Effect of reduced floor space allowances on performance of crossbred weaner barrows


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ABSTRACT

Study was conducted in 36 crossbred (Landrace x Desi) weaned male piglets (6 weeks of age) divided into three groups (n=12) based on space allocation viz. T1 (0.9 m²/weaner pig- as per Indian Standards (IS)), T2 (0.6 m²/pig- 33% reduction of IS) and T3 (0.45 m²/pig- 50% reduction of IS). The average initial (6 week) and final (14 week) body weight of weaner barrows were 8.67±0.26, 9.01±0.33, 9.13±0.36 kg and 19.57±1.19, 21.02±1.22, 21.55±1.28 kg for T1, T2 and T3 groups, respectively. Average total body weight gain during the experimental period was 10.90±1.09, 12.01±0.97 and 12.42±1.19 kg for T1, T2 and T3 groups, respectively. Average daily gain (ADG) of weaner barrows during the experimental period was 194.72±19.46, 214.44±17.37 and 221.73±21.23 g/day for T1, T2 and T3 groups, respectively. The overall feed conversion efficiency (FCE) for T1, T2 and T3 groups for whole period was 0.477±0.009, 0.447±0.006 and 0.461±0.011, respectively. Main economic indicators like ADG, FCE and health indicators like mean total lesion score and mean lesion score of body parts (except head and ears) did not differ significantly among groups and these values were within the acceptable limits. Even lowest k value (coefficient used for floor space allocation based on body weight of pigs) i.e. for T3 group, was higher than suggested critical k value in western countries and performance of animals of this group were also not affected. Therefore, weaner barrows of up to 20 kg body weight can be reared in economically efficient manner using 0.45 m²/pig space allowance in Indian conditions.

Key words: Crossbred, k value, Space allowance, Weaner.

INTRODUCTION

A critical factor in the successful rearing of pigs from three weeks onwards is to have correct balance between the numbers in the group and the space allowance (Bhat et al., 2010). Scientific evidence may indicate that space is not as important for pigs as other resources, e.g. food availability if their minimum space requirement is fulfilled (Marchant-Forde, 2009). However, efficient use of indoor floor space results in low capital investment in buildings and infrastructure, reduced cost of labour and bedding systems, and represent the principal economic and management benefits (Turner et al., 2003; Anil et al., 2007). Increasing space allowance per pig above the recommended requirements for production is not beneficial in terms of behaviour and production performance (Beattie et al., 1996). A recent study (de Greef et al., 2011) on space use, synchronisation and clustering of behavioural activities of pigs indicated that the theoretically derived requirements on space allowance might be reduced without compromising the Comfort Class level (a specific minimal level of husbandry conditions of animals, at which welfare of animals is not compromised).

Most of the developed countries recommend floor space requirement of about 0.15 m²/pig for weaners and South Asian countries of about 0.3 to 0.5 m²/pig without any open space (Oosterwijk et al., 2003; Cho and Kim, 2011). This is relatively less than Indian Standards (IS: 3916-1966) recommendation (covered area of 0.9 m²/weaner pig with same sized open area) although pigs of those countries weigh relative more than Indian grown pigs. Further, average meat yield of pigs in India is 35 kg/animal, which is about 55% less than the corresponding value of world average (FAO, 2009). This clearly indicates that there is huge loss of fixed capital investment which may not be recommended. Similarly, there are no studies indicating that absence of open area leads to adverse effects on the performance of pigs. Further, in all neighboring Asian countries there is no provision for open...
area in pig farming practices. Studies of variations in space allowance without altering group size in conventional pens are also few (Jensen et al., 2010). Therefore present study has been carried out using equal group size of weaner pigs with reduced floor space allocations with only covered area and to find out appropriate k value (coefficient used for floor space allocation based on body weight of pigs) for Indian/tropical conditions.

**MATERIALS AND METHODS**

The experiment was conducted at the Swine Production Farm, Livestock Production and Management Section, IVRI, U.P., between May and July months of year 2012 i.e. during summer season. A total of 36 crossbred (Landrace x Desi) male piglets from 14 litters of unrelated sows farrowed contemporarily were selected randomly taking body weight and age into consideration. These piglets were castrated at one month of age and weaned (Barrows) at 6 weeks of age and subsequently distributed randomly to one of the three treatment groups. The pigs were reared up to 14 weeks of age.

