



Annual Status Report 2001 and Application for Continuation in 2002

For research projects financed by grants from
The Directorate for Food, Fisheries and Agro Business
under the Danish Ministry of Food, Agriculture and Fisheries

1. Research program

Research in organic farming 2000-2005 (DARCOF II)

2. Project title and number

II.7 Pig feeding under organic farming conditions with emphasis on nutrient utilisation, product quality and health

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7. **Start of project:** 2001 (Quarter 3)
End of project: 2005 (Quarter 2)
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8. Annual report/Application for continuation in 2001

A. Objectives and expected achievements (from application)

The overall objective of the project is to obtain new knowledge, that can support the recommendation of suitable dietary composition and feeding strategies for organic pig production. The emphasis will be placed on feedstuffs of organic farmed origin and the nutritional requirements for performance, carcass quality, meat quality and health of the pigs will be studied. Expected achievements comprise:

- Indication of methods and feedstuffs for suitable supplying of pigs with dietary protein and essential amino acids.
- Improvement of the knowledge about requirements for dietary essential amino acids of weaned pigs, growing-finishing pigs and breeding sows.
- Improvement of the knowledge about the demands for dietary supply of vitamins and minerals of pigs under outdoor conditions.
- Development of methods for feeding of piglets in connection with weaning.
- Development of feeding concepts that can be used to improve the animals resistance to infectious diseases of the gastrointestinal tract of growing-finishing pigs.
- Exposure of interactions between the diet composition and the carcass and meat quality in slaughter pigs.

B. Project summary (from application)

A knowledge synthesis initiated by DARCOF revealed that some topics in relation to feeding of pigs under organic farming conditions need to be studied. The demand to be self-sufficient in feed for organic animal production is increasing, but pig production is restrained by the difficulty to provide feed ingredients for suitable nutrient supply. In order to meet the demands for protein, amino acids, vitamins and minerals from pigs, alternative feed crops and feed ingredients therefore have to be found. Thus, there is a great need for evaluation of traditional as well as alternative feed ingredients, which have potential as pig feed. The overall objective of this project is to obtain improved knowledge for development of suitable feed formulations and feeding strategies for organic pig production. The work will be conducted in three work packages and involves experiments with breeding sows, as well as weaned pigs and growing-finishing pigs.

The expected achievements comprise:

- Indication of methods and feedstuffs for suitable supplying of pigs with dietary protein and essential amino acids.
- Improvement of the knowledge about requirements for dietary essential amino acids of weaned pigs, growing-finishing pigs and breeding sows.
- Improvement of the knowledge about the demands for dietary supply of vitamins and minerals of pigs under outdoor conditions.
- Development of methods for feeding of piglets in connection with weaning.
- Development of feeding concepts that can be used to improve the animals resistance to infectious diseases of the gastrointestinal tract of growing-finishing pigs.
- Exposure of interactions between the diet composition and the carcass and meat quality in slaughter pigs.

The research is intended to give valuable information on the effect of lupine and dietary protein level on the performance and nutrient utilisation of growing pigs and product quality of organic pork. The effect of lupin on skatole in back fat is included. Thus, if lupin results in lower skatole in fat, this may be a way to reduce boar taint in entire male pigs. Output from the research also intend to comprise new knowledge, that can be used as basis for recommendation of management for efficient utilisation of pastures and silage in feeding of pregnant sows. In this connection and also in some of the other studies, monitoring of the mineral and vitamin status of the animals will give important informations for the guidance of dietary supplementations. The research will also give a better basis for evaluating the potential of using the diet to reduce digestive disturbances in piglets and infectious diseases in growing pigs. The project will also help to find ways to overcome problems that may occur because of higher infectious pressure for pigs with access to outdoor facilities and straw bedding. Furthermore, the project attempts to provide tools for an environmental friendly production of pigs in Denmark, with minimal use of therapeutic antibiotics and anthelmintics.

Table 1: Work package list (from application)

No.	Work package title	Parti- pants*	Budget (1.000 DKr)	Start	End	Deliverable No:
-	Co-ordination	VDA	248.500	01.04. 2001	30.6 2005	
1	Adequate supply of dietary protein, vitamins and minerals to sows and growing-finishing pigs.	JAF	1.900.000	01.07. 2001	31.12. 2004	D1.2-D1.10
2	Feeding strategies for weaned and growing-finishing pigs with emphasis on gut health.	KEBK	1.900.000	01.07. 2001	30.06. 2005	D2.1-D2.5
3	Effects of nutrient supply for growing-finishing pigs on product quality.	CCM	951.500	01.01. 2002	31.12.2004	D3.1-D3.3
Total			5.000.000			

- Responsible participants are underlined

C. Progress

C.1 Annual description (resume) of main results and conclusions

Approval of the project was given in July this year. Primo August an experiment with feeding of grazing sows was started, but no results are yet available for presentation.

