allocation of supplemental funding of WP2 to allow for a comparison of effect of different strategies of hay production on the vitamin content – the changes allow for fulfilment of the intention of more research in to potentials of hay production which was mentioned in the original project description as a possible extension of the project if supplemental funding could be obtained.

8. Budget

A. Account for any change in budgets

The budget of wp5 has been changed due to the decision to enroll a ph.d. student. The changes can be seen in the budget for SVE. The expected consumption for 2007 is reduced by 464.000 and the budget for 2008 and 2009 is increased with 162000 and 302000 kr. The Changes in WP4 has changed the budget in 2008-2010, resulting in a decrease of 7.000 kr in the total sum of the project, as well as a change in the costs in 2009 and 2010 compared to the first 2008 progress report.

B. Budget for the whole project (1.000 DKK)

Total consumption of funds from DARCOF and expected consumption this year and coming years

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							
Scientific personnel	96.5	0	23	24.1	34.65	21.85	98.6
Technical personnel	78.06	0	24.73	21.5	28.07	1.99	76.3

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	4830	0	1068	983	1704	1151	4694
Technical personnel	2277	0	530	622	864	127	2143
Other operational costs	1818	0	189	808	1043	91	2131
Equipment	0	0	0	0	0	0	0
Others (please specify)	409	0	181	178		0	359
Direct costs	9334	0	1755	2591	3611	1370	9328
Indirect costs (20% of direct costs)	1866	0	351	518	722	274	1866
Total	11200	0	2106	3109	4333	1643	11193

Comments:

9. Signatures and stamps

Name	Institute	Date	Signature
Head of project			

Appendix I. Detailed budget

A. Budget for each participating institute (1.000 DKr)

B. Budget for each participating department (1.000 DKK)

Name of Institute and department: Faculty of Agricultural Sciences
Department of Agroecology and Environment

Year:	Original budget	Consump-tion 2005-2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							
Scientific personnel	26,5	0	6,1	5,4	8,5	6,5	26,5
Technical personnel	23,56	0	7,5	7.5	6.57	1,99	23,56

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	1379	0	277	284	459	359	1379
Technical personnel	750	0	220	228	233	69	750
Other operational costs	569	0	59	300	157	53	569
Equipment	0	0	0	0	0	0	0
Others (please specify)	359	0	181	178	0	0	359
Direct costs	3057	0	736	990	849	481	3057
Indirect costs (20% of direct costs)	611	0	147	198	170	96	611
Total	3668	0	883	1188	1019	577	3668

Comments:

Name of Institute and department: Faculty of Agricultural Sciences
Department of Aninal Welfare, health and nutrition

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							
Scientific personnel	70	0	16.5	17.1	26.2	15.4	72.1
Technical personnel	54.5	0	16	14.0	21.5	0.0	51.5

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	3451	0	791	699	1245	792	3315
Technical personnel	1527	0	310	394	631	59	1393
Other operational costs	1249	0	130	508	886	38	1562
Equipment		0	0	0			
Others (please specify)	50	0	0	0	0	0	
Direct costs	6277	0	1019	1601	2762	889	6271
Indirect costs (20% of direct costs)	1255	0	204	320	552	178	1254
Total	7532	0	1223	1921	3315	1066	7525

C. Budget for co-financing from each participating institute (1.000 DKK)

Name of Institute and department: Faculty of Agricultural Sciences
Department of Agroecology and Environment

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							
Scientific personnel	0	0	0,3	0	0	0	0.3
Technical personnel	0	0	0	0	0	0	0

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	0	0	16	0	0	0	16
Technical personnel	0	0	0	0	0	0	0
Other operational costs	22	0	0	17	5	0	22
Equipment	0	0	0	0	0	0	0
Others (please specify)	154	0	77	81	0	0	158
Direct costs	176	0	93	98	5	0	196
Indirect costs (20% of direct costs)	782	0	174	264	199	145	782
Total	958	0	267	362	204	145	978

Comments:

Name of Institute and department: Faculty of Agricultural Sciences
Dept. of Animal welfare, health and nutrition

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							
Scientific personnel	30		12	12	6		30
Technical personnel							

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	1012	0	391	408	213	0	1012
Technical personnel	0	0	0	0	0	0	0
Other operational costs	0		0	0	0		0
Equipment	0		0	0	0		0
Others (please specify)	640		40	300	300		640
Direct costs	1652		431	708	513		1652
Indirect costs (20% of direct costs)	331		86	142	103		331
Total	1983		517	850	616		1983

Comments:

Description of work packages

(Revised work package (WP2+), 1/2009)

WP No.: 2+
Optimising the natural vitamin content of organic hay through altered curing methods

	Start date or starting event: (please give month and year)		6/2009
Partner id.	DJF, SVE		
Person-months per participant	8.5 VIP 2 TAP		
Total PM VIP: **Total PM:**	**8.5** **10.5**		

(Please give Institution or Department as partner id.)

