Economic analysis of crossbred (Landrace × *Desi*) pig reared under different floor space allowances

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ABSTRACT

Present experiment was conducted to study the relative economics of crossbred (Landrace×*Desi*) pigs with thirty six crossbred barrows reared under 3 different floor space allowances (n=12 each) having group size of 4 pigs/pen. One group (T_{IS}) was provided floor space as per Indian Standards (0.9, 1.35 and 1.8 m²/pig for weaner, grower and finisher stages, respectively) specifications, while other two groups with 33% ($T_{2/3}$) and 50% ($T_{1/2}$) reduced floor space allowances. Only covered floor area was provided for all the groups. Different parameters analyzed during the study involved growth, feed conversion efficiency, requirement of water and labour for floor washing, and some other economic variables. Pigs were reared up to 28 weeks of age. Relative economics of pig rearing for three floor space allocation groups was calculated using partial budget analysis. Major performance traits, i.e. average daily gain (ADG) and feed conversion efficiency (FCE) did not differ significantly among the groups. Although body weights of $T_{2/3}$ and $T_{1/2}$ groups were marginally higher than T_{IS} group. In contrary to minor savings of labour, large quantity of water was saved in $T_{1/2}$ and $T_{2/3}$ groups (805.4 liters/pig and 400.1 liters/pig, respectively) than T_{IS} group between weaner and finisher stages. Additionally, input costs of ₹ 145 and ₹ 96 per pig was saved by providing floor space as per $T_{1/2}$ and $T_{2/3}$ groups, respectively than T_{IS} group. It can be concluded that economic gains were maximum in 50% floor space reduction group without adverse effect on performance traits of crossbred pigs.

Key words: Crossbred pigs, Floor space allowance, Relative economics, Savings

Pig production provides good opportunity for employment generation among rural youth. Efficiency of pig production can be increased through better use of available resources. Space allocation has great impact on production performance, pig flow, capital utilization and market price. Most of the developed countries recommend floor space requirement of about 0.15 m²/pig for weaners and South Asian countries as about 0.3 to 0.5 m²/pig without any open space (Oosterwijk *et al.* 2003, Cho and Kim 2011) which is relatively much lower than IS recommendation (0.9 and 1.8 m²/pig for weaner and finisher pigs, respectively); whereas, their pigs weigh relatively more than average Indian pigs. Therefore, there is scope for reduction in space allocation in India where Indian Standard (IS: 3916-1966) recommends relatively higher floor space per pig. Hence, this study was performed to analyze the effect of space allocations from weaner to finisher stage without altering group size of pigs per pen on the economics of rearing the crossbred (Landrace×*Desi*) barrows.

MATERIALS AND METHODS

Location and climatic condition: The experiment was conducted at the Swine Production Farm, All India Coordinated Research Project (AICRP) on Pig, Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh, India. The farm is located at an altitude of 169.2 m above the mean sea level, at latitude of 28°22' North and at longitude of 79°24' East.

Experimental design and animals: A total of 36 crossbred {Landrace×*Desi* (local Indian)} 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, weaned at 6 weeks of age and subsequently distributed randomly in to three equal groups (n=12 each) on the basis of 3 different floor space allowances. Before weaning, these piglets as littermates were kept with respective dam in

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farrowing pen having 8 m^2 of covered area including provision of creep area. T_{IS} (control) group was provided floor space as per Indian Standards (IS: 3916-1966) specification, while $T_{2/3}$ and $T_{1/2}$ treatment groups with 33% and 50% reduced floor space allocation per pig in comparison to IS. Indian standards suggests covered floor area of 0.9 and 1.8 m^2/pig for weaner and finisher pigs, respectively. During weaner (6–14 weeks), grower (15–22 weeks) and finisher (22–28 weeks) stages, 3 different floor spaces {T_{IS} group (0.9, 1.35 and 1.8 m^2/pig), $T_{2/3}$ group (0.6, 0.9 and 1.2 m^2/pig) and $T_{1/2}$ group (0.45, 0.68 and 0.9 m^2/pig)} were provided (Table 1). Under each treatment group, three units/replications of 4 piglets each were made.

General management of animals: Width of each pen measured 2.5 m and specified floor space allocation was ensured by altering length of the pen using metallic grill gates. Floor was made of concrete with serrations to avoid slippage. Animals were fed twice daily in linear feeder with provision of potable water in linear waterer round the clock. Animals with respect to their stage were fed with weaner and grower-finisher feed as per farm's standard. Pigs were provided with corn-barley-soyabean meal-wheat bran based diet. Standard management practices related to health and hygiene were followed as per farm's guidelines. Similar feeding and watering space was provided in each pen.

Average daily gain (ADG) and feed conversion efficiency (FCE): Pigs were weighed during each stage and average daily gain (ADG) and feed conversion efficiency (FCE) were calculated using conventional formulas considering dry matter intake.

Economic efficiency analysis: Partial budget analysis was done to study the relative economics for different floor space allowance groups. The amount of man hours needed for cleaning under different treatment groups was calculated. Amount of water required for cleaning of floor was also calculated using water flow rate and time required for cleaning. Further based upon average cost of construction per m^2 and its durability (considering prevailing market rate), amount of saving per pig (₹) was

estimated for different space allocation groups. A 10% salvage value was applied for constructed floor (Gruhot *et al.* 2017). Annual savings in the terms of labour and water requirement were also estimated for each treatment group. The validity of these assumptions was tested with respect to time for future implications.

Statistical analysis: The data collected during the experimental period was subjected to the statistical analysis as per the procedures outlined by Snedecor and Cochran (1994) using the SAS 12.0 software package. The mean, standard error and ANOVA were employed to obtain the results for further interpretation.

RESULTS AND DISCUSSION

Effect of floor space allowance on ADG and FCE: Body weight of pigs at the end of weaner, grower and finisher stages did not differ statistically between the groups, though mean values were higher in $T_{2/3}$ and $T_{1/2}$ groups than T_{IS} group (Table 1). Similarly, average daily gain of pigs did not differ statistically between the groups during different growth stages (Table 2). Feed conversion efficiency of pigs did not differ among the groups at various growth stages except during grower stage when it remained higher (P<0.05) for T_{IS} group (Table 2). Overall feed conversion efficiency did not differ among the groups but was numerically higher in T_{IS} group and FCE values fell well within the expected normal range. Sharma *et al.* (2004) investigated floor space requirement for Hampshire grower pigs with 4 different space allocations, i.e. 0.4, 0.6, 0.9 and 1.2 m^2 and group sizes of 12, 9, 6 and 9, respectively and reported maximum ADG and FCE for 0.9 m^2/pig space. No difference in feed conversion was reported as a result of space allocations (Brumm *et al.* 2004) and the impact of space on FCE is less predictable (Brumm 2010). FCE values were non-significant for most of the experimental period between the groups in this study. It differed during grower stage but did not differ for weaner and finisher stages between the groups. There is tendency for high stocking density to adversely affect the FCR of finishing pigs (Leek

Table 1. Body weight (kg) of pigs reared with different floor space allowances

Group	Initial (6th week)	Weaner (14th week)	Grower (22nd week)	Finisher (28th week)
T_{IS}	8.67±0.26	19.57±1.19	52.72±2.47	77.88±2.58
$T_{2/3}$	9.01±0.33	21.02±1.22	53.74±2.53	80.19±3.54
$T_{1/2}$	9.13±0.36	21.55±1.28	54.83±1.93	78.16±2.56

Table 2. FCE and ADG of pigs reared with different floor space allowances

Group	Weaner		Grower		Finisher	
	FCE	ADG (g/d)	FCE	ADG (g/d)	FCE	ADG (g/d)
T_{IS}	0.477±0.01	194.72±19.46	0.36±0.013[a]	591.89±25.76	0.253±0.014	599.21±14.98
$T_{2/3}$	0.447±0.01	214.43±17.37	0.33±0.005[b]	584.38±26.64	0.237±0.001	629.76±29.42
$T_{1/2}$	0.461±0.01	221.73±21.23	0.327±0.004[b]	594.35±15.95	0.21±0.010	555.36±22.00

Values bearing different superscripts column wise differed significantly (P<0.05)

et al. 2004). As FCE is adversely affected at higher stock density, no difference in overall FCE may be due to relatively higher space allowance than earlier studies.

Partial budget analysis: As major economic traits (Body growth, ADG and FCE) did not differ significantly among the three floor space allowance groups, only variable sources of inputs were used for calculation of costs involved in pig production. Time spent for cleaning of floor areas of all three treatment groups were estimated based upon mean values obtained through fortnight observations for each stage of pig production. Average time spent in floor cleaning (sec/pen/day) was significantly (P<0.01) higher in T_{IS} group followed by $T_{2/3}$ and $T_{1/2}$ groups (Table 3). Average quantity of water required (l/day/pen) in floor cleaning was determined using fortnight observations during different growth stages of pigs (Table 4). Average water requirement (l/day/pen) for floor cleaning was significantly (P<0.01) higher in T_{IS} group followed by $T_{2/3}$ and $T_{1/2}$ groups. Total water and labour requirements for floor cleaning during various stages of pig rearing in different floor space allowance groups is given in Table 5. Further, input costs

and savings due to construction of *pucca* (concrete) floor for pig production (per pig) with different floor space allowances were estimated (Table 6). In addition to saving of large amount of water for floor cleaning and minor labour savings of ₹ 145 and ₹ 96 per pig was calculated by providing floor space as per $T_{1/2}$ and $T_{2/3}$ treatment groups, respectively than T_{IS} group. These advantages are in addition to the fact that cost of land has not been considered in analysis as it is highly variable. Further, open floor area was also not provided in all the groups which would be additional advantage in comparison to IS recommendations (equal covered and open area). Considering the cost and size of land holding or herd strength, benefits would be manifold (according to land prices) in pig rearing with floor space allowances as per $T_{2/3}$ and $T_{1/2}$ treatment groups. Monetary benefits presented in this article may vary as per time and spatial conditions.

In commercial pig production, efficient use of space is central to the successful management of resources. It is of considerable economic importance to maximize the utilization of floor space by increasing the pounds of pork produced from a facility (DeDecker *et al.* 2005, Marchant-Forde 2009). Therefore, the tradeoff between production efficiency and space allocation becomes critical for maximizing profit and remaining competitive (Powell *et al.* 1993). The financial margin over feed and other costs can be expressed on the basis of an individual pig (per pig) or on the basis of the pen space available in a year (per pig place per year). The latter value has the advantage of allowing for the real rewards of increased pig throughput (Kyriazakis and Whittemore 2006) which has also been utilized in present study for comparative economics of different floor space allowances. No literature could be cited for comparison of economics of floor space allocation in India. Edwards *et al.* (1988) showed that for the British market, the most economical allocation of pen floor space was less than the space needed for optimal performance with about 0.6 m^2 of floor space required for the best economic performance versus 0.7 m^2 for best pig performance for a grow-finish facility that sold at 90 kg pig. Powell and Brumm (1992), considered the optimum stocking density at alternative cost and price scenarios and similar to Edwards *et al.* (1988) determined that the

Table 3. Time spent (sec/pen/day) in floor cleaning during different stages of barrows reared with different floor space allowances

Group	Weaner	Grower	Finisher
T_{IS}	32.83±2.06[a]	49.33±2.32[a]	68.54±1.69[a]
$T_{2/3}$	26.33±1.97[b]	41.25±1.81[b]	64.17±2.18[a]
$T_{1/2}$	19.00±1.75[c]	36.67±2.06[c]	55.92±1.64[b]

Values bearing different superscripts column wise differ significantly (P<0.01)

Table 4. Quantity of water required (l/pen/day) in floor cleaning during different stages of barrows reared with different floor space allowances

Group	Weaner	Grower	Finisher
T_{IS}	52.53±3.30[a]	78.93±3.71[a]	109.66±2.70[a]
$T_{2/3}$	42.13±3.15[b]	66.00±2.90[b]	102.67±3.48[a]
$T_{1/2}$	30.40±2.80[c]	58.67±3.30[c]	89.47±2.62[b]

Values (Mean±SE) bearing different superscripts column wise differ significantly (P<0.01)

Table 5. Total water and labour requirements per pig production for floor cleaning in different floor space allowance groups

Stage	Group	Water requirement (l)	Labour needed (min)	*Saving of water (l)	*Saving of labour (min)
Weaner	T_{IS}	735.4	7.66	-	-
	$T_{2/3}$	589.8	6.14	145.6	1.52
	$T_{1/2}$	425.6	4.43	309.8	3.23
Grower	T_{IS}	1105	11.51	-	-
	$T_{2/3}$	924	9.63	181	1.88
	$T_{1/2}$	821.4	8.56	283.6	2.95
Finisher	T_{IS}	1151.5	12	-	-
	$T_{2/3}$	1078.1	11.23	73.5	0.77
	$T_{1/2}$	939.5	9.79	212	2.22

*Savings in $T_{2/3}$ and $T_{1/2}$ groups are in comparison to group T_{IS}

Table 6. Estimation of input costs and savings due to construction of pucca floor (per pig production basis)
for different floor space allowances

Group	Floor space allowance (m²/pig)	Construction cost (₹)	Input cost/pig production due to construction (₹)	*Saving per pig (₹)
T_{IS}	1.8	7,740	290	-
$T_{2/3}$	1.2	5,160	194	96
$T_{1/2}$	0.9	3,870	145	145

*Savings in $T_{2/3}$ and $T_{1/2}$ groups are in comparison to group T_{IS}. Assumptions: Land = Own, Construction cost = ₹ 4300/m², Salvage value of floor = 10%, Lifespan of floor = 12 years (excluding maintenance), Production of 2 batches/annum; value of one US dollar ($) is equivalent to 60 to 70 Indian Rupee (₹) as per trend of recent years.

minimum cost for producing a pound of pork was 0.4 m² for growing (18–54 kg BW) and 0.6 m² for finishing space (54–113 kg BW). Increasing the space per fattening pig from 0.70 to 0.80 m² results in 1.16 ecu (European currency unit) extra costs per fattening pig when there is no solid concrete floor available (European Commission Report 1997). In the present study, reduced space allocation is still not smaller enough to hamper the performance of pigs and maximum savings were obtained in $T_{1/2}$ group followed by $T_{2/3}$ group than T_{IS} group.

It is concluded that optimal economic efficiency from crossbred pigs can be obtained with floor space allocations of 0.45, 0.68 and 0.9 m²/pig during weaner, grower and finisher stages under Indian climatic conditions. Limiting resources such as priceless water and labour hours can additionally be saved with recommended floor space allowance for crossbred pig rearing under Indian conditions. Present investigation also strengthens the need to revise basic Indian standards (drafted in year 1966) for housing of pigs based on modern extensive studies.

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