C.2 Fulfilment of tasks and deadlines in individual work packages

(To be completed for each work package)

WP number and title: WP1: Adequate supply of dietary protein, vitamin and minerals to pregnant sows and growing-finishing pigs	Time schedule according to application	Deviations, if any*
Task		
1. Production experiment with growing pigs	2002 – 2004	-
2. Digestibility and balance experiments	2001 – 2002	-
3. Production experiment with pregnant sows	2001 - 2004	-
Deliverables		
1. Protocol for experiments with pregnant sows, 1 replicate	Quarter 3, 2001	-
2. Protocol for digestibility experiments	Quarter 3, 2001	-
3. Protocol for experiments with slaughter pigs, 1. replicate	Quarter 3, 2001	-
4. Progress report	Quarter 4, 2001	-
Milestones: none		

* *Deviations are to be further discussed at C3*

WP number and title: WP2: Feeding strategies for weaned pigs and growing-finishing pigs with emphasis on gut health	Time schedule according to application	Deviations, if any*
Task		
1. Gut challenge and diet screening	2001-2003	-
2. Effect of dietary factors on weaning diarrhoea	2002-2004	-
3. Effect of diets varying in digestible and nondigestible carbohydrates on <i>T. suis</i> infection	2001-2003	-
4. Effects of diets varying in carbohydrate composition on establishment of dual infection with <i>T. suis</i> and <i>B. pilosicoli</i>	2002-2004	-
Deliverables: None		
Milestones: None		

* *Deviations are to be further discussed at C3*

WP number and title: WP3: Effects of nutrients for growing-finishing pigs on product quality	Time schedule according to application	Deviations, if any*
Task		
1. From each of 4 treatments (two levels of lupin and two levels of protein) carcass samples are delivered from 20 gilts and 20 male castrates reared in the experiment described in WP1	2002-2004	-
Deliverables: None		
Milestones: None		

* *Deviations are to be further discussed at C3*

C.3 Discussion on the progress, incl. deviations and achievements in the project as a whole and in the individual work packages and

Due to the very short span of time no deviations in relation to the time schedule have appeared and no achievements have yet been obtained. Most activities have comprised preparations of protocols for the experiments.

WP 1

Task 1.1: "Production experiment with growing pigs" and task 1.2: "Digestibility and balance experiments with growing pigs" are both under planning. In task 1.3: "Production experiments with pregnant sows" the first experiment on pasture was planned and started. Fifteen sows are involved in a system of rotational grazing and fed different supplementary diets. They are still under recording.

WP 2

Task 2.1: "Gut challenge and diet screening" and task 2.3: "Effects of diets varying in digestible and nondigestible carbohydrates on *T. suis* infection" are both under planning. On task 2.2: "Effect of dietary factors on weaning diarrhoea" and task 2.4: "Effect of diets varying in carbohydrate composition on establishment of dual infection with *T. suis* and *B. pilosicoli*" no activities have yet been performed.

WP 3

Task 3.1: "Effects of nutrient supply for growing-finishing pigs on product quality". No activities in 2001.

D. Description of plans and future work in the project as a whole and in the work package (Including plans for publication and communication)

Description according to the application.

Task 1.1

Production experiment with growing pigs will be carried out at the organic farm Rugballegård. Littermate growing female pigs and male castrates (25-30 kg) will be fed until slaughter (105 kg) with 2 diets (a grower diet to 60 kg and a finisher diet thereafter) containing different level of lupin, each level formulated to fulfil either the recommended amounts of amino acids for conventional reared pigs or reduced to 85%, according to the experimental plan below:

Treatment	1	2	3	4	5	6
Amino acid supply, %	100	100	100	85	85	85
Lupin, % in diet	0	10	20	0	10	20

Pigs will be group fed (5 per pen) ad-lib in pens with access to outdoor facilities. The experiment will comprise a total of 240 pigs distributed in 6 treatments replicated 8 times. Feed composition, feed consumption, feed utilisation and growth rate will be determined. Nitrogen, phosphorus and selected trace element flow will be estimated and pig health recorded.

Task 1.2

Digestibility and balance experiments will be carried out at Foulum with 4 of the experimental diets (from Task 1.1) and with two ingredients of special interest (lupin and oats). Diets will be fed restrictively to littermate pigs kept in metabolism cages under standardised conditions appropriate for protein and mineral studies. Lupin and oats will be fed mixed at different levels with wheat starch. The nutritive value of the diets and of the 2 ingredients will be assessed in terms of FUp (net energy for growing pigs) and of nitrogen utilisation. In addition, the availability of calcium, phosphorus selected trace minerals and vitamin E will be determined.

