7

DEVELOPMENT OF ORGANIC PIG PRODUCTION SYSTEMS

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Introduction

There has been a tremendous recent growth in numbers of organic farms in the EU – from below 20,000 farms in 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 the EU on total, however, is still quite low ranging from less than 0.5% in nine out of 18 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 factors 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 degree common expectations can be fulfilled.

The aim of this chapter 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 European countries, the EEC-Regulation No 1804/1999, supplementing regulation No 2092/91 on organic production, has been passed and became law in August 2000. As described by 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 soya bean 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 authorized for conventional animal production under Directive 70/524/EEC should be derived from raw materials occurring naturally in foodstuffs. Synthetic vitamins identical to natural vitamins can, however, be used for non-ruminant 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 body parts, meaning that tail docking,

for example, 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 7.1.

Table 7.1 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
	Record of all veterinary treatment and use of disease control agents
- Treatment	No tail docking and teeth clipping (or grinding)
Indoor housing	
- Outdoor yard	Maximum 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

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 7 weeks of age. However, new

space requirements (Table 7.2) have been introduced which are about 50% larger than earlier. This might increase farmer interest in keeping finishers outdoors for a longer period or up until slaughter even though a number of problems remain to be solved with respect to environment and feed conversion ratio, which might be affected negatively.

Table 7.2 ORGANIC PIG PRODUCTION - SPACE REQUIREMENTS

Space requirements (buildings)	*Indoor space, m^2/animal*	*Solid floor space indoor, m^2/animal*	*Outdoor yard space, m^2/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	0.6	0.3	0.4
Finishers 30–50 kg	0.8	0.4	0.6
Finishers 50–85 kg	1.1	0.55	0.8
Finishers 85–110 kg	1.3	0.65	1.0

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

Thus member states, or the certifying body within the member state, may apply stricter rules to livestock and livestock products produced within their territory, which they often 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, organic pig production is small, in general, compared to other organic enterprises. It is difficult to get an exact assessment of the production in 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 7.3. 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 7.3 may be difficult to interpret in relation to actual amount of organic pork produced (and sold as organic). This is partly because strong expansion has taken place in some countries and partly because different

production structures make it difficult to translate number of pigs for pork production. For instance the most recent data on organic pork (finishers) production in 2001 estimated this at 63,000 in Denmark (Larsen, 2002; *personal communication*) and at 50,000 in France (Dutertre, 2002; *personal communication*).

Table 7.3 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

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

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 in 1996 and 1999 (MAF, 1999) several research initiatives were set in place including projects on pig production. Some of the results are presented in the following sections.

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 pig barns 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 barns were naturally ventilated and the floors 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 barn and, specifically, 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 geo-membrane. Thus rain water and urine were stored, meaning no loss to the underground water system.

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 incorporated 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 libitum* 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 throughout 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 also only have a limited place in organic pig meat production.

In the experiments mentioned above, no reference was made to non-organic production. Hansen *et al.* (2001) did so including assessment of 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 not given to outdoor runs or 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 aforementioned experiment by Danielsen *et al.* (2000)). Some main results are given in Table 7.4.

Table 7.4 EFFECTS OF ORGANIC FEED AND RESTRICTED INTAKE ON DAILY GAIN AND PORK QUALITY (AFTER HANSEN *et al.*, 2001)

	Ad libitum concentrates, organic compared to non-organic	*Organic diet, ad libitum 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%

Organic production (although without access to roughage) resulted in a slightly lower daily gain and a higher content of polyunsaturated fatty acid 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 fatty acid in fat were observed.

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

At present and perhaps also in the future, alternative protein sources will be used because of the ban on GMO-products and products resulting from oil extraction with chemical solvents. Thus it is possible that 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 were 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). Numbers of litters 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 into heat followed by irregular oestrus 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 piglet demand for food. However, in a study comparing weaning ages of 5 and 7 weeks, Andersen *et al.* (2000a, b) 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 7 weeks of lactation than by 5 weeks of lactation, but the piglets seemed to profit by a suckling period of 7 weeks compared to weaning after 5 weeks. It was speculated 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 merely by walking away. Furthermore 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 sow production is keeping on grassland. Investigations have focussed 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 NH_3-volatilization (13%), and by denitrification (8%). As a consequence, with the stocking rate used, the nitrate content in the water under the 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 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 pig 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 *Hyostrongylus 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 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 sows kept on grassland and porkers reared in barns where the pigs have access at the same time 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 invariably castrated to eliminate the risk of boar-taint in the products. For such systems, which may or may not be the situation in 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 consumer expectations of organic farming.
- nose-ringing of sows is indeed questionable. Major organic organisations 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 housing 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 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 meat 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 are often poor. Very different views on that exist in the different countries where, normally, UK will not castrate, whereas in Denmark and Germany castration is almost always done. In the long run, it appears that organic production should avoid routine castration.

It appears that many issues have to be considered in organic commercial pig production. Completely new systems probably need to be developed, where pig production is fully integrated with land use, e.g. where the grass/pasture constitutes a considerable part of feed for sows and the beneficial rooting of pigs are encouraged.

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 with land use allowing sows and finishers to graze in the summer period, whereas in the winter pigs stay in a 'protected' area (Andersen *et al.*, 2000a, b).
- 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 remaining for 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 genotype and group formation on boar taint in entire male pigs.

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

Livestock rearing should contribute to a more balanced overall production of the farm, food safety (in a wide sense) should be enhanced, and animal welfare should be compared better to conventional production methods. Furthermore, 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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