Progress Report 2004 and Application for Continuation in 2005

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The Directorate for Food, Fisheries and Agro Business
under the Danish Ministry of Food, Agriculture and Fisheries

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1. Research program

Research in organic farming 2000-2005 (DARCOF II)

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2. Project title and number

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

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6. Project period (month, year)

Start of project: April 2001
End of project: June 2005

7. Midterm description of the project, its results and progress, and application for continuation in 2005

A. Project summary

A knowledge synthesis initiated by DARCOF revealed that some topics in relation to feeding of pigs under organic farming conditions need to be studied. Thus the overall goal of this project is to provide new insight that can be applied in the formulation of feeding strategies and diets in organic pig production.

The demand for self-sufficiency in feed is increasing, and at the same time the feed sources must contain sufficient nutrients (amino acids, vitamins and minerals) to meet the demands of the pigs. Alternative feed crops and feed ingredients therefore have to be studied. With this background, a series of experiments will be conducted with lupine as a substitute for more conventional protein sources. In this connection, a reduction in protein requirements would make it easier to formulate adequate diets.

Roughage can be a realistic alternative to pigs if feed uptake is not limiting for the production. This is the case for pregnant sows. Thus, the grass uptake of pregnant sows on pasture is investigated during the summer, and clover grass silage uptake is investigated during the winter. It is also investigated whether the requirements for essential nutrients are met (amino acids, vitamins and minerals).

In organic pig production the restrictive use of medicine increases the incitement of applying feed sources and feeding strategies that may prevent infections. This aspect is investigated with regard to reducing weaning diarrhoea and infection with intestinal worms.

Finally the effect of the feeds is investigated with regard to carcass and meat quality, e.g. the effect of lupine on the meat content of skatole.

The work is conducted in three work packages involving experiments with pregnant sows, weaned piglets and growing-finishing pigs. The expected achievements comprise:

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

No.	Work package title	Participants*	Budget (1.000 DKr)	Start	End	Deliverable No:
-	Co-ordination	MTS	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	CCM	951.500	01.01. 2002	31.12.2004	D3.1-D3.3

	growing-finishing pigs on product quality.					
Total			5.000.000			

* Responsible participant

B. Objectives and expected achievements

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:

- Directions on how to increase self-sufficiency in the feed supply
- Increased knowledge with regard to the requirements for essential amino acids in organic pig production
- Increased knowledge with regard to the requirements for vitamins and minerals in organic pig production
- Development of feeding strategies to decrease weaning diarrhoea in organic pig production
- Development of feeding strategies to decrease the risk of infection with intestinal worms in organic pig production
- Description of the effects of selected feed sources and feeding strategies on carcass and meat quality

C. Midterm results and progress

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

WP 1. Adequate supply of dietary protein, vitamins and minerals to sows and growing-finishing pigs

Task 1.1. Production experiments with growing pigs

The experiments concerning effects of reduced dietary protein and different levels of lupin are concluded. Detailed examination of the results is in progress aiming at producing a DIAS Research Report. The experiment comprised 200 pigs (100 females and 100 barrows) reared in pens of 5 pigs each. Preliminary results are presented in the table below:

Performance results (average) of pigs (30-105 kg) fed different levels of lupine and 2 levels of dietary crude protein

	Protein Standard		**Lupin % i mixture**			**Sex**	
	100 %	**85%**	**0**	**12,5**	**25**	**Barrows**	**Sows**
Gain, g/day	**948**	**945**	**950**	**956**	**943**	**956**	**937**
FUp/kg gain	**2,94**	**2,93**	**2,89**	**2,91**	**2,98**	**3,03**	**2,85**
Meat %	**59,8**	**59,2**	**59,0**	**59,0**	**60,0**	**59,0**	**60,0**
N-loss, g/kg gain ≈	**48**	**42**	**37**	**42**	**53**	**47**	**43**

The results indicate that amino acid reduction only had a very modest negative impact on lean content (meat %). However, there is also an indication that inclusion of 25% of lupin to the diet reduced daily gain and deteriorated feed conversion and improved lean content. These findings were more evident in the sows than in the barrows. The results suggest that organic slaughter pigs can be fed lower levels of amino acids relative to conventional recommendations, without serious detrimental effect on production. In addition, lupin seed and triticale seem to be suitable feed-stuffs for organic pig production.

