Final Report

For DARCOF II 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.9 Resource use, environmental impact and economy in organic pig production systems

3. Head of project

John. E. Hermansen

4. Participating institutes

Danish Institute of Agricultural Sciences (Department of Agroecology, Animal Health and Welfare, Agricultural Engineering), Danish Food and Resource Economics Institute, and The National Committee for Pig Production.

5. Other project staff

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6. Project period (month, year)

Start of project: 1.8.2001 End of project: 30.6.2005

7. Final report

A. Project summary

In Denmark, the organic pig production is very scarce today and needs to be developed in order to fulfil the expected potential hereof. In the preliminary work for this research initiative it was anticipated that there was a need to develop new systems in which the pig production is more integrated into land use in order to fulfil the expectations to the organic pig production from different stakeholders and probably also in order to make the production economical feasible.

However, such a development raises several questions, which are being addressed in this project. The project has three work packages (WP). The first WP focuses on grazing strategies for sows and growing pigs. Through two experiments, it is expected that we can 1. Propose alternatives to ringing of sows in the effort to maintain sward quality, and 2. Propose appropriate strategies of combining grazing and barn feeding for growing pigs.

The second WP focuses on the environmental impact of different grazing regimes. In the before mentioned experiments with sows and growing pigs, the level and spatial variation in nutrient load of the grazing areas will be determined (N, P and K) and the distribution between N-losses as leaching, ammonia volatilization and denitrification will be estimated. Furthermore, different pig production systems will be assessed in relation to nutrient losses through strategic sampling on the area grazed. Hereby it is expected that strategies for improved nutrient utilisation and an acceptable environmental load of nutrients in organic pig production can be proposed.

The third WP includes an overall assessment of different pig production systems economical and environmentally. Suitable LCA indicators will be selected and data will be collected from commercial organic farms as well as from experimental units. Through modelling a range of systems will be assessed not only including the actual systems already present but also 'future' relevant systems improved with the knowledge obtained in other WPs in this project.

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

No.	Work package title	Participants*	Budget (1.000 DKr)	Start	End	Deliverable No:
1	Strategies for grazing systems in organic pig production	<u>KSU</u>, MS	1,147	Oct 2001	April 2004	D1.1-D1.3
2	Nutrient load and environmental consequences of pigs on grassland	<u>JE</u>	1,036	Jan 2002	June 2005	D.2.1-D2.3
3	System assessment and co-ordination	<u>JHE</u>,NT, KSU, BHA,NHA	1,317	Aug 2001	June 2005	D3.1-D3.5
Total			3,500			

* Responsible participants are underlined

B. Objectives and expected achievements

The overall perspective of the project is to create knowledge, which can support the development of organic pig production in Denmark. This implies knowledge on how the system at farm level can be constructed so that the production is economically feasible for the farmer and at the same time respects the farmers' and the consumers' perception of the organic ideals as well as societal goals for environmental impact of animal production. The objectives are, during experiments, farm studies, and modelling:to identify optimal strategies for growing pigs at pasture combined with a possible barn fed period in relation to growth, nutrient load at the pasture and an appropriate utilisation of the farm buildings,

- to identify appropiate strategies for keeping sows on pasture without being ringed in relation to sward quality and risk of nutrient losses,
- to quantify the risk of nutrient losses in a range of grazing systems with particular focus on 'improved' grazing strategies,
- to assess different systems in relation to production efficiency, resource use, and environmental impact,
- to propose an economically and environmentally viable future strategy for organic pig production in Denmark.

C. Progress and results

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

WP1: Strategies for grazing systems in organic pig production

Two experiments have been completed according to the application.

The first experiment investigated different strategies for combined grazing and barn kept growing pigs in relation to growth rate, behaviour and meat quality and was carried out at the organic experimental station, Rugballegaard. Five replicates with a flock size of ten pigs balanced in live weight and sex was used. At weaning at an age of 7-8 weeks (app 19 kg live weight) piglets born in an outdoor system were distributed on five treatments as follows:

1. Piglets were moved indoor at weaning and fed ad libitum until slaughter.
2. Piglets stayed on pasture and were fed restrictively with concentrates until 40 kg live weight, followed by ad libitum feeding in a barn pen.
3. Piglets stayed on pasture and was fed restrictively with concentrates until 80 kg live weight, followed by ad libitum feeding in a pen.
4. Piglets stayed on pasture until slaughtering and were fed restrictively in the whole period.
5. As treatment 4, but the growers were fed ad libitum until slaughtering.

The first replicate started January 2002 and the fifth and last replicate was completed April 2003, so that the seasonal variation was expected to be covered by the design.

In the field each experimental unit (group of ten pigs) was allocated to a 'new' piece of land, differing in size according to the expected nutrient load from the pigs. The stocking rate in the field was calculated to cause an excretion of 280 kg N per hectare. To ensure a good distribution of the manure and thereby the environmental load from the pigs on the pasture, the huts, troughs and water supply were moved in a routine. All pigs were individually weighed at weaning, at transmission and at slaughtering. The pigs in treatment 1 were also weighed when pigs in treatment 2 and 3 were moved indoor to estimate the compensatory growth. At the same time points, the social and aggressive behaviour were registered for all treatments. At slaughter the carcass were evaluated for lean percentage and back fat.

Furthermore, as a result of additional funding outside FØJO, the colour, the tenderness and the fatty acid composition of the *Longissimus Dorsi* was measured.

The results of the experiment are in detail given in papers in Livestock Prod. Science and Acta Agric.

Scand. as regards production related and meat quality related results, respectively. In addition the results are presented in Grøn Viden (DJF) and at meetings and conferences including the ISOFAR Conference 2005.

Some main results are given in Tables 1 and 2.