These animals were divided into three equal groups of 12 piglets each based upon space allocation viz. T_1 (0.9 m²/weaner pig- as per Indian Standards (IS: 3916-1966)), T_2 (0.6 m²/pig- 33% reduction of IS) and T_3 (0.45 m²/pig- 50% reduction of IS). IS suggests floor space requirement of 0.9 m² for weaner pigs with same dimensions of open space. In our experiment pigs were reared under covered floor area only. Under each treatment group, three units of 4 piglets each were made and these piglets were kept in independent pens with specified floor space (Table 1).

Each pen of all the treatments had same feeding and watering space allowance. Floor was made of concrete with serration to avoid slippage. Animals were fed ad-lib concentrate mixture as per standards followed at the farm. Concentrate mixture comprised of maize, wheat bran, deoiled soya bean cake, fish meal, mineral mixture and salt as ingredients. The supply of clean, fresh and potable drinking water was ensured always. Feeding space of 150 cm and watering space of 130 cm was available in each pen where 4 pigs were housed. The piglets were given special care through iron and vitamin-B complex for ensuring their survivability. Piglets were vaccinated for swine fever and FMD.

**Estimation of ‘k’ value for floor space allowances:** Many researchers (Petherick, 1983; Gonyou et al., 2006; Averós et al., 2010) have suggested that space allocations for pigs should be based on an allometric equation \( A (m^2) = k \times BW^{0.67} (kg) \), which relates total space requirements (A) to average pig weight (BW) by some appropriate factor (k). For each treatment group, value of coefficient ‘k’ was estimated based upon specified floor space allocation and average body weight of pigs of the same group. Daily feed intake was calculated after making correction for feed residues collected on the following day. Body weights of experimental pigs were recorded at weekly interval using electronic balance. Average daily gain (ADG) and feed conversion efficiency (FCE) were calculated with recorded data.

**Skin lesion score:** All the experimental animals were looked for skin lesion score on the basis of a visual assessment. Weekly, each pig was observed carefully for skin lesions in four body zones i.e. Head and ears, body, legs and tail. Lesions (scratches and wounds) were scored on a 4 point scale of 0–3 i.e. 0 (No apparent lesion or injury), 1 (up to 5 scratches), 2 (5-10 scratches or 1 Abrasion) and 3 (>10 scratches or >1 abrasion or 1 cut) (modified according to Turner et al., 2006).

The data were subjected to the statistical analysis as per the procedures outlined by (Snedecor and Cochran, 1994) using the SAS 12.0 software package.

**RESULTS AND DISCUSSION**

**Estimation of coefficient k for space allocation:** The average body weight of weaner pigs (Table 2) during experimental period ranged between 8.67 - 19.57, 9 - 21.02 and 9.13 - 21.55 kg for treatment groups T_1, T_2 and T_3, respectively. Using standard equation taking body weight and space allowance into consideration, calculated k value (coefficient used for floor space allocation based on body weight of pigs) for treatment groups T_1, T_2 and T_3 ranged between 0.122-0.212, 0.078- 0.138 and 0.058- 0.102, respectively. Lot of values has been suggested for k coefficient, which varies from 0.029 to 0.05 but critical value of k has been suggested as 0.034 (Gonyou et al., 2004; 2006), below which growth rate of pig retards. This indicates that even lowest k value (0.058) of our experiment i.e. for T_3 group, was higher than suggested critical k value of western countries suggesting that IS recommends much more floor space than our western and neighbouring counterparts.

**Effect of space allowance on growth and ADG:** The pattern of growth of weaner barrows (Table 3) during experimental period showed that initial body weight of weaner barrows

<table>
<thead>
<tr>
<th>Type</th>
<th>T_1 Group(IS)</th>
<th>T_2 Group(33% reduction)</th>
<th>T_3 Group(50% reduction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaner barrows (6-14 weeks)</td>
<td>12(3 units with 4 pigs/unit)</td>
<td>12(3 units with 4 pigs/unit)</td>
<td>12(3 units with 4 pigs/unit)</td>
</tr>
<tr>
<td>Space allowance</td>
<td>0.9 m²/pig</td>
<td>0.6 m²/pig</td>
<td>0.45 m²/pig</td>
</tr>
</tbody>
</table>
were 8.67±0.26, 9.01±0.33 and 9.13±0.36 kg for \( T_1 \), \( T_2 \) and \( T_3 \) groups, respectively. With the advancement of age, there were consistent increment in the body weight in all the 3 groups except during first week as growth could have affected due to mixing and weaning stress among the animals. At the end of the experiment body weight reached at 19.57±1.19, 21.02±1.22 and 21.55±1.28 kg for the respective treatment groups. The body weights did not differ significantly between the groups.

ADG of animals showed similar pattern among different treatment groups and it reached at peak values during last week where it crossed 500 g/day except \( T_1 \) group but values did not differ significantly. ADG of weaner barrows during the experimental period was 194.72±19.46, 214.44±17.37 and 221.73±21.23 g/day for \( T_1, T_2 \) and \( T_3 \) groups, respectively which also did not differ significantly between the groups (Table 6). Average total body weight gain during the experimental period for weaner barrow was 10.90±1.09, 12.01±0.97 and 12.42±1.19 kg for \( T_1, T_2 \) and \( T_3 \) groups, respectively (Table 6). Results clearly indicates that reduction in floor space and absence of open space did not have any negative impact on ADG in weaner pigs.

Sharma et al. (2004) studied floor space requirement for Hampshire grower pigs (12-35 kg BW) in hot humid climate of Guwahati, Assam with 4 different space allocations i.e. 0.4, 0.6, 0.9 and 1.2 m\(^2\) and group size of 12, 9, 6 and 9, respectively and reported maximum ADG for 0.9 m\(^2/pig\) space. But in their study, effect of group size and space allocation was confounded. Sinha et al. (1990) also studied under Indian climatic conditions and observed that pigs with floor space of 0.4 m\(^2/pig\) had lower weight gain than the other groups which had 0.56, 0.67, 0.84, 1.12 m\(^2\) of floor space per pig. The variation in performance due to floor space reduction in both the cases could be due to confounded effect of group size as well as space allocation. Whereas in western and neighbouring countries very low space has been utilized for getting optimum ADG and body weight. In weanling pigs housed in groups of four, with 0.28 m\(^2\) to 0.14 m\(^2\) of floor space per pig, the lowest ADG and average daily feed intake (ADFI) were observed in groups with the least floor space (Kornegay et al., 1993). Most of this response is due to a reduction in feed intake. In a recent experiment with 10 kg commercial pigs, an increase in space allowance from 0.14 to 0.22 m\(^2\) per pig was associated with a 10% increase in feed intake (from 440 to 481 g per pig per day). Some authors recommend 0.4 m\(^2\) floor space per piglet for optimum growth in weaner pigs (Kyriazakis and Whittimore, 2006). Crowding to a space allowance coefficient of 0.026 resulted in a reduction in ADG (Done et al., 2006). A recent summary of research studies suggests that the maximum growth rate for the entire grow-finish period would be achieved at a coefficient (\( k \)) of 0.0336 for space allowance (Gonyou et al., 2006). Whereas, in the present study space allocation is higher than most of the above mentioned studies i.e. minimum space allocation group (0.45 m\(^2/pig\)) had \( k \) value (0.058) higher than the suggested critical limit. In this study, ADG did not differ significantly between 3 groups having floor space allowance of 0.9 m\(^2/pig\), 0.6 m\(^2/pig\) and 0.45 m\(^2/pig\). It indicated that lower space allowance (0.45 m\(^2/pig\)) could be used for economically efficient weaner pig production in Indian conditions.

**Effect of space allowance on DMI and FCE:** The DMI (kg/pen/week) of weaner pigs (Table 4) increased in unsteady manner for all the treatment groups during the successive weeks. DMI was almost similar in \( T_2 \) and \( T_3 \) groups but numerically higher than \( T_1 \) group for whole period except for 10\(^{th}\) week. Although mean DMI (Table 6) among the groups differed significantly (\( P<0.01 \)) but DMI during successive weeks and overall DMI had no effect of space allocation. The average total DMI during the experiment for each pen (4 pigs) of \( T_1, T_2 \) and \( T_3 \) groups were 91.88±9.54, 107.70±4.97 and 107.46±4.16 kg, respectively and values didn’t differ significantly. Some studies (Kornegay et al., 1993; Brumm et al., 2001) suggested that crowding has negative impacts on feed intake and growth. However in our study space allocations were not as low as compared to those studies and so DMI also did not differ significantly among groups.