Task 1.2. Digestibility and balance experiments

The digestibility and balance studies have been carried out as planned. Four of the diets used in the production experiments (i.e. diets with 0 or 25 % lupine) and a batch of organic produced oats respectively lupin have been assayed. However, pigs given diets containing lupin diluted with sugar (40/60) refused to eat completely. Different trials with different diluting substances (cereal starch and the like) failed to overcome the problem. Finally, the experiment was accomplished by imposing a severe feed restriction. According to the preliminary results there is no difference in protein digestibility between the four tested diets from the production experiment (mean 78%). Furthermore there were no major differences in the digestibility of phosphorus and the mean value is approximately 50%. The availability of zinc approximated 20% in all four diets. In the dose-response study, increasing amounts of lupine showed that the digestibility of protein, phosphorus and zinc was about 85, 40 and 25%, respectively. The protein digestibility in oat was determined to be approximately 71% which is a little lower than shown in previous studies. In contrast the digestibility of phosphorus was about 37% and higher compared with other studies. This seems also to be true for the availability of zinc (45%).

Task 1.3. Production experiments with pregnant sows

Six turns of experiments with pregnant sows on pasture during summertime or fed clover grass silage during 2 winter periods respectively have been conducted. The results have revealed that sows during pregnancy are able to cover up to 60-65% of their daily net energy requirements by grazing. These results have been obtained by rotational grazing, where three paddocks for each group of sows were in use. Results on feeding of clover grass silage ad libitum to pregnant sows during the wintertime have demonstrated nutritional value in the same proportions as by grazing.
In relation to sows on pasture several measurements of herbage mass and botanical composition of the paddocks have been taken. Furthermore vitamin- and mineral status of the sows is monitored in samples of blood and milk.
The results show that pregnant sows are able to obtain a substantial nutrient supplement from grass or silage. Nutrient content of the supplemental concentrate (dietary protein, vitamins and minerals) can therefore be adjusted accordingly.

WP 2. Feeding strategies for weaned and growing-finishing pigs with emphasis on gut health

Task 2.1. Gut challenge and diet screening

The experience from a project where we have established a gut challenge *E. coli* model for piglets weaned at 4 weeks of age has been modified to piglets weaned at 7 weeks of age simulating organic conditions. All sows in the herd at Foulum Research Centre have been tested for susceptibility to the antigenic attachment factor (F4-fimbrieae adhesion receptor of *E. coli* O 149 in the intestines). Only piglets from mono-zygotic susceptible sows were subsequently used in the challenge experiments. Initially a dose-response experiment was conducted, where three different doses of the *E. coli* O 149 (10^6; 10^8; and 10^{10}) were applied to piglets by stom-

ach tube daily on days 2-4 after weaning. Clinical recordings, assessment of diarrhoea and bacteriological recovery levels of *E. coli* O 149 showed that a dose of 10^8 was more suitable than the two other doses. Thus in the four diet screening experiments a dose of 10^8 was used.

Each of the screening experiments consisted of 32 piglets from 4 sows. The design was 2 x 2 factorial with type of diet and *E. coli* O 149 challenge as the two factors each at two levels. The experimental period lasted for 10 days from weaning. The daily recordings included feed and water intake, growth, faces scoring (from 1=firm and solid to 6=yellow and watery) and clinical observations. Faces was sampled on days 2-5 and tested for *E. coli* strains. The diets tested were:

1. Ad libitum versus restricted feed rations
2. Standard versus low protein level in ad libitum fed piglets
3. Lupine versus soya as protein source in ad libitum fed piglets
4. Control (approx. 60 I.E.) E-vitamin/kg feed versus extra (200 I.E.) E-vitamin/kg feed for ad libitum fed piglets.