Objectives:

- To investigate how climate conditions affects the natural content of fat-soluble vitamins in organic crops for making silage or hay for winter feeding
- To investigate how the curing method (field curing vs. barn curing) affects the development in the vitamin content to find the best method for preserving the natural vitamins in the crop during curing and feed production
- Special emphasis is put on the natural vitamin D content because this vitamin is particularly sparsely described in feed in the past

Description of work:

In the context of an ongoing trial under Karen Søegaard at DJF in Foulum, on modelling of the importance of the curing-method on the development in dry matter content of roughages; samples for assessing the curing-methods impact on the vitamin content can be provided. Particularly regarding the development in, and preservation of, the vitamin D content of roughages, current knowledge is extremely scarce and not previously described within the project.

The two major physiological forms of vitamin D are vitamin D_2 (ergocalciferol) and vitamin D_3 (cholecalcoiferol) derived from ergosterol and 7-dehydrocholesterol, respectively. Vitamin D_3 is produced endogenously in the skin of animals and humans, when they are exposed to intense sunlight. In Scandinavia, this endogenous source of vitamin D_3 is probably sufficient as the only source of vitamin D in grazing animals during summer (Hidirouglou et al. 1979), but winter sunlight is not an effective source of vitamin D in the Nordic countries (Hymøller et al. 2008) as shown in the Ph.D. study "*Vitamin D status and supply of organic dairy cattle*", which runs alongside the FØJO III ECOVIT project. During winter the animals are therefore dependent on vitamin D supplied in the diet, which is conventionally secured through supplementing with artificial vitamin additives. In plant material vitamin D is found in the form of vitamin D_2 and is in the literature reported to be present in very low concentrations in fresh plant material (Thomas & Moore, 1951), which in theory makes sense, since vitamin D_2 is not produced by the plants as such, but by fungi when they are irradiated with sunlight. Fungi that mainly grow on dry and wilted plant material (Richardson & Logrenda, 1997).

The vitamin D_2 content of plants were in classical biological assays reported as increasing, when plant material is dried and sun cured during production of hay and silage for winter feeding. In a number of very early studies with rickets (vitamin D deficiency) in calves Thomas & Moore (1949, 1951) found that lucerne (Medicago sativa) showed different effectiveness in the prevention of rickets in calves, depending on the used curing method. Sun-dried lucerne hay was more effective than cured silage, which in turn was more effective than barn dried hay. Mature stages of lucerne, for example seed stages were more effective than half-bloom stages, which again exceeded bud-stages in vitamin D effect (Thomas & Moore, 1949). Also Russell (1929) and Newlands & Riddell (1952) found that artificially dehydrated lucerne had a lower vitamin D activity than field cured sun-dried lucerne. Other studies of Newland (1948) and Henry et al. (1958) were less unambigu-

ous in their conclusions.

During the aforementioned Ph.D. project a study on the development in the content of fat-soluble vitamins in hay during field-curing and storage was carried out using modern HPLC methods, in contrast to previous studies using biological assays. Results from this new study showed that the vitamin D_2 content apparently is much higher than estimated from the earlier studies using biological assays. This new study showed that vitamin D_2 is not increasing during sun-curing, but rather is degraded (unpublished data) exactly like the other fat-soluble vitamins A and E, probably due to the combined effects of sunlight and heat (Bunnell et al., 1968; Charkey et al., 1961; Thafvelin & Oksanen, 1966).

The aforementioned Ph.D. project forms the background for describing the fate of fat-soluble vitamins in roughages during curing and storage, but unfortunately there is virtually no knowledge of how the climate in terms of the amount of sunlight, humidity and rainfall, etc. affects the vitamin content of the roughage crop harvested, or if artificial drying (barn drying) without the access of sunlight may fully or partially prevent the degradation of the vitamins seen during field-curing and storage (unpublished data).

Referencer:

Bunnell, R.H.; Keating, J.P. & Quaresimo, A.J. (1968): Alpha-tocopherol content of feedstuffs. *Journal of Agricultural and Food Chemistry*, 16: pp. 659-664

Charkey, L.W.; Pyke, W.E.; Kano, A.; & Carlson, R.E. (1961): Carotene and tocopherol content of dehydrated and sun-cured alfalfa meals. *Journal of Agricultural and Food Chemistry,* 9: pp. 70-77

Henry, K.M.; Kon, S.K.; Thompson, S.Y.; McCallum, J.W. & Steward, J. (1958): The vitamin D activity of pastures and hays. *British Journal of Nutrition*, 12 (4): pp. 462-469

Hidiroglou, M.; Proulx, J.G. & Roubos, D. (1979): 25-hydroxyvitamin D in plasma of cattle. *Journal of Dairy Science*, 62: pp. 1076-1080

Hymøller, L.; Mikkelsen, L.K.; Jensen, S.K.; Nielsen, M.O. & Aaes, O. (2008): Access to outside areas during March and April in Denmark has negligible effect on the vitamin D_3 status of organic dairy cows. *Acta Agricultura Scandinavica – Section A Animal Sciences*, 58: pp. 51-54.

Newlander, J.A. & Riddell, W.A. (1952): Rate of vitamin D formation in hay. *Journal of Animal Science*, 11: pp. 419-421

Newlander, J.A. (1948): Vitamin D content of roughages. *Journal of Dairy Science*, 31: pp. 455-460

Richardson, M.D. & Logendra, S. (1997): Ergosterol as an indicator of endophyte biomass in grass seeds.

