

Development of organic pig production systems

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Abstract

There has been a tremendous growth in numbers of organic farms, including livestock farms, in EU over the latest years. Livestock products were within the top five organic products in 14 out of 16 European countries. Pork, however, only plays a minor role in this respect although, at present, there is a considerable development of the sector in some countries. The proportion of organically produced pigs is estimated from 'not detectable' in most countries over 0.2-0.3% in a few countries with a large overall pig production (Denmark, France) to approximately 1% in Austria.

The EU provides a standard that involves the right to label food as organic. It includes specifications for housing conditions, animal nutrition, and animal breeding as well as animal care, disease prevention, and veterinary treatment. These standards are very different from the way in which conventional, intensive pig production is carried out and doubtless form a major constraint for many farmers wanting to convert to organic pig production.

Strategies to cope with acceptable ways of housing, use of roughage and free-range sow production based on recent research results are discussed. It has been concluded that good production results can be obtained in organic pig production. In relation to health, problems concerning control of endoparasites may occur, whereas lung health normally is very good.

In relation to feeding of finishers, it is important to be aware of the risk of reduced fat quality if the diet includes more oil seed as protein source because of difficulties in using soybean meal (no GMO, no use of chemical solvents). It is also important to be aware of a reduced tenderness of the meat for finishers fed too restrictively.

In relation to housing of finishers, systems established as a combination of a barn and an outdoor run give the possibility of obtaining very good production results and animal welfare. However, since the overall housing area needed for such systems is considerable, the costs of production are high and there seems to be a need for development of less capital-intensive systems.

In relation to sows there is a need to establish systems where an effective reproduction can be obtained given the fact that weaning takes place at approximately seven weeks. In addition, there is a need to develop new grazing systems where the risk of environmental problems has been reduced.

Introduction

There has been a tremendous growth in numbers of organic farms in EU over the latest years – from below 20,000 farms in year 1992 to more than 120,000 farms in 1999 (Padel, 2000). Worldwide-certified organic production takes place in 130 countries, half of which are developing countries

(ITC, 1999). The market share in EU on total, however, is still quite low ranging from less than 0.5% in nine out of 18 countries some countries to 5-9% in other countries for some major product groups (Michelsen et al., 1999).

Livestock production and especially ruminant livestock production forms an integral part of many organic farms due to its role in nutrient recycling on farms. Out of 16 European countries, livestock products were within the top five organic products in 14 countries (Michelsen et al., 1999). The market share of livestock products, however, is very different from product to product. In Austria, Denmark, Switzerland and Finland milk products are the most important organic products. Pork and poultry only play a minor role whereas eggs in some countries are quite important.

The actual development can be attributed to an increased consumer interest in organic products throughout Europe while, at the same time, farmers are interested in converting to organic production methods – often stimulated by governmental support or subsidies.

The main actors mentioned, however, do not necessarily have the same expectation to organic farming and the future development in organic farming in general as well as the individual livestock systems in particular may depend on to what degrees common expectations can be fulfilled.

The aim of this paper is to highlight some of the prospects and constraints for the development of the organic pig production.

Regulations for organic livestock farming in EU

In the European countries, the EEC-Regulation No 1804/1999, supplementing regulation No 2092/91 on organic production, has been passed and become law in August 2000. As shortly described in Sundrum (2001), Jakobsen & Hermansen (2001) and Padel et al. (2000), the EEC-Regulation provides a standard that involves the right to label food as organic. It includes specifications for housing conditions, animal nutrition, and animal breeding, as well as animal care, disease prevention, and veterinary treatment, and will create a framework for organic livestock production and labelling products in all European countries on an equal, legal base. An important key principle is to rely mainly on the management of internal farm resources rather than on external input and, in relation to health management, to rely on prevention measures rather than on medical treatment.

As regards feed, this intends to ensure quality production rather than to maximize production, while meeting the nutritional requirements of the livestock at various stages of their development.