The data suggest that ad libitum feeding and protein restriction may have detrimental effects on performance in infected piglets. Performance of pigs offered lupine was not different from the control pigs indicating that lupine is a suitable feedstuff for weaned piglets.

In the experiment with E-vitamin, samples were taken from the small intestine, gall bladder and liver for subsequent analysis of immunological responses including IgA and IgM, intestinal antibodies against *E. coli* O 149, activity of macrophages, and histological examination of the gut morphology. The data showed that Vitamin E supplementation improved the E-vitamin status of the piglets but there were no clear effects on performance.

Task 2.2. Effect of dietary factors on weaning diarrhoea

Based on results from task 2.1 as well as practical possibilities, E-vitamin supplementation was selected as the dietary factor to be tested in organic farmed weaned piglets. This experiment was conducted from the fall of 2003 to the spring of 2004 in three commercial organic farms. At weaning the piglets were split into two groups and one group (E-vit.) received a supplement of 100 mg E-vitamin pr. kg feed while the other group (Control) did not. Weight and faeces score (as a measure of diarrhoea) were recorded at weaning, 5 days after weaning and 3-5 weeks after weaning. Although recordings are on individual pigs, the statistical analysis are based on group means (a total of 44 groups). In one of the three farms, there were frequent occurrence of weaning diarrhoea, while in the other two farms, weaning diarrhoea were rather infrequent. Initial evaluation of the data show that vitamin E supplementation neither affected weaning diarrhoea nor post-weaning weight gain. Thus, the data suggest that in one farm, the load of pathogens was of such a magnitude that the well-documented positive effect of vitamin E on the immune status was insufficient to protect against weaning diarrhoea. In the two other farms the health status was apparently so good that supplementation with vitamin E made no difference.

Task 2.3. Effect of diets varying in digestible and non-digestible carbohydrates on Trichuris suis infection

Two diets with contrasting digestibility have been formulated - the diet containing resistant carbohydrates (Diet 1) is based on triticale, barley, rapeseed cake and silage as the main ingredients while the diet with fermentable carbohydrates (Diet 2) is based on triticale, barley, blue lupines and chicory roots. Assuming that the pigs will consume approximately 7 % of the dry matter from silage and 15 % from chicory roots, the content of feed units for pigs

(FEs) will be 0.96 and 1.09 FEs in Diets 1 and 2, respectively. The two types of diets are fed to four groups of 8 animals:

- Group 1, Diet 1, no infection
- Group 2, Diet 1, infected
- Group 3, Diet 2, no infection
- Group 4, Diet 2, infected.

The pigs were adapted for two weeks to the diets and then infected with 2000 infective eggs of T. suis. Faecal egg samples were taken twice weekly to determine the number of parasite eggs excreted. All the pigs were slaughtered 12 weeks post infection (pi). The large intestine was divided into caecum and 5 colon sections. pH was measured in each section and samples were taken for chemical examinations. The remaining intestinal contents were collected to determine the worm burden. The weight gain on the pigs receiving Diet 1 was lower than on Diet 2 presumably reflecting a lower energy intake, primarily because of less consumption of the silage as expected but there was difference between infected and non-infected pigs. The infected group receiving Diet 1 had higher faecal egg counts compared to the infected pigs receiving Diet 2 until 9 weeks pi, after which the two groups had similar mean egg counts until slaughter. However, the variation in faecal egg counts was substantial. No significant difference was found in the number of worms between the two groups.
The two diets introduced significantly differences in the gastrointestinal environment with pH generally lower and the concentration of short-chain fatty acids (SCFA) generally higher when feeding diet 2 compared to diet 1 but with no significant differences between either pH or SCFA of infected and non-infected pigs. The former diet also clearly stimulated butyrate formation in the large intestine.

Task 2.4. Effect of diets varying in carbohydrate composition on establishment of dual infections with *Trichuris suis* and *Brachyspira hyodysenteriae*

A. Influence of carbohydrates on experimental infection with *Brachyspira hyodysenteriae* – a pilot study

Two diets with contrasting fermentability were formulated. Diet 1 containing resistant carbohydrates is based on triticale, barley, rapeseed cake as the main ingredients supplemented with grass clover silage. Diet 2 containing fermentable carbohydrates is based on triticale, barley, blue lupines and dried grinded chicory roots. Furthermore, a standard pig diet in pellets based on barley, soybean and wheat (Diet 3) was included, as it has been shown to induce high incidence of dysentery.