Task 1.3

Production experiment with pregnant sows will be conducted at the organic farm Rugballegård by the use of first year clover grass. Three plots will be used by three different groups of grazing sows. Each plot will be divided into 3 paddocks for rotational grazing. Fifteen sows in their first stage of pregnancy will be divided in three groups of 5 and allotted the experimental plots. Sows within plots will be given access to rotational grazing by weekly occupation of each paddock. Across plots sows will be subjected to three different feed strategies. The experiment will consist of four turns of 8 weeks each. In two turns sows will be given concentrate diets varying in composition, and in two turns different levels of daily concentrate allowance will be tested. The experiment with grazing will thus comprise four batches of 15 sows. In wintertime sows will be offered clover grass silage ad libitum.

Grass intake of sows will be estimated by the difference between measured herbage mass before and after grazing plus the herbal growth in between. Botanical composition before and after grazing will be measured to calculate selection by the sows. Sow production will be evaluated by measuring weight changes and condition score twice monthly. Concentrate and grass intake will be recorded. The overall N balance will be estimated. Vitamins and mineral status of the sows will be monitored in blood samples prior to farrowing and in blood and milk samples after farrowing.

Task 2.1:**Gut challenge and diet screening**

One of the obstacles with work on prevention of diarrhoea is that diarrhoea seldom is present in experimental animals, therefore making tests of potential cures difficult. One way to overcome this drawback is to introduce a challenge at the gut level that will initiate or imitate diarrhoea conditions. Could diarrhoea conditions be initiated or imitated, test of factors with potential anti-diarrhoea effects would be more reliable. We intend to challenge the gut by an oral dose of *E. coli* O149 and screen different dietary factors (and factor levels) for their relative importance before they are tested under practical conditions (see task 2.2). Diets with defined levels of protein, energy etc. will, one factor at the time, be fed to newly weaned individually stalled piglets, coming from an outdoor system and weaned at 7 weeks of age. Pairwise on each diet factor level, the piglets serve as control respective get a challenge with *E. coli* (10^{10} cfu/day) orally by stomach tube on days 1-3 after weaning. Clinical signs of diarrhoea, feed intake and growth will be monitored for two weeks. It may be necessary with some modification of this infection model with respect to inoculation dose and duration as it was developed to induce diarrhoea in piglets at 4 weeks of age.

Task 2.2:**Effect of dietary factors on weaning diarrhoea**

Different diets will be offered to piglets and weaned pigs to study their effect on weaning diarrhoea. Selection of diets to be studied will be based on results from the literature, common practice and the outcome of the screening in task 2.1. Among potential factors to be studied are energy/feeding level and the dietary level of protein, milk products, nondigestible carbohydrates, vitamin E and zinc. The selected diets will be given to different organic farmed litters from 4 weeks of age. They continue with the same diet after weaning at 7 weeks of age. Clinical signs of diarrhoea, feed intake and growth will be monitored for two weeks after weaning. A blood sample will be taken at day 7 after weaning and measured for vitamin E, zinc, and growth factors when appropriate. Representative pigs will be slaughtered at day 14 after weaning and gut tissue samples will be taken and analysed for villi morphology, cell proliferation, thickness of the mucus layer and immunological responses when appropriate.

Task 2.3:**Effect of diets varying in digestible and nondigestible carbohydrates on *T. suis* infection**

Two diets with contrasting digestibility of carbohydrates will be formulated from wheat, grass, soybean, lupins as the main ingredients. The main dietary constituent will be wheat. Grass will be used as a source of insoluble resistant fibre and lupins (lupins are ~40 % DF) and chicory roots as sources of soluble and fermentable DF. Amino acid levels and composition will be balanced (as much as possible) by soybean. The two types of diets will be fed to four groups of animals; two of the groups will receive the diet with insoluble resistant fibre and the other two groups the diet with soluble and fermentable fibre. Of the two on each diet, one will be infected with 2000 infectious larva of *T. suis*. The pigs will be slaughtered 8 weeks post infection, the gastrointestinal tract removed and samples taken from the last fourth of the small intestine, the caecum and five, by length, equal sections of colon for parasitological investigations, characterisation of chemical composition and physiochemical properties, organic acid concentrations and gut tissue samples. Parameters measured on the gut tissue samples will be neutral, acidic, and sulfomucins, the volume, height and density of the crypt, the thickness of the muscularis externa, the mitotic counts and apoptosis. Parameters to characterise parasite infection will be faecal egg counts, intestinal worm burdens, worm length and female fecundity.

