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Integration of organic pig production into land use

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Abstract

The development in organic livestock production can be attributed to an increased consumer interest in organic products while, at the same time, farmers are interested in converting to organic production methods – often stimulated by governmental support or subsidies. It is important that the organic production systems can fulfil the expectations of each of these stakeholders if the organic livestock production is to increase further. This is in particular important if the organic pig production should move from the present niche-production to a real player in the food marked, like in the case of beef and milk.

In the regulations for organic farming, the aspect of allowing a high degree of natural behaviour of the livestock is among others translated in the requirement that livestock in certain periods of their life or of the year should be allowed to graze or have access to another outdoor area. The most common outdoor systems for pig used in intensively managed organic production have some important drawbacks in relation to environmental impact (risk of N-leaching and ammonia volatilisation), animal welfare (nose-ringed sows) and workload and management constraints.

With the starting point in the present experience in such systems, it is argued that there is a need for a radical development of the systems. There is a need to search for systems where the outdoor/free range systems (for the sake of the livestock) are constructed and managed in a way whereby the livestock at the same time exert a positive influence on other parts of the farming systems. There is evidence that pregnant sows can fulfil their nutritional needs to a large extent by grazing, that co-grazing sows with heifers can diminish the parasite burden of the heifers, and that the pigs' inclination for rooting can be managed in a way that makes ploughing and other heavy land cultivation more or less superfluous. These elements need to be further explored as a basis for future system development.

Introduction

Livestock often plays an important role – besides supporting income for the farmers – in obtaining some of the principle aims in organic farming i.e. diversified production and supporting biological cycles within the farming system. However, some main conflicts may appear in how and to what degree the different aims can be obtained. In relation to livestock, conflicts may appear in the most appropriate keeping practice related to consideration of the basic aspects of their innate behaviour on one hand, the risk of pollution from the production on the other and, in addition, the aim of producing in sufficient quantities. These possible conflicts are reflected in the compromises set in national or EU regulations on organic farming. The regulations, however, often develop after an intensive debate where, sometimes, you may get the impression that livestock production may be acceptable but not desirable in organic farming, at least for some species. In the long term, it therefore seems important that production systems are developed so that different sorts of livestock production can contribute directly to a steadily increasing fulfilling of the organic ideals on a national scale or at farm level. This is in particular true as regards pig production.

Andresen (2000) puts words to the idea saying that the view on livestock should be changed from considering them as being passive (receivers) to active parts of the sustainable development of production systems. More focus should be put on the (various) capabilities of the animals and less on the "requirements" of the animals. The challenge is then to give conditions so that the livestock can optimize the value of their various capabilities rather than to control the animal in the environment. The emphasis on animal performance then shifts from mere feed conversion to functional efficiency in the farming system. This leads to new parameters for evaluation.

In contrast to milk and beef products organic pork were not on the top five list in any of 18 European Countries (Michelsen et al 1999). There is no reason to believe that this difference is caused by a difference in the consumers' preferences. It is more likely that the difference is related to the fact that it is far more difficult for the farmers to change the production system for pigs compared to production systems for cows and other ruminants in a way that gives a harmonious balance between the different aims of organic farming.

The aim of this paper is to highlight some of the prospects and constraints for an integration of pig production into land use based on the Danish experience so far.

Typical pig production systems

Some main requirements within EU as related to pig production are that pigs should have access to grazing for at least some part of the year. Though, finishers can be housed in barns if they have access to an outdoor run in at least 80% of their lifetime. The weaning age for piglets should be at least 40 days.

In different countries or different certification bodies, stricter rules can be implemented. So, several ways of organic pig production take place due to different practice as well as different regulations in different countries. The typical way in Denmark represents some of the major challenges to be met for the development of the organic pig production. Typically, sows are kept in outdoor systems all year round (Figure 1 and 2) and pigs are moved to an indoor pig unit with an outdoor yard when they are weaned at seven weeks of age. This system was stimulated by a simultaneous development of outdoor systems for conventional sow production as indicated in Table 1. Since 1996, the number of sows housed outdoors has doubled and the organic production has increased fourfold. However, as it appears from Table 1, stagnation in organic pig production seems to take place. The number, 74,000, of finishers is only less than 0.3% of the total Danish pork production of approximately 23 mill. per year. This underlines the underdevelopment of this sector in Denmark.