Thirty-eight pigs (female and castrates) tested negative for swine dysentery with an average weight of 26 kg were divided according to weight and sex into 4 groups as follows:
Group A: Diet 1 (10 pigs)
Group B: Diet 2 (10 pigs)
Group C: Diet 3 (10 pigs)
Group D: Diet 3 (8 pigs)

The pigs were fed once a day according to weight. After two weeks of adaptation to the diets pigs in groups A, B, and C were challenged with 5 x 10^6 colony-forming units of *B. hyodysenteriae* on three consecutive days. Group D remained as an uninfected control group. The pigs were weighed every other week and faecal samples were collected twice a week to monitor the infection. The faecal samples were cultured selectively for the presence of *B.*

hyodysenteriae as well as scored according to consistency (normal, loose, watery/mucoid, and bloody diarrhoea), which was utilized as a measure of clinical disease. All the pigs were slaughtered 4 weeks post infection. At slaughter a macroscopic pathological examination was performed on each pig. Tissue samples were taken from caecum and the anterior part of the colon for histopathological examinations. The gastrointestinal tract was removed and the large intestine divided into caecum and colon, which were emptied and the tissue weighed. pH was measured in the contents from each compartment and content samples were taken for chemical analyses.
B. hyodysenteriae was not isolated from the control pigs (Group D) at any time during the study. The infected pigs fed Diet 3 (Group C) all developed clinical dysentery with bloody diarrhoea during the experiment. In Group A, four pigs had clinical disease, and in Group B, only 1 pig was observed with dysentery. *B. hyodysenteriae* was first isolated from faeces 6 days post challenge (p.c.) in Group C and 9 days p.c. in Group A. In both groups the bacteria were found until the end of the experiment (day 26 p.c.). In Group B, however, the bacteria was only isolated on day 12 and 15 post challenge. The isolation of bacteria was correlated with the clinical symptoms, *B. hyodysenteriae* was only isolated from pigs with clinical symptoms (watery/mucoid faeces and bloody diarrhoea). The weight gain of the control pigs fed the standard diet was higher compared with the infected groups.
Diet 2 and to a lesser extent Diet 1 seem to provide considerable protection against swine dysentery compared with Diet 3. Even though the disease is easily spread from pig to pig through ingestion of faecal material, the infection was not transmitted among pen mates.

B. Influence of carbohydrates on dual experimental infections with *Trichuris suis* and *Brachyspira hyodysenteriae*

The objective of the study was: 1) to investigate the interaction of *T. suis* and *B. hyodysenteriae* and 2) to study the effect of carbohydrates with different fermentability on dual infections with *T. suis* and *B. hyodysenteriae*

Diet 1 and Diet 2 from the pilot study were used in the present experiment.

Seventy-two pigs (female and castrates) tested negative for *T. suis* and swine dysentery with an average weight of 22 kg were divided into 8 groups (A-H) according to weight and sex as follows:
Group A: Diet 1, *T. suis and B. hyodysenteriae*
Group B: Diet 2, *T. suis and B. hyodysenteriae*
Group C: Diet 1, *B. hyodysenteriae*
Group D: Diet 2, *B. hyodysenteriae*
Group E: Diet 1, *T. suis*
Group F: Diet 2, *T. suis*
Group G: Diet 1, control
Group H: Diet 2, control

