

## Technical Annex

### Scientific description of the project

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**Title:**

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

**Acronym:** ECOVIT

**Duration:** From: 01/2007 to: 12/2010

**Participating scientists:**

(Titles, names and brief institutional affiliations of scientists in the project. Head of project is written in bold, participants responsible for work packages are underlined).

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**English summary** (1 page, suitable for publication):

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 be 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.

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## **A.0 Introduction, state of the art and objectives of the project (max. 3 pages):**

### **Vitamins, minerals and antibiotics in organic farming**

Self-sufficiency and recirculation of nutrients within the farm are central elements in the organic principles (IFOAM 2002). On the organic farm animal and crop production should exist in a harmonious balance that supplies the animals with the full spectrum of nutrients, access to natural behaviour and contributes to an improvement of the soil. If supplements like vitamins and micro minerals are necessary they should be of natural sources if possible (IFOAM 2002, CEC 1999). However the regulation of the Danish organic livestock production still allows for a number of exceptions from these principles. Only recently Danish organic dairy herds changed to 100 percent organic feeding and most supplements of minerals and vitamins are still based on inorganic and synthetic products imported to the farm. At the moment the Nordic countries have a dispensation from the EU regulations to use synthetic vitamin A, D and E for ruminants.

Also in the handling of disease the basic organic principle of cautiousness and avoidance of synthetic substances are violated with the use of synthetic veterinary medicine like antibiotics and synthetic parasiticides (IFOAM 2002, CEC 1999).

To improve the integrity of the organic dairy production strategies for an integrated mineral- and vitamin supply through optimisation of the choice of forage crops and management and combination of feedstuffs are needed. Our hypothesis is, that in some areas self-sufficiency could be obtained with such strategies. For herds were an optimal supply of vitamins and minerals can not be obtained supplements based on natural sources must be identified and made available. Also new strategies to improve animal health and handle disease without allopathic drugs are necessary. These strategies must be evaluated to give the organic dairy farmer better information about alternatives to conventional veterinary medicine.

### **Content of vitamins in feedstuffs and supply of organic dairy cattle**

Fat-soluble vitamins are important for ruminants in respect to maintain an optimal immune function, reproduction traits and a high quality of the food products produced (milk and meat) (Weiss, 1998; NRC 2001).

In cattle feed the highest concentration of pro-vitamin A (in form of  $\beta$ -carotene) and vitamin E ( $\alpha$ -tocopherol) is found in the green leaves of grass, legumes and other green plants, while stem and seeds together with more mature crops as whole crop and corn silage only contain small amounts (Jensen, 2003). Grassing cattle get normally their requirements for fat soluble vitamins fulfilled (Jukola, 1994). During the indoor season silage and very rear hay are used instead of pasture. Depending on harvest time (in relation to plant development), harvest conditions and storage conditions, the content of fat soluble vitamins in the silage can decrease to very low amounts during storage (Kivimäe & Carpen, 1973; Nadeau et al., 2004), and knowledge about how to avoid this decrease is essential for obtaining self-sufficiency

Vitamin D is only found in plants in low concentrations (Horst, 1986) with the highest concentrations in leaves (NRC, 2001). The vitamin D content in plants increases as a function of UV irradiation of dry leaves and during sun drying of hay (McDowell, 1987). Vitamin D is mainly produced by the animals under exposure to the sun. The exact need for sunlight to guarantee an adequate production of vitamin D is not known and need to be investigated.

## Content of minerals in feedstuffs and supply of organic dairy cattle

Cattle are expected to receive a high proportion of their mineral supply from the feed. Approximately 22 mineral elements are considered to be essential to animals (Underwood & Settle, 1999). However, the content of minerals in general, and micro minerals in particular, vary greatly in both concentrate and forage feedstuffs (Kurtz 1998; Bossed & Awes 2001a; Bossed & Awes 2001b; NRC 2001). Some forage species have a relatively high mineral uptake. This is current for legumes, and especially for Lucerne, which is reported to have a high content of especially Al, Fe and Zn (Clark & Baligar, 2003). Herbs are established in organic grassland with different aims, e.g. high content of micro minerals. The best-analysed species, chicory (*Cichorium intybus*), is reported to have a very high content in general (Berry, 1998), but on a Danish farm this was only the case in spring growth and not in summer growth for Se and Co (Bertelsen, 2002). The great variation in content of the single minerals is due to differences in mineral content in the soil, morphological development etc., but the knowledge about these effects on micro minerals is limited.

Supplementation with inorganic minerals is common in organic dairy production in Denmark as insurance due to uncertainties regarding actual feed mineral content, mineral availability and animal requirements. However, the natural feed content of some macro minerals will often be close to the recommended level for feeding (e.g. Ca) or even above (e.g. P), whereas the content of micro minerals seems to be more variable and in some cases relatively low (NRC 2001; Aaes et al. 2003; Sehested 2004). Furthermore there is increasing focus and evidence on the significance of trace minerals on animal production and health and therefore special emphasis should be given to Zn, Cu and Se (Reffett et al. 1986; NRC 2001; Weiss & Spears, 2004). Natural supplements of minerals are not common in Danish organic dairy herds, possible sources could be by-products from organic production, seaweed or dried products of plants with high content of one or more minerals e.g. Lucerne or various herbs (Zollitsch et al., 2003, Swift et al., 1990).

## Controlling animal health without allopathic substances

According to the EU regulation of organic farming phytotherapy or other non-allopathic treatments should be used if they are scientifically documented (CEC, 1999). About half of all the antimicrobials produced today in the world are used in animal production, presenting both a selective pressure for antibiotic resistance and real possibilities for drug residues in animal food products (WHO, 2001). Danish studies have shown no differences in the prevalence of antibiotic resistance between organic and conventional herds (Bennedsgaard 2003), however some studies from USA where organic cows treated with antibiotics loose their organic status and antibiotic usage is very low and antibiotics are easily available in conventional herds have demonstrated a tendency towards lower prevalence of antibiotic resistance (Sato et al., 2005; Tikofsky et al., 2003, USDA 2000).

In previous Danish studies by the project group focusing on the use of medical treatments in organic dairy herds the complexity of decisions of disease treatment has been described and analysed (Bennedsgaard et al., 2003; Vaarst et al.; 2002, Vaarst et al., 2003a; Vaarst et al., 2003b).

Two major types of strategies for phasing out usage of antibiotics have been identified, namely health promotion alone or with a combination of health promotion and the use of alternative disease treatment methods. These strategies must be viewed as distinct strategies, as the focus of the farmer, the consequences on herd level and the integration in the whole farm system can be widely different for the two different approaches. Experiences from an ongoing project shows that phasing out antibiotic is a realistic goal in many organic dairy herds and is close to reality in some Danish herds (Vaarst et al, 2005). Important elements for realising this goal are a true improvement of herd management and herd health strategies, and a continuous articulation of goals, choices and priorities. This combination forms a major argument for a research project to integrate quantitative and qualitative research methods in order to catch both sides of this development connected to a non-antibiotic herd strategy: the motivations and using experience for further development, and on the other side a proper documentation of the actual consequences of these strategies and priorities. However only a limited number of Danish herds follow a non-antibiotic strategy. The experience of the US organic farmers could probably be of great value in the development of non-antibiotic strategies in Denmark, especially when combined with the experiences of Danish farmers with low antibiotic usage.

Though several different phytotherapeutic and alternative treatments are used among organic dairy farmers no scientific recommendations and only very limited scientific testing on farm animals exists for most of these treatments (Vaarst et al, 2003). Relevant diseases to investigate could be retained placenta and metritis of dairy cows and pneumonia and diarrhoea of dairy calves, which affect a relatively high number of animals and have a high cure rate with antibiotics, making comparison of treatment methods easier. Promising treatment methods are various herbs for pneumonia and aloe vera and garlic for both local and systemic infections. For reproductive disorders acupuncture might be an alternative to hormones.

### **Farm perspective**

In a system (farm) aiming at a high integrity, not only for minerals and vitamins, but for all the driving elements in the production as manure to crop production, energy and specific nutrients for milk production etc., will choices be made in order to meet some of the elements effect the possibilities to meets also some of the others, as the specific elements are connected typical by their content in the fed grown at the farm (Zollitsch, et al., 2004; Hermansen & Kristensen, 2004). As shown by Mogensen & Kristensen (2005) the productivity and economic return to the farmer are very sensitive to how integrity, in this example only within energy and protein to the herd, are obtained through different types of crop rotation. They concluded that high net return is strongly correlated to high productive crops. When integrity is not only on energy, but also on minerals and vitamins, the hypotheses is that the effect on productivity and thereby economic return to the farmer are even more sensitive This is especially true as it seems like most of the crops containing high amounts of minerals are lower in productivity as traditional organic roughage like grass-clover and that aiming after integrity at farm level probably will cause a increased number of crops at each farm, cutting dates specified after more than energy content and perhaps also other and more costly methods of conservation.

Quantity knowledge about concentration of minerals and vitamins in different feeds, the complex interaction between crop production, nutrient management and feeding of the herd need to be seen together with an in depth understanding of the organic dairy farmers management in order to develop strategies, that can be accepted and realized at farm level (Mogensen & Kristensen, 2000). It is also important to highlight the conflict between different rules and ideals within organic farming and the perspectives for obtaining a higher integrity.

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.

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## **A.1 Technical content of the research activity**

The project is organized in 6 work packages. The first work package includes project coordination and the dissemination of the results. The high priority on project coordination is chosen to assure a clear focus on the overall objectives of the project: Increased integrity in organic dairy production and to assure a rapid dissemination of the results from the project.

In WP6 contact are established to six organic dairy herds that will be followed over three years and form the basis for a number of studies in WP2, 4, 6 and eventually WP5.