Figure 1 and 2 and Table 1 here

Because it is part of the organic regulations to have the sows on pasture for at least 150 days during summertime and a number of conventional farmers had positive experiences with keeping their sow herds outdoors all year round, the Danish organic producers choose this system too. In this way, they have only one production system for their sow herd instead of having both, a system for summer housing and a system for winter housing. The layout of the paddocks depends on soil type and the available land at the individual farm. The paddocks are normally moved to a new field every spring, often in a two-year crop rotation - one year with barley with an under-sown grass-ley and one year with sows on pasture. The stocking rate is adjusted to an excretion of 140 kg N in pigs manure per ha and year (often practised as 280 kg N/ha every second year).

The way of production may be different in other countries. In some countries, the sows are mainly kept at pasture in the summer period. On the other hand in Sweden, it is mandatory to keep also finishers on grass in the period May-September in organic systems. Several challenges exist related to management for sows and finishers, respectively, which will be elaborated on in the following.

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. for organic and conventional herds, respectively.

- 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 (seven-eight weeks compared to four-five 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 come in heat followed by an irregularity after weaning.

Sows on grass

One of the major concerns in keeping sows on grass in intensively managed production has been the potential environmental impact due to high excretions of plant nutrients, especially N and P in the manure.

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 the one found on average in conventional outdoor sow herds, the present nutrient surplus definitely represents an environmental risk. 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 are related to nitrate leaching (Eriksen, 2001), ammonium volatilization (Sommer et al., 2001) and denitrification (Petersen et al., 2001

In Denmark, the sows kept outdoors are ringed to prevent them from rooting and damaging the sward. 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). Also, 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.

In a Danish investigation (Eriksen, personal communication), the effect of ringing and short term stocking density for pregnant and lactating sows on vegetation cover and risk for leaching of N is being investigated now. The overall stocking rate evaluated on the basis of expected excretion of N from the sows (equivalent to an expected load of 280 kg N/ha) and calculated on a yearly basis was similar in all treatments. Sows were given either an approximately 360 m^2 or 180 m^2 per sow across a 20-week or 10-week summer period. The preliminary results showed that the ring did not affect the grazing behaviour, but to some extent prevented rooting/damaging the grass cover in the paddocks with pregnant sows. In the nursing pens, ringing had no significant effect if each sow was given an area of 360 m^2. At 180 m^2 per sow (only unringed), the vegetation cover was much lover.

However, the relation between ringing and content of highly soluble N in the soil was not that simple. In fact, no clear effect of ringing was found at the paddock level. On sample plot level, a negative correlation between vegetation cover and content of highly soluble N in the soil was found in the paddocks for pregnant sows but not for lactation sows.

These results indicate that ringing probably should be considered more as a way of maintaining grass sward without necessarily affecting the leaching and in consequence be evaluated as a relevant option in this context.

Rearing of growing pigs in pig houses with access to outdoor areas

As regards construction of pig houses 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 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 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 concentrates. Some of the main results are given in Table 2.

Table 2 here

The organic production resulted in a slightly reduced daily gain and a slightly increased content of polyunsaturated FA in the fat, whereas no differences were observed in lean content, tenderness, and vitamin E content in the muscles. Restricting concentrates gave the same results as in the investigation of Danielsen (2000) in relation to lean content and tenderness i.e. higher lean content and a reduced 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. Also (not shown), organic feeding and access to outdoor run led to a higher proportion of ham muscles in the carcass. These results are much in line with the results of Millet et al (2003) who found that organic housing lead to a higher muscle and back fat thickness.

In the Danish 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.

Growing pigs at pasture

The rearing of organic growing pigs in barns with an outdoor run, which is the common practise in several European countries, is heavily constrained by the fact, that building costs are considerable higher than for conventional production systems due to higher requirements for area etc. At the same time, it may be questioned if pigs reared under such conditions comply with the consumer’s expectations to organic farming. This calls for a reconsideration of the appropriateness of the system.

Several investigations indicate that growth rate obtained in outdoor systems can be comparable to the growth rate at indoor production (Lee et al., 1995, Andresen et al., 2001 Gustafson & Stern, 2003). However, variable feed conversion rates have been obtained. In summer period, a feed conversion comparable to indoor conditions have been obtained in some investigations (Sather et al., 1997), whereas in other periods of the year or in other investigations a higher feed consumption per kg gain have been reported (Stern et al., 2002; Sather et al., 1997).

Although the growing pig can consume grass and other herbage up to 20% of daily day matter intake (Carlson et al., 1999), the overall contribution to the energy supply of the pig when fed *ad lib* with concentrates mixtures is normally much lower, ranging from 2-8%. This means that most feed needs to be concentrates given to the pigs at pasture and consequently high risk of environmental impact can be expected unless measures are taken to counter act this.

At the moment, we are investigating strategies combining grazing and rearing in barns from the perspective to reduce risk of environmental impact and at the same time allow the growing pigs to have plenty of space when they are young and most active. Five strategies are being investigated:

1. Piglets are moved indoor at weaning and fed *ad libitum* until slaughter
2. Piglets stay on pasture and are fed restrictively (70% of expected *ad lib* intake) with concentrates until 40 kg live weight, followed by *ad libitum* feeding in a barn pen
3. Piglets stay on pasture and are fed restrictively with concentrates until 80 kg live weight, followed by *ad libitum* feeding in a barn pen
4. Piglets stay on pasture until slaughtering and are fed restrictively in the whole period
5. As treatment 4, but the growers are fed *ad libitum* until slaughtering

The preliminary results show a normal growth rate (app. 750 g daily gain) and no marked differences between the pigs fed *ad libitum* outdoor or *ad libitum* indoor. However, the feed intake per kg gain outdoor was increased by 13% when fed *ad lib*. On the other hand, outdoor kept pigs, which were restricted in energy intake (strategy 4), had the same feed conversion rate as the indoor treatment (1) and in addition a significantly higher lean content (approximately four units), but growth rate was of course reduced (16%). A very interesting finding was in the strategy with restricted intake in outdoor kept pigs until 80 kg live weight followed by *ad lib* indoor (strategy 3). The strategy resulted in a feed conversion rate comparable to indoor feeding and the overall daily gain was only reduced by 10-15% compared to *ad lib* feed indoor.

These results indicate that there are options that can be used in order to get very good production results from outdoor kept finishers.

With the stocking rate applied (100 m^2 per outdoor pig kept from 20 kg to 100 kg live-weight) however, all vegetation was destroyed (Figure 3). Complementary measurements on risk for N-leaching will elucidate the environmental risks in the systems, but these data are yet not available. However it seems as if a choice have to be made i.e. using a considerable lower stocking rate than used in this experiment to keep a good vegetation cover or to accept the rooting and try to take advantage of it.

Future systems based on integration in land use

Several ways for at better integration of pig production in the land use should be considered.

As regards pregnant sows, which can be handled in relatively large flocks, one perspective could be to base feed intake on forage. There is no doubt that forage can constitute a very large part of the nutrient requirement for pregnant sows. In addition, it has been shown that co-grazing sows and heifers reduce the parasite burden of the heifers and result in an overall better sward quality compared to grazing separately (Roepstorff et al., 2000; Sehested et al., 2003). The live weight gain and the estimated grass intake for heifers and pregnant sows grazing together or separately are shown in Table 4 and in Figure 4 the larvae infection in the grass sward is shown. It appears that both sows and heifers had a higher daily gain when grazed in the mixed systems although only the difference in the growth rate for heifers was significant in each experiment. It can also be observed that the sows' grass-intake corresponded to half of the energy requirement. The peak of larvae infection of importance for the heifers per kg grass DM was in the mixed system only half of the infection in the separately grazed systems. Serum pepsinogen levels in blood samples of the heifers confirmed the lower infection rate in the mixed grazing systems. No difference in parasite burden as regards the sows was observed.

