Combined pig and energy crop production – crop damage and animal behaviour

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Abstract

Organic free-range pig production of today has some disadvantages in terms of nutrient hotspots and poor possibilities for the pigs to perform behavioural temperature regulation. Combining perennial energy crop and pig production might compose a new concept for free-range production with low nitrate leaching and high standards for animal welfare. The aim was to investigate the 1) tolerance of different energy crops to pigs foraging and 2) behaviour of pigs in an area with established energy crops. In total 72 growing pigs were included. The paddocks were divided into different zones representing different types of crops (willow, Miscanthus, grass). Only minor damages on the established energy crops were observed. Behavioural observations showed high preferences for excretory behaviour in zones with willow compared to zones with grass or miscanthus. Environmental temperature influenced the pigs preference for location. At high temperatures there was a clear preference for areas with willow. In conclusion, there are indications that a combined production of energy crop and pig production will improve animal welfare and reduce nitrate leaching compared to the current practice in organic free-range production with pigs on open grasslands.

Introduction

In Denmark and other EU countries, organic free-range production of pigs is characterised by open grasslands and high stocking densities, e.g. 1.4 animal unit per hectare in DK. This system has some disadvantages in terms of nutrient hot spots (Eriksen 2006) and poor working environment due to muddy paddocks in autumn and winter. All though the system has some clear animal welfare benefits compared to indoor housing, the poor possibilities for shadow seeking might constitute a threat to the well-being of the pigs in hot seasons, especially in prefarrowing sows (Buckner et al. 1998). Finally, the barren grassland contrasts with the favourable habitat of pigs, that is, wooded and bushy areas adjacent to grassland (Graves 1984).

Perennial energy crop plantations represent an environment that offers the pig variation and protection from the sun. Energy crops like eg. willow, poplar and miscanthus have a deep root system with high water and nutrient uptakes (Jørgensen et al., 2005). Combining perennial energy crop and pig production might compose a new concept for free-range pig production with low nitrate leaching, good working conditions and high standards for animal welfare.

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The specific aim of this study was to investigate the tolerance of different energy crops to pigs foraging and rooting and the pigs utilisation of the area (preferred sites for excretory behaviour, resting, rooting etc.) and how this is influenced by stocking density and season.

Materials and methods

In total 72 growing pigs were included. In the experiment two treatments (high and low stocking density) were replicated over two seasons (spring 2009, autumn 2009). Each season, 36 pigs were randomly assigned to three experimental paddocks of 0.07 hectare and three paddocks of 0.22 hectare. The paddocks were divided into zones representing different types of crops or usage as shown in Figure 1. The energy crops were established in May 1996. Two varieties of willow were planted in zones divided by areas planted with grass and miscanthus. Willow was planted in rows with a plant density of 1.1 plants per m².

![Figure 1: Illustration of the experimental paddocks. Each paddock was divided into zones with different types of vegetation or usage.](image)

In spring, the pigs were introduced to the paddocks at approximately 50 kg live weight and the stocking densities corresponded to 0.6 AU and 1.9 AU per hectare. In autumn, the pigs were introduced at approximately 30 kg and the stocking densities corresponded to 0.8 AU and 2.5 AU per hectare. According to the Danish legislation 1.4 AU is allowed per hectare. The pigs were fed according to indoor recommendations plus 10% and slaughtered at 100 kg live weight.

Crop damages and behavioural elements were registered weekly over the entire experimental period. The pigs were observed two days a week. In spring from 8 am to 1.30 pm the first day and from 2 - 7.30 pm the second day. In autumn from 8 - 3.30 am the first day and from 4 - 7.30 pm the second day. The following behavioural elements were recorded as scan samples at 2-min intervals: Manipulating energy crops, rooting, eating, grazing, resting, and other activities. Furthermore, excretory behaviour was recorded as all occurrences. The location of the pigs was recorded for each behaviour according to the zones illustrated in Figure 1. Each group of pigs was observed for a period of 15 minutes, six times per week. Chi-square tests were used.
to investigate whether the observed distribution of behaviour differed significantly from the estimated distribution. Crop damages were assessed visually on a scale from 0-10.

**Results**

The pigs caused only minor damages on the well established energy crops and these were mainly related to pigs biting some of the roots and branches. However, the pigs ate most of the new sprouts from newly harvested willow and Miscanthus.