The FCE in treatment groups (Table 5) during successive weeks of experiment with different space allowances were estimated. FCE remained negative for 7\(^{th}\) week age or first week of experiment as animals could have been affected due to mixing and weaning stress. Later it increased and remained fluctuating in narrow limits for all the groups. The overall FCE for \( T_1, T_2 \) and \( T_3 \) groups for the whole period were 0.477±0.009, 0.447±0.006 and 0.457±0.006. **TABLE 2:** Values of coefficient \( k \) for different treatment groups during the experiment

<table>
<thead>
<tr>
<th>Groups</th>
<th>Average body weight (at 6 and 14 weeks of age respectively) (kg)</th>
<th>Space allocation (m(^2/pig))</th>
<th>( 'k' ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_1 )</td>
<td>8.67 - 19.57</td>
<td>0.9</td>
<td>0.212 - 0.122</td>
</tr>
<tr>
<td>( T_2 )</td>
<td>9 - 21.02</td>
<td>0.6</td>
<td>0.138 - 0.078</td>
</tr>
<tr>
<td>( T_3 )</td>
<td>9.13 - 21.55</td>
<td>0.45</td>
<td>0.102 - 0.058</td>
</tr>
</tbody>
</table>
TABLE 3: Average body weight (kg) and ADG (g) of weaner barrows in different treatment groups during successive weeks of age

<table>
<thead>
<tr>
<th>Group</th>
<th>6th week</th>
<th>7th week</th>
<th>8th week</th>
<th>9th week</th>
<th>10th week</th>
<th>11th week</th>
<th>12th week</th>
<th>13th week</th>
<th>14th week</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>8.5±0.26</td>
<td>8.5±0.26</td>
<td>8.5±0.26</td>
<td>8.5±0.26</td>
<td>8.5±0.26</td>
<td>8.5±0.26</td>
<td>8.5±0.26</td>
<td>8.5±0.26</td>
<td>8.5±0.26</td>
</tr>
<tr>
<td>T2</td>
<td>8.7±0.24</td>
<td>8.7±0.24</td>
<td>8.7±0.24</td>
<td>8.7±0.24</td>
<td>8.7±0.24</td>
<td>8.7±0.24</td>
<td>8.7±0.24</td>
<td>8.7±0.24</td>
<td>8.7±0.24</td>
</tr>
<tr>
<td>T3</td>
<td>9.0±0.23</td>
<td>9.0±0.23</td>
<td>9.0±0.23</td>
<td>9.0±0.23</td>
<td>9.0±0.23</td>
<td>9.0±0.23</td>
<td>9.0±0.23</td>
<td>9.0±0.23</td>
<td>9.0±0.23</td>
</tr>
</tbody>
</table>

Values are presented as Mean± Standard error and values in parenthesis indicates ADG (g/day).

Effect of space allowance on body condition: The lesion scores of different body parts and total lesion score for weaner barrows (Table 7) during the experimental period were recorded. Mean total lesion score of pigs for T₁, T₂, and T₃ groups were 0.454±0.063, 0.630±0.063 and 0.546±0.063, respectively. Total lesion score and lesion scores for different parts (except head and ears) were not affected due to different space allocations. However, mean lesion score of head and ears for weaner pigs, was significantly (P<0.05) higher in group T₂ and T₃ when compared to group T₁. It could be due to the fact that animals in T₁ and T₃ groups had lesser free space when compare to T₁ group to escape themselves from face to face interactions of their dominant pen mates especially during feeding and group frolicking. The values for all the groups were under acceptable limits. Reduced space allowances lead to increased aggression-related skin lesion scores (Turner et al., 2000; Anil et al., 2007). In addition, Wolter et al. (2003) found that low floor space allowance also increased the rate of removal of pigs from pens due to injury, poor health, or death. Lower joint swelling scores and 0.461±0.011, respectively. Different space allowances had no effect on FCE of weaner barrows and FCE values fell well within the normal range. Brumm et al. (2004) also reported no difference in feed conversion with space allocations and later Brumm (2010) found that the impact of space on feed conversion efficiency is less predictable. When group sizes of 6, 18, and 36 were maintained at a constant floor space allowance, group size had no effect on feed intake, but FCE was reduced in the larger groups (Petherick et al., 1989).
TABLE 4: DMI (kg/pen/week) of weaner barrows in different treatment groups during successive weeks of age

<table>
<thead>
<tr>
<th>Group</th>
<th>7th Week</th>
<th>8th Week</th>
<th>9th Week</th>
<th>10th Week</th>
<th>11th Week</th>
<th>12th Week</th>
<th>13th Week</th>
<th>14th Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>T_1</td>
<td>2.30±0.29</td>
<td>2.93±0.69</td>
<td>6.47±1.10</td>
<td>9.15±0.49</td>
<td>11.88±1.11</td>
<td>13.31±1.31</td>
<td>21.46±3.01</td>
<td>24.39±2.06</td>
</tr>
<tr>
<td>T_2</td>
<td>2.44±0.45</td>
<td>4.17±0.67</td>
<td>7.76±0.68</td>
<td>8.82±0.42</td>
<td>13.01±0.27</td>
<td>16.64±0.06</td>
<td>26.75±1.00</td>
<td>28.11±1.90</td>
</tr>
<tr>
<td>T_3</td>
<td>2.37±0.31</td>
<td>4.47±0.89</td>
<td>7.91±0.69</td>
<td>8.97±0.42</td>
<td>13.44±0.10</td>
<td>15.05±0.66</td>
<td>26.69±0.77</td>
<td>28.56±0.87</td>
</tr>
</tbody>
</table>

Values are presented as Mean± Standard error.

TABLE 5: FCE of weaner barrows in different treatment groups during successive weeks of age

<table>
<thead>
<tr>
<th>Group</th>
<th>7th Week</th>
<th>8th Week</th>
<th>9th Week</th>
<th>10th Week</th>
<th>11th Week</th>
<th>12th Week</th>
<th>13th Week</th>
<th>14th Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>T_1</td>
<td>-0.199±0.18</td>
<td>0.157±0.08</td>
<td>0.455±0.12</td>
<td>0.554±0.06</td>
<td>0.43±0.03</td>
<td>0.434±0.01</td>
<td>0.558±0.05</td>
<td>0.541±0.01</td>
</tr>
<tr>
<td>T_2</td>
<td>-0.029±0.16</td>
<td>0.320±0.09</td>
<td>0.432±0.02</td>
<td>0.517±0.00</td>
<td>0.451±0.02</td>
<td>0.406±0.01</td>
<td>0.447±0.01</td>
<td>0.506±0.02</td>
</tr>
<tr>
<td>T_3</td>
<td>0.091±0.14</td>
<td>0.392±0.07</td>
<td>0.384±0.02</td>
<td>0.449±0.04</td>
<td>0.423±0.03</td>
<td>0.43±0.02</td>
<td>0.493±0.01</td>
<td>0.528±0.00</td>
</tr>
</tbody>
</table>

Values are presented as Mean± Standard error.

lesions associated with fighting or biting were observed in pens with lesser space (Smith et al., 2004). It has been suggested that there is predisposition to disease when less than 0.5 m² of lying space and less than 0.8 m² of total space is allowed per 100 kg of pig live weight (Kyriazakis and Whittemore, 2006). However, the adverse health effects with decreasing floor space are of concern from both animal welfare and economic perspectives, and require confirmation (Dedecker et al., 2005). As space allowance in our study was not as low as discussed above, overall lesion score didn't differ significantly among different treatment groups. The values of lesion score were under acceptable limits for all the groups when compared with other studies (Turner et al., 2000; Anil et al., 2007). It further strengthens the hypothesis that weaner pigs can be reared without any adverse effect even at 50% reduction in floor space allowance when compared to IS specification.

It is concluded that even after 50% reduction in space allowance when compare to IS recommendation, k value (0.058) was higher than critical k value (0.034) suggested in western countries indicating excessive space allocation for pigs in India. Performance of weaner pigs were not affected with these reduced (33% and 50%) floor space allowances when compare to IS recommendation. This suggests that these reduced floor space allowances can be utilized for economically efficient weaner pig production in India.

REFERENCES