The pigs were fed according to weight once a day. Two pigs (one from Group B and one from Group F) died before the experimental infections and were not replaced. After two weeks of diet adaptation, pigs in group A, B, E, and F were inoculated with 2000 infective *T. suis* eggs each. Pigs in group A, B, C, and D were challenged with 1 x 10^9 colony-forming units of *B. hyodysenteriae* each on three consecutive days. Group G and H were uninfected control groups. The pigs were weighed every other week and monitored daily for clinical symptoms. Faecal samples were collected twice a week to monitor the cause of dysentery. The faecal samples were cultured selectively for the presence of *B. hyodysenteriae* as well as scored ac-

cording to consistency (normal, loose, watery/mucoid, and bloody diarrhoea), which was utilized as a measure of clinical disease. All pigs were slaughtered 6 weeks post infection (p.i.) over a course of 5 days. At slaughter a faecal sample was collected for examination of *T. suis* eggs and a macroscopic pathological examination was performed on each pig. Tissue samples were taken from the anterior part of the colon for histopathological examinations. The large intestine was divided into caecum and 5 colon sections. The sections were emptied and weighed and pH was measured in the contents of each section. Samples were taken from the contents for chemical analyses. The remaining contents were used for recovery of *T. suis*.
T. suis were not found at slaughter and no *B. hyodysenteriae* were isolated from any of the control pigs in group G and H. No clinical signs of dysentery were found in pigs experimentally challenged with *B. hyodysenteriae* that were receiving Diet 2 (Group B and D). Likewise, no bacteria were isolated from faeces in any of these pigs. In contrast, clinical symptoms of dysentery were observed in all experimentally *B. hyodysenteriae* pigs fed Diet 1 (Group A and C, except 1 pig in Group A) and similarly the bacteria were found in faeces of all these pigs at different times during the experiment starting from 6 days p.c.
There was no difference in worm counts between any of the *T. suis* infected groups (Group A, B, E, and F). The lowest worm burdens, however, were found in the pigs fed Diet 2 (Group B and F). The frequency of swine dysentery was lower in pigs with dual infections, but consistent throughout the course of the study. Pigs only infected with *B. hyodysenteriae*, on the other hand, had higher frequency of clinical symptoms, but only over a period of 2 weeks from 9 days to 23 days p.c.
The weight gain did not differ significantly between the groups, but was lowest in pigs with clinical swine dysentery (Group A and C).

Diet 2 prevented completely the occurrence of swine dysentery in both experimentally infected groups (A and C).

WP 3. Effects of nutrients for growing-finishing pigs on product quality

Task 3.1
The activities are combined with the activities in task 1.1 on dietary protein level and inclusion of lupines. Meat samples have been collected from all 4 replicates each of 40 pigs (20 gilts and 20 male castrates) = 160 carcasses reared in four of the treatments in task 1.1 (2 levels of protein (85% and 100%) x 2 levels of lupine (0 and 25%)).

All of the meat quality traits have been analysed for all the planed four replicates. There was no difference in weight at slaughter between protein levels. However, there was a significant difference between 0 and 25% lupines as the 25% lupine fed pigs had lower live weight and warm carcass weight ($P<0.01$). No differences were found between treatments in the case of the following variables: Drip loss, pH in M. long. dorsi 24 hours after slaughter, temperature in M. long. dorsi 24 hours after slaughter. The pigs fed high-level of lupines had higher percent lean meat (60.1) than the pigs fed no lupine (58.9) ($P<0.001$) and the pigs fed the highest protein level (100%) had significantly higher percent lean meat (59.7 vs. 59.2) ($p<0.01$). Gilts had higher percent lean meat (60.0) than castrates (58.9). The pigs fed high-level of lupine had lower concentrations of skatole in backfat (0.028 ppm) compared with the pigs fed no lupine (0.058 ppm). As expected, there was no difference between genders in concentrations of skatole in backfat.

Data from sensory analysis and analysis of fatty acid composition, pigment, IMF and shear force are presently being analysed. Preliminary results indicate that 85% protein level causes

higher intramuscular fat (IMF) in M. long. dorsi than 100% protein level whereas there is no effect of lupine level. The fatty acid composition of the backfat is affected by both protein and lupine level. High level of protein causes higher percent of saturated fatty acids (SFA) and lower percent of polyunsaturated fatty acids (PUFA) while percent of monounsaturated fatty acids (MUFA) is not affected. 25% level of lupine causes lower percent of SFA and MUFA and higher level of PUFA compared with 0% lupine.