Outdoor reared and ad libitum feed pigs had slightly (but significant) lower growth rate and an increased feed consumption per kg gain. The outdoor pigs, which were fed restrictively, had a lower daily gain according to the period of restricted feeding (treatments 2, 3 and 4), but interestingly, no significant differences in feed consumption per kg gain appeared. Considering the growth in different periods, the pigs transferred to the barn at 40 or 80 kg's had a significant lower growth rate when they were kept outdoor and a significant higher growth rate when they were kept indoor compared to the pig kept indoor all the period.

Also carcass traits were significantly affected by the treatments. Pigs reared outdoor in the entire period or until 80 kg's of live weight (treatment 3, 4 and 5) had a significantly higher lean percentage and a lower back fat than the indoor reared pigs. In particular the outdoor pigs which were fed restrictively in the entire period had better carcass traits.

Since problems with too low lean percentage are significant in Danish organic pig production the results are very interesting in that respect. In fact the results show that by keeping the growers outdoor in a significant period of their lives, while fed restrictively, the carcass characteristics can be improved without impairing feed consumption compared to indoor reared pigs, but that the production period will be extended by approx 10%.

Table 1. Performance traits for pigs in different treatment groups; LS means +/- S.E., and P values for significance of differences between treatments.

Treatment	1.Indoor, Ad lib	2.Indoor from 40-100 kg	3.Indoor from 80-100 kg	4.Outdoor, Restricted	5.Outdoor, Ad lib	P-value
Age at slaughtering, days	156[a] (1.3)	161[b] (1.4)	170[c] (1.3)	177[d] (1.3)	160[b] (1.3)	0.0001
Daily gain, g/day	767[a] (8.3)	729[b] (8.8)	673[c] (8.6)	632[d] (8.4)	739[b] (8.4)	0.0001
Feed conversion, MJ ME /kg gain.	37.25[a] (1.7)	40.20[ab] (1.7)	39.86[ab] (1.7)	35.95[a] (1.7)	42.3[b] (1.7)	0.05
Lean percentage, total	57.5[a] (0.4)	57.6[a] (0.4)	60.4[b] (0.4)	61.9[c] (0.4)	59.8[b] (0.4)	0.0001
Backfat, mm	17.6[a] (0.4)	18.4[ad] (0.5)	15.9[b] (0.4)	14.7[c] (0.4)	16.5[ab] (0.4)	0.0001
Lean percentage, central piece	61.9[a] (0.5)	61.4[a] (0.6)	65.4[d] (0.5)	67.3[e] (0.5)	64.2[d] (0.5)	0.0001

a, b, c, d: LS-means with different suffice differ significantly ($P < 0.05$)

Some results of the meat quality assessment are given in Table 2. No difference in pigment (or red colour) between indoor or outdoor rearing were observed, but the restricted feeding impaired the pigment content of the meat. No significant differences in tenderness (Shear force) and vitamine E were observed, although tenderness tended to be poorer following restricted feeding and vit. E tended to be raised under outdoor conditions.

Table 2. Meat quality in five rearing strategies

Treatment	1.Indoor, Ad lib	2.Indoor from 40-100 kg	3.Indoor from 80-100 kg	4.Outdoor, Restricted	5.Outdoor, Ad lib	P-value
Pigment, mg/g, g	0.75	0.67	0.64	0.58	0.75	<0.001
Shear force, Newton	36	37	40	40	36	ns
α-tocopherol, mg/kg	2.5	2.5	2.6	2.7	2.7	ns
PUFA, % of FA	17	18	23	24	19	<0.001
n-6 / n-3 ratio	13	15	17	17	13	<0.001

Outdoor rearing and a restricted feeding resulted in a higher proportion of polyunsaturated FA, but this was entirely as a result of an increased content of n-6 FA, which are less interesting from a nutritional point of view.

We conclude from an overall point of view that outdoor rearing in most of (or in the entire growing period) offers good prospects in terms of production and meat quality aspects, but there is a need to adapt the feeding strategy to balance feed conversion and daily growth.

The second experiment focused on the environmental impact and pasture damage without nose-ringing of sows including treatments with ringed sows. The study was carried out on a private farm and included three treatments for pregnant as well as lactating sows:

1: pasture with nose-ringed sows at a moderate daily stocking rate over a 20 weeks period
2: pasture with un-ringed sows at a stocking rate as above
3: pasture with un-ringed sows with the double stocking density over half the period (10 weeks) followed by introduction to a new piece of land for the next 10 weeks

The stocking density estimated per year was the same in the three treatments, but in treatment 3 the sows admittance to the field was limited to one half from May until June and to the second half from July until September. All three treatments included pregnant (2 replicates) as well as nursing sows (3 replicates). Pregnant sows were housed in groups of five, whereas nursing sows were housed in single farrowing pens. The experiment started in May and the last observations and samplings were completed in September 2002. Pregnant sows were fed 70% of their daily energy requirement in supplementary feed, assuming that 30% could be covered by grazing (or additional roughage). Lactating sows were fed ad libitum.

The behaviour of the sows was registered once a week. Rooting behaviour, grazing, level of activity and location of the sows were recorded in zones in the fields corresponding to the zones where the grass cover were measured by telemetry in July and in September. Input-output of plant nutrients in the pens were recorded.

Figure 1 shows the mean incidence of grazing and rooting behaviour.

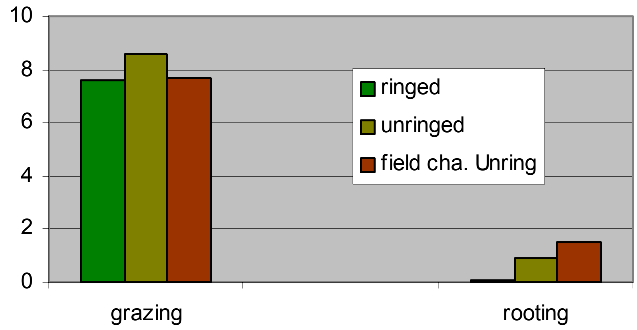

Figure 1. Mean incidence of grazing- and rooting behaviour per hour.

It appears that the incidence of grazing did not differ between treatments whereas rooting was increased in treatments with unringed sows. No significant differences in production results (daily live weight gain and weaned piglets per sow) were observed between treatments. All pregnant sows tended to loose weight during the period illustrating that the complementary feed (which has an impact on the environmental load) was not given in excess. The results on grass cover and risk of leaching which was the main topic in this research, is further elaborated in WP-2.

WP2: Nutrient load and environmental consequences of pigs on grassland

Environmental impact of growing pigs on pasture

In the experiment on outdoor growing pigs at Rugballegaard, the idea was to minimize the space demand within the current regulations on nutrient load and at the same time utilize current knowledge on how to attempt homogenous excretion behaviour by pigs through paddock design and management. The stocking rate was calculated to cause a nitrogen deposition of 280 kg N ha^{-1} ha based on the national definition of a livestock unit and the national guidelines allowing pigs on pasture every second year. Soil samples were collected and grass cover evaluated each time pigs were transferred from the field to housing or slaughterhouse. Grid points were established for every 5x5 m in the 10 m wide paddocks and similarly points were established outside the paddocks for every 5 m as a reference. In each point soil samples were collected to 40 cm by pooling 8 soil cores. A total of 948 soil samples have been analysed for content of mineral N, exchangeable K and extractable P to determine the level and the distribution of nutrients within the paddocks. In addition nutrient balances were calculated on pen level.

The actual nitrogen surplus of the paddocks (Table 3) considerably exceeded the intended 280 kg N ha^{-1}. This was caused by a combination of 20% higher N content of the organic feed and a higher feed consumption (in particular as regards the ad lib fed pigs) than for conventional pigs that formed the basis for the definition of animal units and nutrient load. The nitrogen use efficiency in the paddocks (feed N input relative to animal N output) decreased the longer pigs were kept on the pasture as a results of the well known increased feed consumption per kg gain and reduced N retention with increased live weight. Thus, N in piglets kept outside until 40 kg accounted for 38% of feed N input whereas N in piglets on pasture until slaughtering accounted for only 30% of feed N input.

Table 3. Nutrient balance and nutrient use efficiency (NUE) for N and P in paddocks with growing pigs on pasture. Values with the same letter within each column are not significantly different (P<0.05).

	Nitrogen				Phosphorous			
	Input	Output	Surplus	NUE	Input	Output	Surplus	NUE
		kg/ha		%		kg/ha		%
Treatments								
In(40 kg)	695^{a}	261^{a}	434^{b}	38^{a}	128^{a}	52^{a}	76^{ab}	41^{a}
In(80 kg)	564^{b}	204^{b}	360^{c}	36^{ab}	101^{b}	40^{b}	61^{c}	40^{a}
Out(Restr.)	567^{b}	179^{b}	388^{bc}	32^{bc}	102^{b}	35^{b}	66^{bc}	35^{ab}
Out(*Ad lib.*)	700^{a}	194^{b}	507^{a}	28^{c}	125^{a}	38^{b}	86^{a}	31^{b}
Replicates								
Feb-May	589^{b}	204^{a}	385^{b}	35^{ab}	106^{c}	40^{a}	66^{b}	38^{a}
Apr-Aug	580^{b}	217^{a}	363^{b}	37^{a}	104^{c}	44^{a}	61^{b}	42^{a}
Jul-Nov	674^{a}	199^{a}	475^{a}	30^{b}	122^{a}	39^{a}	83^{a}	33^{a}
Oct-Jan	677^{a}	228^{a}	448^{a}	34^{ab}	121^{ab}	46^{a}	75^{a}	38^{a}
Dec-Mar	611^{ab}	185^{a}	426^{a}	30^{b}	110^{bc}	37^{a}	73^{a}	33^{a}

As feed consumption had pivotal influence on the nutrient input, the P surplus was proportional to the N surplus, but the NUE was 3-4% (absolute) higher than for N and close to typical values for P-retention of 35 %. In the two replicates running from February to August feed consumption was significantly lower than during autumn and winter replicates leading to a lower nutrient surplus and a higher NUE.

The content of inorganic N was significantly raised compared to the soil outside the paddocks (Example from replicate 4 in figure 2). On average the N content in 0-40 cm in- and outside the paddocks corresponded to 144 and 39 kg N ha^{-1}, respectively. There were no significant differences between the treatments and similarly there was no effect of the time of replication. Despite the higher level of N inside paddocks with pigs, the measured inorganic N corresponded to only 18-32% of the N surplus of the N balance.

The level of extractable P was not significantly affected by grazing pigs as the levels were not higher inside than outside the paddocks. Similarly there were no significant differences between individual treatments and replicates.

Pigs on grassland significantly raised the content of exchangeable K but as for inorganic N and extractable P there were no differences between individual treatments and replicates.

A prerequisite for efficient nutrient utilisation is a homogeneous distribution of the manure avoiding hot spots. Regarding this aspect the regular moving of huts, feeding and water troughs seemed successful as inorganic N, extractable P and exchangeable K, although with some variation, was distributed throughout the paddocks (Figure 2).

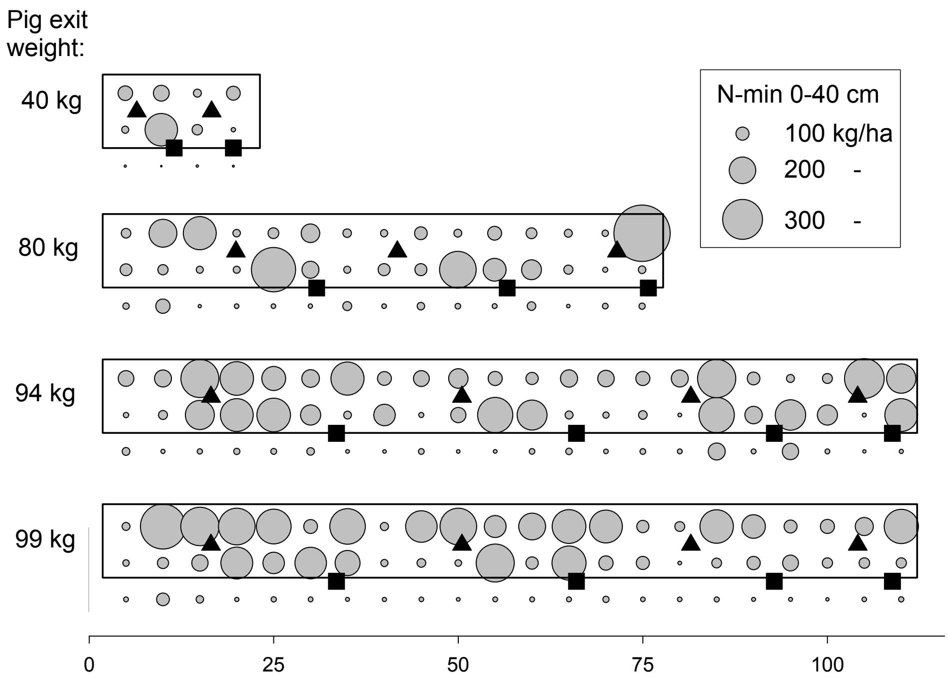

Fig. 2. Bubble plot of inorganic soil nitrogen (0-40 cm) in- and outside the four paddocks in replicate 4 of the experiment on growing pigs. Each paddock contained one hut (▲) and one feeding trough (■) that was moved every four weeks (from right to left). Here are shown all positions throughout the experiment.

Generally, it was difficult to maintain a grass cover in the paddocks especially during autumn and winter. Grass cover was not related to the experimental treatments but only to time of year. During spring and in summer, some grass cover was present in isolated parts of the paddocks whereas during autumn and winter the pigs kept grass cover below 10% at all times. No relationship existed between grass cover and soil inorganic N although some of the few spots in the paddock with grass cover above 50% had very high inorganic N contents.

It is a prerequisite in organic production that pigs should be allowed summer grazing although at the moment it is allowed to keep pigs in indoor facilities with access to an outdoor area. However, keeping growing pigs on pasture may obviously be problematic from an environmental point of view as it carries a high risk of nutrient loss. Certainly, the nutrient loss potential in this experiment was huge and will inevitably have lead to actual losses because of the huge nutrient surplus. This highlights the extreme importance of lowering stock density and reducing the level of dietary N. The data also showed that uniform distribution may be obtained if huts, feeding and water troughs are moved regularly.

Considering the problems of maintaining grass cover high levels of nutrient deposition may only be acceptable if followed by a nutrient demanding catch crop or main crop, which will only be possible if growing pigs are on pasture from February to August. Thus, seasonal production seems the most environmentally acceptable way of keeping growing pigs on pasture. For winter periods other strategies should be explored.

Environmental impact and pasture damage without nose-ringing of sows

In the experiment established at a private farm (see WP1) grass cover was determined during summer grazing and at the end of the experiment by spectral reflectance to determine the influence of nose-ringing and animal density in paddocks with pregnant and lactation sows. At the end of grazing, also soil sampling was carried out in sub-units of each paddock for analyses of mineral N to determine the level and the distribution within the paddocks.

Not surprisingly, it was confirmed that grass cover was better maintained preserved where sows were ringed (Fig. 3). As there was always less grass in paddocks with pregnant sows compared to lactating sows, the effect of ringing was more pronounced here. On average, ringing increased grass cover from 14 to 38% and from 64 to 81% in paddocks with pregnant and lactating sows, respectively. Treatment 3, where paddocks were used by either a single sow or by a group of sows before abandonment, gave different results for different types of sows. With lactating sows grass cover was much reduced, especially at the autumn measurement where intensive use reduced grass cover from 64 to 28%. For pregnant sows there was no effect of grazing intensity at the summer measurement and in treatment 3a the re-growth of the grass in the paddocks used only in the first half of the experiment gave a more extensive grass cover in the autumn, than those with ringed sows.

To determine the nitrogen loss potential, soil samples were taken from localised areas in the paddocks for soil inorganic N analysis. In lactating sow paddocks the level of inorganic N was high but with no significant relation to extent of grass cover (Fig. 4). The nutrient load locally in places probably considerably exceeded the uptake capacity of the grass. In pregnant sow paddocks the soil inorganic N content was significantly reduced by increased grass cover and at 60% grass cover soil inorganic N content was at a low level.

It is difficult to give a definitive answer as to whether nose-ringing of sows should be practised. Partly because we need investigations including a wider range of outdoor production systems and partly because it is a question of attitude how we prioritise animal welfare against the environment. However, from the experiment it was evident that although ringing did have a positive environmental effect, it was not the main factor influencing potential losses. Management choices in terms of feeding, animal density and nutrient distribution are at least as important. Thus, nose-ringing may be considered the farmers' method of maintaining grass cover but without guaranteeing low environmental load. On the other hand, if keep no nose-ringing of outdoor sows is the preferred option, this may be environmentally justifiable sound if sward damage is dealt with by e.g. gradual frequent expansion of the paddocks and a general increase in the area of grassland used for the sows.

Based on data obtained in the two experiments and also earlier experiences were defined principles for estimating distribution of N loss on different pathways from the N surplus at field level. These estimates are used for the overall environmental assessment in WP-3 and published as part of this.

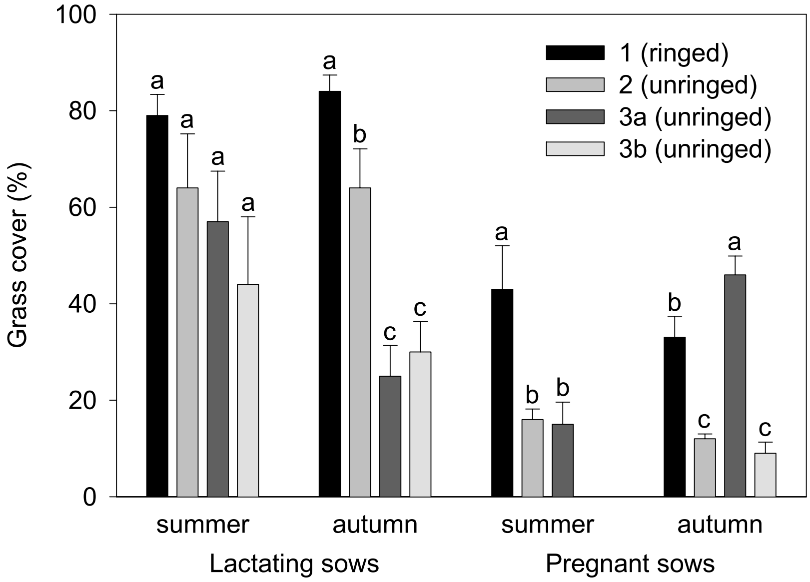

Figure 3. Grass cover in paddocks with ringed or unringed sows

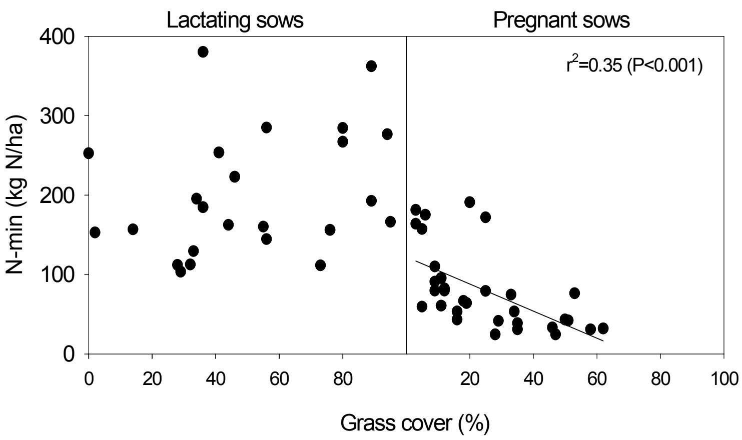

Figure 4. Relationship between grass cover and soil mineral N content in localized areas of the paddocks.

WP3: System assessment and co-ordination

The activities in this WP are strongly related to development projects in which different systems are investigated and sought improved. The overall idea were to be able to compare different solutions as regard environmental impact and economic competitiveness.

These include systems where sows are kept on grass and finishers in barns with an outdoor run, systems based on a one unit pen (strategically placed units (tents) where the pigs (sows and finishers) have easy access to the surrounding area) and systems where sows as well as finishers are kept in the crop rotation all year round. The particular tasks in this WP are to make the environmental evaluation and to investigate the economic performance in the different systems.

The economic performance of the three different systems was assessed by modelling using a further developed version of "Ø-plan Svin". It was assumed that no input of conventional manure, feed or straw took place. It was further assumed that the systems are established from bare ground. A herd of 100 sows and the corresponding slaughter pigs (1800/year) was used as the unit. The economic performance was assessed at 6 different stocking densities for each system (0.2 – 1.4 DE/ha). The technical assumption was obtained partly by interviews and investigations at commercial organic pig farms, partly from existing literature and partly from the results of the present project. The economic result was expressed as the remuneration per kg pig delivered to the slaughterhouse, which is necessary to pay all costs including labour costs. The results of these analyses are published in Report 174 from Institute for Food and Resource Economics, KVL.

The present most often used system with sows at pasture and finishers in barns with access to an outdoor area, was the most economic feasible. The difference to a system in which all pigs were kept at grassland all year round was, however, only limited (3-4%) at a stocking rate of approximately 1 DE/ha and with no difference with the lowest stocking rate of 0.2 DE/ha. The one unit pen system required a higher remuneration (15%) than the other systems, primarily due to a high requirement for straw.

There were no major differences in economic performance between stocking rates of 0.6 – 1.4 DE/ha.

It can be concluded that only small system related differences exist between the traditional rearing of organic pigs and having all pigs at pasture all year round within a large range of animal density. This means that in practice other factors may determine the most economical feasible system.

The fact that the proportion of grass in the crop rotation only influences the economics to a limited extent (due to its equal agricultural support as other crops) allow for a huge flexibility in relevant systems to be considered. The one unit tent system needs to be developed further in order to be economic competitive or other added values need to be considered.

With respect to the environmental impact, the three basic farm models representing different organic pig production systems have been modelled in the Excel tool "EmiproISK" in order to calculate nutrient flows and emissions. The tool allows checking the consistency between nutrients available in home-grown and imported feeds with the estimated crop yields and feed use. This results in nutrient balances, which are consistent at both farm and enterprise levels. Moreover, the necessary grass-clover area for free-range pigs and sows in the three systems was modelled so that the differences in land use were consistent both on herd and farm level. The consequences of this for differences in manure collection and redistribution was modelled and used to estimate and compare –among others - ammonia emissions. The ammonia emissions from pastures were estimated using knowledge from previous investigations. Emissions of nitrate from fields, ammonia from storage and spreading of manure, nitrous oxide and phosphorus losses together with energy use and losses of greenhouse gasses were calculated using standard methodology also used in the establishment of the LCAfood database for basic Danish food items. This will facilitate a comparison with the representative data on emissions from Danish conventional pig farming systems available in the database www.LCAFood.dk.

Assessed on a per ha basis for a stocking rate of 1 DE/ha, the 'conventional' system and the one-unit pen system gave comparable results as regards N- surplus (131 and 143 kg/ha, respectively), whereas the N-surplus was considerable higher for the 'all grazing' system (164 kg N/ha). This higher N-surplus is a consequence of a higher need for imported feed- N (25%), due to a lower on-farm feed production.

The farm gate balance was roughly divided into three categories of losses, ammonia losses, nitrate leaching and denitrification. The 'all grazing' system showed a considerable higher leaching than the other systems (which were comparable), but also considerable lower ammonia evaporation. The practical impact and acceptability of leaching versus ammonia deposition can be site specific.

An important aspect in using the LCA methodology, which expresses the environmental impact per kg product (here kg of pig produced on the farm) was that we wanted to include the impact related to the necessary buildings in the three organic pig systems in order to study the relative importance of physical infrastructure for the environmental ranking of the organic pig production systems, and we wanted to include the environmental load related to the import of feed, which differs among systems. This work, however, remains to be done since we had difficulties in obtaining the information related to resource use and environmental impact of buildings timely. However, the analyses will be performed in collaboration with the project "**Evaluation of innovative agricultural production systems through a life cycle assessment (LCA) methodology**" early next year. One hypothesis is that construction of stables for pigs in the traditional system will require more energy and materials, which will contribute to global warming and possibly result in the highest release of green house gas per kg pig produced.

C.2 Fulfilment of deliverables and milestones

WP1: Strategies for grazing systems in organic pig Production	Time schedule according to application	Deviations, if any*
Deliverables		
1 – Paper on rooting by unringed pregnant sows	Dec 03	Dec 05
2 - Paper on comparison of four strategies for grazing/housing of weaners and finishers	Dec 03	July 05
3 – Project report on proposed optimal strategies for pigs grazing management to be used in system analyses	Jan 04	Dec 05

Milestones		
1 – Design of experiments concluded in the entire project group (including determination of the relevant stocking rate and feeding strategies to be used for different groups of pigs)	Dec 01	
2 – Completion of experiment covering activity 1	June 03	
3 – Completion of experiment covering activity 2	June 03	

- *Deviations are to be further discussed at C3*

WP2: Nutrient load and environmental consequences of pigs on grassland	Time schedule according to application	Deviations, if any*
Deliverables		
1 – Paper on the nutrient losses related to different strategies for keeping growing pigs on grassland.	Feb 04	Dec 05
2 – Paper on the effect of nose-ringing of sows on pasture damage and nutrient utilazation.	March 04	Dec 05

3 – Estimates of nutrient losses from grassland in different outdoor pig production systems to be used in system analyses.	April 04	May 05
Milestones		
1 – Environmental guidelines for keeping growing pigs on pasture have been developed	Sept 04	Dec 04
2 – Environmental recommendation for nose-ringing of sows have been developed	Sep 04	Dec 04

** Deviations are to be further discussed at C3*

WP3: System assessment in an LCA perspective and co-ordination	Time schedule according to application	Deviations, if any*
Deliverables		
1 – Report on relevant indicators for an LCA assessment	Feb 02	Dec 03
2 – Paper on LCA and economics of different systems	Oct 04	July 05
3 – Report on future proposed systems	Nov 04	Cancelled
4 – Annual status report for the project	Nov 01,02,03,04	
5- National meeting with advisors and producers/producer organisations interested in organic pig production	Nov 04	Cancelled
Milestones		
1 - A set of indicators discussed in national and international fora and agreed upon in the project group	March 02	
2 - Co-operation with the farmers established and recording scheme developed	Sept 01	Dec 01
3 – Conceptual model developed	Dec 02	June 03
4 - A series of analyses carried out	Sept 04	Oct 05

** Deviations are to be further discussed at C3*

D. Description of deviations and subsequent adjustments of plans

The experimental work in WP's 1 and 2 have been carried out according to the plans but there is a smaller delay in reporting. Two papers are currently under peer review: 1) Eriksen J., Hermansen J.E., Strudsholm K. & Kristensen K. Nutrient loss potential of different rearing strategies for fattening pigs on pasture. 2) Eriksen J., Studnitz M., Strudsholm K. & Hermansen J.E. Effect of nose ringing and stocking rate of pregnant and lactating outdoor sows on exploratory behaviour, grass cover and nutrient loss potential.

The particular synthesis report and a national meeting, which were planned activities in WP-3, was abandoned for several reasons. There has been a considerable number of popular papers addressing the practical implications of the findings, not least the papers submitted to the theme issue on organic pig production in Forskningsnytt, and in which there are references to the relevant scientific papers. Instead of arranging a particular meeting we prefer to present the results in other relevant form, may be Økologikongressen 2006.

E. Project publications and other products

1. Products from Organic Eprints archive

Peer-reviewed and accepted
English

Eriksen, J; Petersen, SO and Sommer, SG (2002) The fate of nitrogen in outdoor pig production. *Agronomie* 22(7/8).**

Hermansen, John E.; Moustsen, Vivi Aarestrup and Andersen, Bent Hindrup (2003) Development of organic pic production systems, in Wiseman, J.; Varley, M.A. and Kemp, B., Eds. *Perspectives in pig science*. Report, page pp. 97-110. Nottingham University Press.*

Hermansen, John E.; Strudsholm, Karin and Horsted, Klaus (2004) Integration of organic animal production intor land use with special reference to swine and poultry. *Livestock Production Science* 90:pp. 11-26.**

Strudsholm, Karin and Hermansen, John E. (2005) Performance and carcass quality of fully on partly outdoor reared pigs in organic production. *Livestock Production Science* 96:pp. 261-268.**

Not peer-reviewed
English

Eriksen, J. (2005) Grass cover retained by nose-ringing of outdoor sows only partially reduces the risk of N leaching. *DARCOFenews*(3). Online at <http://www.darcof.dk/enews/sep05/sow.html>

Eriksen, J. and Hermansen, J.E. (2005) Outdoor production of slaughter pigs requires an optimized management to mitigate N pollution. *DARCOFenews*(3). Online at <http://www.darcof.dk/enews/jun05/pigs.html>

Hermansen, John E. (2001) Organic livestock production systems and appropriate development in relation to public expectations. Paper presented at 52nd EAAP meeting, Budapest, August 2001; Published in *Book of Abstracts of the 52nd Annual EAAP Meeting*, page pp. 1-27.**

Hermansen, John E. (2005) Integration of organic pig production into land use, in Sundrum, A. and Weissmann, F., Eds. *Organic pig production in free range systems*. Sonderheft (special issue) no. 281, page pp. 3-12. Landbauforschung Völkenrode FAL Agricultural Research.**

Hermansen, John E.; Larsen, Vivi Aa. and Andersen, Bent H. (2002) Development of organic pig production systems. Paper presented at Perspectives in Pig Science, University of Nottingham, Sutton Bonington Campus, Loughborough, Leics LE12 5RD, 10-130902, page pp. 1-16.**

Studnitz, Merete; Eriksen, Jørgen and Strudsholm, Karin, Eds. (2003) Does nose ringing make any sense?. Proceedings of The 37th International Congress of the ISAE, Abano Terme, Italy, 24.-28. June 2003.*

Dansk - Danish

Eriksen, J. (2005) Økologiske søer med ring i trynen. In *Økologisk Jordbrug*, Volume 341, page pp. 4-4.

Eriksen, J. and Hermansen, J.E. (2005) Slagtesvin på friland kræver optimeret driftsledelse for at mindske miljøbelastningen. *FØJOenyt*. Online at <http://www.foejo.dk/enyt2/enyt/jun05/friland.html>

Hermansen, John E. Hermansen, John E., Eds. (2000) Økologisk svineproduktion - udfordringer, muligheder og begrænsninger . FØJO Rapport no. 8, Forskningscenter for Økologisk Jordbrug (FØJO).*

Hermansen, John E. Hermansen, John E., Eds. (1998) Forskning i økologisk svineproduktion. FØJO-rapport no. 1, Forskningscenter for Økologisk Jordbrug (FØJO).*

Strudsholm, Karin and Hermansen, John E. (2004) Opdrætningsstrategier for økologiske svin - produktion og slagtekvalitet. *Grøn Viden, Husdyrbrug*(37):pp. 1-6.
Studnitz, Merete (2002) Forsøg med slagtesvin. *UdendørsNyt*(2):pp. 10-11.*
Studnitz, Merete (2002) Har søers rodeintensitet indflydelse på udvaskning? . *Landsbladet SVIN*(8):32.*
Studnitz, Merete (2002) Nytter trynering overhovedet? . *UdendørsNyt*(2):8.*
Studnitz, Merete; Eriksen, Jørgen and Strudsholm, Karin (2002) Har søers rodeintensitet indflydelse på udvaskning - eller nytter tryneringning overhovedet. *Økologi-Kongres 2002 - Mellem værdier og vækst*:pp. 209-210.*

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

Eriksen, J. & Petersen, S.O. Poster at field day in Foulum 13 June 2002: "Miljøbelastning ved søer på friland"

Eriksen, J., Strudsholm, K. & Studnitz, M. (2003) Environmental impact of outdoor pig production. Oral presentation at Nordic workshop on research in organic pig production, 24-25 April. Horsens.

Hermansen, J.E., 2001: Rammer og udfordringer for frilands- og økologisk svineproduktion. Økologisk og udendørs svineproduktion. Hvor står vi? Temamøde på Danmarks JordbrugsForskning den 21. august 2001. Intern Rapport nr. 145. P. 4-8**.

Hermansen, J.E., Strudsholm, K. & Horsted, K., 2003. Integration of organic animal production into land use with special reference to swine and poultry. IX World Conference on Animal Production. Porto Alegre – RS, Brasil. CD 14 pp.

Hermansen, J.E., Kristensen, T. and Ronchi, B., 2005. Organic livestock systems: characteristics and challenges for improvement. EAAP - 56th Annual Meeting. Book of abstracts p. 309.
Strudsholm, K., Oksbjerg, N. & Hermansen, J.E., 2004. Rearing performance and eating quality in organic pig production. Proceedings from A Satelite Workshop on "High Eating Quality of Danish Pig Meat". The Royal Veterinary and Agricultural University, Copenhagen, Denmark, p. 1-6.

Strudsholm, K., Studnitz, M., 2002: Poster at field day Rugballegård.

Studnitz, M., 2002: Ved naturvidenskabsfestivalen og Åbent hus arrangement den 28. september på stand ved HSV.

F. Scientific education including visiting scientist

During a period of 3 month in 2002 Cecile Cornou from France was employed in the project as part of her preparation for application PhD.-grant. Cecile Cornou has a M.Sc. in Agricultural Science (2002) with main focus on system analysis, statistics and economy.

G. National and international cooperation

This project was closely related to the following Danish research and development projects funded outside FOEJO

- New organic pig production system (2001-2004)
- Optimised welfare for organic pig production in tent systems as well as farrowing huts (2002-2004)
- Meat quality on organic finishers reared on free range (2002)
- Entire male production – influence on welfare aspects and risk for boar taint (2002-2004) and the EU-funded project

- Sustainable Pork Production (2001-2004)

H. Critical reflection on the project

The project group finds that the background, the perspective and the way the work is carried out is sound and valid in relation to some important challenges which exists for the development of organic pig production.

On the other hand, the aspects in focus has been very much investigated within the context of the way organic pig production takes place to day. At the April workshop the question was raised if it really will be possible to think of a competitive organic pig production in this context. It was proposed to consider systems which were not based on an optimised pig production, but where the role of pigs in the system was optimised. In others words there is a need to consider systems where the free range element (for the sake of the pigs) are implemented in a way whereby the pigs at the same time exert a positive influence on other parts of the system. Following that line more focus need to be put on the different capabilities of the pigs i.e. to root for land cultivation and picking up essential nutrients and to interact with other livestock to reduce parasite burden.

In addition it will probably be necessary also to consider pork product qualities, which are really different from the conventional production system. These ideas have been implemented in the forthcoming project in FØJO-III "Quality and integrity of organic eggs, chicken meat and pork"

8. Budget

A. Account for any change in budgets

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B. Budget for the whole project (1,000 DKK)

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

Year:	Consump-tion before 2005	Expected consumption 2005	2006	Total
Man-months				
Scientific personnel	43.7	5		48
Technical personnel	18.8	0.4		18

Year:	Consump-tion before 2005	Expected consumption 2005	2006	Total
Salaries				
Scientific personnel	1,563	216		1,779
Technical personnel	454	12		466
Other operational costs	559	51		610
Equipment	0	0		0
Others (please specify)	70	0		70
Direct costs	2,646	279		2,925
Indirect costs (20% of direct costs)	529	56		585
Total	3,175	335		3,510

Comments:

9. Signatures and stamps

Name	Institute	Date	Signature
Head of project John E Hermansen	 DIAS	 14/12 -05	

Appendix I. Detailed budget

A. Budget for each participating institute (1,000 DKK)

Name of Institute: DIAS

Year:	Consump-tion before 2005	Expected consumption 2005	2006	Total
Man-months				
Scientific personnel	35.7	5		40.7
Technical personnel	18.8	0.4	0	19.2

Year:	Consump-tion before 2005	Expected consumption 2005	2006	Total
Salaries				
Scientific personnel	1,294	216		1,510
Technical personnel	454	12		466
Other operational costs	501	51		552
Equipment	0	0		
Others (please specify)	70	0		70
Direct costs	2,319	279		2,598
Indirect costs (20% of direct costs)	464	56		520
Total	2,783	335		3,118

Comments:

Name of Institute: FØI

Year:	Consumption before 2005	Expected consumption 2005	2006	Total
Man-months Scientific personnel Technical personnel	7.5	0		7.5

Year:	Consumption before 2005	Expected consumption 2005	2006	Total
Salaries Scientific personnel Technical personnel	269	0		269
Other operational costs	58	0		58
Equipment				
Others (please specify)				
Direct costs	327	0		327
Indirect costs (20% of direct costs)	65	0		65
Total	392	0		392

B. Budget for each participating department (1,000 DKK)

Name of Institute and department: DIAS, JPM (tidligere JBS + PVJ)

Year:	Consump-tion before 2005	Expected consumption 2005	2006	Total
Man-months				
Scientific personnel	25.7	3	0	28.5
Technical personnel	15.8	0.4	0	15

Year:	Consump-tion before 2005	Expected consumption 2005	2006	Total
Salaries				
Scientific personnel	968	141	0	1,109
Technical personnel	388	12	0	400
Other operational costs	445	20	0	465
Equipment				
Others (please specify)	70	0	0	70
Direct costs	1,871	173	0	2,044
Indirect costs (20% of direct costs)	374	34	0	408
Total	2,245	207	0	2,452

Comments:

Name of Institute and department: DIAS, HSV

Year:	Consump-tion before 2005	Expected consumption 2005	2006	Total
Man-months				
Scientific personnel	8	0		8
Technical personnel	3	0		3

Year:	Consump-tion before 2005	Expected consumption 2005	2006	Total
Salaries				
Scientific personnel	251	0		251
Technical personnel	66	0		66
Other operational costs	51	0		51
Equipment				
Others (please specify)				
Direct costs	368	0		368
Indirect costs (20% of direct costs)	74	0		74
Total	442	0		442

Name of Institute and department: DIAS, JBT

Year:	Consumption before 2005	Expected consumption 2005	2006	Total
Man-months Scientific personnel Technical personnel	2	2		4

Year:	Consumption before 2005	Expected consumption 2005	2006	Total
Salaries Scientific personnel Technical personnel	75	75		150
Other operational costs	5	31		36
Equipment				
Others (please specify)				
Direct costs	80	106		186
Indirect costs (20% of direct costs)	16	22		38
Total	96	128		224

C. Budget for co-financing from each participating institute (1,000 DKK)

Name of Institute:

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Man-months Scientific personnel Technical personnel						

Year:	Consump-tion before 2002	Expected consumption 2002	2003	2004	2005	Total
Salaries Scientific personnel Technical personnel						
Other operational costs						
Equipment						
Others (please specify)						
Direct costs						
Indirect costs (20% of direct costs)						
Total						

Comments: