

## **Application for funding from DARCOF – August 2000**

### **Project II.1**

#### **Title: Organic dairy production systems**

##### **1. Summary**

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

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

In a situation with feeding based solely on home-grown organic feed, the feed ration and the resulting production will to a larger extent, be a result of the land use. It is therefore important to compare different feed rations based on the crop production from the same area (ha) of land.

Feeding experiment, planned from this concept, will be conducted during periods of four months on two private farms.

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

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

- to determine the milk production potential and efficiency and the impact on animal health and well-being of different types of organic feed produced at an even area
- to evaluate strategies to minimise excessive energy mobilisation and level of ketoses and reproduction problems
- to investigate the effect of prolonged calving interval and reduced level of supplementation in dairy cows on the biological efficiency of milk production and persistency of milk production
- to investigate mammary tissue proliferation, apoptosis and synthesis capacity, reproduction, health, live weight gain and constitution, and energy balance in dairy cows at different calving interval and level of supplementation

- to investigate the effect of supplement feeding on grass intake and selection of herbage during grazing, and on grazing effectiveness and N-balance in a leader-follower rotational grazing system for dairy cows with heifers as followers
- to explore possible indicators for milk quality in relation to human nutrition and health and their relation to feeding
- to investigate the genetic ranking of genotypes(individuals) in organic and traditional dairy farming systems.
- to evaluate the effect at farm level in terms of overall biological efficiency, nutrient turnover, level of production and production economic

## 2. Research group

The research group consists of scientists from five different departments within the Danish Institute of Agricultural Sciences.

*Department of Agricultural Systems.*

Senior Scientist Troels Kristensen (TKR) (project leader)

*Department of Animal Nutrition and Physiology*

Head of Research Unit Kristen Sejrsen (KSE)

Senior Scientist Jacob Sehested (JAS)

*Department of Animal Health and Welfare*

Head of Research Unit Klaus Lønne Ingvarsten (KLI)

*Department of Animal Breeding and Genetics*

Senior Scientist Ivan L. Mao (ILM)

*Department of Crop of Physiology and Soil Science*

Senior Scientist Karen Søgaard (KAS)

## 3. Introduction

*Present Danish organic milk production*

Organic milk production is a well-established production in Denmark with more than 5% of the milk delivery from organic herds (Kristensen & Mogensen, 1999). The present organic milk production is quite developed, at least as regard efficient volume of milk produced. In 1997/98 there were 240 commercial organic herds with cows of dual-purpose breed, which means typical Danish Holstein. The average herd size in the organic dairy farms with dual-purpose breeds was 74 cows, with a milk production on 7022 kg milk, 4,10% fat and 3,45% protein. Compared to the commercial conventional herds, the average herd size was largest at the organic farms, 74 cows against 58, and the milk production 500-kg milk lower and with a lower fat content, 0,11 percentage points (Kristensen & Mogensen, 1999). The effects are the same as found in an earlier study by Kristensen & Kristensen (1998), and the same trend is seen in herds with Jersey cows. The milk production level in the Danish organic herds is significantly higher than in other European countries, like Switzerland (Muhlebach & Muhlebach, 1994), Germany (Krutzinna et al., 1996) and England (Lampkin,

1994). Organic farming in these countries is historically developed from crop production to mixed farming, while the situation in Denmark is the opposite.

The actual farming practice on the organic dairy farm and the resulting production has been described in case studies over a period from 1990 to 1998 on 20 farms with organic milk production. The average crop production from the area in rotation was 5044 SFU<sup>1</sup> per ha and the stocking rate was 0,9 livestock unit per ha. Clover-grass was grown on more than half the area and with an average production of 5600 SFU per ha. In the feeding clover-grass was the most important energy and protein source. On an energy basis clover-grass was more than half the total intake in the summer period. In the winter period silage from clover-grass covers an average of 2/3 of the total roughage intake. It was also characteristic that the organic dairy cows were given a large amount of cereals, more than 1442 SFU per cow per year in the 25% of the herds with the largest amount (Mogensen et al., 1999a). At farm level the self-sufficiency with energy was 86%, meaning that 14% of the energy intake was imported. The import was conventionally grown feeds, like sucker beet pulp and rapeseed cakes. In the present rules for organic farming in DK, it is allowed to use conventional, Danish produced feeds at a maximum of 15% of the energy demand to the herd.

#### *The future organic milk production*

The organic farmers organisation (LØJ) has the declared goal to increase the amount of organic feed in the feeding of the dairy cows and in the latest version of the EU regulations of organic farming it is stated “that the production of organic milk within the next 5 years has to be based entirely on organically produced feed” (Anonymous, 1999).

Compared to the present situation on the Danish organic dairy farms this will force some changes in feeding and land use. Changes that from a feeding point of view will “stress” the cow and possibly influence the production level, milk content and quality as well as animal health and welfare. Effects that might also influence the most effective way of making breeding programmes for the organic herds.

Specialised organic dairy production is rather intensive and is successful with respect to crop production and feed supply, because it is possible to utilise high amounts of clover-grass in the production. However, significant amounts of concentrate feeds are used in the production with relatively low biological efficiency and at increasing costs. Furthermore, the overall biological efficiency of milk production is affected by the applied replacement and reproduction strategy in dairy herds. The biological and economical efficiency can be improved in several ways. One is to simply reduce the application of concentrates for dairy cows or to use the concentrates primarily for pig production by combined production systems. Another is to reduce the proportion of non-lactating cows and heifers in the herd by prolongation of lactation and calving interval. Our hypothesis is, that this will reduce the need for feed for non-producing animals, and reduce the need for concentrates by decreasing the proportion of cows in the peak lactation period and thereby the average production level. Reducing the proportion of cows in peak lactation could further be expected to reduce the health and reproductive problems connected to this period and in turn decrease culling rate and increase lifetime productivity.

Feeding based entirely on organic feed will force the use of home grown roughage. Such a changed feeding pattern can have an impact on the production in several ways

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<sup>1</sup> SFU: Scandinavian Feed Unit. 1 SFU is energy equivalent with 1 kg barley.

- the supply to the high yielding cow with sufficient energy and other nutrient
- the level of clinical and subclinical diseases
- the milk quality in relation to human nutrition
- the effectivity on the organic farm both in biological and economic terms

It could further increase the difference between organic and conventional production conditions and thereby create the need for a breeding evaluation specifically designed for organic dairy cows.

#### 4. State of the art

##### *Milk production*

Based on the present knowledge about organic production in Denmark and the economic relations, Mogensen et al (1999b) have estimated the effect of 100% organic feeding on the herd production. The organic dairy cow will meet challenges with low energy intake due to rations with high amount of roughage, insufficient supply of amino acids (AAT), low level of fatty acids and feed rations with high levels of starch. The effect will primarily occur in the winter feeding season, but also in the summer season reduced energy intake and surplus of nitrogen (PBV) will influence the cow.