Preliminary results of the sensory analysis indicate effect of lupine level but not of protein level on odour and flavour of loin chops of M. long. dorsi.

Pigment in the loin muscle and shear force of M. long. dorsi are neither affected by protein nor by lupine level.

C.2 Fulfilment of deliverables and milestones

(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*
Deliverables:		
D 1.1. Protocol for experiments with pregnant sows, 1 replicate	Quarter 3 – 2001	√
D 1.2. Protocol for digestibility experiments	Quarter 3 - 2001	√
D 1.3. Protocol for experiments with slaughter pigs, 1. replicate	Quarter 3 - 2001	√
D 1.4. Progress report	Quarter 4 - 2001	√
D 1.5. Progress report	Quarter 4 - 2002	√
D 1.6. Progress report including the results of digestibility and balance experiments	Quarter 4 - 2003	√
D 1.7. Progress report including the results of experiments with pregnant sows	Quarter 4 - 2004	√
D 1.8. Progress report including the results of experiments with slaughter pigs	Quarter 4 - 2004	√
D 1.9. Final report	Quarter 4 - 2004	
D 1.10. Dissemination of results (DJF report)	Quarter 4 - 2004	
Milestones:		
M 1.1. Formulation of recommendations for organic pig production with respect to the usage of lupin under consideration of: Overall performance of pigs Impact on the environment of N and P output	Quarter 4 - 2004	
M 1.2. Formulation of recommendations for organic pig production regarding the supply of vitamin and minerals to slaughter pigs	Quarter 4 - 2004	
M 1.3. Formulation of recommendation for outdoor keeping of pregnant sows under consideration of summer and winter feeding methods	Quarter 4 - 2004	

WP number and title: **WP2: Feeding strategies for weaned and growing-finishing pigs with emphasis on gut health**	Time schedule according to application	Deviations, if any*
Deliverables:		
D 2.1. Formulation of feeding strategies for weaned pigs in organic farming	Quarter 2 - 2005	
D 2.2. Paper concerning challenge with E. coli O 149 and dietary factors	Quarter 3 - 2004	√*

D 2.3. Paper concerning dietary effects on weaning diarrhoea in organic farming	Quarter 2 - 2005	
D 2.4. Paper concerning the effect of diets varying in digestible and nondigestible carbohydrates on T. suis infection	Quarter 3 - 2004	√*
D 2.5. Paper concerning the impact of carbohydrate composition on the establishment of dual infection with T. suis and B. pilosicoli	Quarter 2 - 2005	
Milestones:		
M 2.1. Preliminary evaluation of the procedure for gut challenge and diet screening	Quarter 3 - 2002	√
M 2.2. Final evaluation of the procedure for gut challenge and diet screening	Quarter 3 - 2002	√
M 2.3. Evaluation of dietary factors on weaning diarrhoea	Quarter 4 - 2003	√
M 2.4. Preliminary evaluation of dietary effects on T. suis infection	Quarter 4 - 2003	√
M 2.5. Final evaluation of dietary effects on T. suis infection	Quarter 1 - 2005	
M 2.6. Evaluation of dietary effects on dual infection with T. suis and B. pilosicoli	Quarter 1 - 2005	

WP number and title: **WP3: Effects of nutrient supply for growing-finishing pigs on product quality**	Time schedule according to application	Deviations, if any*
Deliverables:		
D 3.1. Protocol for collecting and analysing meat samples	Quarter 3 - 2002	√
D 3.2. Half way progress report	Quarter 3 - 2003	√
D 3.3. Final report	Quarter 4 - 2004	
Milestones:		
M3.1. Formulation of recommendations for organic pig production with respect to the usage of lupin and protein supply under consideration of: Product quality of organic pork Effect of lupin on reduction of skatole level in blood and backfat.	Quarter 4 - 2004	

** Deviations are to be further discussed in D*

D. Description of deviations and subsequent adjustments of plans

The publications planned to be ready by quarter 3, 2004 (deliverables 2.2 and 2.4) are in preparation.

