



Midterm Status Report 2003 and Application for Continuation in 2004

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1. Research program

Research in organic farming 2000-2005 (DARCOF II)

2. Project title and number

Project II.1 Organic dairy production systems

3. Head of project

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6. Project period (month, year)

Start of project: 1.7 2000

End of project: 31.12.2004

7. Midterm description of the project, its results and progress, and application for continuation in 2004

A. Project summary

The Danish organic farmers organisation has the declared goal to increase the amount of organic feed in the feeding of the dairy cows and in the latest version of the EU regulations of organic farming it is stated "that the production of organic milk within the next 5 years has to be based entirely on organically produced feed".

Compared to the present situation on a typical Danish organic dairy farm this will force some changes in feeding and land use. Feeding based entirely on organic feed will force the use of home-grown roughage. Such a changed feeding pattern can have an impact on the production in several ways. It will from a feeding point of view "stress" the cow and possibly influence the production level, milk content and quality as well as animal health and welfare. It will further increase the difference between organic and conventional production conditions and thereby create the need for a breeding program specifically designed for organic dairy cows.

In a situation with feeding based solely on home-grown organic feed, the feed ration and the resulting production will to a larger extent, be a result of the land use. It is therefore important to compare different feed rations based on the crop production from the same area (ha) of land. Feeding experiment, planned from this concept, has been conducted during periods of four months on two private farms.

Prolonged lactation and reduced feeding level for cows are expected to increase the roughage proportion of the cow's diet, and thereby a higher degree of self-sufficiency in feed, and to increase the efficiency and sustainability in the dairy system. A two times two factorial experiment with prolonged or standard calving interval and standard supplementation or no supplementation to clover-grass grazing/silage are carried out at the organic research station Rugballegaard.

The objective is, during modelling, experiments and farm studies, to investigate the effect of different lactation length, feeding regimes and feed rations to dairy cows based on 100% organic Danish grown feed. The more specific tasks are

- to determine the milk production potential and efficiency and the impact on animal health and well-being of different types of organic feed produced at an even area
- to evaluate strategies to minimise excessive energy mobilisation and level of ketoses and reproduction problems
- to investigate the effect of prolonged calving interval and reduced level of supplementation in dairy cows on the biological efficiency of milk production and persistency of milk production
- to investigate mammary tissue proliferation, apoptosis and synthesis capacity, reproduction, health, live weight gain and constitution, and energy balance in dairy cows at different calving interval and level of supplementation
- to investigate the effect of supplement feeding on grass intake and selection of herbage during grazing, and on grazing effectiveness and N-balance in a leader-follower rotational grazing system for dairy cows with heifers as followers

- to explore possible indicators for milk quality in relation to human nutrition and health and their relation to feeding
- to investigate the content of vitamins in organic feed, and evaluate the concentration in milk and blood from animals at different stage of their productive life
- to investigate the genetic ranking of genotypes(individuals) in organic and traditional dairy farming systems.
- to evaluate the effect at farm level in terms of overall biological efficiency, nutrient turn-over, level of production and production economic

Table 1: Work package list

No.	Work package title	Partici- pants*	Budget (1.000 DKr)	Start	End	Deliverable No:
WP1	Co-ordination	<u>TKR</u>	0.2	2000	2004	
WP2	Milk production based on home-grown feed	<u>TKR</u>	1.5	2000	2002	
WP3	Prolonged calving interval and reduced supplementation for dairy cows	<u>JAS</u>	3.8	2000	2004	
WP4	Subclinical health and reproduction	<u>KLI</u>	1.0	2000	2004	
WP5	Milk quality	<u>KIS</u>	0.4	2000	2003	
WP6	Grass intake and selection in dairy cows on reduced supplementation.	<u>KAS</u>	0.6	2001	2003	
WP7	Genetic improvement of dairy cows	<u>PM</u>	0.5	2002	2004	
WP8	Farming systems	<u>TKR</u>	0.45	2003	2004	
WP9	Vitamin status	<u>SKJ</u>	0.60	2001	2001	

* Responsible participants are underlined

B. Objectives and expected achievements

The overall perspective of the project is to increase the biological and economical efficiency in organic animal husbandry. The project aims at developing and assessing biologically and economically efficient organic dairy production systems, which are based on a high degree of feed self-sufficiency, and that implicate - under Danish conditions - a high proportion of clover-grass in the feeding ration.

The objective is, by means of modelling, experiments and farm studies, to investigate the effect of different feeding and reproduction regimes and feed rations to dairy cows based on 100% organic Danish grown feed. The more specific tasks are

- to determine the milk production potential and efficiency and the impact on animal health and well-being of different types of organic feed produced on a fixed size of area
- to evaluate strategies to minimise excessive energy mobilisation and level of ketoses and reproduction problems
- to investigate the effect of prolonged calving interval and reduced level of supplementation in dairy cows on the biological efficiency of milk production, milk production and persistency of milk production
- to investigate mammary tissue proliferation, apoptosis and synthesis capacity, reproduction, health, live weight gain and constitution, and energy balance in dairy cows at different calving interval and level of supplementation
- to investigate the effect of supplement feeding on grass intake and selection of herbage during grazing, and on grazing effectiveness and N-balance in a leader-follower rotational grazing system for dairy cows with heifers as followers

- to investigate the influence feed ration used in organic milk production on the milk content of CLA
- to investigate the genetic ranking of genotypes(individuals) in organic and traditional dairy farming systems
- to evaluate the effect at farm level in terms of overall biological efficiency, nutrient turnover, level of production and production economic
- to investigate the content of vitamins in organic feed to dairy cattle, and evaluate the concentration in milk and blood from animals at different stage of their productive life

C. Midterm results and progress

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

WP1: The project initiated an activity with focus on the vitamin supply to organic feed dairy cattle. The activity was included in the project as WP9, with a budget for 2001 at 600.000 dkr. An application in order to extend this work, did not get support from FØJO II. Based on the present project an application for research funding was submitted to NKJ together with partners in Sweden and Norway. The title of the applied project was "Økologisk mælkeproduktion i Norden - tilpasning under hensyn til bæredygtighed, husdyrsundhed og mælke kvalitet". The aim was to establishing a synergistic internordic corporation on the development of organic milk production. Unfortunately the project did not succeed in getting founding. The project will in cooperation with The Department of Animal Product Quality, DIAS, try to establish a masterproject on technological milk quality, as this is an important aspect, which has not been funded so far.

WP2: Feeding experiments were conducted in the period from December 2000 to April 2001, at two private farms belonging to Erik Andersen and Bent Nielsen. The amount of concentrates (barley and rapeseed or rapeseed cakes), were given in amount corresponding to the expected yield, when grown organic in Denmark. The herd belonging to Erik was spilt into three groups, and three treatments was introduced 1) 5 kg barley, 2) 1 kg rapeseed cake 3) 1,4 kg barley and 1,6 kg rapeseed. All cows had ad lib access to the same silage. In the herd belonging to Bent was only treatment 1 and 3 introduced. Main production results are given in table 2.

Table 2. Feeding experiment with barley and rape (seed or cake) to cows feed ad lib with silage.