The change in feeding from a typical organic feeding based on 85% home-grown organic feed and an import of 15% conventionally grown rape cake seed to a 100% organic feeding based on clover-grass, whole crop silage and barley, is expected to have a negative effect on the milk production because of a lower content of AAT and fatty acids than stated in Danish recommendations (Strudsholm, et.al., 1999). Kristensen (1997) found a decrease of 0.3 kg ECM milk per g reduction in AAT/SFU below 90 g AAT/SFU and Hermansen (1993) found a decrease of milk (3%), fat (4%) and protein (1%) per 10 g reduction in fatty acids per SFU below 30 g/SFU. In a typical organic ration the calculated AAT level is 86 g/SFU and level of fatty acid level 24 g/SFU. The estimated decrease in the milk yield is 356 kg EKM/cow/year (Mogensen et al., 1999b).

A preliminary experiment has been conducted on two private farms with two different kinds of supplementary feeds in order to test the estimated effect. A treatment with a standard level of AAT and fatty acids was compared with a ration with a lower level. No significant effect of the type of supplementary feed on the milk yield was found during the experimental period of 4 month in the winter feeding period. The response of the 100% organic feeding tended to differ on the two farms. This could be related to factors like; quality and type of the ad libitum feed, the level and type of easy fermentable carbohydrates in the ration and the genetic milk capacity in the herd (Mogensen, unpublished).

An increased level of organic feed in the ration is expected to increase the amount of home-grown feed and thereby result in larger amounts of feed from crops with a high yield potential – typically clover grass. The energy intake of the high yielding cow in early lactation is very sensitive to the level and energy concentration of the roughage. At present the typical feeding in the organic herds is based on a long period, 24 to 36 weeks post partum, with the same amount of concentrates and roughage ad libitum. This strategy explain the lower peak yield, 2-3 kg lower in organic herds compared to conventional, but also the higher persistency in milk yield (Kristensen & Kristensen, 1998). There is a need to get more information about the most desirable strategy for feeding, when the amount of concentrates is restricted. The aim of the strategy should be to increase the milk pro-

duction based on large amounts of roughage and, at the same time to avoid excessive energy mobilisation.

### *Reproduction strategi*

There is limited knowledge about systems with long calving intervals and prolonged lactation periods, as the concept of maximising daily output and minimising calving interval has been dominating for the past 40 to 50 years (Knight, 1997). Farm studies by van Amburg et al. (1997) including the effect of BST showed that an extended calving interval resulted in lower incidence of postpartum metabolic diseases, lower veterinary costs, less culling with fewer replacements needed, and an overall improvement in herd life, animal well-being and dairy farm profitability. However, the biological mechanisms controlling persistency/maintenance of lactation, the interaction between pregnancy, persistency of lactation and feeding level and not least carry-over effects are key issues, which have to be addressed. Østergaard (1979) and Kristensen & Kristensen (1998) showed that the feeding strategy affects the shape of the lactation curve, but not necessarily the total yield. Data from Speicher et al. (1994) indicated that heifers had greater persistency than mature cows, and preliminary results from Bertilsson et al. (1997) indicate a generally improved persistency of lactation in cows with an 18 month calving interval as compared with a 12 month interval. However, Bertilsson et al. (1997) observed large individual variations between individuals in the tendency to maintain their lactation. The knowledge about biological mechanisms controlling maintenance of lactation is very limited, especially in ruminants (Knight, 1997; Wilde et al., 1997), but apoptosis of mammary cells and endocrine factors related to pregnancy are expected to be key elements.

### *Animal health and well-being*

One of the concepts in organic farming is to produce milk without compromising animal well-being. We assume that dairy cow well-being is highly influenced by their health and it is furthermore assumed that animal well-being is compromised not only during clinical diseases but also during subclinical disease states. Not only may animal well-being be compromised during disease states, but milk production and milk quality may also be negatively influenced.

Feeding a diet low in energy density will increase the mobilisation of fat from body stores in support of lactation and thereby increase the degree of negative energy balance of the cows (Collard et al., 1999) through complex and integrated regulation of intake and metabolism (Ingvartsen et al., 1999; Ingvartsen & Andersen, 2000). However, the consequences of different feeding strategies possible on Danish organic farms on mobilisation of body reserves and risk of production diseases, particularly on subclinical states, are not well described. Likewise, the consequences of different feeding strategies on organic farms on fertility problems need to be elucidated.

An excessive mobilisation of body fat and thereby a pronounced negative energy balance has adverse effects such as increased risk of production related diseases, including fatty liver and ketosis (Grummer, 1993; Drakeley, 1999, Ingvartsen, 1999), fertility problems (de Vries & Verkamp), and increased risk of infectious diseases (Roepstead et al, 1989). The extent of the problem with negative energy balance and subclinical production diseases, such as ketosis, on organic farms are unknown. One of the reasons for this is that estimates of negative energy balance is difficult to obtain because it requires detailed registration of feed intake, energy in milk, energy requirements for maintenance and energy requirements for fetus growth. Previous studies has used blood metabolites (free fatty acids, ketone bodies, glycerol, and glucose) and hormones (IGF-I, insulin) as indicators of metabolic consequences of different diets. Large individual variation is observed in a number of metabolites (Ingvartsen, 1999). Our preliminary results (Ingvartsen et al., unpublished) have shown

that energy balance may be estimated indirectly based on blood analysis and explain app. 75% of the observed variation during early lactation. In an ongoing project these relationships will be further investigated and quantified.

Most epidemiological studies focussing on production diseases are based only on clinical observations, which generally calls for large numbers of animals. And most present feeding and management strategies consider groups of cows. We suggest another approach focussing more on the individual animals, subclinical states and “risk cows”. Our philosophy is that we need to focus on the individual cow in order to prevent production diseases and that future feeding strategies likewise need to focus more on individual cows rather than on a group of cows. However, before we are able to develop “individual” feeding strategies we need to have more information about the most desirable feeding strategy, when the amount of concentrates is limited. The research concerning animal health should focus on the effect of different feeding strategies on energy mobilisation, indicators of energy balance (metabolites and hormones) and incidence of subclinical and clinical diseases and fertility.

### *Milk quality*

The quality of milk as food depends mainly on its content of major nutrients – fat, protein and lactose - but milk also contains a long list of components with biological activity. The list includes enzymes, antibodies and many vitamins, hormones and growth factors as well as breakdown products of casein. Many of these factors are considered to be essential for the development of the neonate and also of importance for quality of milk for consumers.

Consumers consider organically produced foods to be connected with high quality and health. This is the main motive for their preference for organic products. For milk this statement is supported by the fact that organic milk is guaranteed free of pesticides and that the content of residues of medicine is minimal. Besides that there are no obvious reasons why the quality of organic milk should be different from conventionally produced milk. However, the limitations in use of imported foodstuffs and the increased reliance on home-grown feeds are likely to influence the composition and possibly the quality of milk, since it is well documented that the milk composition is affected by the feed ration (Hermansen, 1995). Other milk components that are likely to vary more in organic milk more with the elimination of imported feed supplements (i.e. soy) and the inclusion of more clover in the diet include conjugated linoleic acid (CLA), vitamin A, and phyto-oestrogens. These factors are all known to have biological effects of relevance for human health. The higher reliance of home grown feeds most likely also lead to increased use of untraditional plants, that may have specific effects on the biological activity of the milk. Secondary metabolites in plants grown without the use of pesticides may also affect milk content of bioaktive components, as may the variation in feeding level and feeding system.