E. Project publications and other products

1. Products from Organic Eprints archive

DIAS Research Reports and papers for scientific journals are in preparation

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

At the workshop on "Organic Pig Production", April 24-25, 2003, Horsens, Denmark, three oral presentations were made. The titles were:

- The supply of protein, vitamins and minerals for sows and finishing pigs*
- An *E. coli* infection model to study weaning diarrhoea*
- Effects of carbohydrates on establishment of infection with T suis*

At the EAAP Working Group on "Production and Utilisation of Meat from Entire Male Pigs", November 13-14, 2003, Dublin, Ireland, an oral presentation was made. The title was:

- Effect of Lupine and Protein level for Growing-Finishing Pigs on Skatole in Backfat (Pig off-odour) of Female and Castrated male pigs*

At the Organic Farming Congress, November 16, 2004, Odense, Denmark, an oral presentation was made. The title was:

- Improved feeding with home-grown protein crops*

At the NorFa Graduate course in Advanced Veterinary Parasitology, 18-23 April 2004 two oral presentation were given with the titles:

- Parasite-nutrition interactions: options for control of pig helminths*
- Dietary modulation of digestive physiology in pigs and implications for disease* susceptibility

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

F. Scientific education

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. A veterinary student has used some of the data generated in task 2.2 for her final "speciale".

G. National and international cooperation

This project has strong links to the 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 Anders Hans Karlsson, KVL. 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), shell 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 lupine testing project “Lupinforsøg, Undersøgelser vedrørende kød- og spisekvalitet” by Danske Slagterier (Hanne Maribo).

H. Critical reflection on the project

As a whole, the plan for the project is followed and the progress has been satisfactory. Two modification of the experimental design has been implemented.

In task 1.1 the number of treatment groups was reduced from six to five (two levels of lupine at normal dietary protein and three levels of lupine at reduced dietary protein). Given the barn facilities at Rugballegård this modification was necessary to meet the time schedule. This modification has no consequences for task 3.1 concerning evaluation of product quality.

In task 2.4 it was decided to use *B. hyodysenteriae* rather than *B. pilosicoli*. This modification was implemented after thorough investigation and discussions with Danish Veterinary Institute. Beyond this, there has not been any reasons for changing plans or goals of the project.

8. Budget

A. Account for any change in budgets

B. Budget for the whole project (1.000 DKK)

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

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Man-months					
Scientific personnel	15,2	14,7	16,4	2,5	48,8
Technical personnel	9,1	13,3	9,7		32,1

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Salaries					
Scientific personnel	599,6	624,4	728,2	110	2062,2
Technical personnel	236,6	374,9	290,1		901,9
Other operational costs	320,7	556,1	271	54,8	1202.6
Equipment					
Others (please specify)					
Direct costs	1156,9	1555,4	1289,6	164,8	4166,7
Indirect costs (20% of direct costs)	231,4	311,1	257,8	33,0	833,3
Total	1388,3	1866,5	1547,4	197,8	5000,0

Comments: Budget before 2003 is corrected in order that it is in accordance with the consumption. Expected consumption in 2004 is 91.000 DDK higher than budget from the 2003 Progress Report because 91.000 DDK were transferred from 2005 to 2004 (Dept. Anim. Health and Welfare). Due to reorganisation at DJF, i.e. closing Dept. of Analytical Chemistry where many chemical analyses previously were bought, some of "Other operational costs" is converted to "salaries".

9. Signatures and stamps

Name	Institute	Date	Signature
Head of project Martin Tang Sørensen			

Appendix I. Detailed budget

A. Budget for each participating institute (1.000 DKr)

Name of Institute: Danmarks JordbrugsForskning

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Man-months					
Scientific personnel	14,5	13,5	15	2,5	45,5
Technical personnel	9	11,5	8		28,5

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Salaries					
Scientific personnel	563	550	640	110	1863
Technical personnel	233	310	224		767
Other operational costs	314,7	491	215	54,3	1075
Equipment					
Others (please specify)					
Direct costs	1110,7	1351	1079	164,3	3705
Indirect costs (20% of direct costs)	222,1	270,2	215,7	33	741
Total	1332,8	1621,2	1294,7	197,3	4446

Comments: Expected consumption in 2004 is 91.000 DDK higher than budget from the 2003 Progress Report because 91.000 DDK were transferred from 2005 to 2004 (Dept. Anim. Health and Welfare). Due to reorganisation at DJF, i.e. closing Dept. of Analytical Chemistry where many chemical analyses previously were bought, some of "Other operational costs" is converted to "salaries".