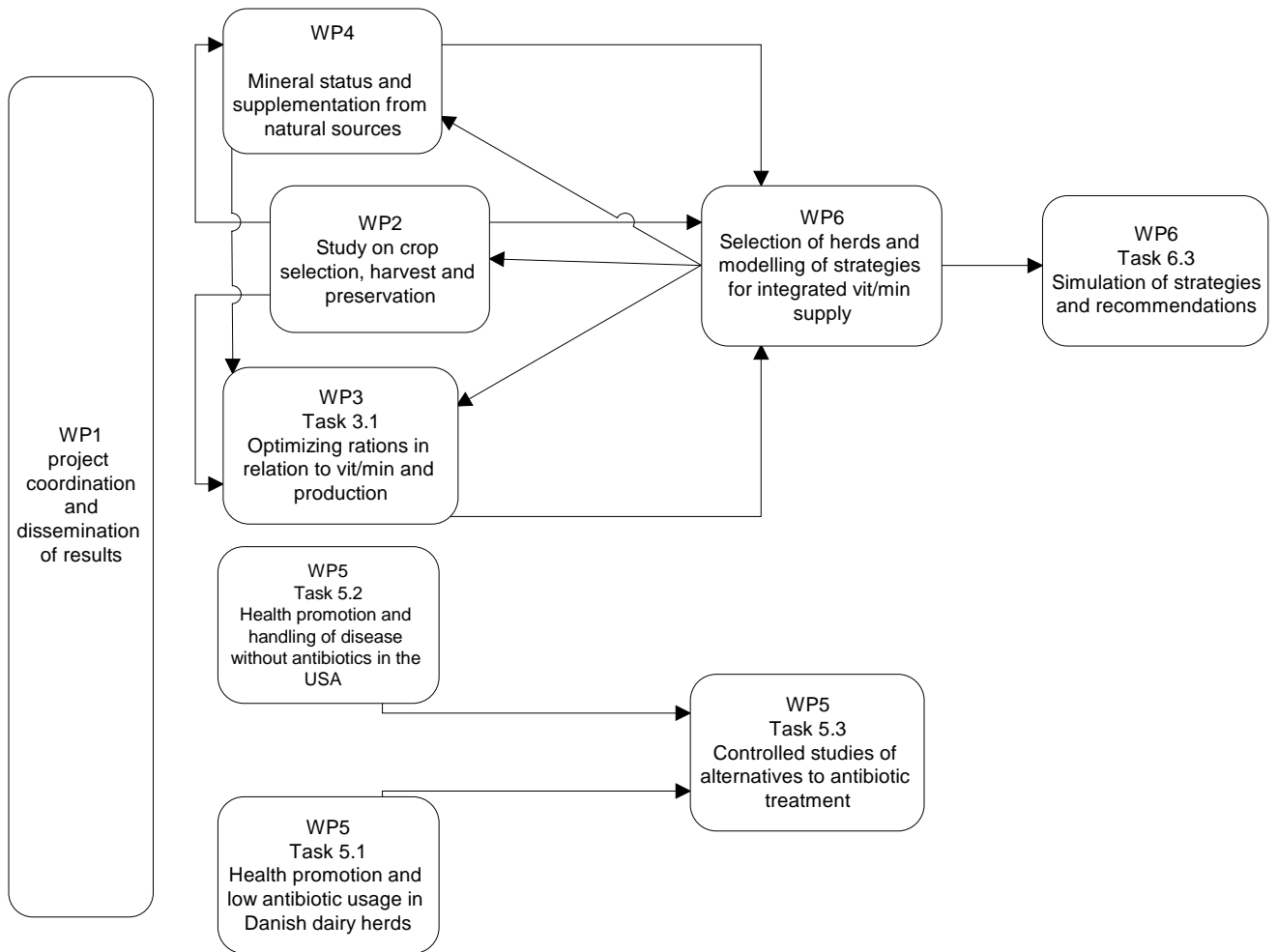
The work in WP6 also includes modelling and system analysis and aims at collecting the new knowledge obtained in the other work packages and make it useable in organic dairy herds.

WP2 includes studies on selection of forage crops, role of harvest time and methods, preservation and effect of storage on the available amount of vitamins and minerals. Furthermore on farm studies of the use of herbs in pasture will be studied. The results will be used in WP3, WP4 and WP6.

WP3 involves experimental studies on integrated supply of vitamins and minerals in organic dairy herds at the research station Rugballegaard. Fodder rations are composed based on the results from WP2 and with a whole farm approach to allow for evaluation of the practical and economical consequences of the chosen rations.

The studies in WP4 deal with the variation between herds and will give information about the role of mineral supplements in herds that have been presented with the very general principles of integrated supply of vitamins and minerals. Furthermore the role of new and more sensitive indicators of udder infections will be evaluated.

The work with the possibilities for a reduction in the usage of veterinary medicine is concentrated in WP5. The work package includes both farm studies in Denmark and USA. The objectives are both to describe the strategies used by the farmers to promote animal health and to discuss the ethical challenges raised by a principle of low or no antibiotic usage. WP5 also includes controlled studies of natural treatments commonly used as alternatives to antibiotics in the herds involved in the studies.



The interactions between the work packages/tasks in the study are illustrated in the PERT diagram .  
 The overall research plan is outlined in the Gantt diagram including a list of Milestones and deliverables



WP No.	WP title	Responsible scientist	Budget DKK	Start	End	Deliverable No.
1	Project coordination and communication	TWB	229	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	1926	1/2007	12/2010	D3.1-D3.6
4	Micro mineral status and relation to health	TLA	1437	1/2007	9/2009	D4.1-D4.3
5	Health promotion and effect of selected non-antibiotic disease treatments	TWB	2340	3/2007	1/2010	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
<b>Total</b>			11200			

(Please give month and year for start and end)

### Deliverables list

Deliverable No	Deliverable title	Lead scientist	Delivery date	Allocated scientific person months	Type of deliverable
D1.1	Field day, presentation of forage crop production	KAS	6/2008	0.5	O
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
D2.1	Present preliminary results at General Meeting of European Grassland Federation	KAS	6/2008	1	C
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 pastures	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
D3.1	Presentation at field day	KAS	6/2008	0.5	O
D3.2	Presentation at project conference	SKJ	9/2010	1	C, P
D3.3	Popular paper with suggestions for integrated	SKJ	4/2011	4	P

	strategies for TMR's for dry cows and milking cows in order to fulfill the requirement for an integrated vitamin and mineral supply				
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
D4.1	Trace element status in organic dairy herds situated on different quality soils.	TLA, TWB	7/2009	4	S
D4.2	The association between cows trace element status and mastitis in organic herds	TLA, TWB	7/2009	7	S
D4.3	Presentation at project conference	TLA	9/2010	0.5	C, P
D5.1	Strategies for health promotion and disease treatment in herds under the USDA national organic standards	TWB, MVA	7/ 2008	4	S, C
D5.2	Effect of treatment no. 1 of XXX in organic dairy cattle	TWB, MVA	2/ 2009	5	S, C
D5.3	Evaluation of the consequences of a long-term non-antibiotic herd strategy in Danish organic dairy herds	MVA	3/2009	7	S
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
D5.5	Workshop for farmers. Handling of disease and herd health promotion without antibiotics in organic dairy 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
D6.1	Prototype of model	TKR	11/2007	2	O
D6.2	Perspectives for integrated mineral and vitamin supply at organic dairy farms	TKR	11/2007	2	R
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

(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.).

## Milestones list

Milestone No	Milestone title	Lead scientist	Delivery date
M 1.1	First project meeting	TWB	01/2007
M 1.2	Last project meeting	TWB	12/2010
M 2.1	Establish plot at Foulumgård	KAS	2006
M 2.2	Select organic dairy farms for experiments together with WP6	TKR	11/2006
M 2.3	Co-ordinate sampling technique and analyses with research in Sweden	SKJ	1/2007
M 2.4	Describe the exact ensiling method	KAS	5/2007
M 2.5	Set-up of Se-analyse	JAS	9/2007
M 2.6	Data hand over to WP3	KAS	1/2008
M 2.7	Evaluate the methods used in the ensiling	KAS	3/2008
M 2.8	Discuss results with farmers and advisors participating the experiment	KAS	4/2008
M 2.9	Data hand over to WP6	KAS	9/2008
M 2.10	Data hand over to WP3	KAS	4/2009
M 2.11	Data hand over to WP6	KAS	2/2010
M 3.1	Fodder crops for the feeding experiment are selected	SKJ	2/2007
M 3.2	Harvest and storage strategy for the selected fodder crops are decided.	SKJ	3/2008
M 3.3	Formulation of TMR diets for dry cows and lactating cows according to the selected strategies	SKJ	9/2008
M 3.4	Experiment with integrated vitamin and mineral supply begin at Rugballegaard	SKJ	10/2008
M 3.5	Experiment with integrated vitamin and mineral supply at Rugballegaard finished	SKJ	5/2009
M 4.1	Select organic dairy farms for experiments	TWB	2/2007
M 4.2	Laboratory analysis developed and selected.	TLA	5/2007
M 4.3	Experimental feeding schemes decided based on preliminary results from WP 2 and WP6	TLA	9/2007
M 4.4	Animal experiments at study herds initiated (mineral substitution)	TLA	10/2007
M 4.5	Blood and milk sampling starts. Initiation of laboratory analysis	TLA	11/2007
M 4.6	Blood and milk sampling finished	TLA	7/2008
M 4.7	Laboratory analysis of samples finished	TLA	12/2008
M 5.1	Establishing contacts in USA	TWB	03/2007
M 5.2	Identification of Danish study herds	MVA	10/2007
M 5.3	Initiation of survey and herd visits in organic dairy herds in USA	TWB	11/2007
M 5.4	Treatment protocol for controlled treatment study I +II	TWB	3/2008
M 5.5	Start of on-farm controlled treatment study I	TWB	3/2008
M 5.6	End of study in Danish herds	MVA	2/2009
M 5.7	Start of on-farm controlled treatment study II	TWB	3/2009
M 5.8	End of on-farm controlled treatment studies	TWB	11/2009
M 6.1	Select organic dairy farms for experiments together with WP2	TWB	11/2006
M 6.2	First round of farm visits – with system description	TKR	1/2007
M 6.3	End of first year's registration	LMO	12/2007

M 6.4	End of farm registration	LMO	4/2009
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**Description of work packages** (this page should be copied for each WP)

**Description of work packages** (this page should be copied for each WP)

**WP No.: 1 Project coordination and dissemination of results**

	<b>Start date or starting event: 01/2007</b>									
<b>Partner id.</b>	1 DIAS, SVE									
<b>Person-months per participant</b>	2.9 VIP									
<b>Total PM VIP:</b>	<b>2.9</b>									
<b>Total PM:</b>	<b>2.9</b>									

(Please give Institution or Department as partner id.)

**Objectives:**

- To coordinate the project activities to create a maximum of synergy
- To coordinate the dissemination of results to organic dairy farmers and advisors

**Description of work:**

Task 1.1 Project coordination

The project will be coordinated by the head of project. The objective is to promote the optimal planning of activities to assure the best possible utilization of the resources. The coordinator will be responsible for arranging project-meetings were preliminary plans and results are discussed.

Task 1.2

Dissemination of results. The results of the project will be communicated on a continuous basis throughout the project to organic dairy farmers, advisors and at scientific meetings. Field days presenting the forage crop production, workshops on non-antibiotic disease management and a final open conference will be organized. Furthermore results and activities will be publicized in the popular agricultural press.