Livestock must be fed on organically produced feeding stuffs, preferably from the farm itself. A limited proportion of conventional feeding stuffs is permitted within a transitional period expiring on 24 August 2005. It is specifically requested that

- The feeding of young mammals must be based on natural milk, preferably maternal milk, for a minimum period depending on the species.
- Roughage, fresh or dried fodder, or silage must be added to the daily ration for pigs.
- Only feed materials listed in Annex II of Council Regulation No 1804/1999, whether conventionally or organically produced, can be used (a positive list). Furthermore, conventional feed materials of agricultural origin can be used only if they are produced or prepared without the use of chemical solvents. This implies that e.g. soybean meal, the most common protein source in animal nutrition, cannot be used in organic feed.
- Antibiotics, coccidiostats, medical substances, growth promoters, or any other substance intended to stimulate growth or production are not allowed in animal feeding.

- No feed components may have been produced with the use of genetically modified organisms (GMOs) or GMO derivatives.
- Vitamins authorised for conventional animal production under Directive 70/524/EEC should be derived from raw materials occurring naturally in foodstuffs. Synthetic vitamins identical to natural vitamin can, however, be used for monogastric animals.

The legislation for organic livestock production aims at providing environmental conditions, which allow animals to perform their natural movements and behaviour. Management methods must not interfere with animals' body parts, meaning that e.g. tail docking is not allowed. However, castration is allowed to reduce aggressions in pens and during transport and to ensure product quality.

The minimal standards in relation to animal welfare are primarily focussed on locomotion areas, floor characteristics and husbandry practices. Dry litter as well as group penning is prescribed for all farm animals. Tethering farm animals is not acceptable. The indoor area is supplemented by an outdoor area that must be at least 75% of the indoor area.

The main minimum requirements for organic pig production are shown in Table 1.

Table 1.

Sows are often kept in outdoor systems and pigs are moved to an indoor pig unit with an outdoor yard when they are weaned at seven weeks of age. However, new space requirements (Table 2) have been introduced. They are about 50% higher than earlier. This might increase farmers' interest in keeping finishers outdoors for a longer period or up until slaughter even although a number of problems remain to be solved with respect to environment and feed conversion rate, which might be affected negatively.

Table 2.

The above mentioned regulation is formed partly on the basis of the guidelines formulated by the International Federation of Organic Agriculture Movements (IFOAM, 1996; IFOAM, 2000). However, it is important to realize that the EU-legislation is an administrative interpretation of the ideas of organic farming, which in their scope have wider goals, mainly originally identified and developed in individual countries.

So, member states, or the certifying body within the member state, may apply stricter rules to livestock and livestock products produced within their territory. And they do. In France, for instance, the herd size is restricted and amounts to a maximum of 85 sows if the farm has a low degree of home produced feed. In Great Britain and Sweden, the 'Soil Association' and 'KRAV', respectively, do not accept nose-ringing of sows on pasture or castration of male pigs (Soil Association).

Size of organic pig productions

As mentioned above, the organic pig production is small, in general, compared to other organic enterprises. It is difficult to get an exact assessment of the production in the different countries due to differences in monitoring. Foster & Lampkin (2000) have collected data from the national

agricultural administrations and certification bodies. These data are shown in Table 3. It appears that Denmark, Germany, and Austria have a considerably larger organic pig production than the other countries mentioned. However, the figures given in Table 3 may be difficult to interpret in relation to actual amount of organic pork produced (and sold as organic). This is partly because a strong expansion takes place in some countries and partly because different production structures make it difficult to translate number of pigs for pork production. For instance are the most recent data on organic pork (finishers) production in 2001 estimated at 63,000 in Denmark (Larsen, 2002; *personal communication*) and at 50,000 in France (Dutertre, 2002; *personal communication*).

No matter the variation in estimates, the organic pork production compared to the conventional pork production is very small.

Table 3.

For Austria the proportion is estimated at just above 1% (Foster & Lampkin, 2000) and in Denmark and France it can be estimated at approximately 0.3% and 0.2%, respectively. This is a small proportion, but, nevertheless, it is of an extent that may be considered 'commercial'.

