Genetic variations and piglet mortality: an empirical study in Northeastern India

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Abstract

Mortality records of exotic, crossbred and indigenous pigs reared under tropical agro-climatic conditions of northeastern India, were analyzed for genetic group, age, sex, environmental factors and causes of death. Results revealed a significant ($P<0.01$) difference in mortality in Ghungroo (10.09%), Hampshire (10.70%), Duroc (11.07%) with that of Niang Megha (7.80%), Crossbred-A (7.75%) and Crossbred-B (7.34%). Highest mortality was observed in age group of 0-15 days (3.20 %) which was gradually decreased in the age group of 30-45 days (1.42%) and then subsequently increased (2.14%) in the age group of 45-60 days which suggested the most vulnerable phase to be 0-15 days. Significantly ($p<0.05$) high mortality rate was observed during winter season. Digestive disorder was found to be the major reason followed by respiratory disorder. A linear regression model was developed which could fairly predict the cyclicity of mortality pattern based on the rainfall, relative humidity, minimum and maximum temperature (R^2=74.2%).

Keywords: Environmental factors; Pig; Mortality; Regression model, Seasonal variation

Introduction

Pig rearing is one of the most important occupations of rural society especially for the socio-economically disadvantageous tribal masses in northeastern region of India (Banik et al., 2013, Banik et al., 2020). The region is predominantly tribal, with pork being the most preferred meat and accounting for a substantial share of total meat consumption. The desi pigs in the northeast region are highly suitable for small-scale pig farmers, maintaining low-input production systems, contributing to sustainable pig farming and livelihoods (Banik et al., 2022, Banik et al., 2024). Approximately 12% of the piglets born alive die before weaning and half these losses happen during the first 3 days of life (Varley, 1995). Measures like improved housing and feeding are taken to for better performance of piglet (Tedtova et al., 2020, Vasnth et al., 2025) and reduce the mortality which affects greatly the profitability in Pig farming in tropics (Mondal et al., 2012). This pre-weaning mortality represents a significant economic loss, and many attempts have been made to identify the key factors involved in neonatal vulnerability. This is often constrained by poor management practices including poor feasibility studies, inadequate feeds and feeding materials, technological application and neonatal mortality among others (Varley, 1995). Frazer (1990) defined neonatal mortality in pigs as death that occurs in piglets within few days of life. Similarly, Varley (1995) on observing the improvement in the reproductive performance of exotic pigs also noted high level of neonatal mortality up to 13%. Several studies had attributed neonatal mortality in pigs to be of multifactor causes including diseases such as colibacillosis, salmonellosis and piglet anaemia (Abonyi et al., 2012). Other factors were low viability, chilling, maternal overlay and poor management practices (Damron, 2009). The mortality pattern and occurrence of different diseases and disorders may also vary with different genetic groups of pigs. Although not all mortality factors are controllable, understanding them can help farmers minimize piglet losses.

Detailed studies are warranted to elucidate the effect of environmental factors and genetic makeup on mortality pattern in pigs. Further knowledge about the effect of climatic factors on pigs allow producers to adjust management tactics to reduce the potential economic losses due to environmental changes.

Several studies have been undertaken to evaluate piglet mortality in India (Basumatary et al., 2009). Assuming the change of climatic parameters globally; and northeastern India in particular, five-year data (2008-2012) on piglet mortality was considered for the present study to compare the effect of climate change on piglet mortality. Data from this period were purposively selected to maximize genetic group effects, as some groups, including Crossbred-B and Duroc, were later discontinued or had very few animals available on the farm. The study period was considered up to 2012 to account for and overcome the effects of the PRRS outbreak from 2013.

In order to examine the causes of mortality of piglets in an organized farm of northeastern India and its environs, this study aimed at identifying the possible causes of piglet mortality in an organized pig farm of northeastern India, provide baseline data which will serve as a reference point for further studies, and possible solutions to identified problem(s) with a view to reduce piglet mortality and hence increase swine productivity within the area. The objective of the present study is to evaluate the effects of genetic and environmental factors on piglet mortality and identify the major causes and critical periods of mortality in northeastern India.

Materials and methods

Study area

The present study was carried out at nucleus pig breeding farm of ICAR-National Research Centre on Pig, Guwahati (latitude 26.01° N and longitude 91.34° E; 56 m above MSL), located in sub-Himalayan northeastern part of India.

Climate of Guwahati is mildly sub-tropical with warm, dry summers from April to late May, a strong monsoon from June to September and cool, dry winters from late October to March. The area experiences an annual rainfall of 180 cm (from May to September) with an average number of 77.3 rainy days annually. While summer temperature ranges from 22 to 38°C, in winters the mercury ranges from 10 to 25°C (Deka et al., 2009).

Animals and management

Two breeds of indigenous pig *viz.*, Ghungroo and Niang Megha; two breeds of exotic pig *viz.* Hampshire and Duroc and two genetic groups of upgraded crossbred variety *viz.* crossbred-A (Hampshire X Ghungroo) also known as Rani and Crossbred-B (Hampshire X Niang Megha) with 50% exotic inheritance were utilized for the study. A total of 3372 pigs comprising of 1021 Ghungroo, 372 Niang Megha, 383 Hampshire, 271 Duroc, 1148 Crossbred-A and 177 Crossbred-B belonging to different age groups were considered for the study. The first incidence of PRRS (Porcine reproductive and respiratory syndrome) in India was reported by Rajkhowa et al. (2015) in 2013. To get an unbiased mortality parameter, 5 years data from 2008 to 2012 were used for the study.

Piglets were housed with their dam in indoor pens (12.0 ft X 10.0 ft with concrete flooring) varying from 6 to 10 piglets per pen (Banik et al. 2012). Water was made available *ad lib*. Starter feed (maize 55.0%, deoiled ground nut cake 21.0%, soybean meal 17.0%, wheat bran 5.5%, mineral mixture 1.0% and salt 0.5%; ME 13.78 MJ/kg diet and CP 24%) of 20 g per animal was offered from third week onward till weaning as per NRC recommendation (NRC, 1998). The amount of ration was gradually increased by 20 g/week till it reached 80 g/piglet/d at the time of weaning (42 days). Routine veterinary care, including deworming, vaccination against FMD and Swine Fever, and iron injection, was provided. Regular health monitoring and disease prevention practices were followed. Piglets were individually identified using ear tags.

Mortality pattern assessment

For the present study, the period from birth was divided into 4 different age groups *viz.*, 0–15 days, 15-30 days, 30-45 days and 45-60 days. The causes of piglet mortality, based on the post-mortem findings, were classified into 9 major classes (digestive, respiratory, cardiovascular, musculoskeletal, nutritional, urogenital disorders, infectious causes, parasitic infestation and miscellaneous conditions) (Basumatary et al*.,* 2009). The rainfall, relative humidity and temperature of different periods were collected from the meteorological department. Based on the meteorological information, the whole year was divided into 3 seasons viz., winter (November–February), summer (March–June) and rainy (July–October).

Statistical analysis

For calculating the percentage of mortality and their distribution pattern, the number of animals died to total herd strength in different genetic groups under different sex, seasons and year were considered. The mortality percentage for age group was calculated as described by Parekh and Singh (1981) by the following formula. Mortality (%) = $d_i/(b-d_{i-1})$ X100; where, d_i= number of animals died in the i^{th} age group, b= total number of animals born and d_{i-1}= the number of deaths upto previous age group.

The tests of significance for breed, sex, season and year of birth were analyzed by analysis of variance for threshold traits as described by Lush et al. (1948). Regression equations of mortality on different climatic parameters were constructed to predict the cyclicity of mortality pattern using SPSS Software.

Results

A total of 305 mortality records out of 3372 total stocks were analyzed with respect to genetic group, sex, season, year of birth, age and cause in different seasons and are presented in Tables 1–3. Results revealed a significant (P<0.01) difference in mortality in Ghungroo (10.09%), Hampshire (10.70%), Duroc (11.07%) with that of Niang megha (7.80%), Crossbred-A (7.75%) and Crossbred-B (7.34%).

Mortality pattern in relation to different Sex

There was no significant difference between sex either within breed or overall. So, this observation suggests that both sexes are equally vulnerable to the factors of mortality.

Mortality pattern in relation to different Season

The overall mortality during different seasons is shown in Table 1. Significantly (p<0.01) higher mortality was observed during winter season compared to the other seasons which suggests that piglets are more susceptible to cold thermal stress than that of summer thermal stress. The overall mortality percentage was 7.83, 10.41 and 8.87 during rainy, winter and summer seasons, respectively (Table 1). During breed wise analysis; significantly (p<0.05) higher mortality was observed in different seasons for all the breeds.

Mortality pattern in relation to different year

Year-wise observations of mortality were similar and non significant for the reported period which suggests almost similar environmental variability in different years.

Mortality pattern in relation to different age groups

Age wise mortality percentage of different breeds is depicted in Table 2. Age-wise mortality pattern was highly significant (p<0.01) in various age groups. The highest mortality was observed in 0-15 days of age (overall 3.20 %) which gradually decreased in 30-45 days of age (overall 1.42%) and then subsequently increased in 45-60 days of age (overall 2.14%). Similar trend was also observed for individual breeds. This suggests that two critical periods exist in the piglet, one just after farrowing till they get their creep ration and another post-weaning when there is change from liquid to solid diet. In the first period, pigs are first exposed to the environmental variable after coming out of dam's womb. However, during second period, weaning stress along with nutritional stress (change in diet pattern) explains the higher mortality during the phase.

Mortality pattern in relation to different etiology

Among different causes, digestive disorders were found to be significantly (p<0.05) higher for overall mortality (37.38%) than other causes (Table 3, Fig-2). This suggests the compromised local gastro-intestinal tract immunity at various points of life as well as diet changes like milk, creep ration, grower ration, etc attributing to digestive disorders as one of the major mortality causing disturbance. The second highest mortality was found to be caused by respiratory disorders (22.62%) followed by cardiovascular diseases (17.38%). This suggests environmental variable to be second responsible agent to the cause as and when they are exposed to extreme conditions during different seasons. The others caused were not found to be prominent for mortality in pigs. Similar pattern was reflected in individual breeds also.

Table 1. Mortality percentage of different breed, sex, season and year of birth

Breed	Ghungroo	Niang Megha	Hampshire	Duroc	Crossbred-A	Crossbred-B	Total
Sex (NS)							
Male	10.14 (52/513)	7.94 (15/189)	10.94(21/192)	11.43(16/140)	7.78(46/591)	7.50(6/80)	9.51(156/1705)
Female	10.04(51/508)	7.65(14/183)	10.47(20/191)	11.69(14/131)	7.72(43/557)	7.22(7/97)	8.94(149/1667)
Season (P<0.01)							
Rainy	9.57^{A} (29/303)	6.21^{A} (10/161)	9.26^{A} (10/108)	9.52^{A} (6/63)	6.76^{A} (30/444)	5.00^{A} (1/20)	7.83^{A} (86/1099)
Winter	10.80^{B} (42/389)	11.61^{B} (13/112)	11.94^{B} (16/134)	13.00^{B} (13/100)	8.65^{B} (36/416)	10.00^{B} (4/40)	10.41^{B} (124/1191)
Summer	9.73^{A} (32/329)	6.06^{A} (6/99)	10.64^{A} (15/141)	10.19^{A} (11/108)	7.99^{A} (23/288)	7.69^{A} (9/117)	8.87^{A} (96/1082)
Year of Birth (NS)							
2008	9.93 (14/141)	7.63 (9/118)	13.04 (3/23)	(0/0)	(0/0)	(0/0)	9.22 (26/282)
2009	10.09 (23/228)	8.05 (7/87)	10.26 (8/78)	10.87 (5/46)	8.51 (4/47)	6.67 (1/15)	9.58 (48/501)
2010	10.04 (25/249)	7.81 (5/64)	10.20 (10/98)	10.71 (15/140)	7.26 (13/179)	8.33 (4/48)	9.25 (72/778)
2011	9.96 (23/231)	7.69 (6/78)	10.87 (10/92)	10.64 (5/47)	7.94 (35/441)	7.02 (8/114)	8.67 (87/1003)
2012	10.47 (18/172)	8.00 (2/25)	10.87 (10/92)	13.16 (5/38)	7.69 (37/481)	(0/0)	8.91 (72/808)
Overall Breed (P<0.01)							
Total	10.09^{a} (103/1021)	7.80^{b} (29/372)	10.70^{a} (41/383)	11.07^{a} (30/271)	7.75^{b} (89/1148)	7.34^{b} (13/177)	9.05 **(305/3372)**

Figures in the parenthesis indicates (Number of animal died/Number of animal exposed); A, B Figures with the same superscripts among the column does not differ significantly (P<0.05) (For Season Variation); a, b Figures with the same superscripts among the row does not differ significantly (for Breed Variation); NS: Not Significant

Table 2. Age wise mortality percentage of different breeds

Breed	Ghungroo	Niang Megha	Hampshire	Duroc	Crossbred-A	Crossbred-B	Total
0-15 days	3.23 (33/1021)	2.96 (11/372)	3.66 (14/383)	3.69 (10/271)	2.96 (34/1148)	3.39 (6/177)	3.20^{A} (108/3372)
15-30 days	2.53 (25/988)	2.22 (8/361)	3.25 (12/369)	3.07 (8/261)	2.60 (29/1114)	1.75 (3/171)	2.60^{B} (85/3264)
30-45 days	1.87 (18/963)	1.13 (4/353)	1.40 (5/357)	1.58 (4/253)	1.11 (12/1085)	1.19 (2/168)	1.42^{C} (45/3179)
45-60 days	2.86 (27/945)	1.72 (6/349)	2.84 (10/352)	3.21 (8/249)	1.30 (14/1073)	1.20 (2/166)	2.14^{B} (67/3134)

Figures in the parenthesis indicates (Number of animal died/Number of animal exposed),A, B Figures with the same superscripts among the column does not differ significantly (P<0.01)

Table 3. Breed-wise Etiology of mortality percentage

Etiology	Ghungroo	Niang Megha	Hampshire	Duroc	Cross bred-A	Cross bred-B	Total
Digestive disorder	38.83	34.48	31.71	36.67	39.33	38.46	37.38
Respiratory disorder	19.42	20.69	21.95	23.33	26.97	23.08	22.62
Cardiovascular disease	12.62	20.69	24.39	20.00	16.85	23.08	17.38
Musculo-skeletal disorder	3.88	0.00	0.00	0.00	2.25	0.00	1.97
Infectious disease	6.80	10.34	4.88	6.67	6.74	7.69	6.89
Parasitic disease	8.74	0.00	4.88	3.33	5.62	0.00	5.57
Nutritional/production and metabolic disorder	4.85	3.45	4.88	0.00	1.12	0.00	2.95
Urogenital disorder	1.94	3.45	2.44	3.33	0.00	0.00	1.64
Miscellaneous disorder	2.91	6.90	4.88	6.67	1.12	7.69	3.61
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

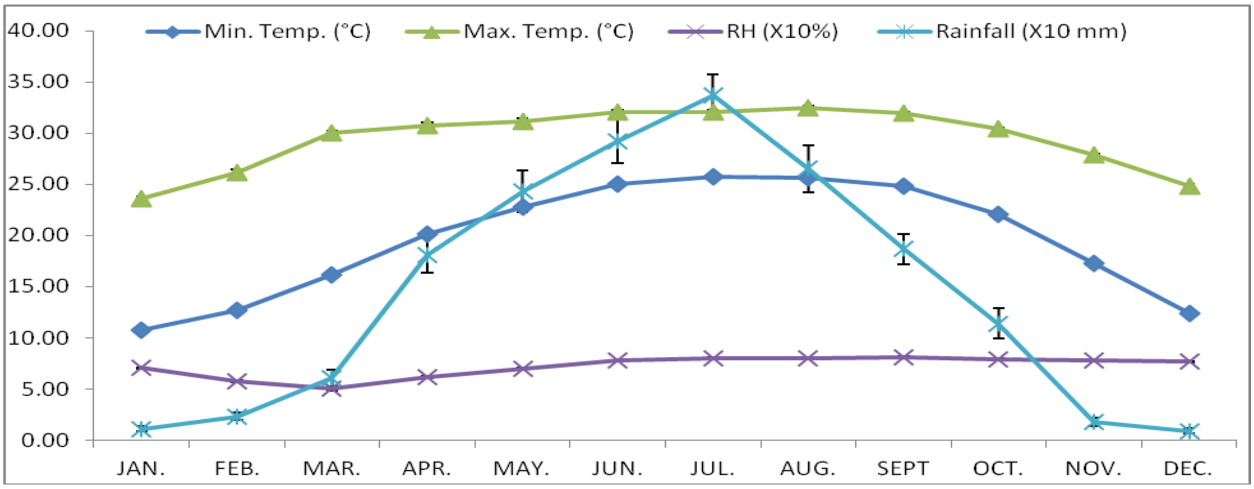

Fig. 1. Monthly average fluctuation of climatic parameters of the study area

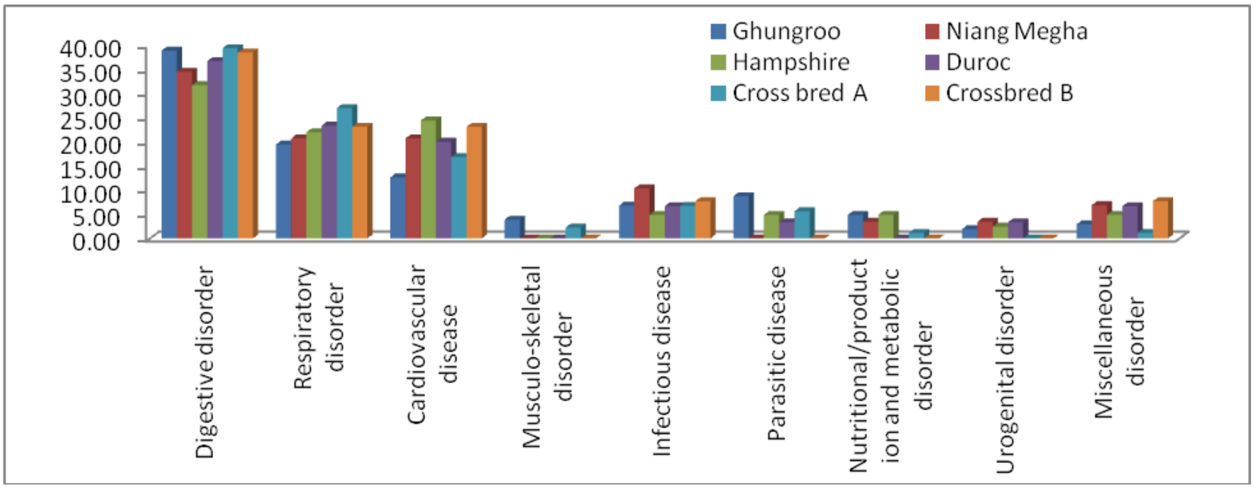

Fig. 2. Etiology of mortality among different breeds

Regression analysis of mortality pattern with climatic parameters

The minimum and maximum monthly temperature, relative humidity and rainfall over the study period are shown in Fig. 1. An attempt was made to predict the mortality of pigs keeping all the climatic parameters into account in different seasons of the year.

The linear regression model of mortality on climatic factors was $Y=-2.244-0.307X_1+0.606X_2-0.018X_3+0.005X_4$, where X_1-minimum temperature, X_2-maximum temperature, X_3-relative humidity and X_4-stands for rainfall. The model showed an R^2 value of 74.2%. From the equation, it is suggested that the temperature (minimum/maximum) are the major factors for mortality in piglets, however, RH and rainfall too contribute to the cause.

Discussion

Understanding climatic, disease and disorder-related factors affecting pig mortality is essential for sustainable pig production and improved farmer livelihoods. The studies conducted at same research station of NRC on Pig, Guwahati by Pourouchottamane et al. (2013) suggested that season had no effect on pre-weaning production performances of Ghungroo breed, however, for Niang Megha and Crossbreds, pre-weaning production performances were significantly ($p<0.01$) altered.

Genetics

Significantly higher mortality was observed in both the exotic breed and Ghungroo than crossbred and Niang megha. Higher mortality among the exotic breeds might be due to small and limited population size which in turn resulted to increase inbreeding effect. Basumatary et al. (2009) observed higher mortality in local pigs than upgraded variety. The reason for higher mortality among Ghungroo might be due to change in their habitation from the natural/field conditions to the confinement and higher litter size. On the contrary, Niang Megha's adaptation to the local climate and smaller litter size ensure lower mortality through better mothering and adequate milk supply. Low preweaning mortality among the crossbred pig indicates the heterozygote superiority among crosses conferring them with better viability and fitness. It is known that characters that are associated with fitness showed epistatic interaction and strong directional dominance resulting in increased vigor for pre-weaning survivability among the piglets (Falconer, 1981).

Sex

Although slightly more males than females are born in a litter, females have a greater survival advantage than males (Svendsen et al., 1986; Becker, 1995). McGlone et al. (1993) reported that castration of male piglets at any age leads to less time spent nursing and standing and more time spent lying, which may lead to more clinical and subclinical disease, resulting in greater mortality compared to females. Although the underlying mechanism(s) responsible for this sexual dimorphism in preweaning mortality rates has not been elucidated, there are some unique sex differences that may account for these observations.

Season

Winter season showed significantly higher mortality as compared with other seasons due to higher susceptibility of piglets to cold stress. Seasonal variation in physiological and stress responses among native, crossbred and exotic pigs indicates differential environmental adaptation (Vashi et al., 2018) Basumatary et al. (2009) reported highest mortality in indigenous pigs during winter, whereas upgraded pigs showed higher post-monsoon mortality, particularly at the pre-weaning stage. Cold stress critically affects piglet survival during the first few days of life (Kelley, 1985). The newborn piglet has a relatively broad range of thermoneutral zone (TNZ), which is defined by upper critical and lower critical temperatures (UCT and LCT, respectively). Temperatures below the LCT or above the UCT trigger thermoregulatory responses. The high UCT reduces heat-stress risk, whereas the LCT of 34.6°C indicates vulnerability to cold stress. However, the piglet's ability to tolerate cooler temperatures increases rapidly with age. Between 24 and 48 h of age, the LCT decreases from 33.3 to 30.1°C (Berthon et al., 1993), and by 1 wk the LCT of the piglet rapidly declines to approximately 25°C (Svendsen et al., 1986).

Year

Year being homogeneous in nature in respect to climatic parameters during the period of study did not show any significant difference in mortality parameters.

Age group

The study revealed that the mortality was highest at 0–15 days, declined up to 15–45 days, and slightly increased at 45–60 days. The highest mortality observed in 0-15 days of age was due to lower adaptability of piglets to exposure to extreme thermal stress during winter/summer season. Slight increase of mortality was observed at 45-60 days as compared with 30-45 days which may be attributed to weaning stress. The farm practice weaning at 42 days of age, results to exposure of piglets to weaning stress.

Etiology

Digestive, respiratory and cardiovascular disorders were the major three cause of mortality in both indigenous and upgraded pigs which is in agreement with the findings of Basumatary et al*.,* 2009. Piglet losses tend to be the result of noninfectious causes and are strongly associated with management practices. However, neonatal disease outbreaks can cause extremely high mortality for short periods. Piglets are immunologically immature at birth and rely on colostrum-derived IgG for early immune protection against pathogens. Neonatal mortality has been associated with low concentrations of serum IgG (Klobasa et al., 1981). The thermal environment can also significantly influence disease susceptibility and subsequent survival (Kelley, 1985). Diarrhoeic piglets have reduced thermoregulatory ability and show greater vasoconstriction during cold stress (Balsbaugh et al., 1986).

Regression

The prediction equation developed based on the climatic factors and mortality pattern in pigs, can be used to estimate the mortality taking minimum and maximum temperature, humidity and rainfall into consideration. The equation can predict the cyclicity of mortality pattern. The R^2 value observed for the best prediction equation was 74.2%. Basumatary et al. (2009) reported a moderate R^2 value of 58.3% while taking average temperature, humidity and rainfall in sub-tropical Himalayan area.

Conclusion

The present findings concluded that the winter is the most critical period for pigs due to exposure to low environmental temperature, and provision of heat source in the crate or creep area could reduce the pre-weaning mortality in pigs. Among the different genetic groups, crossbred animals showed lower mortality due to heterozygote superiority among crosses conferring them with better viability and fitness. Among the different etiology, digestive disorders contributed to high mortality, and proper nutritional and shelter managemental care may need to be undertaken to address these factors. The developed linear regression model could fairly predict the mortality pattern based on the rainfall, relative humidity and minimum and maximum temperature.

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