**Deliverables:**

- D1.1 Field day (O) (6/2008)
- D1.2 Workshop for farmers regarding handling of disease (C) (9/2009)
- D1.3 Open conference on integrated supply of vitamins and minerals and health promotion without antibiotics (C) (9/2010)
- D1.4 Final status report (1/2011)

**Milestones:**

- M 1.1 01/2007 First project meeting
- M 1.2 12/2010 Last project meeting



**WP No.: 2 Minerals and vitamins in forage crops. Effect of plant species, harvest time, conservation and soil type and palatability under grazing.**

	<b>Start date or starting event:</b> (please give month and year) 1/2007		
<b>Partner id.</b>	DIAS, SVE	DIAS, JPM	
<b>Person-months per participant</b>	16.3 VIP 18	12 VIP 12.4 TAP	
<b>Total PM VIP:</b>	<b>28.3</b>		
<b>Total PM:</b>	<b>58.7</b>		

(Please give Institution or Department as partner id.)

**Objectives:** The overall objective is to obtain a broad knowledge about the variation and level of minerals and vitamins in grassland species both for summer and winter feeding and the possibility to affect the content:

- Investigate the effect of grassland species, time in the growing season, morphological development and soil type on the content of minerals and vitamins
- Investigate the effect of ensiling and haymaking process and conditions on the content of vitamins in different plant species under different growing management
- Investigate the degradability of vitamins during silage storage
- Investigate the effect of prewilting on the content of D-vitamin
- Investigate the possibility to improve the micro mineral content of the pasture by including herbs
- Investigate animal selection of the herbs

**Description of work:**

To study the content of minerals and vitamins in fresh and ensiled forage crops experiments will be carried out in two parts: a) plot experiment on Foulumgård Research Station without mineral fertilizers and pesticides with the aim to analyse effect of plant species, morphological development, time in the growing season and aspect concerning ensiling; and b) registrations on organic dairy farms with the aim to examine selection under grazing and effect of soil type.

a) The plot experiment at Foulumgaard will contain different species and seed mixtures in four replicates and will be carried out in 2006 and 2007:

1. Timothy (*Phleum pratense*) and red clover (*Trifolium pratense*)
2. Perennial ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*)
3. Perennial ryegrass and red clover
4. Timothy and birds-foot trefoil (*Lotus corniculatus*)
5. Lucerne (*Medicago sativa*)
6. Red clover
7. Chicory (*Cichorium intybus*)

There will be four cuts per season and the examinations will be concentrated on the spring growth and regrowth after second cut. The plots will be split up in subplots and in each of the two growing periods there will be five harvest times with one week between each time. The third harvest time is planned to be the normal cutting time.

b) Six organic dairy farms, including the four in WP-6, will be selected with different soil types, ranging from coarse sandy soils (JB 1) to clayey sand (JB 4). In 2006 there will be established perennial ryegrass/white clover pastures with different herbs (chicory, caraway (*Carum carvi*), birds-foot trefoil, great burnet (*Poterium Sanguisorba officinalis*) and Lucerne).

**Task 2.1. Content of vitamin and mineral in fresh herbage**

In the plot experiment at Foulumgård the botanical composition (species and leaf/stem) and the herbage quality (IVOMD, NDF and N) are determined at each of the five harvest times. At harvest time 2, 3 and 4 in each species the content of vitamins (E and beta-carotene) and the content of macro and micro minerals (e.g. Ca, P, Mg Na, K, Mn, Cu, Zn, Fe, Se) are measured. The measurements are made on a mean sample from replicate 1+3 and 2+4 respectively.

On the dairy farms the content of minerals and herbage quality in the single plant species will be determined both in the pastures in June and August. In June an area will be fenced off for cutting in the pasture, at the mineral content and herbage quality will be determined. Further minerals and vitamins will be determined in harvested forage crops on the farms.

Soil samples will be analysed for Rt and all the minerals analysed in the plants.

**Task 2.2. Effect of ensiling on vitamin content (plot experiment at Foulumgård)****Task 2.2.1 Good ensiling conditions. Loss of vitamins during ensiling.**

At normal cutting time, harvest time 2, all species are ensiled with two field replicates and four lab replicates in either capped vials or plastic bags. After four month vitamins, At and VFA are examined to determine any decrease of vitamins content during ensiling.

**Task 2.2.2. Bad ensiling conditions. Effect of additives.**

At normal harvest time for third cut bad ensiling is incited by unwilted crop and to low density under ensiling for perennial ryegrass, red clover and white clover. The content of vitamins in the silage is examined with additives, acid and bacterial preparation, and without additives. The exact additives will be coordinated with experiments in Sweden described in section A.5.

**Task 2.2.3. Degradability of vitamins during storage.**

The content of vitamins in silage of perennial ryegrass, white clover and red clover is determined after 3, 4, 5, 6 and 7 month after ensiling under good ensiling condition.

**Task 2.3 Effect of haymaking on vitamin content (plot experiment at Foulumgård)**

#### Task 2.3.1. Effect of prewilting on D-vitamin

The change in content of D-vitamin in perennial ryegrass and Lucerne during prewilting, five sampling from fresh to hay, is determined in spring growth and 2<sup>nd</sup> regrowth at harvest time 4. The analyses of vitamin D (Task 2.3.1. and 2.3.2) will be financed and performed in the Ph. D. project granted by SOAR and SVE-DJF.

#### Task 2.3.2. Effect of haymaking

At harvest time 4 in the second regrowth hay will be made and analysed for content of vitamins (D, E, beta-carotene) just after haymaking and in the following spring.

#### Task 2.3.3. Artificial dried hay

At two different developmental stage the herbage will be dried artificially and the content of vitamins will be analysed.

Task 2.3.3 is not financed by the project, but we will be seeking funding via application to 'Innovationsloven'.

#### Task 2.4. Selection of herbs

Areas of 400 m<sup>2</sup> will be fenced off in two weeks in June and August in the pastures with herbs on the six dairy farms. After the rest period the botanical composition is determined, the fence is removed and the botanical composition is determined again after three days grazing to determine which species and which part of the species the cows are eating.

#### **Deliverables:**

- D2.1 Present preliminary results at General Meeting of European Grassland Federation (6/2008)
- D2.2 Present results at Plantekongres or Økologikongres (2009)
- D2.3 Scientific paper on vitamins and minerals in forage crops (3/2010)
- D2.4 Popular paper on vitamins and minerals in fresh crops (4/2010)
- D2.5 Scientific paper on selection of herbs on pastures (5/2010)
- D2.6 Popular paper on selection of herbs on pasture (6/2010)
- D2.7 Popular paper on effects of ensiling on vitamins in forage crops (10/2010)

#### **Milestones:**

- M2.1 Establish plot at Foulumgård (2006)
- M2.2 Select organic dairy farms for experiments together with WP6 (11/2006)
- M2.3 Co-ordinate sampling technique and analyses with research in Sweden (1/2007)
- M2.4 Describe the exact ensiling method (5/2007)
- M2.5 Set-up of Se-analyse (9/2007)
- M2.6 Data hand over to WP3 (1/2008)
- M2.7 Evaluate the methods used in the ensiling (3/2008)
- M2.8 Discuss results with farmers and advisors participating in the experiment (4/2008)
- M2.9 Data hand over to WP6 (9/2008)
- M2.10 Data hand over to WP3 (4/2009)
- M2.11 Data hand over to WP6 (2/2010)

## Description of work packages

**WP No.: 3 Integrated vitamin and mineral supply on farm level**

	<b>Start date or starting event:</b> (please give month and year)		01/2007
<b>Partner id.</b>	DIAS, SVE	DIAS, JPM	
<b>Person-months per participant</b>	11.5 VIP 14.0 TAP	3 VIP 0.45 TAP	
<b>Total PM VIP:</b>	<b>14.5</b>		
<b>Total PM:</b>	<b>28.95</b>		

(Please give Institution or Department as partner id.)

**Objectives:** The overall objective is to investigate how the vitamin and mineral supply of the herd is affected depending on whether the feed production is optimised in order to maximise output of milk per ha or optimised in order to meet the requirement for an integrated vitamin and mineral supply.

- Investigate the possibilities for satisfactory growth and yield for crops making of an integrated strategy for mineral and vitamin supply possible at farm level.
- Investigate the effect of an integrated vitamin and mineral supply via the two selected feeding regimes on the vitamin and mineral status of cows and cows milk.
- Investigate the relationship between mineral and vitamin supply to cows on the vitamin and mineral status of milk fed calves.

**Description of work:**

The farmer will typically have focus on highest possible milk production pr ha when making decision about type and proportion of crops to be grown in order to feed the dairy herd. If a higher integrity in relation to supply of minerals and vitamins has to be reached, it might conflict with this goal. In order to clarify this an experiment will be performed during 2008 and 09 at the organic research station Rugballegård. The crop production is planned with focus on either high milk production pr ha or total supply of the herd with minerals and vitamins from home grown feed. Based on WP2 and 6 the two strategies will be modelled and types and proportions of crop that is necessary for one years feeding of each half part of the herd is sown out in the field at Rugballegaard in 2007. The development of the crops, yield, quality and chemical composition of the crops are registered. After harvesting and storage the experimental diets for the cows are composed and mixed in a way that optimises either milk production or the supply of vitamins and minerals.

Cows will be allocated to the experimental diet 6 weeks prior to parturition and kept on the diet until 6 weeks after parturition during the stable feeding period. The majority of the calvings is planned to take place in November-January. Vitamin and mineral status of the milk fed calves will be determined at day 4 and week 4. Calves from the two groups of cows will be kept separated and fed milk from cows from their own group.

**Task 3.1 Selection of fodder crops**

Selection, growth, harvesting and storage of fodder crops aiming for an integrated supply of vitamins and minerals at farm level.

**Task 3.2 Feeding experiment and sampling**

At the beginning of the experiment (around 1. October) and 3 and 1 week prior to expected calving blood samples are taken for measurements of vitamin and mineral status in blood. Likewise, 2 weeks and 6 weeks after calving and at the end of the experiment (around 1. May) blood and milk samples are taken for measurements of vitamin and mineral status. All incidences of sickness, reproduction traits and somatic cell count in milk will be registered.

**Task 3.3 Effect of feeding strategies on cows**

Determine the effect of the two different feeding strategies on vitamin and mineral supply of the cows, and on the vitamin and mineral status in plasma and milk from cows.

**Task 3.4 Effect of feeding strategies on calves**

Determine the effect of the two different feeding strategies on the vitamin and mineral status in plasma from milk fed calves.

**Deliverables:**

- D3.1 Presentation at field day, where organic farmers and others are invited to see the growing fodder crops and get informed about the purpose and visions in the project ( 6/2008)
- D3.2 Presentation at project conference (9/2010)
- D3.3 Popular paper with suggestions for integrated strategies for TMR's for dry cows and milking cows in order to fulfil the requirement for an integrated vitamin and mineral supply (4/ 2011)
- D3.4 Scientific paper describing the effects of an integrated vitamin and mineral supply at an experimental organic farm. (4/2011)

**Milestones:**

- M3.1 Fodder crops for the feeding experiment are selected (2/2007)
- M3.2 Harvest and storage strategy for the selected fodder crops are decided. (3/2008)
- M3.3 Formulation of TMR diets for dry cows and lactating cows according to the selected strategies (9/2008)

- |      |  |
|------|--|
| M3.4 | Experiment with integrated vitamin and mineral supply begin at Rugballegaard (10/2008)   |
| M3.5 | Experiment with integrated vitamin and mineral supply at Rugballegaard finished (5/2009) |

### Description of work packages

**WP No.: 4 Micro mineral status and relation to health**  
**The association between micro mineral status in the cow and health, exemplified by the degree of mastitis**

	<b>Start date or starting event:</b> (please give month and year)		1/ 2007
Partner id.	DIAS, SVE		
<b>Person-months per participant</b>	11.5 VIP 11.5 TAP		
<b>Total PM VIP:</b>	<b>11.5</b>		
<b>Total PM:</b>	<b>23</b>		

(Please give Institution or Department as partner id.)

#### Objectives:

- To assess the micro mineral status of cows around parturition in practical organic herds. Farms situated on fertile soils will be compared with farms situated on less fertile soils.
- To investigate the effect of substitution of conventional micro mineral supplementation with alternative organic micro mineral supplementations.
- To describe the association between mineral status of the animal and the degree of inflammation of the cow, e.g. described by the degree of mastitis.

**Description of work:**

The experimental work will be carried out in four different farms described in WP6 and used in WP2. Two of the farms will be situated on fertile soils, two of them will be situated on less fertile ground in order to study the general effect of soil quality on mineral status of the animals. The farms will, as part of the work in WP6, have specific attention to the supply with minerals and vitamins, but there is only limited characterisation of the supply by feed samples during the study period.

All cows within herd will be offered the same roughage, eventually changing throughout the year. The cows will, however, be allocated to two different concentrate mixtures, only diverging by the micro mineral supplementation. One mixture will contain conventional (inorganic) micro minerals according to the normal practice on the relevant farm (farmer's decision). The other concentrate mixture will be supplied with an organic alternative, substituting the commonly used dressing, e.g. sea-weed meal (external input) or alfalfa meal (internal/external input), chosen by the researcher. Calving time will be taken into consideration, when cows are allocated to mineral supplements.

The experimental supplementation will be given in a period of eighth month. About 480 cows (calvings) are expected to be included in the study. Blood samples will be harvested week -2, +3 and +9 in relation to calving. Milk samples will be harvested from all teats week +3 and +9 in lactation. Blood samples will be used to determine the trace element status of the animals; both momentary as well as long time status will be investigated. Analyses will partly be elemental analyses but also specific analyses indicating enzyme activities will be assessed. Furthermore, analyses of acute phase proteins, indicating the general inflammatory status of the animal measured in blood samples. Individual milk samples will be analysed for sensitive markers of mastitis (NAGase and LDH).

**Task 4.1 Micro mineral status**

To assess the micro mineral status of cows around parturition in organic herds on practical dairy farms. The experimental set up will not give a full picture of the variation in mineral status among organic dairy farms, but will make it possible to characterize the within farm variation and give an indication of the variation between farms with large differences in soil fertility.

**Task 4.2 Supplementation of micro minerals from natural sources**

To investigate whether it is possible to substitute the commonly used micro mineral supplementation (inorganic dressings) with alternative plant based micro mineral supplementations and still obtain an acceptable micro mineral status in the animal.

**Task 4.3 Mineral status and indicators of health.**

To describe the association between mineral status of the animal and the degree of inflammation of the cow, delineated by general inflammation parameters in blood as well as more specific parameters connected with mastitis

**Deliverables:**

Article manuscript for submission to international journals:

D 4.1 Trace element status in organic dairy herds situated on different quality soils. (7/2009)

D 4.2 The association between cows' trace element status and mastitis in organic herds. (7/2009)

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

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

**Milestones:**

- M4.1 Select organic dairy farms for experiments (2/2007)
- M4.2 Laboratory analysis developed and selected. (5/2007)
- M4.3 Experimental feeding scheme selected including evaluation of preliminary results from wp2 and wp6 (9/2007)
- M4.4 Animal experiments at study herds initiated (mineral substitution) (10/2007)
- M4.5 Blood and milk sampling starts. Initiation of laboratory analysis. (11/2007)
- M4.6 Blood and milk sampling finished (7/2008)
- M4.7 Laboratory analysis of samples finished (12/2008)

## Description of work packages

**WP No.: 5 Health promotion and effect of selected non-antibiotic disease treatments**

	<b>Start date or starting event:</b> (please give month and year)		03/2007
<b>Partner id.</b>	DIAS, SVE		
<b>Person-months per participant</b>	27.75 VIP 11.0 TAP		
<b>Total PM VIP:</b>	<b>27.75</b>		
<b>Total PM:</b>	<b>38.75</b>		

(Please give Institution or Department as partner id.)

### Objectives:

- To document motivations, experiences, actions and consequences of long-term non-antibiotic herd strategies in organic dairy farming under Danish conditions (task 1)
- To describe strategies and for health promotion and disease treatments in USA in organic dairy herds with no antibiotic usage (task 2)
- To document the effect of non-antibiotic disease treatments used in organic dairy herds by controlled studies (task 3)

## **Description of work:**

### **Task 5.1 Health promotion and low antibiotics usage in Danish herds**

The consequences of long-term non-antibiotic strategies will be studied in 10 Danish organic herds with a history of long-term low usage of antibiotics. Qualitative and quantitative research methods will be used in an integrated manner in order to explore the focus areas, which are potential herd management strategies which can relevantly be developed and used in organic herds under Danish production conditions. The focus will be on health promotion and disease prevention strategies in the herds. Clinical investigations of the animals' health status, animal welfare assessment, monitoring and interviews focusing on herd management and routines as well as epidemiological and statistical modelling will be used to describe the herds and the herd health.

### **Task 5.2 Health promotion and non-antibiotic disease treatment in USA**

Studies on 20 organic dairy farms in two different areas of USA (New York and Wisconsin) will be carried out to identify strategies and motivation for health control and non-antibiotic disease treatment and parasite control without antiparasitic drugs. Furthermore contact to US veterinarians with large involvement in organic dairy herds will be established. Analyses of approaches to the management of explicit non-antibiotic herd strategies will be carried out in cooperation with a team at Quality Milk Production Services, Cornell University, USA.

### **Task 5.3 Controlled studies of alternatives to antibiotics**

Based on the information of usage of non-antibiotic disease treatments in organic herds in USA four promising treatment strategies will be selected. The strategies will be evaluated based on an extensive review of literature on the scientific evidence of the mode of action of the active substances in the treatments and review of literature on non-antibiotic treatment of infectious diseases in animals and humans in general.

Based on the literature study two treatment schemes will be tested in a controlled study. The treatments will be selected based on

1. Relevance to organic dairy production.
2. Evidence of possible effective ingredients
3. Practical implications for testing including the cost of conducting a study with the necessary statistical power.

Disease/treatment combination of special interest based on the knowledge at the moment is retained placenta and metritis, calf pneumonia and diarrhoea. Active substances of special interest based on literature are Aloe Vera, Garlic and Echinacea; however a large number of plants with bioactive properties are used.

To test the effect of an alternative treatment for retained placenta at least 60 cases of retained placenta should be included if the self cure is expected to be around 50 and the cure of antibiotic treatment is 90%. The incidence of retained placenta treated with antibiotics are about 6 pr 100 calvings in Danish organic dairy herds (Benedsgaard et al, 2003), which means that 10 herds should be followed for one year with inclusion of all cases. Experiments with diseases of epidemic character like pneumonia might be conducted by infection experiments because of problems of identifying herds with problem and establishing a treatment protocol in advance. However great efforts will be made to conduct studies on naturally occurring disease to reflect the true immune status of animals acquiring a disease under field condition. For on-farm studies the pilot farms in WP2, 4 and 6 will have first-priority if the farmers are interested, second priority will be given to the farms contacted in task 5.1.

## **Deliverables:**

- D 5.1 Strategies for health promotion and disease treatment in herds under the USDA national organic standards (7/2008)
- D 5.2 Effect of treatment no. 1 of XXX in organic dairy cattle (2/2009)
- D 5.3 Evaluation of the consequences of a long-term non-antibiotic herd strategy in Danish organic dairy herds (3/2009)

- D 5.4 Strategies and principles for health promotion in Danish organic dairy farms with very low usage of traditional veterinary medicine (4/2009)
- D 5.5 Workshop for farmers. Handling of disease and herd health promotion without antibiotics in organic dairy herds (9/2009)
- D 5.6 Effect of treatment no. 2 of YYY in organic dairy cattle (1/2010)
- D 5.7 Presentation at project conference - Handling disease without veterinary drugs (9/2010)

**Milestones:**

- M 5.1 Establishing contacts in USA (03/2007)
- M 5.2 Identification of relevant Danish herds and detailed planning of research and analyses (10/2007)
- M 5.3 Initiation of survey and herd visits in organic dairy herds in USA (11/2007)
- M 5.4 Treatment protocol for controlled treatment study I +II (3/2008)
- M 5.5 Start of on-farm controlled treatment study I (3/2008)
- M 5.6 End of study in Danish herds (2/2009)
- M 5.7 Start of on-farm controlled treatment study II (3/2009)
- M 5.8 End of on-farm controlled treatment studies (11/2009)

## Description of work packages

**WP No.: 6 System analysis and perspectives for integrated vitamin and mineral supply at farm level**

	Start date or starting event: 01/ 2007									
<b>Partner id.</b>	DIAS, JPM									
<b>Person-months per participant</b>	11.5 VIP 10.7 TAP									
<b>Total PM VIP:</b>	<b>11.5</b>									
<b>Total PM:</b>	<b>22.2</b>									

(Please give Institution or Department as partner id.)

**Objectives:** The overall objective is to develop and document different ways of obtaining an integrated mineral and vitamin supply at farm level together with a sustainable, intensive and economic sound dairy production. Specific task are:

- To insure a number of well documented organic farming units for detail experiments (WP 2 and 3)
- To document, by modelling and on farm registration, strategies for integrated mineral and vitamin supply
- To established how dairy farmers can include scientific innovations regarding minerals and vitamins in their farm and herd management aiming at integrity

**Description of work:**

Quantity knowledge about concentration of minerals and vitamins in different feeds, the complex interaction between crop production, nutrient management and feeding of the herd, together with an in depth understanding of the organic dairy farmers management and decision making are the basis elements in the development of strategies for mineral and vitamin supply of the dairy herd with focus on self supply at farm level.

**Task 6.1 Selection of herds and establishing of registrations**

Contact will be taken to a number of organic dairy farmers with motivation for development and introduction of new information in relation to mineral and vitamin supply. Based on interviews and farm visits will contracts be made with 6 farmers for a period of three years. They will be selected in order to represent different soil type, stocking rate, organic history and production level in the herd. Although not randomly selected this variation highlight possible interaction to these elements and give a possibility to test the generality of the results obtained (in this WP and WP2 and WP4). Registration with focus on productivity in general (Kristensen & Hermansen, 2002) and more specific on vitamin and mineral supply will be initiated on the farms. E-vitamin status will be evaluated according to Knudsen et al. (2001) and mineral according to the description in WP4. The registrations also form the basis description for the experimental activities in WP2 and WP4.

**Task 6.2 Decision support model**

A prototype of a decision support model simulating the mineral and vitamin supply during the year to different groups of animals (calves, dry period, early lactation cows etc.) affected by choice of crops, utilization method, cutting date and conservation method together with the feeding scheme will be made. Results from WP2 will be important input to the model. The model will be developed in interaction with visits to the farms, where the aims are to evaluate the present practice and to demonstrate relevant alternatives for mineral and vitamin supply.

**Task 6.3 Simulation of strategies**

Analysis of the results during three years from the farms and information from the specific activities in relation to mineral and vitamin supply (WP2, WP3 and WP4), including consideration in relation to cutting date and conservation, will be used to simulate different strategies with focus on mineral and vitamin supply of the dairy herd based on self supply at farm level with feed and manure. The strategies will be evaluated based on their effect on supply with vitamin and minerals as well as farm productivity and economic return. The model by Mogensen & Kristensen (2005) will be extended with relevant new crops and feedstuffs and used for the calculations combined with the more detailed model developed in task 2 in relation to supply during the season.

**Deliverables:**

- D 6.1 Prototype of model (11/2007) (O )
- D 6.2 Perspectives for integrated mineral and vitamin supply at organic dairy farms (11/2007) (R)
- D 6.3 Presentation at project conference (9/2010)
- D 6.4 Integrated mineral and vitamin supply at organic dairy farms (11/2010) (S)
- D 6.5 Sådan opnår du en integreret vitamin og mineral forsyning (12/2010) (R)

**Milestones:**

- M 6.1 Contract made with 6 farmers and start of registration (11/2006)
- M 6.2 First round of farm visits – with system description (1/2007)
- M 6.3 End of first year's registration (12/2007)
- M 6.4 End of farm registration (4/2009)

### A.3 Project resources and budget overview

The partners has extensive experience in conducting research in organic farming

Partner 1, DIAS, Dept. animal, health and nutrition (SVE) has laboratory facilities for routine analyses for the vitamins and minerals in focus in the study. They have been developing methods for evaluating health through measurement of indicators of inflammation in milk and blood. The department also has extensive experience in describing strategies of herd health management through qualitative and quantitative methods and in analysis of data on health and production.

Partner 2, DIAS, Dept. of Agroecology (JPM) has coordinated several research projects in organic farming and has performed on-farm research with organic farmers since 1989.

For more than 20 years the research group 'Farming Systems Unit' has worked with livestock farming research based on studies on commercial farms as a key element. The aims have been to describe production and environmental impact in different farming systems, to test ideas for the improvement and to develop decision tools for farmers and advisors. The approach is based on a respect for the individual farmer and his possibilities and motivation. The group has through different project a running contact to and activities on 20 to 30 farms. Skilled technicians follows the farms throughout the project to ensure the necessary data quality.

The research group 'Crop Production' has worked with forage crop production in a broad perspective for many years. Concerning grassland herbage production, ensiling, quality and utilization have been in focus. There is a broad experimental knowledge about grazing experiment both under well-controlled conditions and on farm level.

The departments have access to organic research facilities, which will be used in WP 2 and 3. This allows for very detailed control of the experimental conditions.

**Table for person month allocated on WP's and partners**

Partner	1	2	3	4	5	6	n	Total
WP	(SVE)	(JPM)	(name)	(name)	(name)	(name)	(name)	
WP1	2.9	0						2.9
WP2	16.3	12						28.3
WP3	11.5	3						14.5
WP4	11.5	0						11.5
WP5	27.75	0						27.75
WP6	0	11.5						11.5
Total	69.95	26.5						96.45

(Please give Institution or Department as partner id.)

**Table for breakdown of total budget on partners and different cost categories (DKK)**

Participating institution	Responsible scientist	Salaries		Equipment	Operational expenses	Total budget DKK
		Academic	Techn. adm.			
DIAS, SVE	TWB	3451	1527	0	1299	7532
DIAS, JPM	TKR	1379	750	0	569	3668

#### **A.4. Dissemination of scientific results**

Please enclose information on:

- Planned education of scientists including Ph.D. and post-docs  
WP2 & 3 will be part of the Danish PhD project “Vitamin D status and vitamin D supplementation to organic produced dairy cattle” financed by SVE, DIAS and SOAR, KVL.  
WP2 & 3 will be part of the Swedish PhD project “Vitaminförsörjning till nötkreatur inom ekologisk production” (*supplementation of vitamins to organic produced dairy cattle*) financed by SLU in Skara.  
Additional funding for a Ph.D. study in relation to the activities in WP5 will be applied for.
- Stays abroad, guest researchers etc.

Research stay at Quality Milk Production Services at Cornell University will be part of the work in WP5. Supplemental funding for visiting guest scientist from QMPS will be applied for.

A Swedish Ph.D. student will stay at SVE in a longer period as part of the co-operation on vitamin supply.

- Communication of results. Publication strategy, contributions to national or international workshops etc.

#### **National information strategy:**

The research on selection of crops and conservation will be made available to Danish farmers and advisors through field days. The results of the experiments will be presented at Danish organic and farmer conferences and meetings and in articles in magazines.

The research in WP5 regarding health promotion without antibiotics will be presented at a workshop for organic dairy farmers after the studies in USA are finished.

The results and conclusions from the project will be presented at an open meeting at DIAS in September 2010 and the proceedings of this meeting will be published in Danish.

#### **International publication strategy:**

Preliminary results will be presented at relevant scientific congresses as much as possible.

The major contributions and discussions at the international meetings regarding strategies for health promotion in other European countries will be published in proceedings.

The results of all major studies will be published in peer reviewed journals according to the deliverables in the work packages.

#### **A.5. Scientific collaborations**

- Collaboration with other research institutes (national and international collaborative partners etc. please include a brief description of the collaborative scheme)

##### **SLU, Sweden**

The research in WP2 and WP3 will be performed in tight coordination with three Swedish organic Research projects: Research leader Elsiabet Nadeau, SLU in Skara, coordinates the first two projects. (1) “Organic milk – project 5: Vitamins in organically grown forage legumes and grasses”, founded by the Swedish Research Council, running from 2004-2006. In this project with organic grown forages, the same forages are sown out at two places in Sweden and here at Foulumgaard. Thus, plant yield, quality and vitamin content, as well as conservation techniques will be performed in tight coordination. The vitamin analysis in the Swedish experiment will be performed in our lab in Foulum by assistance by a Swedish Ph.D. student financed and connected to SLU in Skara. In the project (2) “Vitamin status of

dairy cows in organic production”, founded by “Jordbruksverket” running from 2003-2005, the vitamin status of dairy cows in organic production are followed in a two year feeding experiment at “Tingvall” (a Swedish organic experimental station). In this experiment one group of cows is fed with synthetic vitamin additions (95% organic) and the other group is fed without addition of vitamins (100% organic). The vitamin samples from this study are also analyzed here at Foulum. The third collaborative project with Sweden comprise the project (3): “Vitamininnehåll i norrländskt grovfoder” (vitamin content in forages grown in northern Sweden), coordinated by Research leader Gun Bernes, SLU Rönnebydalen, Umeå, running from 2003-2005 also here the vitamin analyses is performed in Foulum. Thus this tight collaboration ensures the maximal coordination and synergistic effects of these projects. Furthermore samples from the Swedish experiments will be used in the vitamin D part of this project. The vitamin D project is a Ph.D. project, which is separately financed by a grant from SOAR and SVE.

### **QMPS, Cornell University**

Collaboration has been established with Quality Milk Production Services at Cornell University, USA. The collaboration will deal with the research questions in WP5 ”Health promotion without antibiotics”. QMPS will be running a project in transitioning organic dairy herds until 2007 and the research team in WP5 will work with these and other herds in the USA with explicit focus on the strategies for handling disease with out antibiotics and the ethical considerations of the dairy farmers. The collaboration will include research visits (visit at QMPS in 2006, 2007 and 2008) and joint scientific publications (e.g. D 5.2). (Letter of collaboration included).

### **Organic research networks**

The research group have been involved in close collaboration with researchers in organic livestock production in the networks ”Network on Animal Health and Welfare in Organic Agriculture” (NAH-WOA) and SAFO. These contacts will be involved in the collection of information on strategies for health promotion and disease treatment in organic dairy herds in European countries.

Results from the project concerning vitamins and minerals in the forage crops will be discussed in the COST-action:

EU-COST-action 852 “Quality Legume-Based Forage Systems for Contrasting Environments of Europe”.

- Co-ordination with other projects (relations with other projects within the same field, which have been granted public funding)

DARCOF III application ‘Organic Milk of High Quality – Development of Production Concepts Based on grazing of the Dairy Cows and Gentle Treatment of the Milk during Handling and Processing’ analyses the effect of legumes in grassland on the milk quality, which among other elements are  $\alpha$ -tocopherols and  $\beta$ -carotene. In this study only a few species and management will be examined. The broad knowledge about vitamins in forage crops from present experiment could contribute to a broader analyze concerning the effect of vitamins in forage crops on milk quality. There is no experimental or financial overlap.

DARCOF III application ‘Grass-clover in organic dairy farming - options to reduce costs and improve nutrient utilization OrgGrass’ has on pastures on dairy farms included measurements of botanical composition and biodiversity dynamic on three seed mixtures. In present application the selection and the mineral content will be measured in the same pastures in the seed mixture with herbs (WP2 task 1). There is no financial overlap. The research is coordinated through overlap in project staff (K. Søgaard).

- Collaboration with private business partners or networks (names, titles)

## **DLG**

DLG will contribute with knowledge of natural sources of minerals e.g. different variants of seaweed products. They will act as supplier of seaweed products for the experiments in WP3 and WP4.

## **Nor-Feed A/S**

Collaboration has been established with Nor-Feed A/S. Nor-Feed is a Danish company, established in 1989. The company's mission is to develop, manufacture and market internationally cost-effective, standardized, safe, completely natural and environmental additives for inclusion in animals' feeds and drinking-water, especially for pigs, cattle, sheep, poultry, fish and companion animals. Further on the company's mission is to replace synthetic growth promoters and antibiotics in the agriculture with natural alternatives. The company has experience in developing natural additives through many years and has established a comprehensive network of contact partners both national and international. In the present project Nor-Feed A/S will contribute with knowledge concerning botanicals used as feed additives and will aim to contribute with natural products for trial purpose.

## **Danish Agricultural Advisory Service**

Danish Agricultural Advisory Service will be involved in the field day where organic farmers and others are invited to see the growing fodder crops and get informed about the purpose and visions in the project ( contact person: Solveig Struck Pedersen)).

## **A.6 Other issues**

(E.g. special considerations concerning conducting of experiments in relation to principles of organic food and farming).

The diets in the experimental studies regarding vitamin- and mineral supply are all expected to supply the animals with an amount of vitamins and minerals within the normal recommendations. The safety margin might however be smaller than normal practice at some periods. However there will be no major risk of malnutrition.

The controlled studies of alternative to antibiotic treatments will be carried out with naturally occurring infections as far as possible. However the study design might require the use of experimental infections. In all cases all possible measures to reduce the suffering of the animals will be taken, and protocols for handling of animals not responding to an experimental treatment will be made. The treatments used in the controlled studies will all be treatments used in organic dairy herds to day, and the documentation of their effect is so important that we think it can justify the use of the treatments as an alternative to antibiotics in an experiment. The studies will be carried out in accordance with the legal regulations.

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## **A.8 Curriculum vitae**

(CV's of central persons describing their key qualifications for the project. The CV for each person should be 1 page, including a list of the most significant publications during the last five years).

## Curriculum Vitae

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<b>Name:</b>	Troels Kristensen
<b>Born:</b>	27. marts 1956
<b>Education:</b>	1983 Mc Agric. The Royal Veterinary and Agricultural University of Copenhagen. 1996 Projektlederkursus I og II, forskningssekretariatet 1998 Ph.d The Royal Veterinary and Agricultural University of Copenhagen
<b>Employment:</b>	1983 Scientist, Dep. of Research in Cattle and Sheep, Danish Institute of Animal Science 1987 Advisor Cattle Production, Farmers Organization, Randers 1988 Scientist, Dep. of Research in Cattle and Sheep, DIAS 1999 Senior Scientist, Dep. of Agricultural Systems (now Dep. of Agroecology) DIAS
<b>Other activities</b>	Co-supervisor for PhDs and Master students and ad hoc reviewer for Scientific journals. Member of the cattle network and coordination group within cattle research at DIAS
<b>Main research projects:</b>	2000-2005 Organic dairy production systems, DARCOF II – project leader 2000-2005 Organic production of steers and use of bioactive forages in livestock, DARCOF II 2000-2004 Effektive kvægbedrifter, Dansk Kvæg, - project leader 1999-2005 Demonstration og udvikling af nye økologiske jordbrugssystemer, DFFE, project leader 1997 – 2001 Stude på marginaljord, ARL97, 1997-2001
<b>Research interests:</b>	Senior Scientist Troels Kristensen has a broad experience with farming systems research based on registration on private farms; experiments conducted on private farms and modeling. Different aspects of feed supply on organic and conventional dairy farm has been the main working topics and more specific pasture management, grazing systems and effects of supplemental feeding have been in focus in the recent years. Highly experienced in designing and analysis of on farm data with respect to production, economy and environmental aspects. Project leader and participant in several major research and demonstration projects during the last years.
<b>Some recent publications</b>	Børsting, C.F., <i>Kristensen, T.</i> , Misciattelli, L., Hvelplund, T. & Weisbjerg, M.R., 2003. Reducing nitrogen surplus from dairy farms. Effects of feeding and management. <i>Livestock Production Science</i> . 83: 165-178 Nielsen, N.M., <i>Kristensen, T.</i> , Nørgaard, P. & Hansen, H., 2003. The effect of low protein supplementation to dairy cows grazing clover grass during half of the day. <i>Livestock Production Science</i> . 81: 293-306. Nielsen, N.M. & <i>Kristensen, T.</i> , 2001. Malkekøernes kvælstofudskillelse og udnyttelse på besætningsniveau - analyse af data fra Studielandbrug. DJF rapport, Husdyr nr. 33, 34 pp. <i>Kristensen, T.</i> , Mogensén, L. & Kristensen, I.S. 2000. Danish organic dairy cattle production-systems – pasture utilisation and animal performance. <i>Grassland Farming. Balancing environmental and economic demands</i> (Edited by: K. Søegaard, C. Ohlsson, J. Sehested, N.J. Hutchings, <i>T. Kristensen</i> ). EGF 2000, 22-25 may 2000, Aalborg Denmark. p. 564-565. Kristensen, I.S. & <i>Kristensen, T.</i> 1997. Animal production and nutrient balances on organic farming systems. Prototypes. In: <i>Proceedings ENOF workshop "Resource use in organic farming"</i> . Ancona, Italy, 4-5 June. 21 pp.

## Curriculum Vitae

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- Name:** Lisbeth Mogensen
- Born:** 31. oktober 1968
- Education:** 1996 Mc Agric. The Royal Veterinary and Agricultural University of Copenhagen.  
2004 Ph.d The Royal Veterinary and Agricultural University of Copenhagen
- Employment:** 1996 Research assistant, Dep. of Animal Health & Welfare, DIAS  
1997 Research assistant, Dep. of Agricultural Systems, DIAS  
1999 Ph.D. student Scientist, Dep. of Agricultural Systems, DIAS  
2004 Scientist, Dep. of Agroecology, DIAS
- Main research projects:** 1999-2004 Ph.D. project: Organic milk production based entirely on home-grown feed, DARCOF I  
2000-2004 Organic dairy production systems, DARCOF II  
1999-2003 Demonstration and development of new, organic farming systems, DFFE
- Research interests:**
- farming systems research based on registration on private organic dairy farms
  - feed supply on organic dairy farms
  - production experiments conducted on private farms
  - scenario modeling of organic farming systems
- Publications**
- Mogensen, L., 2004. Organic milk production based entirely on home-grown feed. Ph.D thesis. The Royal Veterinary and Agricultural University, Copenhagen. November 12, 2004. 158 pp.
- Mogensen, L., Ingvarsten, K. L., Kristensen, T., Seested, S., Thamsborg, S. M. 2004. Organic dairy production based on rapeseed, rapeseed cake or cereals as supplement to silage ad libitum. *Acta Agric. Scand., Sect A, Animal Sci.* 54: 81-93.
- Mogensen, L. and Kristensen, T. 2003. Concentrate mixture, grass pellets, fodder beets, or barley as supplements to silage ad libitum for high-yielding dairy cows on organic farms. *Acta Agric. Scand., Sect. A, Animal Sci.* 53: 4, 186-196.
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- Mogensen, L. Kristensen, T. 2000. Private farms for research in organic milk production in Denmark. 5<sup>th</sup> International Livestock Farming Systems Symposium. EAAP publication no. 97. Posieux. 96-101.
- Langer, V, Odderskær, P., Heidmann, T., Dalgaard, T. & Mogensen, L. 2000. Conversion to organic farming – estimated effects on environment and nature based on existing farm data from a study area. Proceedings 13<sup>th</sup> International IFOAM Scientific Conference, Basel, 28-31 august. p 458

## Curriculum vitae

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<b>Name:</b>	Karen Søgaard
<b>Born:</b>	15 October 1953
<b>Education:</b>	1980 M.Sc.(Biology) from Århus University
<b>Employment:</b>	1980-87 Scientist at Dept. of Irrigation and Soil Physics 1987-94 Scientist at Dept. of Soil Science, Danish Inst. of Plant and Soil Science. 1994- Senior Scientist at Dept. of Plant Physiology and Soil Science (now Agroecology), Danish Institute of Agricultural Sciences.
<b>Other activities:</b>	Member of executive committee of European Grassland Federation Member of board of Danish research Centre for Organic Farming Member of national groups concerning feed quality valuation and grassland seed mixtures respectively
<b>Main research projects:</b>	2000-2005 Organic dairy production systems, DARCOF II 2000-2005 Organic production of steers and use of bioactive forages in livestock, DARCOF II 2000-2003 Nitrogen fertilization of grass/clover at different managements 2001-200x Prognosis for herbage growth and quality in pastures (project leader) 2004-2005 White clover soil fatigue – what is it ? 2003-2006 Irrigation in a holistic resource perspective 2003-2007 Development of EFOS <sub>kvæg</sub> method for determination of digestibility of forage crops 2003-2006 Lower N-surplus at grazing with dairy cows (project leader)
<b>Research interests:</b>	Main working area is forage crops, production and quality. Mostly grassland both for cutting and grazing. Management of herbage quality, quality in relation to the demand of the dairy cow and analysing methods. Environmental problems as N-losses and improved N-utilization in grasslands.
<b>Relevant publications:</b>	Eriksen, J., Vinther, F.P. & Søgaard, K. (2004) Nitrate leaching and N <sub>2</sub> -fixation in grasslands of different composition, age and management. <i>Journal of Agricultural Science</i> 142, 141-151. Nielsen, A.L. & Søgaard, K. (2000) Forage quality of cultivated and natural species in semi-natural grassland. <i>Grassland Science in Europe</i> vol 5., 213-215. Sehested, J., Søgaard, K., Danielsen, V., Roepstoff, A. & Monrad, J. (2004) Grazing with heifers and sows alone or mixed : herbage quality, sward structure and animal weight gain. <i>Livestock Production Science</i> 88, 223-238. Søgaard, K. (2004) Kvægbrugssædskifter. I : Muligheder for forbedret kvælstofudnyttelse i marken og for reduktion af kvælstoftab, (Ed.: U. Jørgensen),DJF-rapport Markbrug nr. 103, 114-127 Søgaard, K. 2004. Kvælstof til kløvergræs ved forskellige benyttelsesformer. Afgræsning, slæt, markens alder og fordeling af N gennem sæsonen. DJF-rapport Markbrug nr. 106, 47 pp Søgaard, K., Hopkins, A., Bommelé, L. and Gierus, M. (2004) Effects of grassland renovation on crop and animal performance. <i>Grassland Science in Europe</i> 9, 523-525. Søgaard, K., Berntsen, J., Nielsen, K.A. & Thygesen, I. (2005) Prognosis for herbage production under continuous grazing. <i>Grassland Congress Ireland</i> . Accepted for publication. Søgaard, K. & Møller, K. (2005) White clover soil fatigue – an establishment problem on large and intensive dairy farms. <i>Grassland Congress Ireland</i> . Accepted for publication

## Curriculum Vitae for Søren Krogh Jensen

**Address:** Danish Institute of Agricultural Sciences (DIAS), Dep. of Animal Health, Welfare and Nutrition, Research Centre Foulum, P.O. Box 50, DK-8830 Tjele, Tlf.: +45 8999 111, Fax: +45 8999, E-mail: [sorenkrogh.Jensen@agrsci.dk](mailto:sorenkrogh.Jensen@agrsci.dk)

### Degrees:

1991 Ph.D. (Biochemistry), The Royal Vet. Agric. Univ., Denmark (RVAU)  
1987 Ms Sci. (cand.agro.), RVAU

### Employment:

1995- Senior Scientist, Department of Animal Nutrition and Physiology, DIAS  
1991-95 Research Scientist, Department of Animal Nutrition and Physiology, DIAS  
1991-88 Ph.D. student Dep. Chemistry, RVAU/ Novo Nordisk A/S  
1987 Teaching Assistant, Dep. Chemistry, RVAU

### Competence and Field of work

Since 1991 he has worked at Danish Institute of Agricultural Sciences with research within animal nutrition with special emphasis on fat soluble vitamins, antioxidants, lipids and lipid oxidation in relation to nutrition, animal product quality and animal health. Special attention has been paid to biochemical and physiological aspects the importance of fat, fatty acids, fat-soluble vitamins (including their antioxidative properties), as well as the physiological importance of anti-nutrients in rapeseed and legumes. During the last years he has been involved in projects related to utilisation of naturally occurring vitamins in plants by sows and cattle in relation to organic farming. Special focus is on elucidating the difference in the biological value of natural versus synthetic vitamin E. In this connection relatively simple and fast methods capable of separating stereoisomers of  $\alpha$ -tocopherol has been implemented based on chiral HPLC. The work has been published in more than 100 publications within the area of basic physiology, nutrition, biochemistry, animal product quality and animal health, as well as development of new sensitive analytical methods on HPLC and GLC.

### Relevant publications

- Bertram, H. C., Kristensen, N.B., Malmendal, A., Nielsen, N.C., Jensen, S.K. & Harmon, D.L., 2004. An NMR-based metabolomic approach to assess metabolism in splanchnic tissues of steers. *J. Anim. Feed. Sci.* 295-298.
- Knarreborg, A., Lauridsen, C., Engberg, R.M. & Jensen, S.K., 2004. Dietary antibiotic growth promoters enhance the bioavailability of  $\alpha$ -tocopheryl acetate in broilers through mediations of the lipid absorption processes. *J. Nutr.* 134, 1487-1492.
- Sehested, J., Jørgensen, C., Mortensen, S.B., Jensen, S.K., Vestergaard, M., Koch, P., Jungersen, G. & Eriksen, L., 2004. Effect of oral  $\alpha$ -tocopherol and zinc on plasma status, IGF-I levels, weight gain and immune response in young calves. *J. Anim. Feed Sci.* 13, suppl. 1, 609-612.
- Jensen, S.K., 2003. Absorption og omsætning af vitaminer. Hvelplund, T. & Nørgaard, P. (red). *Kvægets ernæring og fysiologi. Bind 1 - Næringsstofomsætning og fodervurdering, DJF rapport Husdyrbrug 53*, 375-388.
- Jensen, S.K., 2003. Malkekoens vitaminbehov og -forsyning., 2003. Strudsholm, F. & Sejrsen, K. (red). *Kvægets ernæring og fysiologi. Bind 2 - Fodring og produktion, DJF rapport Husdyrbrug 54*, 179-188.
- Knudsen, B.S., Hermansen, J.E., Jensen, S.K., Kristensen, T. & Nielsen, M.O. 2001. E-vitamin til malkekøer forekomst og funktion samt vitaminstatus og sammenhæng til hyppigste produktionssygdomme i økologiske besætninger. *DJF Rapport Nr. 27*, pp. 76.
- Jensen, S.K., Engberg, R.M. & Hedemann, M.S., 1999. All-rac- $\alpha$ -tocopherol-acetate is a better vitamin E source than all-rac- $\alpha$ -tocopherol-succinate for broilers. *J. Nutr.*, 129, 1355-1360.
- Jensen, S.K., Johansen, A.K.B. & Hermansen, J.E., 1999. Quantitative secretion and maximal secretion capacity of retinol, beta-carotene and  $\alpha$ -tocopherol into cow's milk. *J. Dairy Res.* 66, 511-522.
- Stapelfeldt, H., Nielsen, K.N., Jensen, S.K. & Skibsted, L.H., 1999. Free radical formation in freeze-dried, raw milk in relation to its  $\alpha$ -tocopherol level. *J. Dairy Res.* 66, 461-466.

## Curriculum Vitae for Jakob Sehested

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### Degrees:

1994 Ph.D. (animal physiology), The Royal Vet. Agric. Univ., Denmark (RVAU)  
1990 M.Anim.Sci. (cand.agro.), RVAU

### Employment:

1998- Senior Scientist, Department of Animal Nutrition and Physiology, DIAS  
1995-98 Senior Advisor and Head of Section, The Danish Agricultural Advisory Center  
1995-95 Assistant Professor, Inst. Anat. Physiol., RVAU  
1991-94 Research Assistant and Ph.D.-student, Inst. Anat. Physiol., RVAU  
1990-91 Teaching Assistant, Inst. Anat. Physiol., RVAU

### Competence and Field of work

My main research area is phosphorus (P) metabolism in cattle with focus on P utilisation and P availability in feeds for cattle. But my research also covers other aspects of animal nutrition and feeding, e.g. Zn for calves and piglets, and organic dairy production systems. I am working with intensive animal models and production trials, as well as chemical analysis and *in vitro* methods. I have coordinating experience as head of section and as project leader in a number of projects. I have further been advisor for a number of students at bachelor, master and ph.d. level and do teaching from farmer to university level.

### Some recent publications

- Carlson, D., Poulsen, H.D. & Sehested, J., 2004. Influence of weaning and effect of post weaning dietary zinc and copper on electrophysiological response to glucose, theophylline and 5-HT in piglet small intestinal mucosa. *Comp. Biochem. Physiol. Pt. A.* 137, 757-765.
- Roepstorff, A., Monrad, J., Sehested, J & Nansen, P., 2000. Mixed grazing with sows and heifers - parasitological aspects. In: *Ecological Animal Husbandry in the Nordic Countries*, (eds.) J.E. Hermansen, V. Lund & E. Thuen. DARCOF Report no. 2/2000, 41-44.
- Sehested, J. (2004): Feeding phosphorus (P) to cattle: A new basis for nordic recommendations. Review article. *Acta Agric. Scand., Sect. A., Anim. Sci.* 54, 169-180.
- Sehested, J. & Aaes, O., 2004. Phosphorus for cattle. DIAS-report no. 60, 39 pp. (In Danish)
- Sehested, J., Aaes, O., Andersen, J.B., Kristensen, N.B., Diernæs, L., Møller, P.D. & Skadhauge, E., 2000. Feed-induced changes in the transport of butyrate, sodium and chloride ions across the isolated bovine rumen epithelium. *Acta Agric. Scand., Sect. A, Anim. Sci.* 50, 47-55.
- Sehested, J. & Danfær, A., 2003. Prolonged calving interval and reduced supplementation in an organic dairy herd. Abstracts of the 54th Annual Meeting of the European Association for Animal Production, Poster C4, 279.
- Sehested, J., Jørgensen, C., Mortensen, S.B., Jensen, S.K., Vestergaard, M., Koch, P., Jungersen, G. & Eriksen, L., 2004. Effect of oral  $\alpha$ -tocopherol and zinc on plasma status, IGF-I levels, weight gain and immune response in young calves. *J. Anim. Feed Sci.* 13, suppl. 1, 609-12.
- Sehested, J. & Kristensen, T., 2002. Økologisk mælkeproduktion - Strategier og foderforsyning ved 100 procent økologisk fodring. Sehested, J. & Kristensen, T. (eds.), FØJO-Rapport 17, 77 pp. (In Danish)
- Sehested, J., Kristensen, T. & Søgaard, K. 2003. Effect of concentrate supplementation level on production, health and efficiency in an organic dairy herd. *Livest. Prod. Sci.* 80, 153-165.
- Sehested, J., Søgaard, K., Danielsen, V., Roepstorff, A. & Monrad, J., 2004. Grazing with heifers and sows alone or mixed: herbage quality, sward structure and animal weight gain. *Livest. Prod. Sci.* 88, 223-238.
- Sehested, J. & Weisbjerg, M.R., 2002. Release of phosphorus from feedstuffs for cattle. *J. Dairy Sci.* 85, Suppl. 1, p. 364.
- Storeheier, P.V., Sehested, J., Diernæs, L., Sundset, M.A. & Mathiesen, S.D., 2003. Effects of seasonal changes in food quality and food intake on the transport of sodium and butyrate across ruminal epithelium of reindeer. *J. Comp. Physiol. B*, 173, 391-399.

## Curriculum Vitae - Mette Vaarst -

**Born:** 13.October 1961, Aalborg, Denmark

### Education and qualifications:

Maj 1990: Cand.med.vet., KVL.  
1993- 1995 Internordic postgraduate course, veterinary epidemiology, (28 days)  
June 1994: 3 years education as Human Classical homoeopath completed  
Marts 1995: Veterinary Ph.D. degree  
1998 -2000: Education in philosophy, Århus University, half time student, (open university)  
September 1999: Education as veterinary homoeopath (international education acknowledged by International Association for Veterinary Homoeopathy).  
August 2000 Final examination, Medical Anthropology, Århus University (Open University; all in all 2 years half time study)

**Current employment:** Senior scientist at the Danish Institute of Agricultural Sciences.

**Employment since 1991:** Research assistant, Ph.D.student, scientist and since April 2000 senior scientist at the Danish Institute of Agricultural Sciences (Department for Research in Cattle and Sheep 1991-1996 and Department of Animal Health and Welfare 1996-).

**Work:** Participation and leadership of research activities in organic dairy herds, organic pig herds and conventional dairy herds. Participation in international conferences, work-shops etc. Participation in expert panels and research advisory boards. Since June 1999 participating in international EU network project: Network on Animal Health and Welfare in Organic Agriculture; since March 2003 leadership of International EU-funded Network: Sustaining Animal Health and Food Safety in Organic Farming. Editor of international book (CABI): Animal Health and Welfare in Organic Animal Husbandry (December 2003). Research activities in LSRP, Uganda: Participation in activities in two part projects in Smallholder Dairy Theme concerning tick borne diseases and helminthosis, and mastitis.

**Teaching and supervising experience:** Teaching experience & education (farmers, veterinary and agricultural science students, Ph.D.students, veterinarians, agricultural advisors etc.). Supervisor for 4 master students 1994-2000. Supervisor of 3 current Ph.D.students (one finished in March 2003).

### Selected publications

Alrøe, H.F., Vaarst, M., Kristensen, E.S., 2000. Er husdyrvelfærd i økologisk jordbrug noget særligt? I: Videnssynthese om sundhed, velfærd og medicinanvendelse ved omlægning til økologisk mælkeproduktion (eds: E.S. Kristensen and S.M. Thamsborg). FØJO-rapport nr. 6: 145-158. Forskningscenter for Økologisk Jordbrug, Foulum.  
Vaarst, M., 2000. Omlægning til økologisk drift set fra dyrlægers og konsulenter synsvinkel. I: Kristensen, E.S. & Thamsborg, S.M. (red.), Sundhed, velfærd og medicinanvendelse ved omlægning til økologisk mælkeproduktion. FØJO-Rapport nr. 6, 15-46.  
Vaarst, M. & Bennedsgaard, T.W., 2001. Reduced medication in organic farming with emphasis on organic dairy production. Acta Vet. Scand., Suppl. 95, 51-57.  
Vaarst, M., Alban, L., Mogensen, L., Thamsborg, S.M. & Kristensen, E.S., 2001. Health and welfare in Danish dairy cattle in the transition to organic production: problems, priorities and perspectives. J. Agric. Environm. Ethics 14, 367-390.  
Vaarst, M., Paarup-Laursen, B., Houe, H., Fossing, C. & Andersen, H.J., 2002. Farmers' choice of medical treatment of mastitis in Danish dairy herds based on qualitative research interviews. J. Dairy Sci. 85, 992-1001.  
Vaarst, M., Thamsborg, S.M., Bennedsgaard, T.W., Houe, H., Enevoldsen, C., Aarestrup, F.M. & De Snoo, A., 2003. Organic dairy farmers decision making in the first 2 years after conversion in relation to mastitis treatments. Livestock Production Science 80, 109-120.  
Vaarst M, Bennedsgaard TW, Klaas I, Nissen TB, Thamsborg SM, Østergaard S. 2006. Development and daily management of an explicit strategy of nonuse of antimicrobial drugs in twelve Danish organic dairy herds. J Dairy Sci 89, 1842-53

## Curriculum Vitae

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- Name:** Torben Larsen
- Born:** 17. Sept. 1951
- Education:** 1983 M.Sci. University of Copenhagen.  
1992 Ph.d. Research Department of Human Nutrition  
The Royal Veterinary and Agricultural University of Copenhagen
- Employment:** 1983 Assistant lecturer. Dept of Microbial Ecology, University of Copenhagen.  
1986 Scientist, Dept. of Animal Physiology and Biochemistry, DIAS  
1993 Senior Scientist, Dept. of Animal Physiology and Biochemistry, DIAS  
1995 Senior Scientist, Dep. Animal Health and Welfare, DIAS
- Other activities** Co-supervisor for PhDs and Master students and ad hoc reviewer for Scientific journals.  
Member of the censor staff, Research Department of Human Nutrition  
The Royal Veterinary and Agricultural University of Copenhagen
- Main research projects:** 1995-2000 Food and Nutrition Security. A collaborative project on training and research between Bangladesh and Denmark (ENRECA)  
1995-2000 Collaborative Research on Ruminant Animal Production in Tanzania and Uganda (ENRECA)  
1997-1999 Minimisation of the feeding health load by control of the calcium homeostasis and the acid-base balance in dairy cattle (Cepros, Cep97-1)  
2002-2005 Milk production, greater animal welfare through research and development of a new principle to prevent milk fever. Directorate for Food and Fisheries and Agri Business  
2001- Biosens. A Collaborative Research Program between. Lattec I/S, Danish Cattle Association and DIAS
- Research interests:** Senior Scientist Torben Larsen has a broad experience in laboratory practice. The main work has been organization, development and elaboration of chemical and biochemical analysis in various matrices, i.e. feedstuffs, urine, feces, blood (fractions), animal tissues, biopsies and milk (fractions).
- Some recent publications**
- \* **Larsen, T.**, Møller, G., and Bellio, R. (2001). Evaluation of clinical and clinical chemical parameters in periparturient cows. *J. Dairy Sci.* 84, 1749-1758.
  - \* Thilising-Hansen, T., Jørgensen, R.J., Enemark, J.M.D., and **Larsen, T.** (2002). The effect of Zeolite A Supplementation in the Dry Period on Parturient Calcium, Phosphorus, and Magnesium Homeostasis. *J. Dairy Sci.* 85, 1855-1862.
  - \* Andersen, J. B., **Larsen, T.**, Nielsen, M.O. and Ingvarsten, K.L. (2002). Effect of energy density in the diet and milking frequency on hepatic long chain fatty acid oxidation in early lactating dairy cows. *J. Vet. Med., A.* 49, 177-183.
  - \* **Larsen, T.**, Thilsted, S.H., Biswas, S.K., and Tetens, I. (2003). The leafy vegetable amaranth (*Amaranthus gangeticus*) is a potent inhibitor of calcium availability and retention in rice-based diets. *Br. J. Nutr.* 90, 521-527.
  - \* Andersen, J.B., Friggens, N.C., **Larsen, T.**, Vestergaard, M., and Ingvarsten, K.L. (2004). Effect of Energy Density in the Diet and Milking Frequency on Plasma Metabolites and Hormones in Early Lactation Dairy Cows, *J. Vet. Med. A*, 51, 52-57.
  - \* Phiri, E.C.J.H., Pereka, A.E., Balthazary, S.T., Mgasa, M.N. & **Larsen, T.**, 2004. Calcium and phosphorus supplementation in grazing, lactating Zebu cows, in Iringa district, Tanzania. *Tanzania J. Agric. Sci.* 5(1), 71-76.
  - \* Friggens, N.C., Andersen, J.B., **Larsen, T.**, Aaes, O. & Dewhurst, R.J., 2004. Priming the dairy cow for lactation: a review of dry cow feeding strategies. *Anim. Res.* 53, 453-473.
  - \* **Larsen, T.** (2005). Determination of lactate dehydrogenase (LDH) activity in milk by a fluorometric assay. *J. Dairy Res.* 72, xxx, In press.
  - \* **Larsen, T.** and Nielsen, N.I. (2005). Fluorometric determination of BHBA in milk. *J Dairy Sci*, Accepted.

## CURRICULUM VITAE

<b>Name</b>	Torben Werner Bennedsgaard
<b>Born</b>	11th November 1968
<b>Education</b>	1996: Cand. med. vet., RVAU 2003: Ph. D. "Reduced use of veterinary drugs in organic dairy herds - Potentials and consequences, RVAU 2003: Project leader course
<b>Employment</b>	1996-1997: Veterinary practice. 1998-2003: Ph.D. student and research assistant, Dept of Animal Health and Animal Husbandry; Royal Veterinary and Agricultural University 2003-: Scientist at DJF, Department of animal health, welfare and nutrition
<b>Research projects</b>	Development of af herd health scheme for organic dairy farms (1998-2000) Description of the conversion procedure from conventional to organic farming with regard to medication strategies, attitude to prevention and treatment of mastitis, and antibiotic resistance (CEPROS) (1999-2003) Use of antimicrobials and occurrence of resistance in organic cattle herds (DARCOFII) (2000-2005) Mastitis diagnostics and improvement of udder health in future milk production systems (CEPROSII) (2003-2006)
<b>Research interests</b>	Epidemiology regarding animal health in organic dairy herds with special emphasis on interactions between management and treatment strategies, udder health and welfare. Herd health management in herds with automatic milking systems.
<b>Publications</b>	Bennedsgaard T.W., Thamsborg S.M., Aarestrup F.M., Enevoldsen C, Vaarst M., Christoffersen A.B. 2006, Resistance to penicillin of Staphylococcus aureus isolates from cows with high somatic cell counts in organic and conventional dairy herds in Denmark. Acta Vet. Scand., 48, 24, doi: 10.1186/1751-0147-48-24. Vaarst M, Bennedsgaard TW, Klaas I, Nissen TB, Thamsborg SM, Østergaard S. 2006. Development and daily management of an explicit strategy of nonuse of antimicrobial drugs in twelve Danish organic dairy herds. J Dairy Sci 89, 1842-53 Bennedsgaard T.W., Thamsborg S.M., Vaarst M., Enevoldsen C. 2003. Eleven years with organic dairy production in Denmark – herd health and production in relation to time of conversion and with comparison to conventional production. Livestock Production Science. 80, 1-2, 121-131. Bennedsgaard T.W., Enevoldsen C., Thamsborg S.M., Vaarst M..2003. Effect of mastitis treatment and somatic cell counts on milk yield in Danish organic dairy cows. Journal of Dairy Science. 86, 2174-3183. Bennedsgaard T. W., Thamsborg S. M., Vaarst M.. 2000. Anvendelse af veterinære lægemidler. Kvægets velfærd og sundhed ved omlægning til økologisk mælkeproduktion. In: Sundhed, velfærd og medicinanvendelse ved omlægning til økologisk mælkeproduktion, FØJO-rapport nr. 6. Sato K., Bennedsgaard T. W., Bartlett P. C, Erskine R.J., and Kaneene J.B.. 2004 Comparison of antimicrobial susceptibility of Staphylococcus aureus isolated from bulk tank milk in organic and conventional dairy herds in the Midwestern United States and Denmark. Journal of Food Protection 67[6], 1104-1110. Vaarst, M, Bennedsgaard, T.W.. 2001. Reduced medication in organic farming with emphasis on organic dairy production. Acta Vet Scand Suppl. 2001: 95, 51-7