Journal of Agricultural and Food Chemistry, 45: pp. 3903-3907

Russel, W.C. (1929): The effect of the curing process upon the vitamin A and D content of alfalfa. *Journal of Biological Chemistry*, 85: pp. 289-297

Thafvelin, B. & Oksanen, H.E. (1966): Vitamin E and linolenic acid content of hay as related to different drying conditions. *Journal of Dairy Science*, 49: pp. 282-286

Thomas, J.W. & Moore, L.A. (1949): Vitamin D content of forages as affected by various curing procedures. *Journal of Dairy Science*, 31: p. 689

Thomas, J.W. & Moore, L.A. (1951): Factors affecting the antirachitic activity of alfalfa and its ability to prevent rickets in young calves. *Journal of Diary Science*, 34: pp. 916-928

Deliverables:

D 2.8 Article manuscripts for submission to international and domestic journals 6/2010

D 2.9 Guidelines on how to cure crops for silage or hay and how to preserve the natural vitamin content of the crop 6/2010

Milestones:

M 2.12 Crops harvested and samples collected 9/2009

M 2.13 Laboratory analyses finished 1/2010

Revised budget:

SVE WP4 (WP2)	2005	2006	2007	2008	2009	2010	Total
Senior scientist					4.3	4.2	
Scientist							
PhD							
IT							
Lab/technician					2		
VIP					185	185	370
TAP					61		61
Equipment							
Operational costs					155		155
Other							
Total direct costs					401	185	586
Overhead (20%)					80.2	37	117.2
Total costs					**481.2**	**222**	**703.2**

Description of work packages
(revised work package 1/ 2009)

WP No.: 4 The effect of integrated mineral supplementation on physiological status and health of dairy cows and their calves.

	Start date or starting event: (please give month and year)		1/ 2007
Partner id.	DIAS, SVE		
Person-months per participant	4.6 VIP 6.5 TAP		
Total PM VIP: **Total PM:**	**4.6** **11.1**		

(Please give Institution or Department as partner id.)

Objectives:

- To investigate the effect of substitution of conventional mineral supplementation with a ration optimized for maximum level of minerals in the roughage.
- To describe the association between general physiological status of the animals in the two feeding rations and the degree of inflammation of the cow and her calf, e.g. described by the degree of mastitis and immunoglobulin levels.

Description of work:

The experimental work will be carried out in the same experiment as described in WP3

The experimental feeding will be given in a period of 5 month. About 40 cows (calvings) are expected to be included in the study.
Blood samples will be harvested from the cows: week -1 , at calving, day 7, day 14, day 21, day 28, week 5, week 12 (and week 24 if possible within the study period). The samples are analyzed for general parameters: total protein, albumin, macro mineral status: Ca, Mg, inorganic P, Energy status: glucose, NEFA, β-OH-butyrate, phospholipids, Acute phase indicators: C-reactive protein (CRP), haptoglobin and physiological function: Ceruloplasmin activity, Di-amin-oxidase activity

Milk samples are collected at calving (colostrum), day 7, day 14, day 21 , week 5, week 12 and week 24. Samples are analysed for mastitis indicators: LDH, NAGase-activity and AP-activity.

Blood samples are harvested from the calves at day 4, 10, 19 and 28. The samples are analyzed for general parameters: total protein, albumin, macro mineral status: Ca, Mg, inorganic P, Acute phase indicators: C-reactive protein (CRP), haptoglobin, fibrinogen, immune status: Immunoglobulins and physiological function: Ceruloplasmin activity, Di-amin-oxidase activity

Task 4.1 Mineral status and indicators of health.
To describe general physiological status of the animals and the degree of inflammation of the cow and her calf, delineated by general inflammation parameters in blood and milk as well as more specific parameters connected with mastitis

Deliverables:

Article manuscript for submission to international journals:

D 4.4 Integrated mineral and vitamin supply for dairy cows and their milk fed calves and effect on physiological status and immune status and mastitis indicators in an organic herd. (4/2010)

D 4.3 Presentation for Danish farmers and advisers (9/2010)

The obtained results will also be published in domestic journals covering organic farming.

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Milestones:

M4.2 Laboratory analysis developed and selected. (5/2007)
M4.4 Animal experiments at study herd initiated (mineral substitution) (11/2008)
M4.5 Blood and milk sampling starts. (11/2008)
M4.6 Blood and milk sampling finished (4/2009)
M4.7 Laboratory analysis of samples finished (12/2009)

Revised budget

SVE WP4	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
Senior scientist			0.57	0	4		4.6
Scientist				0			0
PhD							0
IT							0
Lab/technician			0.45	0	6		6.5
VIP	0	0	28	0	212	0	240
TAP	0	0	12	0	176	0	188
Equipment							0
Operational costs			8	0	140		148
Other			0	0	30		30
Total direct costs	0	0	48	0	558	0	606
Overhead (20%)	0	0	10	0	112	0	121
Total costs	**0**	**0**	**58**	**0**	**669**	**0**	**727**

Reduc-tion in budget: **710**