In this project we propose to focus the investigations on CLA. CLA is a common name for a group of isomers of linoleic acid with conjugated doubled bonds. They are formed in the rumen by microbial hydrogenation of unsaturated fatty acids. Since the milk content of CLA is strongly affected by the feed ration, especially the amount of pasture products and the type of concentrate, it is logic to assume that organic milk contains more CLA than most traditionally produced milk. We plan to collect milk samples from the planned experiments and the experimental organic herds and compare the CLA content in this milk with the content in milk produced in cows fed traditional rations. The

samples will be collected so it is possible to eliminate and describe the influence of other factors that might influence the CLA content. I.e. season and stage of lactation.

### *Grazing*

Recent data (Søgaard & Sehested, unpubl.) from grazing experiments with organic dairy cows in continuous grazing systems indicate that cows on reduced or no supplementation are more selective when grazing. In Danish organic farms, continuous grazing is standard practice, and the herbage allowance in the last half of the grazing season is often very low in this grazing system (<200 kg DM ha<sup>-1</sup>). The dairy cows on reduced or no supplementation are expected to need a higher herbage allowance to be able to meet their energy requirement by grazing, as compared with cows on standard supplementation. It is expected that a rotational grazing system will be superior to the continuous grazing systems, with respect to herbage allowance and possibility of the cows to be selective. This is supported by Wales et al. (1997), who found that selection increased with herbage mass. It is further expected that a rotational grazing system will ensure a more continuous herbage allowance of good quality during the grazing season, as compared with continuous grazing systems under non-irrigated conditions. This is important to ensure milk production in feeding regimes with no supplementation. In support of this Phillips & Leaver (1986) concluded that high-yielding cows with high intake requirements could suffer from herbage restriction at continuous grazing. Using a 'leader-follower' system is also expected to optimise the herbage quality for the dairy cows/leaders, because the 'followers' will utilise the herbage of lower quality.

In continuously grazed clover-grass pastures the protein to energy ratio normally exceeds the requirements of dairy cows (Beever & Reynolds, 1994). However, under cutting conditions, the protein to energy ratio normally decreases with increasing herbage mass (Søgaard, 1994). It is therefore our hypothesis that the protein to energy ratio in clover-grass pasture grazed by dairy cows in a rotational system with a high herbage allowance will be lower, than observed in continuous grazing systems. A rotational grazing system is therefore expected to improve the N-balance of grazing cows and thereby decrease the N-surplus of the grazing system.

### *Genetic improvement of dairy cows for organic farming systems*

At present, all dairy breed associations in Denmark conduct an efficient selection program for traits of importance, either in economical terms or in considerations of ethics and animal welfare. However, these breeding programs were designed to optimise genetic improvement for maximum profits in traditional farming systems. The same breeding strategies may not meet the same goals in organic farming systems.

Future organic farming systems are expected to increasingly rely on home grown organic feeds. Such reliance means an increased use of roughage, which will lead to even greater difference from the traditional farming systems. As the environmental and managerial differences between the two systems become more distinct, the concerns of different genotypes may perform at different levels differently, or genotype by environmental interaction (GxE), also increase. If GxE does exist, the current genetic evaluation would produce biased results, and the ecological dairy farms would reap less benefit from the current breeding programs than expected.

Current models for genetic evaluation of dairy cattle assume that GxE interactions do not exist. However, earlier investigations have shown significant such interactions in cattle (Mao & Burnside, 1967, Jensen et al, 1995, Hohenboken et al, 1995). The existence of GxE means the rankings of

bulls and cows in their breeding values would be different in different systems, and should prompt genetic evaluation, and choice of mates for selective mating, be done on a within farming system basis.

There are differences between organic and traditional farming systems in general. However, there is a considerable amount of variation within each system. Although within system variation overlap to a degree depending of the scale of measurements, they must be taken into account by models for genetic evaluations. Such accounting must also be dynamic in such a way that future changes can be accommodated.

A new development in modeling GxE interactions is the use of “Reaction Norms” (RN), which explains how a specific genotype reacts to gradual environmental changes. Such models can accommodate gradual changes in the environment involved in the interaction, and also can accommodate and predict the effect of future changes in these environmental effects.

#### *Farming system*

An increased reliance on home grown organic feed will change not only the feeding and production of the herd, but also the total production on the dairy farm. The land use has, more directly, to reflect the demand for feed. The arable land of the farm will become a resource limiting the milk production. It is therefore of interest to get some information about the direct value for milk production of different ways of using a certain area (ha) of land. Changes in land use and feeding will not only affect the milk production, but also the total turnover of nutrients on the dairy farm.

In traditional experiments it is not possible to evaluate the effect of changes in feeding and land use at farm level. Bakken & Johansen (2000) and Askegaard et al. (1999) have established large plots with crop rotations reflecting different feeding and manure systems, but the experiments do not involve animals directly. Vereijken (1997) describes a method with theoretical prototyping and disseminating to a number of test farms. At our institute we have been working with a method that includes a combination of experiments, case farm studies and modelling (Sørensen & Kristensen, 1993). A key point in the concept is that the farmer is an active partner in developing and testing of the system in progress (Kristensen & Halberg, 1997).

A farming system has to be evaluated not only in terms of economic performance and production efficiency. In the organic concept of farming resource efficiency and environmental protection is declared items that should be taken into consideration. Halberg & Kristensen (1997) have described a number of indicators of resource use and environmental impact that can be monitored at farm level. Nitrogen farm gate balance as an indicator of the long-term risk of nitrogen loss from the livestock farm, for example. Several works have been made in the recent years evaluating the organic farming practice in Denmark (Halberg & Kristensen, 1996, Halberg et al., 1995, Kristensen, et al., 1997 and Kristensen & Kristensen, 1998). The methods used in these papers will be further developed in this project.

### **5. Objectives and expected achievements**

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

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

- to determine the milk production potential and efficiency and the impact on animal health and well-being of different types of organic feed produced at an even area
- to evaluate strategies to minimise excessive energy mobilisation and level of ketoses and reproduction problems
- to investigate the effect of prolonged calving interval and reduced level of supplementation in dairy cows on the biological efficiency of milk production, milk production and persistency of milk production
- to investigate mammary tissue proliferation, apoptosis and synthesis capacity, reproduction, health, live weight gain and constitution, and energy balance in dairy cows at different calving interval and level of supplementation
- to investigate the effect of supplement feeding on grass intake and selection of herbage during grazing, and on grazing effectiveness and N-balance in a leader-follower rotational grazing system for dairy cows with heifers as followers
- to investigate the influence feed ration used in organic milk production on the milk content of CLA
- to investigate the genetic ranking of genotypes(individuals) in organic and traditional dairy farming systems
- to evaluate the effect at farm level in terms of overall biological efficiency, nutrient turnover, level of production and production economic.

## **6. Description of work packages including methods**

Based on the common problem identification the project will work, with different methods due to the character of the different task. The feeding experiments, described in WP's 2 and 3, will form the experimental fundament for the activities in WP's 2-6.