Budget for each participating institute (1.000 DKr)

Name of Institute: Slagteriernes Forskningsinstitut

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Man-months					
Scientific personnel	0,7	1,2	1,4		3,3
Technical personnel	0,1	1,8	1,7		3,6

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Salaries					
Scientific personnel	36,6	74,4	88,2		199,2
Technical personnel	3,6	64,9	66,4		134,9
Other operational costs	6,0	65,1	56,0		127,1
Equipment					
Others (please specify)					
Direct costs	46,2	204,4	210,6		461,2
Indirect costs (20% of direct costs)	9,3	40.9	42,1		92,3
Total	55,5	245,3	252,7		553,5

Comments:

Budget for each participating department (1.000 DKK)

Name of Institute and department: Danmarks JordbrugsForskning, HEF

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Man-months					
Scientific personnel	11,5	8	10	2,5	32
Technical personnel	7	8	7		22

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Salaries					
Scientific personnel	438	328	425	110	1301
Technical personnel	182	216	196		594
Other operational costs	259,7	366	145,0	54,3	825
Equipment					
Others (please specify)					
Direct costs	879,7	910	766,0	164,3	2720
Indirect costs (20% of direct costs)	175,9	182	153,1	33,0	544
Total	1055,6	1092	919,1	197,3	3264,0

Comments: Due to reorganisation at DJF, i.e. closing Dept. of Analytical Chemistry where many chemical analyses previously were bought, some of "Other operational costs" is converted to "salaries".

Budget for each participating department (1.000 DKK)

Name of Institute and department: Danmarks JordbrugsForskning, HSV

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

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Salaries					
Scientific personnel	60	120	151		331
Technical personnel	25	53			78
Other operational costs	30	60	46		136
Equipment					
Others (please specify)					
Direct costs	115	233	197		545
Indirect costs (20% of direct costs)	23	46,6	39,4		109
Total	138	279,6	236,4		654

Comments: The expected consumption in 2004 is 91.000 DDK higher than the budget from the 2003 progress report because 91.000 DDK were transferred from 2005 to 2004 (in order to speed up the publication process).

Budget for each participating department (1.000 DKK)

Name of Institute and department: Danmarks JordbrugsForskning, ARK

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Man-months					
Scientific personnel	0,5	1,5	1,5		3,5
Technical personnel		1,5	1		2,5

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Salaries					
Scientific personnel	25	61	64		150
Technical personnel		41	28		69
Other operational costs	25	65	24		114
Equipment					
Others (please specify)					
Direct costs	50	167	116		333
Indirect costs (20% of direct costs)	10	33,4	23,2		66,6
Total	60	200,4	139,2		399,6

Comments:

Budget for each participating department (1.000 DKK)

Name of Institute and department: Danmarks JordbrugsForskning, JPM

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Man-months					
Scientific personnel	1	1			2
Technical personnel	1				1

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Salaries					
Scientific personnel	40	41			81
Technical personnel	26				26
Other operational costs					
Equipment					
Others (please specify)					
Direct costs	66	41			107
Indirect costs (20% of direct costs)	13,2	8,2			21,4
Total	79,2	49,2			128,4

Comments:

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

Name of Institute and department:

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Man-months Scientific personnel Technical personnel					

Year:	Consumption before 2003	Consumption 2003	Expected consumption 2004	Budget 2005	Total
Salaries Scientific personnel Technical personnel					
Other operational costs					
Equipment					
Others (please specify)					
Direct costs					
Indirect costs (20% of direct costs)					
Total					

Comments: