Effect of improved housing on performance of piglets in tropics

J. Vasnth[1], S. Usha[1*], T.K. Patbandha[2]

[1]Department of Livestock Production Management, Madras Veterinary College, Tamil Nadu Veterinary and Animal Sciences University (TANUVAS), Chennai, [2]Polytechnic in Animal Husbandry, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Junagadh, Gujarat, India

Journal of Livestock Science (ISSN online 2277-6214) 16: 385-391
Received on 11/2/25; Accepted on 15/5/25; Published on 20/5/25
doi. 10.33259/JLivestSci.2025.385-391

*Corresponding author e-mail: drushavet@gmail.com

Abstract

Present study aimed to find effect of improved housing on micro-environment, and piglets' performance and economics. A total of 24 piglets, six in each were allotted to Solid-concrete floor (T1), Rubber-mat floor (T2), Solid-concrete floor with foggers (T3) and Rubber-mat floor with foggers (T4). Temperature-humidity of house and piglets' performance were recorded fortnightly. Carcass quality (live weight, hot carcass weight, dressing %, carcass length, back fat thickness, loin eye area, meat %, bone %, fat % and meat bone ratio) and cost of production were also assessed. Temperature was significantly (P<0.05) lower in house with foggers (T3 and T4) than without foggers (T1 and T2), but relative-humidity did not differ. Live body weight, growth, feed intake and feed efficiency among the groups did not differ (P>0.05). Improved housing significantly (P<0.05) affected carcass quality parameters except pre-slaughter live weight, carcass weight and dressing percentage. Production cost was higher in T4 followed by T2, T3 and T1. Results showed that improved housing *i.e.*, concrete floor with foggers (T3) results better carcass quality and returns, which can be advocated for piggery in tropical climate to provide favourable micro-environment, better productivity and increase profitability.

Key words: Enriched housing; Micro-environment; Growth; Feed efficiency; Carcass quality; Economics

Introduction

Pigs contribute around 2.01% of total livestock population in India under diversified agro-climatic conditions. Population of pig in the country is 9.06 million as per latest livestock census in 2019, and global pig population during the same period is about 900 million (Thomas et al., 2021). Pork production in India accounts for 0.32% of global production and pork meat accounts for 4.98% of the total meat produced (Singh et al., 2020). Global pork production accounts more than 30% of the total meat production (Wang and Li, 2024). In India, about 80 percent of pigs are owned by the small/ marginal farmers and landless laborers, reared under low or zero input production system (Thomas et al., 2021). Traditional animal production systems are not static, but follow to changing circumstances such as increased population and changing consumption patterns. As compared to other livestock species, pig has a great potential to contribute to a faster economic return to farmers due to early market age (Tedtova et al., 2020). Pig farming only requires a small investment in building and equipment. It has huge potential to ensure nutritional and economic security for the weaker sections of the society in a sustainable manner. In Asia including India, pig farming is highly unorganized and traditional smallholders, who rear majority share of the pig population and low input demand drove the production system (Thomas et al., 2021; Wang and Li, 2024). To develop pig farming as an industry there is need of transfer of technology regarding scientific rearing of pigs, marketing strategies, and creation of awareness and importance of pork among the farmers as well as consumers (Bhadouria et al., 2023).

Typical pig production system consists of a simple pig sty, and feeding comprises of locally available grains, vegetables, agricultural by-products and kitchen waste. To increase the quality and quantity of pork production with enhanced animal welfare, the pig husbandry practices are necessary to improve (Neha et al., 2019). Pig farming is adapted for both diversified and intensive agriculture. Pigs efficiently convert agricultural by-products and waste material into high-quality protein with 65-70 per cent dressed carcass weight (Thomas et al., 2021). Successful pig-rearing requires the provision of suitable enriched environmental conditions with favourable micro-environment for better growth performance in tropics due to climate change. Sustainable pig rearing under the changing climate scenario requires a great deal of management, skill, application of scientific management practices and constant care and attention, which is lacking in most of the livestock farms including piggery (Subhalekha et al. 2022). In any livestock production system, the floor is in regular contact with animals throughout their life and proper hygiene should be maintained to reduce disease incidences. Previous study reported that environmental enrichment particularly micro-environment reduces aggressive behaviour in pigs by developing their social skills and changing behavioral priorities leading to better performance in terms of growth and feed efficiency, health and welfare (Nannoni et al., 2016). Hence, the current study was proposed to assess the effect of improved housing conditions on micro-environment and piglets' growth performance, feed intake, carcass quality traits and economics in tropical climate which will be immensely helpful to the pig farmers to adopt a suitable housing facility under changing climate scenario in tropics to get better economic benefit.

Materials and Methods

The present study was carried out at Pig Breeding Unit, Postgraduate Research Institute in Animal Sciences, Kattupakkam, Tamil Nadu, India. The Pig Breeding Unit is located 40 km South of Chennai city at an altitude of 36 meters above mean sea level, at 12°49' 10.149" (North) latitude and 80°2' 3.541" (East) longitude, mostly semi-arid region. The climate is warm and humid, classified as "Tropical maritime monsoon" type. The maximum temperature ranged from 28.5°C to 39.1°C and the minimum temperature from 21.1°C to 26.5°C throughout the year.

Experimental housing design

Twenty-four Large White Yorkshire piglets weaned at 42 days of age and average body weight around 11.73 kg were taken for the study. Enriched housing management of pig rearing system *viz.*, Control group: Solid-concrete floor (T1), Rubber-mat floor (T2), Solid-concrete floor with water fogging (T3), Rubber-mat floor with water fogging (T4) were constructed as an experimental improved housing designs and 6 piglets (3 males and 3 females) were allotted in each housing system. The foggers were operated in a controlled manner for 10 minutes, once in an hour between 11.00 am and 3.00 pm to cool the house during the experimental period. The buildings were located in East - West orientation and the piglets were provided with a floor space of 1 square meter per animal. Four pens of equal sizes were taken for the treatment T1, T2, T3 and T4, respectively with asbestos roofed area. Each pen had feeding trough and nipple drinker, and all the animals were maintained under similar feeding management system. Concentrate feed of 750 gm/ animal/ day was given at first fortnight and each fortnight increased by 250 gm and at the end of the trial *i.e.*, during 10th fortnight 3 kg for each animal. Duration of study was 4 months and 15 days from April to August 2023 (age of piglets 75 days to market age *i.e.*, 210 days).

T1 - Solid Concrete Floor

T2 - Rubber Mat Floor

T3 - Solid Concrete Floor with Foggers

T4 - Rubber Mat Floor with Foggers

Recording of parameters and economics

Air temperature (°C) and Relative humidity (%) were recorded by Easy-Log temperature-humidity data logger (HTC Instruments, Mumbai, India). Growth performances (body weight, body weight gain) and feed intake (daily feed intake and feed conversion ratio) of pigs were recorded at fortnightly interval. For evaluation of carcass quality traits, two animals from each treatment group were selected randomly at the end of the experiment. The carcass quality traits like pre-slaughter live weight, hot carcass weight, dressing %, carcass length, back fat thickness, loin eye area, meat %, bone %, fat % and meat bone ratio were recorded. The economics of pig production under enriched housing management were calculated by adding the cost of construction of rubber mat floor, foggers and cost of feed consumed by animals. The cost of production per kg live weight gain was calculated by taking ratio of feeding cost (Rs.) during the study period to the total body weight gains (kg) during the same period.

Statistical analysis

The collected data were statistically analysed by One Way analysis of variance using IBM SPSS® Version 20.0 for Windows®. The pair wise significance ($P<0.05$) between two groups was tested using Duncan's multiple range tests.

Results and Discussion

Micro-environment

The morning and afternoon air temperature and relative humidity under improved housing management systems are presented in table 1. The air temperature was significantly ($P<0.05$) lower in house with water fogging (T3 and T4) than without water fogging (T1 and T2) both at morning and afternoon. While, the relative humidity was not affected by the enriched housing with water fogging system compared to without water fogging. The results are in agreement with Huynh *et al.* (2004), who reported that water cooling system had positive impact on micro-environment. The water-cooling reduced surface temperature of the solid-floor and improve thermal comfort, which further improve growth performance and feed intake in growing pigs. Hence, under intensive pig production system the fogger system can be recommended for pig rearing in tropical climate under the changing climate scenario. Irrespective of housing enrichment, the afternoon air temperature remained high and the morning relative humidity remained high. However, the enriched housing with water fogging system reduced micro-environment air temperature by 1.0-1.5 ºC during afternoon, which is in agreement with Huynh *et al.* (2006). Further, in this study, the improved housing with water fogging system did not alter the relative humidity as compared to house without water fogging system, which is an added advantage. Previous studies (Correa et al., 2009 and Zhou et al., 2015) reported that the air temperature and relative humidity of micro-environment were not affected by the floor type (solid concrete and deep litter floor) which is supported by this study. In the current study, these parameters (temperature and humidity) of micro-environment in solid concrete and rubber mat floor remained statistically similar.

Table 1: Temperature and humidity of micro-environment in enriched housing system

Parameters	SCF-Control (T1)	RMF (T2)	SCFF (T3)	RMFF (T4)	'F'- value
Temperature (ºC)					
Morning (8-9 am)	32.44 ± 0.17^{a}	32.31 ± 0.17^{a}	31.66 ± 0.15^{b}	31.62 ± 0.15^{b}	6.831**
Afternoon (2-3 pm)	37.23 ± 0.25^{a}	36.77 ± 0.24^{a}	35.47 ± 0.21^{b}	35.51 ± 0.21^{b}	15.064**
Relative Humidity (%)					
Morning (8-9 am)	74.76 ± 0.88	74.72 ± 0.85	74.51 ± 0.86	75.15 ± 0.89	0.093^{NS}
Afternoon (2-3 pm)	58.06 ± 1.07	58.14 ± 1.07	58.43 ± 1.05	58.52 ± 1.05	0.044^{NS}

SCF- Solid Concrete Floor; RMF-Rubber Mat Floor; SCFF-Solid Concrete Floor with foggers; RMFF-Rubber Mat floor with foggers

Table 2: Growth and feed intake of piglets reared under different housing system

Parameters	SCF-Control (T1)	RMF (T2)	SCFF (T3)	RMFF (T4)	'F'- value
Initial live weight (kg)	11.73 ± 1.04	11.80 ± 1.09	11.81 ± 1.14	11.85 ± 1.09	0.01^{NS}
Final live weight (kg)	68.31 ± 3.08	69.22 ± 6.48	72.70 ± 3.26	70.78 ± 2.10	0.22^{NS}
Total live weight gain (kg)	56.58 ± 2.41	57.41 ± 6.07	60.88 ± 2.28	58.93 ± 1.47	0.28^{NS}
Growth rate (g/d)	420.00 ± 0.19	425.00 ± 0.44	450.00 ± 0.16	436.70 ± 0.10	0.26^{NS}
Total feed intake (kg)	1436.32 ± 0.35	1450.82 ± 0.27	1465.80 ± 0.48	1440.89 ± 0.19	0.43^{NS}
Daily feed intake (kg/day)	1.587 ± 0.03	1.605 ± 0.02	1.624 ± 0.03	1.592 ± 0.01	0.51^{NS}
Feed conversion ratio (FCR)	3.42 ± 0.38	3.41 ± 0.76	3.26 ± 0.21	3.30 ± 0.36	0.62^{NS}

SCF- Solid Concrete Floor; RMF-Rubber Mat Floor; SCFF-Solid Concrete Floor with foggers; RMFF-Rubber Mat floor with foggers
n=6 piglets in each group

Table 3: Carcass traits of piglets reared under different housing system

Parameters	SCF-Control (T1)	RMF (T2)	SCFF (T3)	RMFF (T4)	'F'-value
Live weight (kg)	82.80 ± 0.80	80.75 ± 0.75	83.67 ± 0.32	82.12 ± 0.62	3.60^{NS}
Hot carcass weight (kg)	56.65 ± 1.35	55.28 ± 0.68	59.44 ± 0.59	57.56 ± 0.36	4.38^{NS}
Dressing Percentage (%)	68.40 ± 0.97	68.46 ± 0.21	71.03 ± 0.43	70.09 ± 0.08	5.64^{NS}
Carcass length (cm)	80.50^{b} ± 0.50	76.50^{c} ± 0.50	84.15^{a} ± 0.35	79.40^{bc} ± 0.90	27.93**
Back fat thickness (cm)	3.65^{ab} ± 0.05	3.75^{a} ± 0.05	3.35^{c} ± 0.05	3.45^{bc} ± 0.05	13.33*
Loin eye area (cm^2)	28.50^{bc} ± 0.50	27.50^{c} ± 0.50	31.00^{a} ± 0.01	30.00^{ab} ± 0.01	19.33**
Meat percentage (%)	43.83^{c} ± 0.18	43.25^{c} ± 0.05	47.51^{a} ± 0.03	45.87^{b} ± 0.19	209.68**
Bone percentage (%)	33.71^{b} ± 0.01	35.58^{a} ± 0.08	31.81^{c} ± 0.01	32.45^{c} ± 0.25	159.15**
Fat percentage (%)	22.46^{a} ± 0.17	21.16^{b} ± 0.13	20.67^{b}±0.05	21.68^{b} ± 0.06	43.96**
Meat bone ratio	1.94^{c} ± 0.02	2.04^{bc} ± 0.01	2.30^{a} ± 0.01	2.11^{b} ± 0.00	106.43**

Table 4: Cost of production per kg body weight gain (Rs.) of piglets reared under different housing system

S. No.	Particulars	SCF-Control (T1)	RMF (T2)	SCFF (T3)	RMFF (T4)
1	Number of Pigs	6	6	6	6
2	Total initial body weight (kg)	70.40	70.80	70.90	71.10
3	Total final body weight (kg)	409.90	415.30	436.20	424.70
4	Total weight gain (kg)	339.50	344.50	365.30	353.60
5	Total feed intake (kg)	1436.32	1450.82	1465.80	1440.89
6	Total feed cost (Rs.) @ Rs 34/kg	48,835.00	49,328.00	49,837.00	48,990.00
7	Cost of construction of foggers (Rs.)	-	-	5250.00	5250.00
8	Hours of foggers operated	-	-	112.00	112.00
9	Electricity (in watts) used for operating foggers @ 500 watt/ hr	-	-	56,000.00	56,000.00
10	Cost of operating foggers @ Rs. 5/ kwh	-	-	280.00	280.00
11	Per day operating cost of foggers (Rs.)	-	-	2.10	2.10
12	Cost of construction of various floors in Rs. (17.55 sq. m)	6,000.00	20,000.00	6,000.00	20,000.00
13	Total cost of production in Rs. (feed cost + floor + foggers construction cost)*	54,835.00	69,328.00	61,367.00	74,520.00
14	Cost of production/ kg body weight gain (Rs.)	161.50	201.20	167.99	210.75

SCF- Solid Concrete Floor; RMF-Rubber Mat Floor; SCFF-Solid Concrete Floor with foggers; RMFF-Rubber Mat floor with foggers;
*Assuming all other cost of production such as labour charges, medicine cost. etc., remains same for all the treatment groups

Growth and feed efficiency

The live body weight, body weight gain, daily growth rate, feed intake and feed conversion ratio (FCR) of Large White Yorkshire weaned pigs under different improved housing management are presented in table 2. Statistically there was no significant difference (P>0.05) between the treatment groups. However, numerically higher body weight was observed in solid concrete floor with foggers (T3) followed by rubber mat floor with foggers (T4), rubber mat floor (T2) and solid concrete floor (T1) (72.70, 70.78, 69.22 and 68.31 kg), respectively. The pigs reared in concrete floor with foggers (T3) gained numerically higher body weight (60.88 kg) and average daily gain (450 g/day) than other treatment groups. Higher body weight recorded in T3 group of pigs reflects the beneficial effect of concrete floor with foggers system throughout the age of weaned pigs in all seasons. Subhalekha et al. (2021) reported that flooring systems did not affect performances such as body weight, body weight gain and average daily gain in grower pigs which is supported by the current study. Paiano et al. (2017) evaluated growth performance of growing-finishing pigs on compact floor pen and shallow floor pen. They did not observe any floor effect on the growth performance. The pigs reared under various housing systems such as standard house wooden floor or standard house concrete floor or traditional house made up of bamboo splits with concrete floor did not differ in their body weight, but those reared in standard housing with concrete floor had improvement in the overall body weight gain (Lyngkhoi et al., 2020). On the other hand, Gnanaraj et al. (2002) recorded that the live body weight of pigs at 180 days of age under water cooling was higher than in conventional housing systems. Adebiji et al. (2020) reported that the body weight gain of the piglets placed on a concrete floor with floor enriched with straw beddings was higher than those raised on a conventional concrete floor with no enrichment (4.75 vs. 3.34 kg). The results are contrast to Zhou et al (2015), who reported that pigs raised in deep litter system had significantly higher (P<0.05) growth compared to concrete floor system. Environmentally enriched house made from wood shaving as bedding material and with hanging toys improved growth performance in weaned piglets, exhibiting higher body weight gain (18.3 kg) compared to their counterparts, deprived of any enrichment (14.5 kg) (Oliveria et al., 2016). In summer season, weaned pigs reared under-insulated roof with 10 minutes fogging attained a higher body weight gain (40.39kg) and higher average daily gain (480.80 g/day) than 5 minutes fogging system (Rani et al., 2018). The disparity of results among different studies might be due to interaction between housing system and local climatic conditions inaddition to breed, nutrition, season and location of animal house that can affect the performance of pigs (Ludwiczak et al., 2021).

The results of the current study revealed no treatment effect (P>0.05) on feed intake and feed conversion ratio (FCR). However, the pigs reared in Concrete floor with foggers (T3) had numerically higher feed intake (1465.80 kg) followed by Rubber-mat floor (T2) (1450.82 kg), Rubber-mat floor with foggers (T4) (1440.89 kg) and Concrete floor (T1) (1436.32 kg). The FCR of pigs reared in Concrete floor (T1) was numerically higher followed by Rubber-mat floor (T2), Rubber mat floor with foggers (T4) and Concrete floor with foggers (T3) (3.42±0.38, 3.41±0.76, 3.30±0.36 and 3.26±0.21, respectively). Gnanaraj et al. (2002) recorded higher feed intake of pigs under water cooling than in conventional housing systems. Zhou et al. (2015) observed that housing system (deep litter floor or concrete floor) did not affect average daily feed intake but affected feed to gain ratio during whole growth stage. Subhalekha et al. (2021) found higher fortnightly average feed intake of Large White Yorkshire grower pigs reared in raised slatted concrete floor than polypropylene floor and concrete floor. Rani et al. (2018) found that enriched housing using fogging did not significantly affect FCR in weaned piglets. However, during the summer season, better feed conversion efficiency of 3.78 was recorded in piglets housed under roof enrichment with 10 minutes of fogging and the grower pigs reared under an asbestos roof without fogging and enrichment recorded poor feed conversion efficiency of 4.08.

Carcass quality

The carcass quality traits (pre-slaughter live weight, carcass weight, dressing percentage, carcass length, back fat thickness, loin eye area, meat, fat, bone percentage and meat to bone ratio) of pigs under enriched housing management systems are presented in table 3. There was significant (P<0.05) effect of treatments on all carcass traits except pre-slaughter live weight, carcass weight and dressing percentage. The results are in agreement with Kaswan et al. (2016), who indicated that floor did not affect major carcass traits like final slaughter weight, hot carcass weight, dressing percentage and carcass length. However, Rani et al. (2018) observed higher carcass weight, dressing percent and carcass length in pigs reared in enriched roofing with 10 minutes fogging housing system. Further, Borah et al. (2022) observed significant effect of floor type on carcass characteristics in crossbred Hampshire pigs. The pigs reared in deep litter housing had higher slaughter weight, hot carcass weight, dressing percentage and carcass length than conventional housing.

Mun et al. (2022) recorded higher back fat thickness in lower temperatures (12 to 19 ^{O}C) than high temperatures (31 to 37 ^{O}C) of crossbred pig sty which is supported by the current study. Rinaldo and Mourot (2001) also reported reduced back fat thickness in pigs reared in tropical climates than in environmentally controlled houses (20 ^{O}C). This could be owed to the tendency of increased voluntary feed intake in house with comfortable micro-environment resulting in higher live weight and thicker back fat. In contrast, Borah et al. (2022) did not observe any floor effect on the back fat thickness and loin eye area. Xin et al. (2016) investigated the effect of high ambient temperature on carcass traits in a pig and reported no significant effect on back fat thickness.

However, Gentry et al. (2004) observed that carcass from pigs reared outdoor had similar back fat measurements and loin eye area compared to pigs reared indoors. The results are similar to Rani et al. (2018), who observed that carcass characteristics under enriched roofing and water fogging system with weaned pigs had significantly (P< 0.05) higher meat percentage and meat-bone ratio when compared to control which is supported by the current study. Borah et al. (2022) observed that meat to bone ratio was significantly higher (P<0.01) in deep litter floors than in conventional concrete floor housed pigs.

Economics

The results (Table 4) showed that under improved housing systems (rubber mat floor and/or foggers), the T3 group had a lesser cost of production (Rs.167.99 per kg of body weight gain); while, T4 group (rubber mat floor with foggers) had higher cost of production (Rs. 210.75 per kg of body weight gain). The cost of production of T2 (rubber mat floor) groups was Rs. 210.20 per kg of body weight gain. However, lowest cost of production was observed in T1 (concrete floor) group, Rs. 161.50 per kg of body weight gain. Though, the cost of production was lowest in T1 group compared to T3 group, the carcass quality (Table 3) was better in T3 group. Further, under long run the fogger system (T3 group) would be more beneficial as compared to T1 group. Additionally the cost of feed in the T3 group was higher due to higher feed intake as compared to other improved/enriched housing groups (T2 and T4). Thought the average body weight was numerically higher in T3 group, the better feed conversion ratio might have resulted lower cost of production per kg live weight gain than the other improved housing groups. These findings are well corroborated by Lontoc et al. (2016), who also reported higher net profit due to the use of an evaporative cooling system. In a similar line, Rova and Vidyarthi (2020) investigated economic analysis and observed higher overall net profit per kg live weight gain and benefit to cost ratio in the water sprinkling group of pigs as compared to the control group.

Conclusion

The improved housing with water fogging system reduced air temperature without affecting relative humidity of micro-environment irrespective of the floor type. The floor type did not influence the growth performance and feed intake of intensively reared pigs. However, the pigs reared in improved housing, comprised of concrete floor with water fogging pattern had improvement in the overall growth, carcass length, loin eye area, meat percentage and meat to bone ratio, ultimately leading to favorable economic returns to the farmers. Hence, ‘concrete floors with foggers’ improved housing systems can be advocated for rearing of pigs under prevailing conditions of tropical climate to provide favourable micro-climate, better productivity and increase profitability.

Acknowledgement

The authors express their sincere gratitude for the support and resources offered by TANUVAS, Chennai, India, which facilitated the successful completion of the research work.

Conflict of interest

There is no conflict of interest among the authors.

References

1) Adebiyi, O.A., Famakinwa, A.A., Adebiyi, F.G., Bankole, T.O., Benneth, E.O. and Muibi, M.A. (2020). Straw bedded pigsties height: effect on growth and skin lesion of pigs. Nigerian Journal of Animal Production, 47(6):91-98. doi.org/10.51791/njap.v47i6.2900.
2) Bhadouria, P., Singh, S., Aparna, S., Inderjeet and Sheoran, P. (2023). Pig farming techniques and technology. ICAR - Agricultural Technology Application Research Institute, Zone-1, Ludhiana, Punjab, India. p. 125.
3) Borah, P., Bora, J.R., Haque, A., Borpuzari, R., Hazarika, S. and Konwar, P. (2022). Effect of housing system on carcass characteristics of crossbred (Hampshire x Assam local) pigs. Journal of Livestock Science, 13:208-212. doi. 10.33259/JLivestSci.2022.208-212.
4) Correa, E.K., Bianchi, I., Ulguim, R.R., Correa, M.N., Turnes, C.G. and Junior, T.L. (2009). Effects of different litter depths on environmental parameters and growth performance of growing finishing pigs. Ciencia Rural, Santa Maria. 39(3):838-843. doi.org/10.1590/S0103-84782008005000094.
5) Gentry, J.G., McGlone, J.J., Miller, M.F. and Blanton, J.R. (2002). Diverse birth and rearing environment effects on pig growth and meat quality. Journal of Animal Science, 80(7):1707-1715. doi: 10.2527/2002.8071707x..
6) Gnanaraj, P.T., Sivakumar, T., Arunachalam, S., Gajendran, K. and Ramesh, V. (2002). Influence of heat alleviating measures on the performance of growing pigs. Indian Journal of Animal Sciences, 72(10):936-938.
7) Huynh, T.T.T., Aarnink, A.J.A., Spoolder, H.A.M., Verstegen M.W.A. and Kemp, B. (2004). Effects of floor cooling during high ambient temperatures on the lying behavior and productivity of growing finishing pigs. Transactions of the ASAE, 47(5):1773-1782. doi: 10.13031/2013.17620.

8) Huynh, T.T.T., Aarnink, A.J.A., Truong, C.T., Kemp B. and Verstegen, M.W.A. (2006). Effects of tropical climate and water cooling methods on growing pigs' responses. Livestock Science, 104(3):278-291. doi.org/10.1016/j.livsci.2006.04.029.
9) Kaswan, S., Patel, B.H.M., Singh, M., Dutt, T., Gaur, G.K., Kamal, R. and Godara, A.S. (2016). Carcass traits of crossbred (Landrace × Desi) barrows reared with different floor space allowances under intensive system. Indian Journal of Animal Sciences, 86(3):335-340. doi.org/10.56093/ijans.v86i3.56767.
10) Lontoc, C.A.A., Punay, L.C.L., Cajano, P.J. and Vega, R.S. (2016). Comparative performance of sows housed with and without evaporative cooling system at temperature humidity index of 73-83. Philippine Journal of Veterinary and Animal Sciences, 42(2):77-84.
11) Ludwiczak, A., Skrzypczak, E., Składanowska-Baryza, J., Stanisz, M., Ślósarz, P. and Racewicz, P. (2021). How housing conditions determine the welfare of pigs. Animals, 11(12): 3484. doi: 10.3390/ani11123484.
12) Lyngkhoi, C.L., Rutsa, M.C., Savino, N., Zuyie, R. and Vidyarthi, V.K. (2020). Effect of different housing systems on some behavioural characters and growth performance of upgraded Tenyivo pigs. Livestock Research International, 8(3):104-110.
13) Mun, H.S., Rathnayake, D., Dilawar, M.A., Jeong, M.G. and Yang, C.J. (2022). Effect of ambient temperature on growth performances, carcass traits and meat quality of pigs. Journal of Applied Animal Research, 50(1):103-108. doi.org/10.1080/09712119.2022.2032084.
14) Nannoni, E., Sardi, L., Vitali, M., Trevisi, E., Ferrari, A., Barone, F., Bacci, M.L., Barbieri, S. and Martelli, G. (2016). Effects of different enrichment devices on some welfare indicators of post-weaned undocked piglets. Applied Animal Behaviour Science, 184:25-34. doi.org/10.1016/j.applanim.2016.08.004.
15) Neha, T., Sarita, K., Ashish, S., Priyanka, M., Manaswini, S. and Manoj, B. (2019). Pig: potential future meat animal of India. International Journal of Current Microbiology and Applied Sciences, 8(2): 3149-3155. doi.org/10.20546/ijcmas.2019.802.368.
16) Oliveira, R.F., Soares, R.T.R.N., Molino, J.P., Costa, R.L., Bonaparte, T.P., Silva, E.T., Pizzuttoand, C.S. and Santos, I.P. (2016). Environmental enrichment improves the performance and behavior of piglets in the nursery phase. Arquivo Brasileiro de Medicina Veterinaria e Zootecnia, 68:415-421. doi.org/10.1590/1678-4162-8253.
17) Paiano, D., Moreira, I., Quadros, A.R.B., Milani, N.C., Zoot, Nunes, M.L., Machzdo, G. and Silva, A.S.D. (2017). Effect of stocking rate and floor types on performance, skin temperature and leukogram in pigs rearing. Revista-MVZ Corodoba, 22(1):561- 5618. doi:dx.doi.org/10.21897/rmvz.921.
18) Rani, S.P., Vanan, T.T., Sivakumar, T., Balasubramanyam, D. and Thennarasu, A. (2018). Carcass characteristics of Large White Yorkshire grower pigs maintained under roof insulation and water fogging system during summer season. Indian Journal of Veterinary and Animal Sciences Research, 47(4):1416-1419.
19) Rinaldo, D. and Mourot, J. (2001). Effects of tropical climate and season on growth, chemical composition of muscle and adipose tissue and meat quality in pigs. Animal Research, 50:507-521. doi.org/10.1051/animres:2001142.
20) Rova, S. and Vidyarthi, V.K. (2020). Performance of pig as affected by body cooling through water sprinkling. Livestock Research International, 8:166-172.
21) Singh, M., Mollier, R.T and Rajchowa, D.J. (2020). A way forward for revitalizing Pig farming in Nagaland. Indian Farming, 70(6):23-26.
22) Subhalekha, R., Yasotha, A., Sundaram, S.M. and Kumar, R.P. (2022). Growth performances of fattening pigs on three different flooring systems. Journal of Krishi Vigyan, 11:68-72.
23) Tedtova, V.V., Temiraev, R.B., Kairov, V.R., Dzhaboeva, A.S., Yurina, N.A., Temiraev, K.B., Baeva, Z.T., Bobyleva, L.A., Zagaraeva, E.F., Efendiev, B.S. 2020. Effect of soybean feeding on productivity of sows, growth of piglets and quality of pork. Journal of Livestock Science 11:20-25. doi. 10.33259/JLivestSci.2020.20-25
24) Thomas, R., Singh, V. and Gupta, V.K. (2021). Current status and development prospects of India's pig industry', Indian Journal of Animal Sciences, 91(4):255-268. doi.org/10.56093/ijans.v91i4.114325.
25) Wang, L. and Li, D. (2024). Current status, challenges and prospects for pig production in Asia. Animal Bioscience, 37:742-754. doi: 10.5713/ab.23.0303.
26) Xin, W.U., Li, Z.Y., Jia, A.F., Su, H.G., Hu, C.H., Zhang, M.H. and Feng, J.H. (2016). Effects of high ambient temperature on lipid metabolism in finishing pigs. Journal of Integrative Agriculture, 15(2):391-396. doi.org/10.1016/S2095-3119(15)61061-9.
27) Zhou, C., Hu, J., Zhang, B. and Tan, Z. (2015). Gaseous emissions, growth performance and pork quality of pigs housed in deep-litter system compared to concrete floor system. Animal Science Journal, 86:422-427. doi:10.1111/asj.12311.