Task 2.4:**Effect of diets varying in carbohydrate composition on establishment of dual infection with *T suis* and *B. pilosicoli***

The two diets as used in task 2.3 will be fed to eight groups of pigs; one of the groups on each diet will be the control group (non-infected), one of the groups will be infected only by *T. suis*, another group will be infected by *B. pilosicoli* and the last group will be dual infected with *T. suis* and *B. pilosicoli*. The same procedure as described under task 1 will be followed for collections of samples from the gastrointestinal tract at slaughter and for parasite examination. Additionally, bacterial infections will be monitored by bacteriological examination of faeces and by gross- and histopathological examinations of the intestine.

Task 3.1.

From each of 4 treatments (two levels of lupin and two levels of protein) carcass samples are delivered from 20 gilts and 20 male castrates reared in the experiment described in WP1. The following traits will be analysed:

- Sensory profiling of pork loin (*M. longissimus dorsi*).
- Fatty acid composition in backfat.
- Intramuscular fat in pork loin (*M. longissimus dorsi*).
- Pigment in *M. longissimus dorsi*.
- Warner Bratzler shear force in pork loin (*M. longissimus dorsi*).
- Skatole in backfat (skatole equivalents using the colorimetric method described by Mortensen and Sørensen (1984)).
- pH 24 hours after slaughter in *M. longissimus dorsi*
- Driploss in *M. longissimus dorsi* by the Honnikel method.

E. Project publications None

1. **Articles in international, scientific journals with review procedures**
2. **Presentations at congresses, symposiums etc.**
3. **Articles in agricultural journals etc.**
4. **Other presentations at meetings, field days etc.**

F. Scientific education (ph.d. and post doc.), including visiting scientists and visits abroad

By collaboration with the Danish Centre for Experimental Parasitology, KVL and the Danish Veterinary Laboratory a joint Ph.D. student funded by the Research School for Animal Production will use the data generated from tasks 2.3 and 2.4 in WP2 as parts of her Ph.D. thesis. Collaboration with professor Jens Peter Nielsen, KVL about the challenge model with *E. coli* O 149 to be used in tasks 2.1 and 2.2. is supposed to be implemented as a result of the Ph.D. project – “The influence of feed intake during lactation on piglets susceptibility to post-weaning diarrhoea”, which is funded within the framework of the Research School for Animal Production.

G. National and international co-operation

This project has strong links to the recently appointed EU project QLRT 30162 "Sustainability in the production of pork with improved nutritional and eating quality using strategic feeding in out-door production" (SUSPORKQUAL) through the project co-ordinator Dr. Anders Hans Karlsson Head of Research Unit for Muscle Biology and Meat Quality at the Danish Institute of Agricultural Sciences. Furthermore, the co-ordinator of WP1 in this project (JAF) is also the co-ordinator of WP1 (Sustainable Pig Production) in the EU project. The two projects, although with different goals, will complement each other. The ultimate goal of SUSPORKQUAL is to improve the nutritional value, increase eating quality (tenderness), shelf life and technological quality of pork. This will be achieved by combining strategic feeding resulting in compensatory (accelerated) growth in the time up to slaughter, with known feeding strategies (enrichment with E-vitamin, PUFA etc.) that gives rise to improved nutritional value of the out-coming pork.

This project is also linked to the DARCOF II project I.5: "Grain legumes and cereals – new production methods for increased protein supply in organic farming systems", which is co-ordinated by Erik Steen Jensen, professor at KVL and in which Knud Erik Bach Knudsen is partner. KEBK is further collaborating with the Danish Centre for Experimental Parasitology, KVL (Allan Roepstorff) and the Danish Veterinary Laboratory (Kristian Møller). Ellen-Margrethe Vestergaard is collaborating with professor Jens Peter Nielsen, KVL about the challenge model with *E. coli* O 149 to be used in tasks 2.1 and 2.2.

The project in question has links to two other DARCOF projects on organic pig production: II.9 "Resource use, environmental impact and economy in organic pig production systems", co-ordinated by John E. Hermansen and II.8 "Management in relation to health and health safety in organic pig production co-ordinated by Jan Tind Sørensen. Both projects are parts of the same DARCOF research programme as this project. The three projects are complementary, but also synergetic, why the collaboration is relevant for the total output.

The project has also links to the project: "Organic production of steers and bioactive forages for grazing livestock". The links are through the project co-ordinator Stig Milan Thamsborg and one of the tasks of the project "Influence of bioactive forages on animal health with emphasis on parasitic infections and effects on meat and eating quality" in steers and pigs. There are links to the organic project "Effect of organic pig production on meat and eating quality" too, project co-ordinator Henrik J Andersen.

Furthermore, the project has links to lupin testing project "Lupinforsøg, Undersøgelser vedrørende kød- og spisekvalitet" by Danske Slagterier (Hanne Maribo).

H. Possible elaboration of project and achieved results