Farm Treatment	Erik Andersen			Bent Nielsen	
	Barley	Rapeseed cake	Barley and rapeseed	Barley	Barley and rapeseed
N	21	21	21	36	36
Milk, kg ECM	24,7	24,3	26,1	25,7	24,9
Fat, g	1047	1013	1085	1055	968
Fat, %	4,24	4,07	3,96	4,09	3,64
Protein, g	776	772	817	854	830
Protein, %	3,14	3,10	2,98	3,31	3,12

The data has to be analysed more into details, both with respect to production response and together with the results given in WP4. The conclusion is that rapeseed significant depressed fat and protein content, but not the amount. The milk production was reduced by feeding rape cake from an area corresponding to the area needed to grow barley, but the reduction was

lower than expected, based on the energy intake and amount of protein (AAT/PBV) and fatty acid in the ration.

The potential private farms for experiment during the winter 2001/2002 had already changed to 100 percent organic feeding by the autumn 2001, which from the overall idea with this project is positive, but it gave some restriction on the possibility to make stringent treatments. As the experiment in 2000/2001 showed a large depression of fat content by the used amount of rapeseed, it was decided to look at the response in milk of increasing amounts of rapeseed. The same two farms as in 2000/2001 were used.

Table 3. Feeding experiment with increasing amount of rapeseed, instead of barley to cows feed silage ad lib.

Farm Treatment, SFU	Erik Andersen			Bent Nielsen		
	5	4.4	3.8	5	4.4	3.8
- barley	5	4.4	3.8	5	4.4	3.8
- rapeseed	0	0.6	1.2	0	0.6	1.2
N						
Milk, kg ECM	23.0	24.0	25.9	27.6	27.2	27.3
Fat, g	973	1000	1080	1114	1105	1114
Fat, %	4.37	4.15	4.12	3.95	4.03	4.03
Protein, g	712	738	800	899	889	887
Protein, %	3.19	3.04	3.05	3.19	3.24	3.21

WP3: At the organic research station “Rugballegaard”, four different groups has been established in the dairy herd including two levels of feeding (L and N) and two calving intervals (12 and 18 months). Group L is fed only forage *ad lib.* and group N is fed the same forage *ad lib.*, but supplemented with concentrates according to the currently used feeding principle (flat feeding). Lactation curves obtained so far from the four groups of cows are presented as least square means of daily milk yield from calving to end of lactation in figure 1 and figure 2 for first calving heifers and older cows, respectively. The milk yield is higher, but the persistency of lactation is lower in older cows than in first parity cows. The persistency is not influenced by feeding level. As expected, the milk yield is higher in group N (supplemented with concentrates) than in group L (without supplements). The observed milk yield is higher in group N18 compared with group N12, especially in the older cows (figure 2). We still have no explanation for this difference in milk yield. In first parity cows, the persistency decreases during the last trimester of the gestation period at the high feeding level (groups N12 and N18) and to some extent also at the low feeding level with prolonged calving interval (group L18). The same trend is observed in older cows, but only at the high feeding level with prolonged calving interval (group N18).

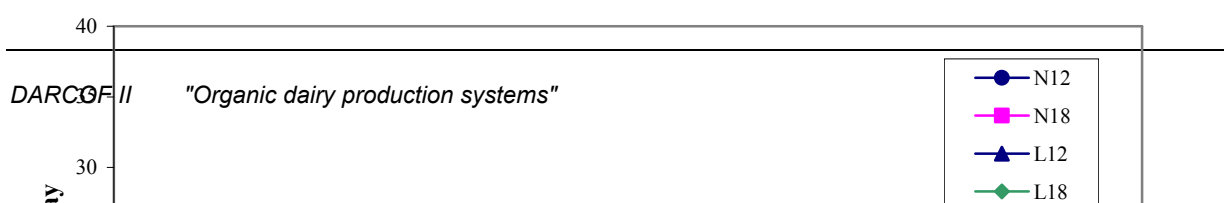


Figure 1. Milk yield in cows at different feeding levels (N or L) and with different calving intervals (12 or 18 months). First lactation cows.

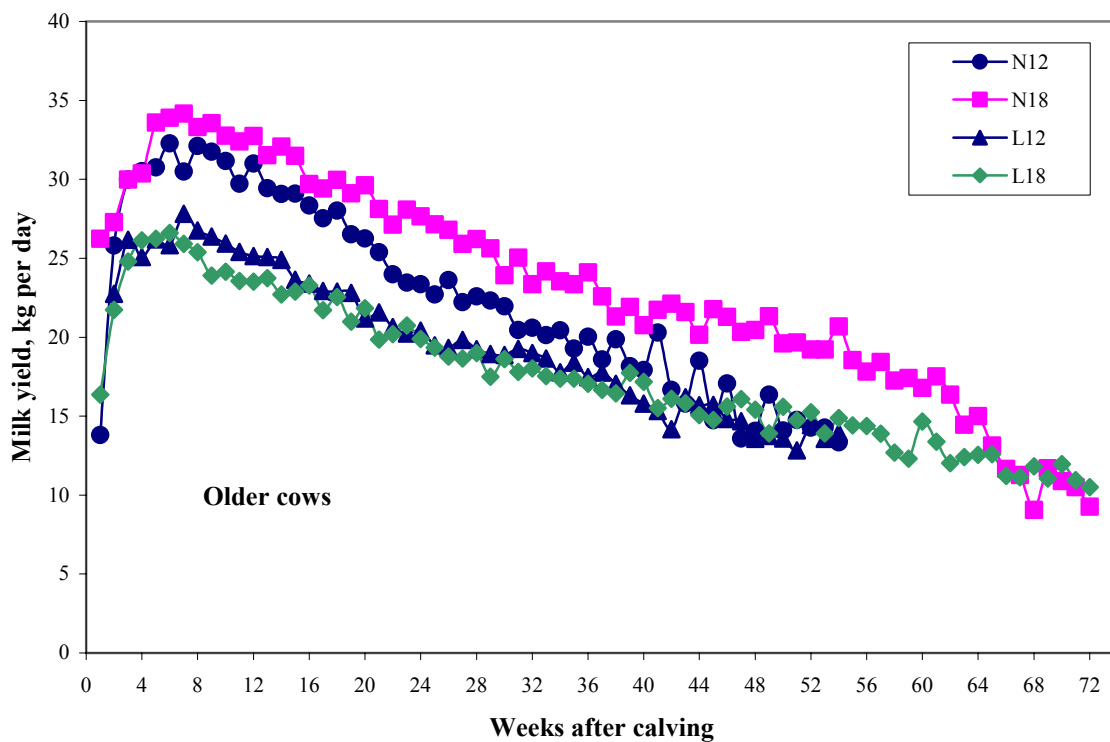


Figure 2. Milk yield in cows at different feeding levels (N or L) and with different calving intervals (12 or 18 months). Older cows.

Some reproduction results are presented in Table 4. There are no significant differences between groups regarding the number of inseminations per pregnancy. The differences from group 12 to group 18 in calving interval and in days to first insemination are less than planned, but there is no significant effect of feeding level (group N versus group L) on these parameters. There are no significant interactions between treatment and parity on any of the parameters shown.