Research in organic pig production

Few published results address organic pig production specifically.

As part of two Danish action plans for organic farming (1996, 1999, (MAF, 1999)) several research initiatives were set in motion including projects on pig production. Some of the results are presented in the following.

Housing systems for finishers

A comprehensive work programme has been carried out in relation to organic production of slaughter pigs. As regards the construction of pigbarns with access to outdoor runs, Møller (2000), Olsen (2001) and Olsen et al. (2001) investigated the influence of the type of indoor floor (deep-bedded and partly slatted floors), the size of outdoor run and a partial cover of the outdoor run on production and behaviour. In all cases, the stables were naturally ventilated and the floor of outdoor runs were solid (concrete). Overall, very good production results were obtained in these systems, >900 g daily weight gain, low feed consumption and a lean content of approximately 60%. Aggression levels among pigs were low and the indoor climate was good with a low concentration of ammonia, carbon dioxide, and dust. This was partly a result of the fact that most of the manure (>80%) was placed on the outdoor run. This resulted in a low straw consumption compared to other systems based on deep litter.

In relation to the planned treatments, differences were small. These types of stable and, maybe especially, the type described in detail by Olsen (2001) can doubtless function very well, but they are expensive to establish.

An alternative concept where pigs were raised from weaning to slaughter in a climate tent system with access to an outdoor, deep-bedded run has been investigated. The deep-bedded run was placed on the top of a basin created by a layer of seashells on the top of a geomembrane. Thus rainwater and urine was stored, meaning no loss to the underground.

In general, such a system yielded very good production results (Jensen and Andersen, 2000). However, control of endoparasites was difficult. Another interesting feature of the system is that the N-loss from this outdoor area was far smaller than expected (Møller et al., 2000) and that the N-

content of the liquid collected in the basin was extremely low, indicating that the N was microbiologically built into the deep litter.

Feeding of finishers

Several investigations have focussed on the use of roughage. The overall idea was to explore what beneficial effect could be obtained in relation to feeding.

Danielsen et al. (2000) investigated the effect of restricting concentrate on the *ad libitum* intake of clover grass and clover grass silage, respectively, in two experiments, as well as on the production results and sensory meat quality:

Restricting concentrate to 70% of ad lib intake on a daily basis resulted in:

- a higher roughage intake (20-30%), but, nevertheless, only amounting to 5-6% of total energy intake
- a lower daily gain (12-16%)
- a lower feed consumption per kg gain (10%)
- an increased lean content (1-2%)
- reduced tenderness of the meat
- an increased hardness of the meat

The effects mentioned were significant for at least one of the two experiments carried out.

Jensen & Andersen (2000) compared roughage given separately from the concentrate and as a mixed diet in different proportions through the growing period. The overall results from this experiment were that the mixed diet resulted in a significantly lower daily gain and that a roughage intake of 5-10% of the total energy could be obtained without compromising daily gain. It is clear from the experiments, so far, that fibre-rich roughage will have a limited place, only, also in organic slaughter pig production.

In the experiments mentioned above, no reference was made to non-organic production. Hansen et al. (2001) did so including focus on almost all aspects of meat and sensory quality. Treatments included non-organic production in the same environment as the organic production except that access was given to neither outdoor run nor roughage. In three other treatments, organic concentrates were given without access to roughage or with access to two different types of roughage and, at the same time, a reduced level of concentrate (comparable to the before-mentioned experiment by Danielsen et al. (2000)). Some main results are given in Table 4.

The organic production (although without access to roughage) resulted in a slightly lower daily gain and a higher content of polyunsaturated FA in the fat whereas no differences were observed in lean content, tenderness, and vitamin E content. Restricting concentrate gave the same results as in the investigation of Danielsen (2000) in relation to lean content and tenderness. In addition, a marked reduction in intramuscular fat and vitamin E content in muscles and a higher content of polyunsaturated FA in fat were observed.

Table 4.