More energy crop damage was observed at the higher animal density but still the damages did not severely affect the crops, and no plants or shoots died during the experiment. The rooting behaviour did not cause deep holes in the soil that could seriously disturb the subsequent energy crop harvesting.

The most frequent behaviours were resting and rooting that represented 54 % and 19 % of all observations, respectively. Table 1 shows the estimated and the observed proportion of observations in each zone for resting, rooting and excretory behaviour. Observed values are total values for all paddocks. There was no major effect of animal density.

**Table 1: Observed (obs.) and estimated proportion (%) of observations in the different zones**

<table>
<thead>
<tr>
<th></th>
<th>Feed. area</th>
<th>Willow + popl.</th>
<th>Grass1</th>
<th>Cut Misc.</th>
<th>Miscanthus</th>
<th>Grass2</th>
<th>Willow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated1</td>
<td>9</td>
<td>15</td>
<td>8</td>
<td>17</td>
<td>29</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Resting</td>
<td>Obs., spring</td>
<td>8</td>
<td>18</td>
<td>2</td>
<td>38</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Obs., autumn</td>
<td>7</td>
<td>40</td>
<td>5</td>
<td>13</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>Rooting</td>
<td>Obs., spring</td>
<td>15</td>
<td>17</td>
<td>10</td>
<td>14</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Obs., autumn</td>
<td>36</td>
<td>10</td>
<td>7</td>
<td>11</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Excretory</td>
<td>Obs., spring</td>
<td>9</td>
<td>53</td>
<td>1</td>
<td>0</td>
<td>28</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Obs., autumn</td>
<td>6</td>
<td>44</td>
<td>2</td>
<td>3</td>
<td>18</td>
<td>3</td>
</tr>
</tbody>
</table>

1 Estimated value is equal to the proportion of the area of each zone

2 Including the hut

There were significant effects of season on the distribution of behavioural elements in the different zones. The observed distribution of behaviour in zones differed significantly from the estimated for resting and excretory behaviour in both seasons and for rooting in autumn. The zone with cut Miscanthus included the hut. In spring, the pigs preferred to rest inside the hut (37 % of all resting observations), whereas in autumn the pigs preferred to rest in the willow and poplar zone (40 % of all resting observations). The majority of excretory behaviour was performed in the zone with willow and poplar adjacent to the feeding area and in the zone with uncut Miscanthus.

The pigs’ preference for location was influenced by temperatures. At very low temperatures (< 0 °C, only registered in spring), the pigs preferred to stay in the huts (83 %), whereas at high temperatures (> 15 °C) the pigs preferred to stay in the two
zones with willow (e.g. 80 % in spring). Registered temperatures were in average 10.3 °C (-1 °C - 18 °C) and 10.9 °C (3 °C - 18 °C) in spring and autumn, respectively.

Discussion

Access to shadow seeking or wallowing is essential for the welfare of outdoor pigs. It was clear that the pigs in the current study benefitted from the possibility for shadow seeking in the forest-like areas with willow. Especially prefarrowing sows are exposed to heat stress due to a high heat production (Buckner et al. 1998). It is likely that access to areas with willow will improve the welfare of prefarrowing/lactating sows. However, we do not know whether sows and piglets will cause more damages to the energy crops than growing-finishing pigs. Further studies are needed before it is possible to conclude whether energy crop plantations are suitable for piglet production also.

In accordance with previous studies with pigs on open grasslands (Eriksen 2006) and pigs in semi-natural environments (Stolba & Wood-Gush 1989), the pigs did not deposit the manure randomly in the present study. Results of soil samplings (data not shown) support the behavioural results with highest concentrations of soil inorganic N in zones with willow, and indicate lower nitrate leaching than found in the usual grassland system (Sørensen 2010).

Conclusions

The results from this study indicate that it is possible to combine growing-finishing pig and energy crop production without serious crop damages. Only, pigs should not be held on newly harvested willow or in miscanthus in the period of sprouting in spring. Behavioural studies indicate that a combined production will improve animal welfare and reduce nitrate leaching compared to the current practice in organic free-range production with pigs on open grasslands. Further larger-scale studies are needed to illuminate whether energy crop plantations are suitable for piglet production also.

References