Table 4. Reproduction parameters for cows at different feeding levels and calving intervals.

Feeding level	Group N		Group L		n
	12	18	12	18	
Calving interval, months	320-390	500-570	320-390	500-570	
Planned interval, days	320-390	500-570	320-390	500-570	
Calving to 1. insemin.,	74 ± 9	235 ± 8	74 ± 9	212 ± 8	117
No. insemin. per pregnancy	2.4 ± 0.4	2.3 ± 0.3	2.3 ± 0.4	2.3 ± 0.3	117
Calving interval, days	400 ± 17	535 ± 14	390 ± 15	512 ± 15	73
No. of calvings	23	40	24	32	
1 st parity	13	23	12	22	
Older cows	10	17	12	10	

A literature review on mammary gland physiology and milk production in relation to persistency of lactation has been done by Hans Christian Christiansen and presented in his bachelor thesis "Prolonged lactation in dairy cows".

WP4: In the herd at Rugballegaard (WP3) has blood been drawn from app. 60 milking cows every second week from calving until 16 weeks after calving if the interval coincided with the winter feeding (Mid December to Mid April). A milk sample has been stripped from one (healthy) teat concomitantly with the blood sample. Both blood and milk samples were instantly measured for its acetone content using a "head space" analyser (year 1). The rest of the samples (blood plasma and milk) were stored on ice until freezing could be practised "home" at the laboratory. A novel procedure for ketone body analyses in whole milk has been developed in our laboratory and analyses of milk samples have been initiated concerning two parameters, β -OH-butyrate and urea. Gathered blood samples have further been analysed for its content of metabolites, i.e. free fatty acids, glucose, and β -OH-butyrate. Data has, however, not yet been analysed statistically.

The two private herds (WP2) of Holstein dairy cows were followed during the period with feeding experiment. The animals (week 0-12 from parturition) were in an average medium score body condition (2.5) and offered good quality roughage. Blood and milk samples were taken every second week, and analysed throughout the period. Blood was analysed for acetone, acetoacetate and β -OH-butyrate (ketone bodies), free fatty acids (FFA), triglyceride, free glycerol, glucose and urea. Milk was analysed for ketone bodies. Routine milk samples were collected in parallel and analysed for e.g. urea.

No risk factors were observed concerning sub clinical *ketosis* when 1 SFU rape seed cake substituted for 5 SFU cereals in an *ad libitum* feeding. Nor did substitution of 5 SFU of cereals with 1.4 SFU cereals and 2.6 SFU rape seed cake affect the energy status of the animals. There was no statistical significant difference in milk production or composition when feeding strategy was altered. Blood urea dropped 1.6 mM and milk urea 0.5 mM when low amounts of rape seed cake

was substituted for 5 SFU of cereals, however, it appeared that the animals compensated by increased intake of roughage.

Blood metabolite profiles appeared in the “normal”, physiological range, indicating that the cows, in the chosen time interval, have not been in energy deficiency. Significant effect of rape seed/ barley feeding vs. barley feeding was seen in the triglyceride concentration in blood plasma (0.08 vs. 0.06 mM), presumably reflecting the fat composition of the rapeseed itself. Also blood urea was reflected by the feeding strategy: 4.6 vs. 3.3 mM for rapeseed containing rations vs. cereal feeding.

It can be concluded that the conditions and parameters under observation did not indicate any signs of low energy status or ketotic conditions in the cows when reducing the feed concentrates towards future legislation for ecological dairy cows.

WP5: The preliminary results from the first feeding experiment in WP2 showed that the content of CLA increased feeding rape seed cakes and especially rape seed.

Table 5. Content of CLA and t-vaccenic acid in milk from cows feed different amount and type of concentrate (production data is given in table 2).

	Group 1	Group 2	Group 3
	Barley	Rape seed cakes	Rape seed + Barley
CLA, % of milk fat	0,72	0,78	1,11
t-vaccenic acid, % of milk fat	1,82	2,02	3,36

In two other experiments, with increasing amount of rapeseed substituted barley, the content of CLA was increased from 0,40 to 0,48 g per 100 g fatty acids in one experiment and from 0,46 to 0,79 g per 100 g fatty acids in the other experiment. In a third experiment, where higher amounts of rape seed (2,6 scand. FU) substituted barley, the CLA content was increased from 0,72 to 1,11 g per 100 g fatty acids.

That the content of CLA and t-vaccenic in milk increase just after turn out on pasture was confirmed in an experiment where milk samples were collected and analysed 8 times during the year (fig 3).

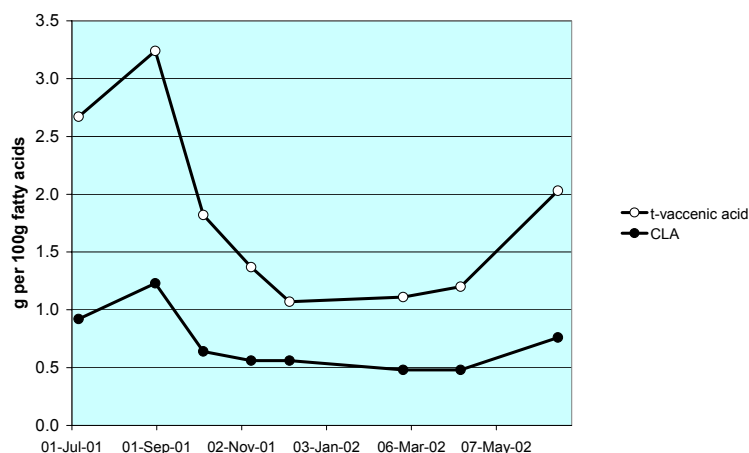


Figure 3. CLA and t-vaccenic acid in milk samples collected during the year

Figure 3 show that as well CLA as t-vaccenic acid are almost doubled for cows at pasture relative to winter feeding.

In 13 organic and 7 conventional herds the average CLA content in milk was 0,57g per 100 g fatty acids. No significant difference between organic and conventional farms was found. But the variation between herds was very high (0,29 -0,76 g per 100 g fatty acids), se figure 4. The reason why some organic farms had a very low CLA content will be analysed further.