In all the experiments mentioned soybean meal was the primary source of protein. It appears that even in this situation the organic feeding, and especially if fed restrictively, resulted in an increased content of polyunsaturated FA.

At present and perhaps also in future, alternative protein sources will be used because of the ban on GMO-products and products resulting from a fat extraction with chemical solvents. Hereby, probably more fat-rich sources will be considered. The above-presented results indicate that it will be important in this situation to consider harmful effects on the 'fat-quality' of the pork.

Sow production

Only limited data on the overall productivity of the outdoor organic sows are available.

Investigations over a 4-year period from four organic herds gave production results on a per-litter basis, which in the last part of the investigation period was almost comparable to the 25% best results from Danish indoor herds, i.e.

- born alive/litter: 11.8 versus 12.1
- weaned/litter 9.8 versus 10.8

(Lauritsen et al., 2000; Larsen, 2001). Number of litter per sow was lowest in the organic system, partly because of a longer weaning period (7-8 week compared to 4-5 weeks) and partly because of poorer reproduction results. Larsen & Jørgensen (2002) found in non-organic, outdoor herds that the reproduction results were comparable to results from indoor systems indicating that poor production results are not related to the fact that sows are kept outside *per se*. A possible explanation for the poorer reproductive performance observed in organic herds may be related to the longer lactation period in which some sows came in heat followed by an irregularity after weaning.

It has been speculated that the longer lactation period may compromise the welfare of the sow because of weight loss and a growing conflict between the willingness of the sow to suckle and the piglets' demand for food. However, in a study comparing a weaning age of five and seven weeks, Andersen et al. (2000) found no differences in weight loss (-4 kg versus -3 kg), restlessness, or aggression towards the piglets related to weaning age. The authors concluded that overall there was no indication that sows suffered more by seven weeks of lactation than by five weeks of lactation, but the piglets seemed to profit by a suckling period of seven weeks compared to weaning after five weeks. It was specified that the lack of effect of weaning age on restlessness and piglet-directed aggression in the present study might be due to the outside housing in a paddock which allowed the sows to avoid the piglets by merely walking away. Also the piglets had access to more natural substrates for exploration, which might be an explanation for the stable level of restlessness and aggression towards the piglets between sows in the two treatments.

Sows on grass

Another important feature of the sow production is the keeping on grassland. Investigations have focused on environmental load, grass intake, health aspects, and sow welfare.

As regards the environmental load, Eriksen (2001) and Eriksen & Kristensen (2001) evaluated the risk of N-leaching in relation to management of organic, outdoor sows, and Petersen et al. (2001) and Sommer et al. (2001) investigated the consequences for denitrification losses and ammonia volatilization. These authors found that of the 56% N input to the sows that was not accounted for in piglets produced, the major part seemed to be lost by leaching (16-35%), by NH₃-volatilization (13%), and by denitrification (8%). Hereby, with the stocking rate used, the nitrate content in the water under soil zone was unacceptably high in different parts of the grazing area, primarily related to the feeding place.

This environmental load is obviously related to the huge import of nutrients to the grazing area. There seems to be a perspective in relying, to a higher degree, on intake of grass produced on the grazing area in the sows' diet. Danish and Scottish grazing experiments indicated that pregnant sows

can consume 2-4 kg grass DM daily, which may correspond to more than half their energy requirement (Sehested et al., 2000; Rivera Ferre et al., 2000).

It is not clear if and how much the lactating sows can rely on grass. Experiments with silage for outdoor, lactating sows indicate a maximum of 10-15% of energy from grass without compromising litter gain (Kongsted et al., 2000).

Pig health and welfare aspects

The rearing of pigs under organic conditions may influence several aspects of health and welfare. Carstensen et al. (2002) found a relatively high prevalence of helminth infection compared to levels normally observed in conventional pig production. Based on faecal samples collected during the summer period in nine organic swine herds, it was shown that the organic pigs were infected with *Ascaris suum* (28% of weaners, 33% of fatteners, 4% of sows), *Trichuris suis* (4% of weaners, 13% of fatteners, <1% of sows), and *Oesophagostomum* spp. (5% of weaners, 14% of fatteners, 20% of sows). No infections with *Hyostrogylus rubidus*, *Metastrongylus* spp., or *Strongyloides ransomi* were detected. Although it was higher than in conventional herds, the infection was considerably lower than found in a previous investigation from 1990 to 1991, which probably reflects an increasing professionalism in organic pig rearing with rotational grazing etc.