**Table 1: Work package list**

<b>Work-package No</b>	<b>Work package title</b>	<b>Responsible participant</b>	<b>Budget, mill DKK</b>	<b>Start</b>	<b>End</b>	<b>Deliverable No (See table 3)</b>
WP1	Co-ordination	TKR	0.2	2000	2004	
WP2	Milk production based on home-grown feed	TKR	1.5	2000	2002	
WP3	Prolonged calving interval and reduced supplementation for dairy cows	JAS	3.8	2000	2004	
WP4	Subclinical health and reproduction	KLI	1.0	2000	2004	
WP5	Milk quality	KIS	0.4	2000	2003	
WP6	Grass intake and selection in dairy cows on reduced supplementation.	KAS	0.6	2001	2003	
WP7	Genetic improvement of dairy cows	ILM	0.5	2002	2004	
WP8	Farming systems	TKR	0.45	2003	2004	

**Table 2: Description of Work packages**

**WP1: Co-ordination**

Work package number:	1
Start date or starting event:	July 1, 2000
Responsible person:	Troels Kristensen
Contributing persons:	Jakob Sehested, Klaus Lønne Ingvarsten, Kristen Sejrsen,, Karen Søegaard, Ivan L. Mao
Person months:	4 scientific

**Objectives**

The objectives of the work package are to

- ensure the communication, co-ordination and synergy between the work packages and scientist/technicians
- ensure that the project plan, the budget and the deliverables are accomplished according to the plan
- ensure that the results of the project are implemented according to the list of deliverables

**Description of work**

The co-ordinator will ensure a continuous flow of information and results between the participants through regular meetings. There will be 3 such general meetings each year. The general meetings will constitute the fora for making general decisions and securing the overall co-ordination of work plans and research activities, and furthermore be the fora in which to discuss results and deliverables. Inbetween meetings, communication will be ensured using E-mail or by organising ad hoc meetings when requested or otherwise necessary.

The co-ordinator will ensure the preparation of the annual status reports and the final report with the requested input from the work packages.

**Deliverables**

D1,1; D1,2 National meeting organic advisors  
D1,3 Two general meetings each year  
D1,4 Annual status reports and a final report

## **WP2: Milk production based on homegrown feed**

Work package number:	2
Start date or starting event:	July 2000
Responsible person:	Troels Kristensen
Contributing persons:	Lisbeth Mogensen
Person-months:	14 scientific, 9 technical

### **Objectives**

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

- to determine the milk production potential and efficiency
- to evaluate the impact on animal health and well-being
- to evaluate the milk production and efficiency of feeding strategies develop to minimise excessive energy mobilisation

### **Description of work**

In a traditional free market is it possible to import feedstuffs to the farm in order to optimise the feed ration, to fulfil the demand of the high yielding cow. In a situation with feeding based solely on home-grown organic feed, the feed ration and the resulting production will to a larger extent, be a result of the land use. It is therefore of interest to compare different feed ration based on the crop production from the same area (ha) of land.

Feeding experiment, planned from this concept, will be conducted during periods of four months on two private farms. In the winter 2000/2001, the experiment will focus on the effect of energy and nutrient supply by setting up treatments with different types of home grown concentrates on one farm and different type of roughage on another farm, including a similar control treatment at both farms. In the winter 2001/2002, the experiments will focus on different feeding strategies of concentrates during the first part of lactation.

The private farms participate in the period 1999-2003 in the on-farm project “Development of new organic farming systems”, run by the Department of Agricultural Systems. The number of cows is 120-180, calving all year round. The farmer performs the daily management of the herd. A skilled technician makes the registration in relation to the project and the feeding experiments. The milk yield, feed intake, live weight, condition score and data concerning health and reproduction are continuously recorded. In the experimental period, a more intensive registration will be introduced, including individually daily recording of the intake of concentrates.

### **Deliverables**

D2.1: Thesis  
D2.2, D2.4: International papers  
D 1.1: National meeting and proceeding

**Milestones**

M1: Design of experiments for 2000/2001 is concluded between WP's 2-5.

M2: Contract with farmers about experiment is signed

M3: Design of experiments for 2001/2002 is concluded between WP2 and WP4.

### **WP3: Prolonged calving interval and reduced supplementation for dairy cows**

Work package number: 3  
Start date or starting event: July 1, 2000  
Responsible person: Jakob Sehested  
Contributing persons: Kristen Sejrsen,, Karen Søgaard  
Person months: 33 scientific, 10 technical

#### **Objectives**

The objectives of the work package are to investigate the effect of prolonged calving interval and reduced level of supplementation on:

- the biological efficiency of milk production, i.e. feed to milk ratio, need for replacement heifers, etc.
- milk production and persistency of milk production during the lactation
- mammary tissue proliferation, apoptosis and synthesis capacity
- reproduction and health
- live weight gain, constitution (condition score, physical dimensions, health), and estimate of energy balance

#### **Description of work**

Four milk production systems will be defined, established and assessed at the organic research station, Rugballegaard, which holds a herd of 60 dairy cows. The systems will be established according to a two times two factorial design with two levels of roughage in the feeding ration (1 and 2) and two calving intervals (a and b). The feeding of all four groups will be based on pasture as grazing in the summer and grass silage in the winter:

- 1) supplementation according normal practice
  - a) regular calving interval (approx. 12 month)
  - b) prolonged calving interval (regular plus 6 month, i.e. approx. 18 month)
- 2) no supplementation
  - a) regular calving interval
  - b) prolonged calving interval

The systems will be defined and established during 2000 and continued to the middle of 2004. This will make it possible to follow a minimum of two consecutive lactations in cows with prolonged calving intervals. The cows will be allocated to the four groups to ensure an even number of lactations in each group, i.e. approximately 35 lactations per group. The reproduction and replacement will be managed according to a preplanned strategy, and the difference in calving interval of 6 month between the two groups (a and b) will be secured.

The research will focus on the effect of length of lactation period and level of supplementation on milk production, shape of lactation curve, feed utilisation and production efficiency, reproduction and health, mammary synthesis capacity and regression of mammary tissue. The research will be tightly integrated with WP6 regarding pasturage. Evaluation of specific health risk parameters will be performed by collaboration with WP4.

The methods will be:

- registration of milk yield and composition, feed intake, live weight gain, condition score, health and reproduction
- mathematical and statistical evaluation of shape of lactation curve, production efficiency, etc.
- analysis of metabolic and reproductive hormones and metabolites in blood/milk from selected cows in different stages of lactation
- evaluation of mammary biopsies for cell division, apoptosis and of enzymes regulating milk synthesis

### **Deliverables**

D3,1; D3,2: International papers

D3,3: National report

D1,2: National meeting and proceeding

### **Milestones**

M1 Definition and initiation of strategies for feeding, reproduction and replacement, allocation of cows

M2 Strategies for sampling of blood, milk and biopsies

M3 The strategies are fully implemented and the four groups established

M4 Evaluation of strategies and preliminary results

M5 Final report and publication

#### **WP4: Subclinical health**

Work package number: 4  
Start date or starting event: November 2000  
Responsible person: Klaus Lønne Ingvarsten  
Contributing persons: Torben Larsen, Nic Friggens  
Person-months: 10 scientific, 8 technical

#### **Objectives**

The overall objective is to prevent subclinical and clinical ketosis and reproductive problems by improving feed rations and feeding strategies to dairy cows based on 100% organic Danish grown feed. Specific tasks are:

- To investigate the effect of different feed rations and feeding strategies on plasma metabolites relevant as indicators of the degree of body mobilisation (negative energy balance).
- To describe interrelationships between plasma metabolites and hormones, subclinical ketosis and other clinical production related diseases.
- To describe the effect of different feed rations and feeding strategies on reproduction and inter-relationships between plasma metabolites and hormones and reproduction

#### **Description of work**

A program will be initiated to regularly sample blood and milk in relation to calving, in addition to the basic registration carried out by WP2. Plasma samples will be analysed for metabolites (e.g. free fatty acids, ketone bodies, urea, protein, glucose) and hormones to be decided based on ongoing experiments. The effect of treatment will be analysed and the variation described. Furthermore, we will describe the relationship between data obtained in WP2 (milk yield, feed intake, live weight, condition score, health and reproduction data). If relevant (due to no. of animals) consequences of different production diseases will be analysed.

The focus in WP3 is on feeding strategies (100% roughage feeding versus supplementation with concentrates) and extended lactation (12 versus 18 month calving interval). During the winter period, starting fall 2000 and until April 2004, a program will be initiated to regularly sample blood and milk during periparturition. Plasma samples will be analysed for metabolites (e.g. free fatty acids, ketone bodies, urea, protein, glucose) and hormones (progesterone, selected metabolic hormones – to be decided bases on ongoing experiments). The effect of treatment will be analysed and the variation described for all the blood/milk analysis. Furthermore, the relationship between these metabolic data and data obtained in WP3 (milk yield, feed intake, live weight, condition score, health and reproduction data) will be described.

Based on data from the experiments, interrelationships between plasma metabolites and hormones, subclinical ketosis, other clinical production related diseases and reproduction will be analysed and the effect of different feed rations and feeding strategies evaluated.

#### **Deliverables**

D4.1 M.Sc. thesis  
D4.2, D4.3 International paper

D1.1; D1,2 National meeting and proceeding

**Milestones**

M1: Sampling and laboratory analysis of samples finished for experiments 1 and 2

M2: Sampling and laboratory analysis of samples finished for experiments 3

M3: Sampling and laboratory analysis of samples finished for experiments 4 (Rugballegård)

M4: Evaluation of different feeding strategies on cow health and reproduction

## **WP5: Milk quality**

Workpackage number: 5  
Start date or starting event: July 2000  
Responsible person: Kristen Sejrsen  
Contributing persons:  
Person-months: 2 (scientific), 8 (technical)

### **Objectives**

- Investigation of the effect of different feed rations on the biological activity of milk in mammary and intestinal cells.
- Investigation of the mechanism behind observed effects

### **Description of work**

The changes in feed stuffs and feedings regimes in organic milk production are likely to affect the CLA content in organic milk. In this project we will investigate the CLA content of milk from cows fed different types of home-grown concentrates (2000/2001) and different types of roughage (2001/2002) (WP 2), including Rugballegård (WP3) and a larger number of organic farms participating in the on-farm project.

Milk samples will be collected on individual base to account for variation related to season, stage of lactation etc. The samples will be analysed for fatty acid composition and CLA content.

### **Deliverables**

D5.1 International publication  
D5.2 National report  
D1.1 National meeting and proceeding

### **Milestones**

M1: Start collection of samples  
M2: Start of lab-analysis  
M3: Evaluation of results and preparation of reports

## **WP6: Intake and selection at grazing by dairy cows on reduced supplementation**

Work package number: 6  
Start date or starting event: January 1, 2001  
Responsible person: Karen Søgaard  
Contributing persons: Jakob Sehested  
Person months: 6,5 scientific, 4 technical

### **Objectives**

The objectives of the work package are to:

- adjust the leader-follower rotational system to dairy cows without supplementation and with heifers as followers
- describe how the level of supplement feeding influences the grass intake and selection of herbage during grazing
- describe the effect of supplementation on grazing effectiveness and N-balance

### **Description of work**

The research will be integrated with WP3 regarding dairy production systems with prolonged lactation and reduced supplementation. The dairy cows will graze in two groups according to level of supplementation. The cows in each group will graze on alternate days in two rotational systems, which will be replicates. There will be five to six paddocks per rotational system, and in total four rotational systems.

The grazing system with dairy cows as leaders and heifers as followers will start in 2001 and be adjusted during the grazing season. In 2002 and 2003, sward measurements will be carried out in two paddocks per rotation system. Three times during the grazing season intake will be measured as difference in herbage mass before and after grazing plus calculated growth in the grazing days. The intake results will be analysed together with results of animal performance.

Selection of herbage will be measured by examining the herbage mass and botanical composition in three horizontal layers before grazing and every day under grazing, three to four days.

The structure of the paddocks will be described by measurement of grazing height (newly grazed spots) and sward height by plate raising meter. Data will be analysed as frequency measurements both after cow and heifer grazing.

The herbage quality will be analysed for in vitro organic matter digestibility and crude protein. Data from intake, crude protein, N in milk, N in supplementation and time in paddocks per day will be used for calculation of N-balances per ha for each group of dairy cows.

### **Deliverables**

D 6.1 International paper  
D 1.2 National meeting and proceeding  
D 3.3 National report

**Milestones**

M1 Conclusions on the grazing method and initiation of the grazing experiments

M2: Evaluation of preliminary results

M3: Final report and publication

## **WP7: Genetic Improvement of dairy cows**

Workpackage number:	7
Start date or starting event:	July 1. 2002
Responsible person:	Ivan L. Mao
Contributing persons:	Per Madsen
Person-months:	8 scientific

### **Objectives**

The overall goal is to investigate the existence of genotype by environment interaction in each of the economically important traits, where environments are the organic farming system and the traditional farming system in Denmark. Specific objectives are:

- to investigate if the genetic rankings of bulls and cows in organic farming system are different from those in the traditional farming system,
- to estimate genetic variation within each system, and to determine if the genetic variation within one system is different from the other, and
- to model genetic evaluation procedures to facilitate selective mating in different farming systems, if genotype by environmental interaction is significant.

### **Description of work**

A data set will be established complete with animal and parental identifications and identification of farming systems for the three major breeds in Denmark. Within each farming system, environmental, feeding and managerial categories or levels will be identified. Each cow will may have records in this data set on her milk yield, milk contents, mastitis incidence, somatic cell counts, other health related incidences and characteristics, and reproduction occurrences and characteristics.

“Reaction norms” approach will be used to examine how a genotype with respect to a specific characteristic reacted to changes or differences in environment and systems, and also to predict how will it respond to future possible changes. This will be done first on milk yield, and then other non-production traits. The results will indicate if different genotypes would perform differently in organic farming system or in traditional farming system. Genotypes can be breeds, and can be individual breeding values.

If genotype by environment interactions is proved to be significant, and thus cannot be ignored in the genetic evaluation models, models that are different from the current ones, will be fitted to generate unbiased breeding value estimates for selective matings in different farming systems.