Table 4 & Figure 4 around here

Another strategy for pregnant sows and growers could be to take advantage of their rooting inclination in the land cultivation. Stern & Andresen (2003) found in experiments with growing pigs at pasture that grazing and rooting were most frequent on newly allotted areas (three-six m^2 per pig daily) compared with transfer and dwelling areas. Also defaecation and urination were most frequent in newly allotted areas. At a reduced level of supplementary feed, a higher frequency of rooting appeared. These results suggest that it is possible through management measures like allocation of new land, feeding strategy, and movement of housing and feeding facilities to have a stratified land cultivation and nutrient load on the land. In fact, Andresen et al. (2001) demonstrated that the rooting could replace a mechanical treatment and even result in a higher crop yield of the following crop.

Andersen et al. (2000) and Jensen et al. (2002) have proposed a system handling both sows and finishers in small de-centralized units. Each unit consists of a climate tent placed upon an area protected against leaching (Figure 5). A layer of sea shells is put on a bio-membrane and covered with a layer of straw, upon which the climate tent is constructed. The idea is that four-six sows are farrowing in the unit. At weaning, the sows are moved to another tent and the finishers stay in the unit. In periods where there is a crop to be grazed or a need for a controlled tillage of the soil, the pigs – whether sows or finishers – are allowed access to the field. This way, a considerable part of the manure produced can be colleted and used elsewhere in the farming system and the risks of excessive leaching of nutrients can be diminished.

At present this system is being tested and further developed. Growth and nutrient management is functioning very well. However, there is still some way to go in order to have farrowing functioning well and to have an acceptable workload in the system.

Conclusion

The most common outdoor systems for pigs used in intensive managed organic production have some important drawbacks in relation to environmental impacts (risk of N leaching and ammonia volatilisation) and animal welfare (nose-ringed sows). There is a need for a radical development of the systems. There is a need to search for systems where the outdoor/free range systems (for the sake of the livestock) are constructed and managed in a way whereby the livestock at the same time exert a positive influence on other parts of the farming systems. Major elements to be considered are the ability of pig to forage and hereby fulfil their nutritional needs, the ability of the pigs to contribute to land cultivation and the importance of diversified livestock rearing in order to reduce parasite burden. These elements need to be further explored as a basis for future system development.

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Table 1. Scale of outdoor and organic pig production in Denmark, 1996-2002.

Year	**Outdoor**			**Organic**		
	Herds, no.	**Breeding animals, no.**	**Percentage outdoors**	**Herds, no.**	**Sows, no.**	**Finishers produced, no.**
1996	451	19,839	1.9	210	1,073	18,000
1997	1,059	28,021	2.5	335	1,726	20,000
1998	1,264	36,735	3.1	448	2,966	47,000
1999	1,234	39,096	3.3	535	4,084	63,000
2000	1,171	39,612	3.4	483	3,344	64,000
2001	1,080	41,209	3.5	400	3,939	62,500
2002	961	41,969	3.5	-	4,078	74,000

Table 2. Production results and carcass characteristics in growers fed organic or conventional concentrates *ad lib*, or restricted amounts of organic concentrates together with silage *ad lib*. (After Hansen et al 2001).

Concentrates:	Conventional (*ad lib*)	Organic (*ad lib*)	Organic (70% of *ad lib*)
Silage:	No	No	Yes
Outdoor area:	No	Yes	Yes
Daily gain, g	999	935	728
Feed conversion, SFU[1)]/kg gain	2.99	3.09	2.96
MJ per kg gain	23.1	23.9	22.8
Lean content, %	60.6	60.4	61.6
<u>In muscles</u>			
Intramuscular fat, %	1.6	1.5	1.2
Vitamin E	3.13	3.15	2.81
Tenderness	8.7	8.6	7.5
<u>In fat</u>			
Saturated FA, %	41	40	39
Monosaturated FA, %	45	43	42
Polyunsaturated FA, %	14	15	18
Iodine value	68.3	72.2	74.6

[1)] Scandinavian Feed Units for pigs

Table 3. Growth and estimates grass intake for grazing heifers and pregnant sows grazing separately or mixed (average of two experiments; after Sehested et al, 2003).

Grazing system:	Separately	Mixed
<u>Heifers</u> (per heifer and day)		
Live weight gain, g	866	1063
Grass intake, NE, MJ	41.1	52.5
<u>Sows</u> (per sow and day)		
Daily live weight gain, g	512	557
Supplementary concentrates, NE, MJ	11.0	11.0
Grass intake, NE, MJ	10.3	10.8

Figure 1. Outdoor lactating sows in summertime.

Figure 2. Outdoor sow herd in wintertime.

Figure 3. Growing pigs at pasture at a high stocking rate.

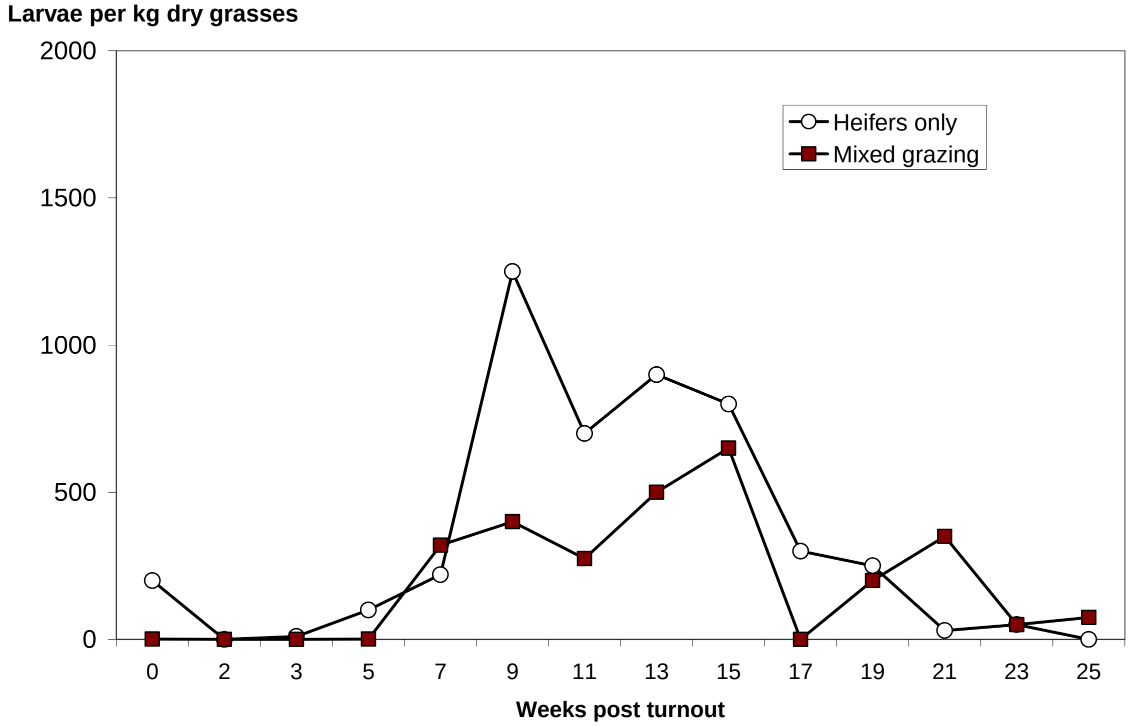

Figure 4. Numbers of infective O. Ostertagi larvae per kg dry grass on two pastures grazed by heifers only or by a mixed herd of pregnant sows and heifers (after Roepstorff et al., 2000).

Figure 5. One unit pen in climate tents (Andersen et al, 2000)