For outdoor sows Vaarst et al. (2000) observed few clinical diseases. Physical injuries causing lameness, skin traumas, and sunburn were the most prominent clinical findings. Feenstra (2000) studied the occurrence of pathogens through blood samples and examinations of lungs at slaughter from four organic herds. It was concluded that the lung health was better than normally seen in conventional herds, which is in agreement with a major Swedish investigation based on investigations at the slaughterhouse (Hansen et al. 1999).

Antibodies to *Mycoplasma hyopneumonia* and *Salmonella* were present in sows from all herds. These antibodies were not present in the piglets, but antibodies to *Salmonella* were found in finishing pigs at low titre. Post weaning diarrhoea due to *Escherichia coli* was the most prominent health problem.

Challenges to commercial organic pig production

The main approach so far has been to have the sows kept on grassland and the porkers reared in barns where the pigs at the same time have access to an outdoor run often made out of concrete. The sows are often given a nose-ring to prevent them from rooting and damaging the pastures which, among other things, are expected to increase N-losses from the grazing area. Male pigs are most often castrated to eliminate the risk of boar-taint in the products. For such systems, which may or may not be the situation in the different countries, several challenges exist

- barns for finishers with an established outdoor run made of concrete are very expensive considering the requirements for area per pig given in the EU regulations, which puts a heavy burden on the producer. In addition, it may be questioned if pigs reared under such conditions comply with the consumers' expectations to organic farming,
- nose-ringing of sows is indeed questionable. Major organic actors in several countries (e.g. Soil Association in England and KRAV in Sweden) do not accept this, and there is an urgent need to develop keeping strategies for sows on pasture without a nose-ring. In this respect the risk of environmental load is important,
- despite regulations on stocking density on the grazed area, considerable N-losses are often seen on the grazing area. Danish investigations showed an N-surplus ranging from 300 to 600 kg N/ha on the areas used for sows on grass. It is estimated that this can lead to a leaching of 150 kg N/ha

and of ammonia evaporation of 70 kg N/ha (Eriksen, 2000). Such an environmental load might easily be considered unacceptable by the authorities,

- until now, feeding has often included a supplement of conventional feed (up to 20% of DM), mainly for obtaining a good protein and vitamin supply. Several restrictions on that have been implemented now and from year 2005 only organically produced feed is accepted. This puts a heavy pressure on finding the most appropriate source for protein and vitamin supply to ensure an efficient production without compromising the product quality, which may be impaired if, for instance, more unsaturated fat is used in the diet for slaughter pigs.
- routinely castration of the male pig is also a matter of concern considering the integrity of the animal and the working conditions of the farmers – especially in the free range systems, where facilities often are poor. Very different views on that exist in the different countries, where, normally, UK will not castrate, whereas e.g. in Denmark and Germany castration is almost always done. In the long run, it appears that the organic production should avoid routinely castration.

It appears that many issues have to be considered in the organic commercial pig production. Probably, completely new systems need to be developed, where the pig production is fully integrated in the land use; e.g. where the grass/pasture constitutes a considerable part of feed for sows and the rooting of the pigs are taken advantage of. The present Danish work programme to elucidate some of these concerns are argued in detail in a so-called 'work of knowledge synthesis' (Hermansen, 2000) and includes:

- Development of a one-unit pen in climate tents. Sows are removed at weaning leaving the pen for 4-6 litters to finish in the tents. The tents are fully integrated in the land use allowing sows and finishers to graze in the summer period, whereas in the winter period the pigs are staying in a 'protected' area (Andersen et al., 2000).
- Investigation of the functionality, level of production, investment costs, running costs, sensitivity, and management options for four different housing systems for weaners and finishers (open barns and three types with both an indoor and an outdoor area (deep litter (compost), deep dry litter, and straw flow).
- Investigating if and how nose-ringing of sows (and differences in rooting) influences the risk of leaching N.
- Development of grazing strategies for finishers staying only part of the rearing period on grass in order to reduce environmental load on one hand and to reduce costs on the other (www.foejo.dk).
- Investigating grazing strategies for sows.
- Investigating new protein sources for finishers in relation to growth and product quality.
- Investigating the influence of geno-type and group formation on boar taint in entire male pigs.

This effort is expected to contribute in the process of having the organic pig production systems to comply with expectations of different kinds.

The livestock rearing should contribute to a more balanced overall production of the farm, the food safety (in a wide sense) should be enhanced, and the animal welfare should be better compared to conventional production methods. Also, the environmental load should be low. The success of the expansion of organic systems will depend on to what degree these different expectations can be fulfilled without resulting in too high premium prices of the products.

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Table 1. Organic pig production – minimum requirements

| Item | Requirement |
|------------------|---|
| General | |
| - Age at weaning | 40 days (DK: 49 days) |
| - Feed | Less than 20% non-organic feed – from 2005 100% organic feed Access to roughage or rooting material |
| - Use of drugs | No preventive medical treatment of animals Medical treatment only after instruction and diagnose by a veterinarian Subsequent treatment with therapeutic drugs - only by a veterinarian 2 times longer retention time than required by veterinary authorities Log of all veterinary treatment and use of disease control agents |
| - Treatment | No tail docking and teeth clipping (or grinding) |
| Indoor housing | |
| - Outdoor yard | Max. 50% covered with roof |
| - Gestation sows | Group-housed |
| - Lactating sows | Loose |
| - Weaners | Flat-deck pens not allowed. |
| - All categories | Free access to roughage Clean and dry litter in lying area Each lying zone must accommodate all animals in pen |
| Outdoor housing | Access to grazing area at least 150 days from 15 April – 1 November (except for weaners and finishers) Access to shelter, shade and cooling facilities Clean and dry litter in lying area |

Table 2. Organic pig production - space requirements

| Space requirements (buildings) | Indoor space, sqm./animal | Solid floor space indoor, sqm./animal | Outdoor yard space, sqm./animal |
|--------------------------------|------------------------------|--|------------------------------------|
| Boars | 6.0 | 3.0 | 8.8 |
| Lactating sows | 7.5 | 3.75 | 2.5 |
| Gestation sows | 2.5 | 1.25 | 1.9 |
| Weaners 40 days – 30 kg | .6 | .3 | .4 |
| Finishers 30-50 kg | .8 | .4 | .6 |
| Finishers 50-85 kg | 1.1 | .55 | .8 |
| Finishers 85-110 kg | 1.3 | .65 | 1.0 |

Table 3. Certified pigs in different countries (after Foster & Lampkin, 2000)

| Country | 1995 | 1998 |
|----------------|-------------|-------------|
| Austria | - | 41,000 |
| Germany | 23,000 | 50,000 |
| Denmark | 13,000 | 83,000 |
| Finland | - | 11,000 |
| France | - | 10,000 |
| Great Britain | 6,000 | 9,000 |
| Netherlands | - | 5,000 |
| Sweden | - | 21,000 |
| Switzerland | - | 12,000 |

Table 4. Effects of organic feed and restricted intake on daily gain and pork quality (after Hansen et al., 2001)

| | Ad lib concentrates Organic compared to non-organic | Organic diet Ad lib concentrate compared to restricted |
|--------------------|--|---|
| Daily gain | -7% | -20% |
| Lean content | NS | +2% |
| In muscles | | |
| Intramuscular fat | NS | -20% |
| Vitamin E | NS | -10% |
| Tenderness | NS | -13% |
| In fat | | |
| Saturated FA | NS | -5% |
| Monounsaturated FA | -4% | -3% |
| Polyunsaturated FA | +13% | +15% |