### **Deliverables**

D7.1: National report  
D7.2 International paper  
D 1.2 National meeting and proceeding

**Milestones**

M1: Establishment of data sets

M2: Models developed set

M3: Further Models fitted on production data

M4: Models fitted on non-production data

## **WP8: Farming Systems**

Work package number: 8  
Start date or starting event: January 1. 2003  
Responsible person: Troels Kristensen  
Contributing persons: Lisbeth Mogensen  
Person-months: 4 scientific, 1 technical

### **Objectives**

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

- to evaluate the effect in terms of overall biological efficiency, level of production and production economic
- to evaluate the effect in terms of resource use and environmental impact

### **Description of work**

The first part of the work will be based on the activity in WP's 2 to 6 in this project and data from the on-farm project "Development of new organic farming systems", run by the Department of Agricultural Systems. This information will be used in prototyping of different scenarios for organic milk production with 100% organic feeding. The prototyping will use parts of an existing model describing the on-farm effect of different types of crop production on nutrient. The more detailed effects on herd production and herd structure will be monitored by a dynamic herd model SIM-HERD.

In the next part of the work, the results from the prototyping will be introduced on 3 to 5 organic dairy farms, in collaboration with the on-farm project. Although it is not possible to make a formal test of the actual effects, due to the limited length of the project, the introduction of the results obtained from the experiments in an authentic farm situation will reveal limitations not accounted for in the experiments. The activity will bring valuable information in relation to some of the farm effects, including the farmers' attitude to the problem, when milk production has to be based entirely on organic feed, preferably home-grown feed.

### **Deliverables**

D8.1: National report  
D1.2: National meeting and proceeding

### **Milestones**

M1: Workshop as start of the WP planned and conducted  
M2: Prototype of farmlevel  
M3: Evaluation and final report

## **7. Implementation and time schedule**

Due to the co-operation with the running on-farm project, the experiments will be able to start in November 2000. The running project will insure the production of the amounts and qualities of organic feed needed in the experiments. The methods used to evaluate the different feeding strategies will be based on data from the first year's experiments.

Due to the limited resources available, more of the project part elements are planned to be performed in shorter time courses within the project period. We aim at creating a natural flow of the part elements through the period taking into account the co-ordination of scientific parts and a homogeneous technical workload at the research station.

The activities around evaluation of different breeding strategies are not related to the on-farm experiments as the data will be taken from the central database. The intention is to run this activity as in the period 2001-2003

The farm level evaluation is based on the data from the experiments in this project and data from the running on-farm project. This activity will therefore be concentrated to the last two years of the project.

Besides the reports, meetings, etc. listed in table 3, the project results will be part of the material used in courses and meeting for organic advisors and farmers during the project period. Preliminary results and the idea behind the project will be presented at relevant international meeting, with proceedings.

**Table 3: Deliverables list**

<b>Deliverable No</b>	<b>Deliverable title</b>	<b>Delivery date</b>	<b>Meeting</b>	<b>Nature<sup>1</sup></b>
D4.1	Influence of different feed rations on plasma metabolites and subclinical ketosis	Sept 2001		Mc Th
D2.1	Milk production	Dec 2001		Th
D2.2	Organic milk production with 100% organic feed	Dec 2001		Pu
D4.2	Factors influencing plasma metabolites, hormones, health and reproduction in organic farms	Okt 2002		Pu
D1.1	Meeting for organic advisors	Okt 2002		Pro-na
D2.4	Effects of organic feeding strategies	Dec 2002		Pu
D 6.1	Effects of supplementations on intake and selection under grazing	Apr 2003		Pu
D5.1	Effect of concentrates and roughage on CLA content in organic milk	May 2003		Pu
D5.2	Variation in CLA content of milk in organic farms	Okt 2003		Re
D4.3	Influence of feeding strategies and extended lactation on plasma metabolites, subclinical ketosis and reproduction	Okt 2004		Pu
D1.2	Meeting for organic advisors	Okt 2004		Pro-na
D7.1	Genetic evaluation in organic dairy farming systems	Okt 2004		Re
D7.2	Genetic evaluation in organic dairy farming systems	Okt 2004		Pu
D3.3	Organic dairy systems based on prolonged calving interval, reduced supplementation and high levels of clover-grass - effects on feeding, production, reproduction, health and grass intake	Okt 2004		Re
D8.1	Evaluation of different organic dairy farming system	Nov 2004		Re
D3.1	Effects of calving interval and supplementation level on milk production and persistency of lactation in an organic production system	Dec 2004		Pu
D 3.2	Effect of prolonged calving interval on mammary synthesis capacity and apoptosis	Dec 2004		Pu

<sup>1</sup>Please indicate the nature of the deliverable using one of the following codes:

**Pu**= International publications in books and journals

**Re**= Reports

**Pro-in**= Proceedings/abstracts at international symposia, conferences etc.

**Pro-na**= Proceedings/abstracts at national conferences etc.

**Pup**= Popular papers

**Oral**= Oral presentations, lectures etc.

**Th**= Theses

**O**= Others

#### **Table 4: Time table.**

Page 36-37.

### **8. Collaborative partners and educational aspects**

The scientists behind the present project have a well-established national and international co-operation both within our respective professional areas and as a group.

The project is dependent on the collaboration with the project "Development of new organic farming systems". The leader of this project is also responsible for the activities on the dairy farms in the on-farm research project.

WP3 will benefit strongly from results from the projects "*Feed intake capacity, nutrient partitioning and risk for production diseases*" and "*Importance of milk synthesis and liver metabolism in the development of metabolic diseases*" financed by the programme: Future Animal Production considering Product Quality and Environment, Ministry of Agriculture and Fisheries.

Kristen Sejrsen has several years collaborated with Dr. Chris Knight, Hannah Research Institute, Scotland on aspects of the biology of the lactation curve and extended lactation.

Contact to Erling Thuen, NLH, who is responsible for a long-term experiment with organic milk production. The project involves activities within feeding, crop production and modelling.

#### *Educational aspects*

The activities concerning the production and efficiency of different feeding rations will form the basis for the Ph.D. work by Lisbeth Mogensen (LIM). It is further the intention to set up a Master project in relation to the activities in WP4 and WP6 together with the Royal Veterinary Agricultural University.

All the participants in the project are involved in the education of advisors within animal production and health, which will insure the dissemination to the farmer of the results during the project. The on-farm activities will also be a way of quick dissemination.

### **9. Budget**

The total budget is 8.45 mill. DKK, including an overhead of 20 percent of salary and operation costs.

<b>Institution (DJF)</b>	2000	2001	2002	2003	2004
Salary (scientific)	265000	744300	907065	867160	673598
Salary (technical)	27800	279280	346547	292412	146114
Operation	305000	679000	620000	504500	383500
Overhead	119560	340516	374722	332814	240642
<b>Total</b>	<b>717360</b>	<b>2043096</b>	<b>2248334</b>	<b>1996886</b>	<b>1443854</b>

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## Curriculum vitae for Troels Kristensen

**Born:** 27. marts 1956

### Education:

1983 M.Sc. Agric. The Royal Veterinary and Agricultural University of Copenhagen.

1998 Ph.d The Royal Veterinary and Agricultural University of Copenhagen

### Employment:

1983 Scientist, Department of Research in Cattle and Sheep, Danish Institute of Animal Science.

1987 Advisor Cattle Production, Farmers Organization, Randers.

1988 Scientist, Department of Research in Cattle and Sheep, Danish Institute of Animal Science

1999 Senior Scientist, Department of Agricultural Systems, Danish Institute of Agricultural Sciences

### Occupation

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. Pasture management, grazing systems and effects of supplemental feeding have been in focus in the recent years. Responsible for registration, data handling and publication of the on farm research activities (30-40 farms) at the department and editor of the annual reports from these activities.

### Examples of publications:

Kristensen, I.S. & Kristensen, T. 1997. Animal production and nutrient balances on organic farming systems. Prototypes. In: Proceedings ENOF workshop "Resource use in organic farming". Ancona, Italy, 4-5 June. 21 pp.

Kristensen, T. & Aaes, O. 1999. Interaction between level of concentrate supplement, season and stage of lactation on performance of dairy cows at pasture. *Acta Scand. Agric, Sect. A*, 49, 1, 1-11.

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## Curriculum vitae for Kristen Sejrsen

### Personal data:

Born: 13 July 1947 in Råby, Denmark.  
Home address: Absalonsvej 14, 8900 Randers, Denmark.

### Present position

Head of Research Unit, Growth and Lactation Physiology,  
Department of Animal Nutrition and Physiology, Danish Institute of Agricultural Sciences,  
Research Centre Foulum, P.O. Box 50, 8830 Tjele, Denmark.

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### Degrees:

Cand. agro. (M. Sc.) Royal Veterinary and Agricultural University (RVAU), Copenhagen, Denmark, 1973.  
Ph.D. Michigan State University, East Lansing, Michigan, USA, 1981.

### Previous positions:

1973 - 1977 Research assistant, Danish Institute of Animal Science, DIAS), Denmark.  
1977 - 1980 Graduate Assistant, Department of Dairy Science, Michigan State University, USA.  
1981 - 1997 Research Assistant, Senior Scientist and Head of research unit, DIAS, Denmark.  
1992 - 1993 Visiting Scientist at Hannah Research Institute, Scotland, UK.  
Since Apr. 1997 Head of research unit Growth and Lactation Physiology (see above)

### Areas of research:

Feeding of growing heifers and milk yield capacity; Hormonal basis for influences of nutrition on mammary growth and lactation; Hormonal regulation of growth, development and meat quality; Bioactive peptides in milk: effects on mammary physiology and development of the new-born; Regulation of milk protein synthesis: physiological effects of peptides and hormonal regulation; Biology of the lactation persistency.

### Award, memberships:

- International Dairy Production Award from the American Dairy Science Association in 1997.
- Dairy Science Association, British Endocrine Society and The Nordic Society of Agricultural Scientists.
- Steering committee EAAP/ASAS Workshop on Biology of Lactation in Farm Animals, chairman 1994-96
- Secretary for the Physiology Commission of the European Association of Animal Production,
- Member of the management committee for EU COST action 825: "Mammary gland biology".

### International collaborators:

Bauman et al., Cornell University, USA. R.M. Akers et al., Virginia Polytechnic Institute and State University, USA, Karen Plaut, Vermont University, USA, Chris Knight & D. Flint et al., Hannah Research Institute, Scotland, Bridgett Drew, ADAS, England

### Selected publications:

- Weber, M.S., Purup, S., Vestergaard, M. Ellis, S.E., Akers, R.M. & Sejrsen, K. 1999. Contribution of insulin-like growth factor-I (IGF-I) and IGF-binding protein-3 (IGFBP-3) to mitogenic activity in bovine mammary extracts and serum. *J. Endocrinology*, 161, 365-363.
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- Sejrsen, K., Purup, S., Vestergaard, M. Weber, M.S., & Knight, C.H. 1999. Growth hormone and mammary development. *Domestic Animal Endocrinology*, 17, 117-129
- Purup, S, Vestergaard, M. & Sejrsen, K. 1999. Involvement of growth factors in the regulation of pubertal mammary growth. Invited paper Cost 825 conference 1999 Tours France.
- Akers, R.M., McFadden, T.B., Purup, S., Vestergaard, M., Sejrsen, M., Sejrsen, K. & Capuco, A.V. 2000. Local IGF-I Axis in peripubertal ruminant mammary development. *Journal of Mammary Gland Biology and Neoplasia*. (accepted).
- Ellis, S., Purup, S., Sejrsen & Akers, R.M. 2000. Growth and morphogenesis of epithelial cell organoids from peripheral and medial parenchyma of heifers. *J. Dairy Sci.* (accepted).
- Sejrsen, K., S. Purup & M. Vestergaard. . High body weight gain and reduced bovine mammary growth: physiological basis and implications for potential milk yields. *Domestic Animal Endocrinology*, (accepted)

## Curriculum Vitae for Jakob Sehested

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Web site: <http://www.agrsci.dk/hef/jas/>

### Personal data:

Born April 26, 1964 in Denmark  
Danish citizenship

### Degrees:

1994 Ph.D. (animal physiology), The Royal Veterinary and Agricultural University, DK (RVAU)  
1990 M.Anim.Sci. (cand.agro.), RVAU

### Employment:

1998- Senior Scientist, Danish Institute of Agricultural Sciences, Department of Animal Nutrition and Physiology (DIAS)  
1995-98 Senior Advisor, The Danish Agricultural Advisory Center  
1995-95 Assistant Professor, Institute of Anatomy and Physiology, RVAU  
1991-94 Research Assistant and Ph.D.-student at the Institute of Anatomy and Physiology, RVAU  
1990-91 Teaching Assistant at the Institute of Anatomy and Physiology, RVAU

### Field of work

During the employment at the Danish Institute of Agricultural Sciences my research has mainly been within organic dairy production, grazing systems, and estimation of grass intake and selection. During the employment at The Danish Agricultural Advisory Center my field of work was mainly developing the advisory services regarding production, nutrition and breeding of small ruminants. At The Royal Veterinary and Agricultural University my main fields of work were teaching and research in the areas of ruminant physiology, especially physiology of the rumen and transport of nutrients and electrolytes across the ruminal epithelium.

### Relevant publications

Kristensen, T.; Sehested, J. (1999): Dairy cows at pasture - a Nordic perspective. In: NJF-report no 126, Grazing and pasture management in the nordic countries, Nordic Association of Agricultural Scientists.  
Kristensen, V.F.; Sehested, J.; Danielsen, V.; Søgaard, K.; Kristensen, T. (1998): Samgræsning mellem svin og kvæg. In: Forskning i økologisk svineproduktion, ed. J.E. Hermansen. FØJO-rapport nr. 1, 53-55. Forskningscenter for Økologisk Jordbrug. (In Danish).  
Roepstorff, A.; Monrad, J.; Sehested, J.; Nansen, P.; (1999): Mixed grazing with sows and heifers - parasitological aspects. Proceedings at NJF-seminar no 303, Horsens, Denmark, 16-17 September 1999.  
Sehested, J.; Søgaard, K.; Danielsen, V.; Kristensen, V.F. (1999): Mixed grazing with sows and heifers - effects on animal performance and pasture. Proceedings at NJF-seminar no 303, Horsens, Denmark, 16-17 September 1999.

## Curriculum Vitae – Klaus Lønne Ingvarsten (KLI)

### Academic degrees

- 1992 Ph.D. The Royal Veterinary and Agricultural University, Copenhagen.  
1983 M.Sc., Animal Science. The Royal Veterinary and Agric. University, Copenhagen

### Employment

- 1998- Head of Research Units for Production Diseases and Immunology, Dept. of Animal Health and Welfare.  
1995-97 Senior Research Scientist at DIAS, Dept. of Animal Health and Welfare. Temporarily co-ordinator of the group concerning Production Related Diseases.  
1993-95 Senior Research Scientist at DIAS, Dept. of Research in Cattle and Sheep.  
1984-93 Research Scientist at DIAS, Dept. of Research in Cattle and Sheep.

### Research focus and experience

KLI has a broad experience in research management and research with cattle, including calves, young stock and cows. Recent and ongoing research activities in cows focus on elucidation of how nutrition, management and genotype may affect the risk of production diseases and how production diseases affect feed conversion, production, product quality and animal welfare. Ongoing projects addresses mechanisms involved in the etiology of metabolic disorders including changes in and regulation of appetite, metabolism and nutrient partitioning and relationships with the immune system and the risk of infectious diseases. Furthermore, the research will include a description of biological parameters in blood, liver and milk which may be potential markers for subclinical diseases, inexpedient physiological conditions and suboptimal production and which may be used in health and production management.

### Selected publications

- Andersen, J. B. and Ingvarsten, K. L. 1999. Ketosis - patogenesis and prevention. *Boologisk Selskab*, September 1999. (Invited paper, In Danish)
- Ingvarsten, K. L. 1999. Variations in physiological parameters around calving with special focus on appetite and productiondiseases. *Boologisk Selskab*, September 1999. (Invited paper, In Danish)
- Burton, J. and Ingvarsten, K. L. 1999. Immunosuppression and production diseases in dairy cattle - state of art and visions. Research school for Animal Production and Health opening meeting. Program and Proceedings. 31. Marts 1999. (Invited paper – paper in preparation)
- Ingvarsten, K.L., N.C. Friggens, and F. Faverdin. 1999. Feed intake regulation in late pregnancy and early lactation. *Br. Soc. Anim. Sci. Occ. Publ. No. 24*: 37-54. (Invited paper)
- Andersen, J.B., J. Sehested, and K.L. Ingvarsten. 1999. Effect of dry cow feeding strategy on rumen pH, concentration of VFA and rumen epithelium development. *Acta Agric. Scand., Sect. A, Anim. Sci.* 49: 149-155.
- Ingvarsten, K.L. and J.B. Andersen. 2000. Integration of metabolism and intake regulation: a review focusing on periparturient animals. *J. Dairy Sci.* (Invited paper, In press)

## Curriculum Vitae for Karen Søegaard

### Personal data

Name: Karen Søegaard  
Age: 46 years  
Education: M.S. Biology, Aarhus University, Denmark, 1980

### Working area and appointment

1980-1987: Jyndevad Research Station, Statens Planteavlsvforsøg  
Working area was irrigation and fertilization of grass and cereals. N- and water balance, plant physiology.

1987- : Department of Crop Physiology and Soil Science, Research Centre Foulum.  
Working area is forage crops, production and quality. Mostly grassland both for cutting and grazing. Is senior scientist and Scientist leader for the Group of Forage and Energy Crops.

### Five relevant publications

- Askegaard, M.; Eriksen, J.; Søegaard, K. & Holm, S. 1999. Næringsstofhusholdning og planteproduktion i fire økologiske kvægbrugssystemer. (Nutrient balances and plant production at four dairy organic systems) DJF-rapport Markbrug nr. 12, 112 pp. (In Danish)
- Eriksen, J. & Søegaard, K. 2000. Nitrate leaching following cultivation of contrasting temporary grasslands. Grassland Science in Europe, vol. 5. Accepted.
- Søegaard, K.; Petersen, S. O. & Vinther, F.V. 1996. The effect of N in urine under grazing on herbage production, N fixation and ammonia volatilization. Eds. G.Parente et al. Grassland Science in Europe 1, 615-619.
- Søegaard, K. & Aaes, O. 1997. Herbage quality at continuous grazing with dairy cows at different N-intakes and sward types. Proc. of the XVIII Int. Grassl. Congress, Canada, Vol 2, 1755-1756.
- Søegaard, K & Nesheim, L. 1999. Growth, quality, and management of white clover-grass pastures. NJF-utredning, Rapport nr. 126. Grazing and Pasture management in the Nordic countries.

## Curriculum vitae for Ivan L. Moa

**Personal Data:** Born on September 16, 1940 in China. Citizen of U.S.A.

**Education:** Ph.D. Cornell University, Animal Breeding & Biometrics (1970)  
M.Sc. University of Guelph, Animal Breeding & Genetics (1967)  
B.Sc. National Taiwan University, Animal Science (1964)

**Appointments:**

Professor (90% research and 10% teaching), Department of Animal Science, Michigan State University (1984-present).

Visiting Professor at Akvaforsk, Norway (1998), Agriculture University of Norway (1991), Italian Livestock Association (1990), and Swedish University of Agricultural Sciences (1981-82). NATO Visiting Professor at the Ministry of Agriculture of Italy (1984).

Honorary Professor, Institute of Animal Science, Chinese Academy of Agricultural Sciences, People's Republic of China (1986-present).

Administrative Intern, Michigan Agricultural Experiment Station (1992-93).

Extension Specialist, Michigan Cooperative Extension Service (1972-79).

Assistant Professor, Dept of Dairy Science (1972-78), and Associate Professor, Department of Animal Science (1978-84), Michigan State University.

Research Associate, Department of Animal Science, University of Guelph (1971-72); Cornell University (1970-71).

**Areas of research:**

A livestock breeder, quantitative geneticist and biometrician, Dr. Mao has close to 30 years of experience in applied research and development for livestock improvement. He has published over 100 scientific papers in refereed journals and proceedings, has made over 100 presentations in scientific conferences and over 70 presentations to producers and "lay-audiences". Many of the presentations were invited speeches in 15 different countries in Europe and Asia. He has trained over 40 M.Sc. and Ph.D. students and postdoctorates from 19 countries in Americas, Europe, Asia, and Africa.

**Recent publications.**

J.E. Pryce, M.D. Royal, P.C. Garnsworthy, I.L. Mao. 2000. Fertility in the high producing dairy cow. *Proceedings of High yielding dairy cows: Integration of physiology, nutrition, management and health aspects*. 51<sup>st</sup> Annual Meeting of the EAAP. August 21-24, The Hague, The Netherlands.

Mao, I.L. 1999. Efficient dairy production system. Invited keynote. *Proceedings of Bilateral Symposium on the Development of Dairy Cattle Industry*. April 13~16, 1999. Ministry of Agriculture of China, Beijing, China.

Norris, D., R.J. Tempelman and I.L. Mao. 1999. Effect of dominance variation and population structure on estimation of additive genetic variance. *J. Dairy Sci.* 81:65.

Norris, D., I.L. Mao and M. Rye. 1999. Effect of full-sib family density on the detection of dominance genetic effects. *J. Ani. Sci.* (submitted)