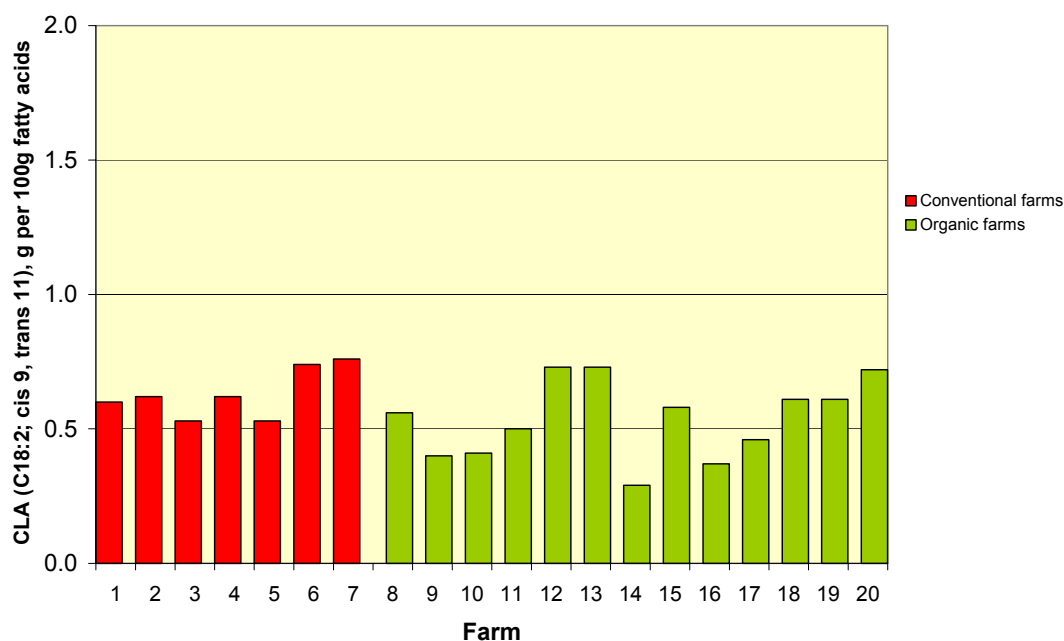


Figure 4. CLA content in cow milk from 13 organic and 7 conventional farms

WP6: A leader-follower rotational grazing system was introduced at Rugballegård in 2001 and was adjusted during the season. The leaders, app. 54 dairy cows, grazed separately in paddocks at two levels of supplements (cf. WP 3, N and L cows) and the followers, app. 46 heifers and dry cows, were also split up in two. Both 1st and 2nd year heifers are included. Routines were developed in 2001 for change of paddocks, irrigation and topping.

A master student (Per Meinert) analysed intake, performance, and health relations in the two groups of heifers in 2001. He concluded from the registrations that:

- heifers are a good alternative to low yielding cows
- there were no negative effects on health for 1st year heifers as followers
- the mean weight performance were 848 and 666 g day⁻¹ for 1st and 2nd year heifers respectively
- the daily intake measured by n-alkane were on average 6.6 and 10.6 g DM day⁻¹ for 1st and 2nd year heifers.

In 2002 and 2003 the grazing system was continued with the exception of the grazing length. In 2001 there was three days grazing in each paddock, which was changed to two days in 2002 and 2003 with the aim to optimise the herbage quality and to a better cleaning up by the followers. In 2002/2003 there were 10-12 paddocks in spring at turn out and the number increased to 17-18 during the season. In five of these paddocks the sward height was measured before leaders grazing, after the leaders grazing, and after the followers grazing. Further, the herbage mass and herbage quality was measured by harvesting three plots to 4 cm with a plot-

harvester before and after cow grazing. New areas were harvested every time. Five times during the season the botanical composition is measured in two horizontal layers before and after cow grazing.

For the period from start of day and night grazing at mid May and to mid August 2002/2003 the compressed sward height was on average 14.4/14.0 cm before leaders grazing, 6.6/5.7 cm after leaders grazing, and 5.6/5.3 cm after followers grazing. It was calculated, that the goal for herbage mass should be 1400 Scandinavian feed units (SFU) ha⁻¹ at start of leaders grazing and 300 SFU at start of followers grazing. This correspond app. to a compressed sward height of 14 and 5 cm respectively. This means that in mean the herbage allowance has reached approximately the goal. However, due to no optimal irrigation there have been some fluctuations in herbage production and mass in both 2002 and 2003.

The analyses of selection during grazing has shown, that the cows prefer both white clover leaves and flowers and avoid grass stem and old/dead plant material. On average in 2003 (May – August) the content of white clover leaves and flowers decreased from 40.7 to 26.5% of dry matter above 6 cm height. In the layer 2-6 cm corresponding decrease was from 35.3 to 24.2% of dry matter. The amount of grass stems increased 9 and 3%-units in the two layers and the content of dead plant material increased, from 1.8 % to 12.4% in the upper layer and from 6.3% to 14.5% of dry matter in the lower layer.

The followers seem to clean up satisfactory; which is illustrated in figure 5. They grazed a relatively great amount of rejected areas. Only one topping has been necessary in both 2002 and 2003.

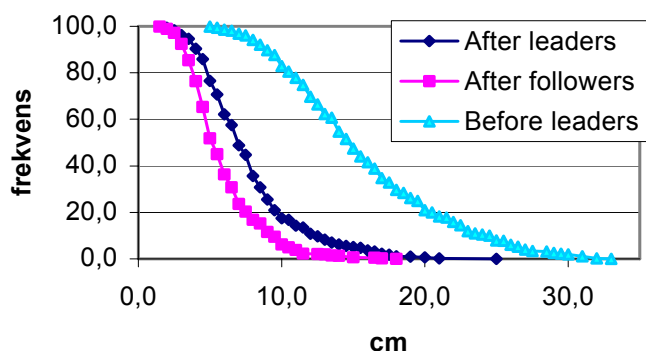


Figure 5: Sward structure in paddocks grazed by cows at treatment N. Results from mid May – mid August. App. 1400 measurements in total.

WP 7: A literature review with the title: "Genetic Improvement of Livestock for Organic Farming Systems" has been conducted in cooperation with A.F. Groen from Wageningen University and accepted for publication (Boelling et. al 2003). This review was not part of the original plan for WP 7, and together with change of personal (D. Boelling left the department by the end of 2002), the data preparation for genetic analyses of milk production traits has been delayed. The work has now been taken over by T. Villumsen.

The original plan was to use production data for the last 10 years, and include all herds with organic milk production together with a matching conventional herd. However, it has shown to be impossible to get information on production systems for herds that have stopped as a milk producer (organic or conventional) prior to 2002. It was therefore decided only to in-

clude the 636 organic herds that were active in 2002, table 6 and 7

Table 6. Descriptive statics for organic and conventional dairy herds, 2002.

Productionssystem	Conventional		Organic	
	Mean	SD	Mean	SD
No. of herds	6233		636	
Mean no. of cows per herd	76,6	43,9	93,1	38,4
Total no. of cows	477.451		59.239	
Mean milk yield, kg	7930	1314	7285	1267
Mean fat yield, kg	347	45	304	37
Mean protein yield, kg	275	38	248	35

Table 7. Organic dairy herds distribution on housing systems, 2002

Housing system	Tied-up		Loss-housing		Unknown	
	Mean	SD	Mean	SD	Mean	SD
No. of herds	70		555		11	
Mean no. of cows per herd	55,6	22,2	98,4	37,3	61,4	34,9
Total no. of cows	2.231		54.616		552	
Mean milk yield, kg	6.659	1.320	7.369	1.239	6.992	1.324
Mean fat yield, kg	292	36	306	37	276	46
Mean protein yield, kg	234	35	250	34	240	40

The selection of match herds is ongoing, and is based on breed, housing system, herd size, and geographic location.

The results of the analysis will, for the part being relevant, included in the scenario in WP 8.

WP8. A quest nary has been made among organic advisors concerning how farmers have adopted to 100% organic feeding. Based on answers from 18 advisors it is judged that the milk yield has dropped in half of the herds due to introduction of 100 organic feeding, although the strategy in almost all herds had been to continue at the same production level as before. The most common concentrates were cereals and commercial low protein mix, with cereal given by 1/3 of the farmers by more than 4 kg pr day both during pasture and winterfeeding. Close to ¼ of the farmers has increased the area due to 100 % organic feeding leading to a higher degree of self-supply. Pasture and clover-grass silage are the most common roughage, but the degree of maize has increased and around ¼ of the farmers use maize silage. Only few farmers has included new crops, as lupine and rapeseed, in the feeding. More information (in Danish) <http://www.lr.dk/kvaeg/informationsserier/lk-meddelelser/1190.htm>

WP9. Samples of blood and milk from cattle as well as feed from 8 organic farms, was collected in April 2001 just before the grazing season. The samples has been frozen (roughage was freeze dried) and subsequent analysed for vitamin A, E and carotenoids. The samples were collected just before the grazing season because it was expected that vitamin content in the roughage would be at a minimum level at that time. Fourteen to sixteen cows and 6-8 of the youngest calves was se-

lected from each farm. The cows were separated in first lactation cows and older cows, due to the fact that off-flavour from the milk and health problems related to deficiencies in vitamin supply most often occur in younger cows in early lactation.

Six of the eight farms used smaller amounts of synthetic vitamins, thus the levels measured in most cows is a result of the dietary vitamins provided by the feed and the dietary vitamins provided by the supplemental mineral mixture.

The sampling was performed in a satisfactory way. All farms had more than 100 cows so it was easy to select the cows, all were of the Holstein-Friesian breed. The selection criteria was:

- First lactation cows 1-3 month post partum,
- older cows in mid lactation,
- the 6-8 youngest calves

Besides a sample of each feed ingredient was taken (5-8 samples/farm).

All samples has been analysed for their content of vitamin A, E and carotenoids.

In connection to our vitamin research, a visiting Ph.D student, Lucia Cortinas from University of Barcelona has established a method, which make it possible to distinguish between natural and synthetic vitamin E. The method is based on chiral column HPLC, and the benefit of this method in relation to quality assessments of organic produced products should not be neglected.

The analysed blood samples showed on average a satisfactory vitamin A and E level, however, around 10% of the investigated cows had a relative low vitamin E level ($< 3 \mu\text{g } \alpha\text{-tocopherol/ ml plasma}$). The majority of these cows were from the two farms, which did not use supplemental vitamins, and most of them was in the beginning of the lactation period.

All investigated calves were low in both vitamin A and E (retinol: < 0.12 ; $\alpha\text{-tocopherol: } < 1.5 \mu\text{g/ml plasma}$), however, at present we do not have reliable reference values, so it is not possible to elucidate the importance of this finding.

All milk samples has been analysed for their vitamin content, but even after they have been standardised for fat content the vitamin content shows too big deviation from normal values. The average content of alfa-tocopherol was $1.8 \mu\text{g/g milk}$, but the variation varied from $0.2\text{-}8 \mu\text{g/g milk}$. We thus have to conclude that in order to use milk as a parameter it is necessary to take a representative sample of the whole milking or use tank milk on farm level, rather than a hand milked sample.

The concentration of vitamin E and carotenoids in the roughage are shown in Table 8.

Table 8. Analysed content of vitamin E and A (as β -carotene) in feed.

	E-vitamin		A-vitamin	
	IU/kg dry matter			
	Avg	SD	Avg	SD
Grain/concentrate	41	25	262	338
Clover grass silage	96	43	16169	5806
Grass pellets	58	11	5980	3071
Barley/pea whole crop	84	38	3701	4153

Table 8 shows the average content and standard deviation of vitamin A and E in international units (IU) in the roughage and concentrate used at the investigated farms. From Table 6 it is seen that clover grass silage and whole crop silage are good sources for vitamin A and E. However, from Table 6 it is also seen that the individual variation between different batches/farms of the same feed item is very big. The implication of this result is that it is very difficult to use table values for exact vitamin contents.

Table 9 show the amounts of vitamin A (in the form of β -carotene) and E fed to each cow with the feed based on the individual analysed feed samples and the average feeding plan. The table shows that half of the farms meet the requirement for vitamin A and all farms meet the requirement for vitamin E.

Table 9. Estimated daily intake of β -carotene and vitamin E per lactating cow.

farm nr	β -Caroten, mg/cow/day					Sum
	Grass silage	Whole crop	Grass pellets	Grain	Rape seed	
1	63	69		0	1	132
2	366	8	7	6	1	389
3	164	1	52	1	0	221
4	292	2	54	1		353
5	498		39		1	542
6	146	144	19		2	314
7	599			1	1	607

farm nr	E-vitamin IE/day/cow						Sum
	Grass silage	Whole crop	Grass pellets	Grain	Rape seed	Other	
1	180	774		111	166	60	1232
2	584	67	49	123	111	98	935
3	322	295	201	66	49		935
4	950	395	166	114		38	1628
5	1275		142	45	111		1579
6	366	849	72	55	189		1538
7	1709			105	69		1891

In agreement with the big variation in the content of vitamins in the analysed feed samples a big difference in the vitamin intake between the cows from the different farms was notified. However, the estimated intake and the measured vitamin status of the cows showed on farm level rather good correlation's (β -carotene $R^2 = 0.75$; vitamin E $R^2 = 0.34$).

It can be concluded that the level of both vitamin E and carotenes in the analysed roughage were lower than expected based on the values found in the literature. Likewise, especially the vitamin E content in cows fed without supplemental vitamins was in the lower range of the recommended level, though without showing severe deficiencies.

With respect to the vitamin D situation a more comprehensive study need to be initiated, as the levels of the different metabolites in the blood showed too big fluctuations to allow a clear conclusion.

C.2 Fulfilment of deliverables and milestones

WP number and title	Time schedule according to application	Deviations, if any*
WP1: Co-ordination		
<i>Milestones</i>		
M1 Project meeting	Sept. 2000, May and Sept. 2001, 2002, 2003, and 2004	
M2 Annual report	Dec. 2000, 2001, 2002, 2003, and 2004	
<i>Deliverables</i>		
D1.1;D1.2: National meeting organic advisors	Oct. 2002 and Oct. 2004	
D1.3: Two general meetings each year		
D1.4: Annual status reports and a final report		
WP2: Milkproduction		
<i>Milestones</i>		
m1 Design of experiments for 2000/2001	July 2000 – August 2000	
m2 Contract with farms	August 2000 and May-June 2001	
m3 Study tour	September 2000	
m4 Design of experiments for 2001/2002	April 2001 – May 2001	
<i>Deliverables</i>		
D2.1: Thesis	Dec. 2001	1)
D2.2;D2.4: International papers	Dec. 2001 and Dec. 2002	1)
D1.1: National meeting and proceeding	Oct. 2002	2)
WP3: Prolonged lactation		
<i>Milestones</i>		
m1 Final plan for feeding and reproduction strategies	August 2000	
m2 Final plan for sampling of blood and biopsis etc.	July 2002	
m3 Evaluation of strategies and preliminary results	August 2001, 2002, 2003, and May 2004	
m4 Report	September 2004	
<i>Deliverables</i>		
D3.1;D3.2: International papers	Dec. 2004	
D3.3: National report	Oct. 2004	
D1.2: National meeting and proceeding	Oct. 2004	
WP4: Health		
<i>Milestones</i>		
m1 Sampling and laboratory analysis of samples finished for experiments 1 and 2	July – Sept. 2001	
m2 Sampling and laboratory analysis of samples finished for experiments 3	July – Sept. 2002	
m3 Sampling and laboratory analysis of samples finished for experiments 4	June – August 2004	
m4 Evaluation of different feeding strategies on cow health and reproduction	Oct. – Nov. 2001, Oct. – Nov. 2002, and August – December 2004	
<i>Deliverables</i>		
D4.1: M.Sc. thesis	Sept. 2001	
D4.2;D4.3: International paper	Oct. 2002 and Oct. 2004	3)
D1.1;D1.2: National meeting and proceeding	Oct. 2002 and Oct. 2004	
WP5: Milk quality		
<i>Milestones</i>		
m1 Start collection of samples	Dec. 2000, May and Dec. 2001	
m2 Start of lab-analysis	May – June 2001 and May – June 2002	
m3 Evaluation of results and preparation of reports	Aug. – Sept. 2001 and Nov. – Dec. 2002	
<i>Deliverables</i>		
D5.1: International publication	May 2003	4)
D5.2: National report	Oct. 2003	
D1.1: National meeting and proceeding	Oct. 2002	

WP6: Grass intake		
<i>Milestones</i>		
m1 Conclusions on the grazing method	April 2001	
m2 Evaluation of preliminary results	Dec. 2001 and Dec. 2002	
m3 Final report and publication	Dec. 2003	
<i>Deliverables</i>		
D6.1: International paper	April 2004	
D1.2: National meeting and proceeding	Oct. 2004	
D3.3: National report	Oct. 2004	
WP7: Genetic improvement		
<i>Milestones</i>		
m1 Establishment of data sets	Aug. – Sept. 2002 and March – April 2003	
m2 Models developed	March – April 2003	
m3 Models fitted on production data	March – April 2003	
m4 Models fitted on non-production data	Sept. – Oct. 2004	
<i>Deliverables</i>		
D7.1: National report	Oct. 2004	
D7.2: International paper	Oct. 2004	
D1.2: National meeting and proceeding	Oct. 2004	
WP8: Farming systems		
<i>Milestones</i>		
m1 Workshop	April 2003	1)
m2 Prototype of farmlevel	January 2003	1)
m3 Evaluation and final report	December 2004	
<i>Deliverables</i>		
D8.1: National report	Nov. 2004	
D1.2: National meeting and proceeding	Oct. 2004	
WP9: Vitamin		
<i>Milestones</i>		
m1 Sampling of feed, blood and milk completed	April 2001	
m2 Analysis for Vitamin A, E and D completed	Sept 2001	
m3 Evaluation and final report	December 2001	
<i>Deliverables</i>		
D9.1: National report	Nov. 2001	
D1.2: National meeting and proceeding	Oct. 2001	2)

* Deviations are to be further discussed in D

D. Description of deviations and subsequent adjustments of plans

Specific comments in relation to notes in the table in C2.

ad 1)

Lisbeth has maternity leave in the period from June 2003 to May 2004. Due to this will one of the international the papers and the final thesis be delayed, but with planned graduation in winter 2004/05.

ad 2)

Results from the experiment in WP2 and WP9 were presented at a meeting for advisors and farmers arranged by DJF and FØJO. Material from the meeting is available at www.fojo.dk.

ad 3)

Part of the results is published in Mogensen et.al. (2004), and other results will be part of a scientific paper with similar measurements from conventional herds. A manuscript will be published I due course, hopefully early next year.

Ad 4)

General results have been published in a preliminary report (Andersen et al., 2003), but the scientific paper is delayed because we are still conducting experiments in the companion project. A manuscript will be published in due course, hopefully early next year.

General comments to adjustment in activities

WP 6 has been enlarged by grass intake measured by n-alkane in both heifers and cows in 2001. This has been possible as the project co-operated with two master students from KVL. Karen Søgaard has been on a study tour to Ireland in June 2002 studying rotational grazing without supplementation. She visited Teagasc (Grange Research, Oak Park research and Dairy Research Centre Moorepark), two dairy farms, and one beef farm.

WP3 A strategy have been made to increase the available area for grazing and cutting silage, as Rugballegaard have obtained a contract on milk delivery, which demands a 100 % organic feeding ration. As this is a general trend in Danish organic dairy production, a pressure is expected on the feed market, and this might cause some restrictions on the supply to this project of especially concentrated and protein rich feeds. Rugballegaard has agreed to try and grow rape seeds to try to ensure the supply of heat treated rape seed cakes.

Comments to plans remaining part of the project period

WP2 + WP8: Major effort will be given to submission of the thesis, which will be slightly changed in order also to incorporate some of the work in WP8.

WP3: It is planned to continue and maintain the feeding and reproduction strategies until spring 2004.

WP4: A strengthening of the metabolite profiles, analysing for specific liver enzymes in the blood, may be considered, as the present material indicated that it might be a reasonable expansion of the study.

WP 7: The use of reaction norm models to describe G*E interactions rely on that it is possible to describe the environment on a continuous scale. Typical, some form of herd average for the trait in question has been used to describe the herd environment (e.g. Kolmordin et al. 2002). However, this lead to some statistical problems because the co-variable is more or less a function of the data to analyse. This theoretical problem has been solved using Bayesian methods and is now under implementation and will be tested in a simulation study. This new method together with more traditional method of describing the herd environment will be used to analyse milk production traits in autumn 2003. Analyses of fertility and health traits will be conducted during the first halve of 2004.

Plan for publication

Working titles and authors (and relations to WP) for the main deliverables in table 1, besides the paper already published or accepted.

International papers

Production, health and physiological status of organic dairy cows feed rape seed or cereal as supplement to silage ad libitum (Lisbeth Mogensen, Klaus Lønne Ingvarsten, Troels Kristensen), WP2, WP4.

Effect of reduced feeding level and prolonged calving interval on feedintake, milkproduction, - quality, live weight (Allan Danfær/Jakob Sehested, Kristen Sejersen, Karen Søegaard), WP2, WP5, WP6.

Effect of reduced feeding level and prolonged calving interval on health (clinical and subclinical) and mobilisation measured directly and by physiological indicators (Klaus Lønne/Torben Larsen, Allan Danfær/Jakob Sehested), WP4, WP2

Pasture utilisation and N efficiency in a leader-follower grazing system with organic dairy cows and heifers (Karen Søegaard, Allan Danfær/Jakob Sehested, Troels Kristensen), WP6, WP2

Interaction between genotype and dairy production system (organic or conventional) (Per Madsen), WP7

Prototyping of different organic dairy production systems – consequence on productivity, animal health and environmental impact (Lisbeth Mogensen, Troels Kristensen, other project partners), WP8

National reports

Organic milk production – results from experiments and modelling of different productions systems (Troels Kristensen and all other project partners), WP1 to WP8.

E. Project publications and other products

1. Articles in international, scientific journals with review procedures

Boelling, D., Groen, A.F., Sørensen, P., Madsen, P. & Jensen, J., 2003. Genetic Improvement of Livestock for Organic Farming Systems. *Livestock Production Science* 80, 79-88.

*Mogensen, L. & Kristensen, T., 2002. Effect of barley or rape seed cake as supplement to silage for high-yielding organic dairy cows. *Acta Agr. Scand.* 52(4), 243-252.

*Sehested, J., Kristensen, T. & Søegaard, K. 2003. Effect of concentrate supplementation level on production, health and efficiency in an organic dairy herd. *Livest. Prod. Sci.* 80, 153-165.

**Søegaard, K; Sehested, J.; Danielsen, V. (2000): Mixed grazing with heifers and pregnant sows. *Grassland Science in Europe*, 5:359-361.

Papers accepted for publication

*Mogensen, L. & Kristensen, T. 2003. Concentrate mixture, grass pellets, fodder beets, or barley as supplement to silage ad libitum for high-yielding dairy cows on organic farms. *Acta Agr. Scand.* In Press

Mogensen, L., Ingvarsen, K.L., Kristensen, T., Seested, S. and Thamsborg, S.M. 2004. Organic dairy production based on 100% organic feed grown at equal area per cow – rape seed, rape seed cake or cereal as supplement to silage ad libitum. *Acta Agr. Scand.*

2. Papers presentations at congresses, symposiums etc.

Jensen, S.K. 2001. Vitaminforsyningen hos økologiske kvæg. Bilag til Temadag om Økologisk Mælkeproduktion, 3. oktober, Forskningscenter Foulum, s. 35-37.

Jensen, S.K. 2001. Kvægets vitaminbehov og –forsyning. Fodringsdag. Temadag om aktuelle fodringsspørgsmål, Herning Kongrescenter den 28. august 2001. Landbrugets rådgivningscenter. Landkontoret for Kvæg, 8200 Århus N, 80-86.

**Kristensen, T., Kristensen, I.S. & Sehested, J., 2002. Malkekøveg som dynamo for en alsidig udvikling af økologisk jordbrug. I: Sehested, J. & Kristensen, T., 2002. Økologisk mælkeproduktion. Strategier og foderforsyning ved 100 procent økologisk fodring. FØJO-rapport nr. 17, 43-56

**Kristensen, T. & Sehested, J., 2002. Introduktion - perspektiver ved 100% økologisk fodring. I: Sehested, J. & Kristensen, T., 2002. Økologisk mælkeproduktion. Strategier og foderforsyning ved 100 procent økologisk fodring. FØJO-rapport nr. 17, 9-13.

**Mogensen, L., Kristensen, T. & Sehested, J., 2002. Tilskudsfoder til vinterfodringen af økologiske malkekøer. I: Sehested, J. & Kristensen, T., 2002. Økologisk mælkeproduktion. Strategier og foderforsyning ved 100 procent økologisk fodring. FØJO-rapport nr. 17, 27-42.

*Mogensen, L; Kristensen, T. 2001. Økologisk mælkeproduktion. Resultater fra forsøg med selvforsyning med økologisk foder. Bilag til Temadag om Økologisk Mælkeproduktion, 3. oktober, Forskningscenter Foulum, s. 9-12.

Sehested, J.; Kristensen, T. (2001): Økologisk mælkeproduktion - reduceret foderniveau og strategisk anvendelse af tilskudsfoder. Bilag til Temadag om Økologisk Mælkeproduktion, 3. oktober, Forskningscenter Foulum, s. 13-16.

**Sehested, J. & Kristensen, T. 2002. Økologisk mælkeproduktion - Strategier og foderforsyning ved 100 procent økologisk fodring. Sehested, J. & Kristensen, T. (eds.), FØJO-Rapport nr. 17, pp 77.

**Sehested, J.; Roepstorff, A.; Monrad, J.; Søgaard, K. Danielsen, V. (2000): Performance and parasitosis in heifers grazing together with sows. Oral presentation and Handout Book at the 51st Annual Meeting of the European Association for Animal Production, session M5.

3. Reports, articles in agricultural journals etc

Andersen, H. Refsgaard, Sejrsen, K., Sørensen, M.T., Kristensen, T. & Straarup, E.M. 2003. CLA-indhold i komælk <http://www.foejo.dk/enyt2/enyt/aug03/cla.html>

Christiansen, H.C., 2001. Forlænget laktation hos malkekøer. Bachelorprojekt fra KVL.

Jensen, S.K. & Lauridsen, C. 2002. E-vitamin styrker dyrenes immunforsvar. Landsbladet Agro, nr. 5, 32.

Kristensen, T. 2002. Perspektiver ved 100 procent fodring. Økologisk Jordbrug, nr 262, side 6.

Kristensen, T. 2001. Koen som dynamo. Ændret produktionsstrategi for økologisk mælkeproduktion. Økologisk Jordbrug, nr 246, side 14.

Kristensen, T.; Sehested, J. (2001): Mange køer æder nu kun økologisk foder. Landsbladet Kvæg, nr 6, 31. maj, s. 34.

Mogensen, L. 2003. Hvordan søger de økologiske mælkeproducenter at sammensætte en 100 % økologisk fodring – resultater af en spørgeskemaundersøgelse blandt konsulenter. <http://www.lr.dk/kvaeg/informationsserier/lk-meddelelser/1190.htm>

*Nielsen, P.M. 2002. Systemer til styring af græsoptagelsen hos køer og kvier. M.Sc. Speciale i Kvægproduktion fra KVL.

Seested, S. 2001. Økologisk mælkeproduktion baseret på 100% økologisk fodring og 100% selvforsyning – konsekvenser på malkekøers fodring, produktion og sundhed i tidlig laktation med fokus på subklinisk ketose. M.Sc. Speciale fra KVL.

**Sehested, J. (2000): Høj tilvækst med kvier og søer i samme fold. Økologisk Jordbrug nr. 216, 20. årgang, s. 14.

**Sehested, J.; Kristensen, T. (2000): Køer og svin i samme sædskifte. Økologisk Jordbrug nr. 217, 20. årgang, s. 13.

Sehested, J.; Kristensen, T.; Søgaard, K.; Nielsen, J.H. (2000): Køerne klarer sig med mindre kraftfoder. Økologisk Jordbrug nr. 217, 20. årgang, s. 13

4. Oral presentations, public meetings, field days etc.

Jensen, S.K. 2002. Vitaminforsyningen hos økologiske drøvtyggere. Efteruddannelse for økologiske landmænd. Borris Landbrugsskole/Vestjysk Landboforening 15. januar.

- Kristensen, T. 2002. Fodring med økologisk foder. Efteruddannelse for økologiske landmænd. Hovborg. 5. februar.
- Kristensen, T. 2003. Proteinfodermidler i den økologiske mælkeproduktion- Foredrag – Løgumkloster.
- Mogensen, L. 2002. Selvforsyning med foder. Efteruddannelse økologiske rådgivere. Koldkærgård august.
- Sehested J. 2002. Økologisk mælkeproduktion – 100 % økologisk fodring. Efteruddannelse økologiske landmænd. Lemvig 22. januar.
- Søegaard K. 2002. Afgræsning og fodring af malkekvæg på græs. Efteruddannelse for konsulenter. Koldkærgård, marts 2002
- Søegaard K. 2003. Grovfoderproduktion og –udnyttelse. Efteruddannelse for konsulenter. Koldkærgård, september 2003

The project has been presented 7. august 2001 at a field day on Rugballegaard.

F. Scientific education

The Ph.d work by Lisbeth Mogensen is to a large part based on the activities in WP2 and WP8.

The activities in WP2 and WP4 has been the back bone of a master project by Susanne Seested, from the Royal Veterinary and Agricultural University, Copenhagen.

The activities and ideas behind WP2 and WP6 has been a major part of master projects by Per Meinert and Sarah Meilbak, and bachelor project by Hans Christian Christiansen

Sinclair Mayne from Agricultural Research Institute of Northern Ireland has visited DJF and participated in a roundtable meeting with discussion about grazing and grazing systems.

G. National and international cooperation

Hanne H. Hansen, KVL has been closely involved in the activities about use of n-alkanes to estimate feedintake (WP3).

A project “Protein feeds to milk and meat production” (2002-2004) founded by the Danish farmers union, will be closely co-ordinated with this project.

The project (WP9) has made contact to Elisabet Nadeau from SLU in Skara, Sweden and it has been agreed that we shall analyse around 150 roughage samples for them in 2002 for their content of vitamin E and carotenoids. These samples show variations with respect to botanical composition, harvest time, harvest conditions and storage.

Also in relation to WP9 contact to Karin Perhsson Waller SVA in Uppsala, Sweden has been made in order to study differences in the effect of natural and synthetic vitamin E on udder health.

H. Critical reflection on the project

The overall idea in the project “feeding 100 % organic”, has showed to be even more realistic than we argued, as the dairy industry during the summer 2001, started making contract with the farmers with this restriction.

The activities in the project so far, has been initiated and conducted in agreement with the plans, and some of the information has been given earlier than planned as a consequence of the demand from extension officers due to the mentioned new situation with contracts based on 100 pct organic.

The introduction of a new grazing system and reproduction strategies at Rugballegaard was more time consuming than expected, but the outcome in terms of the present grazing management, feeding and reproduction results is satisfactory.

The activities at private farms have been useful, both as experimental units and as contact to farmers and local advisor.

The work with milk quality and with vitamin supply has shown the benefit of having a good contact to farmers, which made it possible to extent the project with extra milk samples and the WP with vitamin supply.

The herd at Rugballegård and the two private herds have been heavy used for sampling of data and samples. At present there is analysis and discussion between the WP about how to use these information in order to give information with new dimensions, based on a collaboration between scientist with different working areas, like feeding, health, physiology and milk quality.

We believe that the outcome of this project will be valuable for a more holistic development of organic milk production, as it will give information from quit different perspective, breeding, feeding, reproduction, grazing, farming system ect.

The work within breeding is based on advanced statistical methods, using the production data from the present organic and conventional herds in Denmark. Based on these results, and contact to organic farmers, there could be an opportunity to describe the effect of alternative breeds and ways of breeding.

The project works with a large number of agronomical areas, which as mentioned earlier is very useful, but it also have the consequence that some areas still need to investigated. At present it is clear that the project activities within the area of vitamin status and supply is not power full enough to clarify the problems and possibilities within this important area.

Although the project in WP8 will work with prototyping of new milk production system, there will in the project be generated partial information, which in an extension of this project could be used as input for documentation of future organic milk production systems.

8. Budget

A. Account for any change in budgets

WP2 and WP8: 75.000 dkr has been transferred from 2003 to 2004, due to the delay in data analysis and publishing.

B. Budget for the whole project (1.000 DKK)

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

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	50	21	16		87
Technical personnel	31	11	5		48

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	2017	929	736		3682
Technical personnel	778	322	146		1246
Other operational costs	658	183	162		1003
Equipment	69	24	5		98
Others (please specify)	995	300	215		1510
Direct costs	4517	1758	1264		7539
Indirect costs (20% of direct costs)	907	352	253		1511
Total	5425	2108	1517		9050

Comments:

9. Signatures and stamps

Name	Institute	Date	Signature
Head of project Troels Kristensen	DIAS	26.09 2003.	

Appendix I. Detailed budget

A. Budget for each participating institute (1.000 DKr)

Name of Institute: Danish Institute of Agricultural Science

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	50	21	16		87
Technical personnel	31	11	5		48

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	2017	929	736		3682
Technical personnel	778	322	146		1246
Other operational costs	658	183	162		1003
Equipment	69	24	5		98
Others (please specify)	995	300	215		1510
Direct costs	4517	1758	1264		7539
Indirect costs (20% of direct costs)	907	352	253		1511
Total	5425	2108	1517		9050

Comments:

B. Budget for each participating department (1.000 DKK)

Name of Institute and department: Dept. of Agricultural Systems

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	16	3	3.5		22.5
Technical personnel	7	2	1		10

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	644	131	155		929
Technical personnel	206	64	34		304
Other operational costs	173	17	34		224
Equipment	45	20	5		70
Others (please specify)	295	0	15		310
Direct costs	1363	232	243		1837
Indirect costs (20% of direct costs)	273	46	48		368
Total	1636	278	291		2205

Comments:

75.000 kr. (1.5 VIP) transferred from 2003 to 2004

Name of Institute and department: Department of Animal Nutrient and Physiology

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	24	8	8		35
Technical personnel	1	4	3		18

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	953	354	369		1676
Technical personnel	400	103	81		584
Other operational costs	344	80	70		494
Equipment	0	0	0		0
Others (please specify)	700	300	200		1200
Direct costs	2397	838	719		3954
Indirect costs (20% of direct costs)	480	168	144		791
Total	2877	1005	863		4745

Comments:

Name of Institute and department: Department of Animal Health and Welfare

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	5	3	2		10
Technical personnel	5	2	1		8

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	216	139	97		452
Technical personnel	140	60	32		232
Other operational costs	81	34	19		134
Equipment	15	0	0		15
Others (please specify)	0	0	0		0
Direct costs	453	233	147		833
Indirect costs (20% of direct costs)	91	47	29		167
Total	543	280	177		1000

Comments:

Name of Institute and department: Department of Crop Physiology and Soil Science

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	3	3	0.5		6.5
Technical personnel	1	3	0		4

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	123	129	23		275
Technical personnel	31	94	0		125
Other operational costs	50	30	7		87
Equipment	9	4	0		13
Others (please specify)	0	0	0		0
Direct costs	213	257	30		500
Indirect costs (20% of direct costs)	43	51	6		100
Total	256	308	36		600

Comments:

Name of Institute and department: Department of Animal Breeding and Genetics

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Man-months					
Scientific personnel	2	4	2		8
Technical personnel	0	0	0		0

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	Total
Salaries					
Scientific personnel	84	176	92		352
Technical personnel	0	0	0		0
Other operational costs	10	22	33		65
Equipment	0	0	0		0
Others (please specify)	0	0	0		0
Direct costs	94	198	125		417
Indirect costs (20% of direct costs)	19	40	25		83
Total	113	238	150		500

Comments: