Darcof project II.9. Acronym: PIGSYS

Title: Resource use, environmental impact and economy in organic pig production systems

Date: 05/02 2001

1. Summary

In Denmark, the organic pig production is very scarce today and need to be developed in order to fulfil the expected potential hereof. In relation to this there is a need to develop new systems in which the pig production is more integrated into land use in order to fulfil the expectation to the organic pig production from different stakeholders and probably also in order to make the production economical feasible.

In the preliminary work for this research initiative, two in principle different systems have been suggested as alternatives to the dominant way of production of organic pigs today. Today, the sows are outdoors on pasture whereas the growing pigs are indoors with access to an outdoor run of limited size. The two alternatives are characterised by either mobile huts, which can be moved in an appropriate way in the crop rotation allowing the pigs to forage, or by establishment of decentralized, strategically positioned fixed units, where the pigs have easy access to the surrounding area.

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 within a life cycle assessment (LCA) framework and also including economic considerations. 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.

2. Research group

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3. Introduction

The organic pig production in Denmark is still very limited. A recent estimate gives an annual production of 80,000 slaughter pigs (Hermansen and Lauritsen, 2000). This corresponds to less than 0.4% of the total Danish pig production and is far from what is necessary to supply the home market with organic pork with the share of 15-30%, which has been predicted as a realistic level (Andersen, 1999). Since it is also part of the Danish strategy to stimulate exports of organic products, there is a need to consider if it is realistic to increase the organic pig production and, if so, how this may be done.

The actual development of organic pig production, however, will depend on to which degree the production can fulfil the expectations of different stakeholders, i.e. the organic farmers' interpretation of the organic ideals and their need for earnings, the organic consumers and the agricultural policy and related regulations.

Today, the typical organic pig production in Denmark is a system where nose-ringed sows are kept on pasture while weaners and finishers are kept in barns with access to an outdoor run - normally of limited size and with a concrete floor. Although there is only limited experience, the preliminary results indicate that good production results can be obtained in such systems (Danielsen et al., 2000; Lauritsen et al., 2000; Møller, 2000). However, there is a number of buts which have been identified in a recent knowledge synthesis work initiated by DARCOF (Hermansen et al., 2000).

The costs of buildings following the future EU regulation in relation to area (m^2) per pig etc. is very high, and this may be considered a real obstacle to future development. At the same time, the building construction is energy demanding in terms of fossil energy, and the growing pigs are not allowed to graze during summer, which, according to the ideas of organic farming, should be possible. As regards the sow production in free-range systems, the present practice is to ring sows in order to minimize rooting on the grassland and thereby reduce risk of nitrate leaching. This practice clearly conflicts with organic ideals of respecting the integrity of the animal and its ability to fulfil the natural behavioural needs and it also conflicts with practices and regulations in other EU-countries.

These considerations have led to the conclusion that there is a need for development of new systems for organic pig production. These new systems should be less energy demanding and the pigs should be allowed to summer graze without being ringed and without contributing to a high risk of nutrient leaching. Moreover, the systems should be economically efficient. Two strategies to achieve this have been proposed (Hermansen et al., 2000), both of which include a higher integration of the pig production in the land use. One strategy proposed is to keep both sows and finishers in free-range conditions exploiting the total area through an appropriate rotation. Another strategy proposed is to establish small stationary units appropriately placed in the area, where sows and finishers are housed in a way, where most of the manure can be collected, but where at the same time the pigs have access to a grazing area when appropriate. Andersen et al. (2000) has described this system in more detail.

However, very little experience is available with these proposed systems and a proper development of these 'new' systems raises some important questions, which need to be addressed:

- Can appropriate management strategies for unringed sows on pasture be developed in relation to maintaining sward quality and minimize the risk for leaching?
- Can the aim of an efficient production for finishers better be solved by a combination of grazing and barn feeding than by either one or the other?
- What measures should be taken in order to reach acceptable levels of risk of leaching when keeping pigs on pasture?
- What economic potential and risk is related to different systems?
- What are the overall possibilities for different systems to reach goals and expectations of production efficiency, resource use and environmental impact?

4. State of the art

Sward quality in relation to pig grazing activities

For outdoor production, a well-maintained grass-sward serves several important purposes. The uptake of nitrogen and water by the grass decreases the risk of nitrogen by leaching (Watson and Edwards, 1997). In paddocks for lactating sows, a high level of grass cover is one of the factors which seem to decrease piglet mortality (Kongsted and Larsen, 1999). For pregnant sows, grass can constitute a significant part of their daily energy requirement (Sehested et al., 1999; Ferre et al., 2000). Moreover, the pregnant sows are fed a restricted diet, so they are not saturated. On the other hand, if grass is available, it serves as a source of fibre-rich feed and as a source of occupation. For weaners and finishers, limited knowledge is available of the part grass takes in the production.

In Denmark, the sows kept outdoors are ringed to prevent them from rooting. In the UK, Soil Association prohibits ringing of sows, and from September 2001, ringing is prohibited in The Netherlands, too (Mul and Spoolder, 2000). However, even though the sows are ringed, a clearly seasonal pattern of grass cover/grass height has been found under Danish conditions (Larsen and Kongsted, 2000). Where ringed sows were grazing, the level of grass cover was low (20-30%) in the beginning of the year and reached a higher level (60-80%) during the summer period. A similar pattern was found in Scotland (Watson and Edwards, 1997). Reasons for the pattern seen on Danish outdoor herds were that early spring was the end of the period for use of an area. In addition, the climatic conditions did not favour the growth of grass. The grass cover reached a higher level during April and May because of shifts to new paddocks and climatic conditions, which favoured growth of grass. In the autumn, the grass cover decreased because of wear and climatic conditions. Besides the differences in level of grass cover caused by the stocking rate and the time of first insertion, it was likely that the function of a paddock influenced the level of grass cover. The legislation required a lower stocking rate (in animals per hectare) in lactation paddocks compared to gestation paddocks because of a higher level of feed supplied to lactating sows, which causes an increase in nutrient input (Larsen and Kongsted, 2000). A French investigation (Ogel, 1997) concluded that three factors were essential to maintain grass cover. The factors were the area available, the ringing of sows and the use of supplementary paddocks. In another experiment (Watson and Edwards, 1997), it was shown that unringed sows reduced the vegetation cover to 10% within a month.

However, the placing of a ring in the snout of sows prevents the sows from carrying out rooting, which is one of the sows' basic behaviours, by creating pain for the animal. This is in disagreement with organic ideals for animal husbandry and should be avoided, if possible. Out-

door domestic pigs in semi-natural environments spend about half their active time exploring (Blasetti et al., 1988; Tober, 1996) and 40% of their exploration consist of rooting (Stolba and Wood-Gush, 1984). By rooting, the pigs search for, locate and harvest food. Studnitz et al. (2001) demonstrated that rooting is the preferred explorative behaviour of pigs, and rooting behaviour is considered to be a behavioural need of pig (Horrel et al., 2001), which according to the organic ideals must be taken into consideration. Edwards and Watson (1997) showed that the rooting activity of pregnant sows resulted in a higher level of disturbance of the surface area than the rooting behaviour of lactating sows. Possibly because the lactating sows were fed on higher levels and the stocking rate was lower. As animal welfare is part of the image of organic production, one or more alternatives to ringing is needed in order to reduce the rooting behaviour of the sows.

Some results suggest that it might be possible to reduce the rooting behaviour to a certain degree by providing the sows with a fibre-rich diet (Brouns et al., 1994; Martins and Edwards, 1994; Braund et al., 1998) and by a lower stocking rate (Andresen, 2000). However, further research is needed to identify management initiatives, which allow for maintaining grass as a source of feed for the sows and thereby obtain satiety, and at the same time make it possible for the sows to follow their inclination to root. It seems most important that the research activities focus on the pregnant sows because they are fed restricted but at the same time have the highest potential to utilise grass as a very significant part of their energy and protein requirement.

Growth rate for pigs at pasture and in barns
Based on the present knowledge, it is related to a poor feed conversion and an increase in labour, if the production of weaners and finishers is outdoors compared to conventional production or to the way the majority of the organic pigs are produced today. However, the magnitude of the increase is not known. Previous investigations of production of finishers outdoors (Pedersen and Jørgensen, 1992; Lee et al., 1995; Andresen et al., 2001) indicated a growth rate comparable to indoor production. However, large variations existed in for instance the feed conversion rate for pigs housed outdoors.

For pigs housed indoors with access to outdoor runs, experiments indicated that the production results are comparable with conventional production (Danielsen et al., 2000). However, the future regulation by EU causes a significant increase in available area (m^2) per pig needed. If the piglets are inserted in the pen at weaning, they only take up a limited part of the pen. Besides being economically unfeasible, the costs of farm buildings taken into consideration, difficulties in managing the elimination behaviour may occur during the rest of the growing-finishing period (Boykel and Lauritsen, 2001).

Preliminary results (Oksbjerg et. al., 2001) indicate that feed restriction in the early growing period results in compensatory growth of muscle tissue in the finishing period, if the pigs are fed ad libitum during the last period. Based on these results, a relevant strategy to investigate is keeping the weaned pigs on pasture and then housed indoors for the last part of the growing-finishing period. It can be hypothesised that if the weaned piglets are fed a low-density diet while on pasture, followed by an intensively feed-period in a barn, this will allow an improved feed conversion rate on pasture and a relatively smaller nutrient load on the grazed area. In addition, the strategy can lead to a lower total workload in relation to feeding and handling of the pigs without compromising the overall productivity. Moreover, such a strategy seems to allow a good utilisation of the building costs per kg pork produced.

Environmental impact of outdoor pig production

To a wide extent, the environmental impact of outdoor pig production is related to the amount of nutrients in the supplementary feed for the pigs and the stocking density. Recent investigations have shown a surplus of 330-650 kg N per ha of land used for grazing sows on organic farms (Larsen et al., 2000). Although this level is lower than found on average in conventional outdoor sow herds, the present nutrient surplus definitely represents an environmental risk, as it has proved difficult to obtain optimal efficiency of the nutrients deposited during grazing (Zihlmann et al., 1997; Williams et al., 2000; Eriksen and Kristensen, 2001). The adverse consequence of this is considerable losses from grazed pastures and undesirably low nutrient availability in the rest of the crop rotation. Nitrogen losses due to outdoor pigs in the form of nitrate leaching (Eriksen, 2001), ammonium volatilization (Sommer et al., 2001) and denitrification (Petersen et al., 2001) contribute to eutrophication of natural environments, acid rain and global warming (Ryden et al., 1984; Schulze et al., 1989; Wang et al., 1976). Low nutrient availability in other fields has adverse effects on the economic profit of the farmer as it causes decreasing feed crop yields and consequently lower livestock production. From the year 2005, when all feed must be organically produced, this will become particularly important.

In order to obtain sufficient feed production and to protect ground water and atmosphere from pollution, it is necessary to improve the nutrient use efficiency in pastures grazed by pigs. In previous investigations in sow paddocks (Eriksen et al., 2001), the N input in feed to the paddock could be accounted for in piglets (44%), as ammonia volatilisation (13%), as denitrification (8%), or as nitrate leaching (16 to 35%). In these investigations, four matters were of major importance for nutrient utilization: 1) Type of paddock: the nutrient load in lactating sow paddocks were higher than in pregnant sow paddocks due to 3-4 times higher nutrient excretion from lactating sows. 2) Stock density: the number of sows per area unit decides the feed input and thus the nutrient input into the paddock. 3) Nutrient distribution in the paddock: without regularly shifting the position of the shelters and feeders during grazing the deposition of excreta by the sows becomes extremely inhomogeneous and causes substantial nitrogen losses, particularly around the feeding areas. 4) Grass cover: for utilization of nutrients in the subsequent crops of the crop rotation it is important to maintain a grass cover especially in autumn and winter that efficiently captures the deposited nutrients.

The effect of ringing on grass cover and soil-N was investigated by Watson and Edwards (1997) showing a significantly lower maximum soil nitrate for ringed sows where grass cover was maintained. Currently, it is recommended in Denmark that sows are nose-ringed to avoid pasture damage. However, a number of other countries prohibit nose ringing as this inhibits the natural behaviour of the sows, so obviously, there is a need to find a solution to this problem, a solution that considers both animal welfare and the environment. It can be argued that one of the alternative systems proposed, keeping sows and finishers in small stationary units where most of the manure can be collected, represents a smaller risk for nutrient losses. The other alternative with both sows and finishers on pasture throughout the production period may represent a system with a higher risk for nutrient losses.

However, very little is known about the absolute magnitude of the risk of nutrient losses from different outdoor pig production systems with respect to the different groups of pigs including growing pigs and unringed sows and with respect to different strategies (management measures) for limiting the nutrient load. Therefore, improved knowledge on this part is necessary for an assessment of the environmental impact of the systems, but also as a background for optimised nutrient management on organic farms, which is of utmost importance for the overall level of production.

Economically important parameters
Since a significant increase of the organic pig production is dependent on if "new players" dare to establish an organic pig production, it is very important that these potential producers have access to relevant information about the expected economic results, including the risks associated with this production. The economic risk is particularly related to future pork prices, organic feed prices, productivity of production, investments and labour requirements.

Tvedegaard (1999) has shown that farms producing organic pigs have significant variations in the economic outcome. In order to estimate the economy producing organic pigs, a model called Ø-plan has been used (Tvedegaard, 1999). Previous work with this model has primarily dealt with the conversion period from conventional to organic farming. This work has, for instance, shown that pig farms have very big differences in the suitability for converting to organic production. Also, it seems that the economic risk increases considerably when the self-sufficiency with organic feed is low (Tvedegaard, 1999).

Overall consequences of different systems
Several stakeholders have an interest in an overall assessment of the resource use, the environmental impact and the production efficiency related to organic pig production in general, and how these outputs are affected by the way in which the production is established. The organic farmer in his effort to address the goals of organic farming, the consumers to support their choice of value-oriented buying of foods and the society as such represented by the agricultural policy makers in deciding on regulation and what types of production systems to be stimulated. However, very little data exist suitable for such an assessment, also due to the limited experience in general on organic pig production.

Andresen et al. (2000) made a case study on emergy efficiency in organic versus conventional pig farming demonstrating an advantage of integrating pig production into land use from an energy point of view, but, in general, no comprehensive work has been published in this area. Also the methodology for doing such assessment is only scarcely developed. Halberg (1999) investigated indicators for resource use and environmental impact based on data from organic and conventional farms with milk production and conventional pig production including use of fossil energy (direct (diesel, electricity) and indirect (energy used for feed and fertilizer import)), nutrient surplus and biodiversity. The paradigm used seems promising from the organic farmers' point of view, considering changes in farming practise in an established production system, and makes a good starting point for an assessment. Dalgaard et al. (1999) have improved the basis for assessing use of fossil energy in organic and conventional crop production, and Dalgaard et al. (2000) have published global data to be used for calculation of emission of green house gasses. However, none of these investigations included fossil energy variation according to the farm buildings, which in the present case is expected to be considerable and also highly different between systems. Therefore, such information need to be obtained.

In recent years, methods for life cycle assessment (LCA) of foods are being developed (Weidema and Meeusen, 2000) following the paradigm of LCA used for industrial products but adjusted to the factors which are important in relation to farming. The overall idea of LCA is that the resource use and environmental impact are allocated to the product produced rather than on a per ha basis. Cederberg and Mattsson (2000) have used the method in comparing organic versus conventional milk production, and in Denmark a project has been initiated where the main agricultural produce is being evaluated (Hermansen, 2001). Since LCA seems to develop as a tool to evaluate agriculture, and since it includes major topics of concern (global warming,

acidification, eutrophication and ozone depletion) to which the Government has committed itself with reduction goals, it seems appropriate to apply the LCA method in an assessment of different systems.

Data on organic pig production systems
In Denmark, a demonstration project is going to be implemented in the coming years. In the project, the before-mentioned 'new' systems will be established at experimental units and on commercial farms. Furthermore, existing systems on commercial farms will be sought improved in relation to productivity. These activities are expected to supply valid data from a total of 7-9 organic pig farms where pig farming is the main activity, and thereby give a basis for an assessment.

In the UK and Holland, demonstration projects have already been initiated (ADAS, 2000; Steverink, 2001 (personal com.)), and in Sweden system analyses are going to be implemented in an experimental unit combining pig and ruminant production (G. Gustavson, personal comm.). Results from these projects may add to the paradigm and the empirical basis for an evaluation of different pig production systems.

5. 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 appropriate 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 within an LCA framework,
- to propose an economically and environmentally viable future strategy for organic pig production in Denmark.

Table 1: Work package list

WP No	WP title	Responsible participant	Budget	Start	End	Deliverable, No
1	Strategies for grazing systems in organic pig production	VAL	1,147	Oct 2001	April 2004	D1.1-D1.3
2	Nutrient load and environmental consequences of pigs on grassland	JE	1,036	Jan 2002	Aug 2004	D2.1-D2.3
3	System assessment in an LCA perspective and co-ordination	JHE	1,317	May 2001	Dec 2004	D3.1-D3.5
Total			3,500			

Table 2: Description of work packages

WP1: Strategies for grazing systems in organic pig production	
Work package number:	WP1
Start date or starting event:	October 2001
Responsible person:	Vivi Aarestrup Larsen
Contributing persons:	Merete Studnitz
Person months:	17 scientific, 8 technical

Objectives

The overall objective is to elaborate alternatives to ringing of sows in order to avoid pasture damage and to elaborate grazing and feeding strategies for slaughter pigs in organic pig production. The strategies must take into account the differences in needs and possibilities of the various groups of animals in relation to their natural behavioural needs, the grass intake and the nutrient load on the grazed area. The two main objectives are:

- to investigate the consequences of high-fibre diet and low stocking rate for unringed pregnant sows compared to the normal procedure - ringed sows - on rooting behaviour and pasture damage,
- to investigate the consequences of the age of the pigs (weaners/finishers) at moving from a paddock to a pen with access to an outdoor run on production, grass cover and utilisation rate of building facilities.

Description of work

In activity 1 and 2, the number of animals in a paddock, the number of feed days and the dimensions of the paddocks are measured to determine stocking rate. The level of grass cover will be monitored. Each paddock is divided into a number of sections and for each section, the proportion of the area covered by plants, uprooted, mud or bare soil is determined monthly. For the area covered by plants, the proportion of clover, grass and weeds is determined. The level of feed supplied per paddock is recorded.

Activity 1 – Initiatives to reduce rooting by unringed pregnant sows

The first objective is accomplished in a trial, which compares ringed sows on a normal diet and stocking density according to the organic regulations to sows on two levels of fibre-rich diets and two stocking rates. The behaviour will be recorded by scan samplings (Studnitz et al., 2001) and the environmental impact as part of WP2. Stable groups of 6-10 pregnant sows with six replicates will be used.

Activity 2 – Strategies for weaners/finishers on pasture/in barns

The second objective is accomplished in a trial, which includes comparisons of four strategies for housing of weaners/finishers. One strategy is similar to the practice in Denmark today, where the piglets are moved indoors at weaning. In the second strategy, the expected advances of compensatory growth are exploited, so the weaners stay on pasture until about 45 kg live weight with moderate feeding followed by intensively feeding in the pen. In the third strategy, finishers stay outdoors until approximately 80 kg, a time when e.g. work load for handling increases. In the fourth strategy, the finishers remain outdoors until delivery, which renders buildings superfluous. The environmental consequences are investigated in WP2. Groups of 10-15 pigs with six replicates will be used.

Activity 3 – Propose appropriate strategies for management of pigs grazing

The knowledge learned in activity 1 and 2 is synthesised to propose appropriate strategies for management of pigs grazing.

Deliverables

D.1.1. Paper on rooting by unringed pregnant sows
D.1.2. Paper on comparison of four strategies for grazing/housing of weaners and finishers
D.1.3. Project report on proposed optimal strategies for pigs grazing management to be used in system analyses

Milestones

M.1.1. 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)
M.1.2. Completion of experiment covering activity 1
M.1.3. Completion of experiment covering activity 2

WP2: Nutrient load and environmental consequences of pigs on grassland

Work package number:	WP2
Start date or starting event:	January 2002
Responsible person:	Jørgen Eriksen
Contributing persons:	
Person months:	9.5 scientific, 7 technical

Objectives

The overall objectives are to improve nutrient utilization in organic pig production, to reduce the risk of losses to the environment, and increase the crop production. Specifically WP2 examines the loss potential and utilization of nutrients deposited by pigs during grazing in relation to different strategies for outdoor pig production, such as keeping growing pigs on grassland and sows without nose-rings.

Description of work

In all three activities in WP2 nutrient excretion by outdoor pigs and the potential environmental impact will be investigated through intensive soil sampling in the paddocks covering both spatial and temporal variations as described by Eriksen and Kristensen (2001). These studies will permit comparison between different grazing strategies regarding level of nutrient deposition, distribution in the paddocks in relation to the distance to feeding area, housing etc. and recovery of nutrient input in feed. The nutrients studied are nitrogen, phosphorus and potassium with the main focus on the mobile and volatile forms of these. The distribution between N-losses (nitrate leaching, ammonia volatilization and denitrification) will be estimated from models for ammonia volatilization (Sommer et al. 2001) and denitrification (Petersen et al. 2001) in grazed paddocks.

Activity 1 - Environmental impact of growing pigs on pasture

The four housing strategies for weaners/finishers outlined in WP1 represent wide differences in pasture use and grassland requirement. To determine the environmental consequence and possibilities for improvements, a field experiment is established containing the four systems in a replicated design. In all repetitions of these systems is determined the level, distribution and loss potential of N, P and K by soil sampling in transects through the paddock during grazing and in autumn and winter. Similar sampling is made in reference areas without pigs.

Activity 2 - Environmental impact and pasture damage without nose-ringing of sows
The effect of nose-ringing of sows will be investigated in the experiment outlined in WP1 for pregnant sows. The effect of nose-rings on the pasture damage (percentage of grass cover) is determined and so is the level, distribution and loss potential of N, P and K. A similar sampling is made in reference areas without pigs. Furthermore, the effect of the different strategies for decreasing rooting behaviour is determined.

Activity 3 - Characterization of environmental impact of different production systems
For the three types of organic pig production systems in the project "Integration of pig production and crop rotation in systems with low impact on the environment and high level of accept by consumers", nutrient balances established in WP3 are supplemented by determinations of the level, distribution and loss potential of N, P and K. They will be based on strategic sampling in grazed fields of the systems where uneven distribution may be expected.

Deliverables
D2.1 Paper on the nutrient losses related to different strategies for keeping growing pigs on grassland.
D2.2 Paper on the effect of nose-ringing of sows on pasture damage and nutrient utilization.
D2.3 Estimates of nutrient losses from grassland in different outdoor pig production systems to be used in system analyses.

Milestones
M2.1 Environmental guidelines for keeping growing pigs on pasture have been developed and published.
M2.2 Environmental recommendation for nose-ringing of sows has been developed and published

WP3: System assessment in an LCA perspective and co-ordination

Work package number:	WP3
Start date or starting event:	May 2001
Responsible person:	John Hermansen
Contributing persons:	NT, VAL, BHA, HBL
Person-months:	21 scientific, 3 technical

Objectives:
The overall objective is to assess different organic pig production systems in relation to production efficiency, resource use and environmental impact with focus on systems that are expected to fulfil 'organic' goals for the production. The objectives are:

- To define relevant indicators for assessment in an LCA (system boundaries etc.)
- Collection of data from existing farms and experimental units as well as global data
- Modelling of resource flow, production and environmental impact in optimized virtual systems based on the information from existing farms and the results from other WPs
- Analysis of pros and contras for different systems in an LCA framework
- Co-ordination of the entire project (coherence in activities; flow of information)

Description of work:
Different systems will be considered ranging from the p.t. most common system, where sows and piglets are on pasture while finishers are kept in barns, to other systems where also slaughter pigs are kept on pasture, and a system where sows and slaughter pigs are kept in a one-unit-pen constructed as a tent system placed on deep litter on the top of a membrane. These systems represent very different requirements of input of non-renewable resources, workload and risk for environmental load, and they represent different opportunities for allowing pigs to perform their natural behaviour including grazing.

Activity 1 - LCA indicators
Based on the experience from earlier investigations in organic pig production, current work in another project regarding LCA in food in general, and co-operation with systems projects in Holland, Sweden and UK, a set of indicators suited for evaluation of organic pig production systems will be set up and discussed in national as well as international fora. Special emphasis will be put on indicators that reflect differences in the systems mentioned.

Activity 2 - Data collection
Data will be collected from a total of 7-9 farms and an experimental unit located at the organic research station representing the different systems. These farms are expected to participate in a development project in which basic recordings on system description, feed intake, land use and production are going to take place. Complementary recordings necessary for the calculation of the indicators chosen in the present project will be implemented.

Activity 3 - Systems modelling
A conceptual model covering the holistic view of the systems will be constructed and the data obtained from the farm investigations in this WP just as the results from the other WPs will be used to substantiate this model. The model will be used to search for a balanced solution with respect to the range of goals for organic farming, not only covering the systems investigated in practise, but also appropriate combinations. Concurrently, an existing model tool (Ø-plan) focussing on the economic aspect of organic pig farming will be improved in order to include risk and production stability in different systems.

Activity 4 - Systems assessment
Finally, the most interesting and promising systems will be evaluated in an LCA framework and a detailed economic assessment of different systems will be performed.

Activity 5 - Co-ordination
Throughout the project period, project meetings will be held in order to ensure coherence in activities and mandatory reporting etc.

Deliverables:
D.3.1. Report on relevant indicators for an LCA assessment
D.3.2. Paper on LCA and economics of different systems
D.3.3. Report on future proposed systems
D.3.4. Annual status report for the project
D.3.5. National meeting with advisors and producers/producer organisations interested in organic pig production

Milestones:
M.3.1. A set of indicators discussed in national and international fora and agreed upon in the project group
M.3.2. Co-operation with the farmers established and recording scheme developed
M.3.3. Conceptual model developed
M.3.4. A series of analyses carried out

6. Implementation and time schedule

Table 3: Deliverables list

Deliver-able, No	Deliverable title	Delivery date	Meeting	Nature
D.3.4.	**Annual report**	**Dec 01**		**Re**
D.3.1.	**LCA-indicators**	**Feb 02**		**Re**
D.3.4.	**Annual report**	**Dec 02**		**Re**
D.1.1.	**Paper on rooting by pregnant sows submitted**	**Dec 03**		**Pu**
D.1.2.	**Paper on strategies for finishers submitted**	**Dec 03**		**Pu**
D.3.4.	**Annual report**	**Dec 03**		**Re**
D.1.3.	**Strategies for grass management**	**Jan 04**		**Re**
D.2.1.	**Paper on nutrient losses for finishers on pasture submitted**	**Feb 04**		**Pu**
D.2.2.	**Paper on effect of unringed sows on pasture submitted**	**Mar 04**		**Pu**
D.2.3.	**Nutrient losses of different systems**	**Apr 04**		**Re**
D.3.2.	**Paper on system assessment**	**Oct 04**		**Pu**
D.3.3.	**Future systems**	**Nov 04**		**Re**
D.3.5.	**National meeting**	**Nov 04**		**Oral**

Table 4: Timetable

TITLE		2001*				2002*				2003*				2004*			
Tasks	Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
	WP1:																
1	Experiment 'unringed pregnant sows'					x	x	x	x	x	X						
2	Experiment 'strategies for finishers on pasture'					x	x	x	x	x	X						
3	Propose strategies for grazing management											x	x	X			
M.1.1	Design of experiments completed				X												
M.1.2	Completion of experiment on 'un-ringed pregnant sows'										X						
M.1.3	Completion of experiment on 'strategies for finishers on pasture'										X						
	WP2:																
1	Experiment 'nutrient losses for growing pigs on pasture'					x	x	x	x	x	X						
2	Experiment 'pasture damage and nutrient losses for unringed pregnant sows'					x	x	x	x	x	X						
3	Nutrient losses in different pig production systems							x	x	x	x	x	x				
M.2.1	Environmental guidelines for keeping growing pigs on pasture															X	
M.2.2	Environmental impact related to use of nose-ring															X	
	WP3:																
1	LCA-indicator choice and development			x	x	X											
2	Data collection					x	x	x	x	x	x	x	X				
3	System modelling							x	x	x	x	x	X				
4	System assessment											x	x	x	x	X	X
5	Co-ordination		x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
6	Project meeting		x		x		x		x				x			x	
7	Annual report				x				x				x				X
M.3.1	LCA indicators agreed					X											
M.3.2	Co-operation established			X													
M.3.3	Conceptual model developed								X								
M.3.4	Assessment analysis developed															x	

* If convenient, indicate the actual month (can be done by numbers: January is 1 etc.)

7. Collaborative partners

This project will be carried out in close co-operation with the Danish development project 'New organic pig production systems integrated into land use with focus on environmental impact and consumers' accept', in which data from farms and experimental units are going to be collected. Further, co-operation will be established with the project 'MANORPIG'(DARCOF II.8), headed by Jan Tind Sørensen, which also is related to the development project, focusing on health aspects of the different pig production systems. Results from this project are expected to contribute to the evolution of proposed future systems in the latter part of the present project.

The project 'ORGANICPIGFEED (Pig feeding under organic conditions with emphasis on nutrient utilization, product quality and health), DARCOF II.7, headed by Viggo Danielsen, is expected to yield results, which can contribute to the overall assessment of different systems, and so is the EU-project 'Sustainability in the production of pork with improved nutritional and eating quality using strategic feeding in outdoor production' in which participants in the present project have a minor role.

Besides these formal linkages, co-operation is expected to take place with relevant projects in UK, Holland and Sweden (contact persons Sandra Edwards, IMJ de Boer, and Gunnela Gustafson, respectively).

8. Budget

Institution 1 (JBS)	**2001**	**2002**	**2003**	**2004**	**Total**
Months (scientific)	2	5	6	5	18
Months (technical)	1	3	3	1	8
Salary (scientific)	75	178	220	200	673
Salary (technical)	22	69	72	25	188
Consultancy [1)]	10	30	30	30	100
Operation – other	10	100	70	40	220
Overhead	23	75	78	59	235
Total	140	452	470	354	1.416

[1)] *National committee for Pig Production*

Institution 2 (PVJ)	**2001**	**2002**	**2003**	**2004**	**Total**
Months (scientific)		2	2.5	5	9.5
Months (technical)		4	3.0	-	7.0
Salary (scientific)		84	111	234	429
Salary (technical)		99	76	-	175
Operation – equipment					
Operation - other		100	99	60	259
Overhead		57	57	59	173
Total		340	343	353	1.036

Institution 3 (HSV)	**2001**	**2002**	**2003**	**2004**	**Total**
Months (scientific)	1	4	2	1	8
Months (technical)		3		-	3
Salary (scientific)	30	124	64	33	251
Salary (technical)		66		-	66
Operation – equipment					
Operation - other		20	20	10	50
Overhead	6	42	17	9	74
Total	36	252	101	52	441

Institution 4 (JBT)	**2001**	**2002**	**2003**	**2004**	**Total**
Months (scientific)	1	1	1	1	4
Months (technical)					
Salary (scientific)	36	37	38	39	150
Salary (technical)					
Operation – equipment					
Operation - other	8	8	10	10	36
Overhead	9	9	10	10	38
Total	53	54	58	59	224

Institution 5 (SJFI)	**2001**	**2002**	**2003**	**2004**	**Total**
Months (scientific)	0,5	2	2	3	7,5
Months (technical)					
Salary (scientific)	17	70	72	110	269
Salary (technical)					
Operation – equipment					
Operation - other	6	16	16	20	58
Overhead	4	17	18	26	65
Total	27	103	106	156	392

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