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Least-square Analysis of Non-genetic Factors on the Growth Performance Traits of HD-K75 Pigs

Jyotishree Bayan [a], Galib Uz Zaman [a*], Dhireswar Kalita [a], Rabindra Nath Goswami [a], Arundhati Phookan [a], Farzin Akhtar [b] and Sourabh Sulabh [c*]

[a] Department of Animal Genetics and Breeding, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-781022, Assam, India.
[b] Goat Research Station, Assam Agricultural University, Byrnihat- 785013, Assam, India.
[c] Department of Animal Science, Kazi Nazrul University, Kalla, Asansol-713340, West Bengal, India.

Authors' contributions

This work was carried out in collaboration among all authors. The corresponding author GUZ and author DK contributed to the study conception and design. Collection of the data was done by author JB and analysis was performed by authors JB and RNG. Inference to the analyzed data was drawn by author JB and SS. Formations of charts, figures and tables were done by author SS, AP and FA. The first draft of the manuscript was written by author JB and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Northeastern India has a good population of indigenous pig breeds with unique traits. However, they possess reduced productive and reproductive potential compared to exotic breeds of pigs. So, the HD-K75 pig variety with 75% Hampshire inheritance and 25 % indigenous inheritance has been

**Corresponding author: Email: gzaman60@gmail.com, sourabhjsr.vtro4@gmail.com;*

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developed under AICRP on pigs. Records about the progenies of 44 sires and 114 dams of HD-K75 pigs maintained over 6 years were utilized through least square analysis to study the pre- and post-weaning growth. The least squares analysis of variance technique was carried out to study the effects of season of birth, sex, and parity on the traits under study. Duncan's Multiple Range Test (DMRT) was used to make all the pairwise comparisons among the means to test the significance of differences among the different subclasses for various traits. The overall least-squares means of the HD-K75 pigs for body weight at birth, 1 month, weaning, 2 months, 3 months, 4 months, 6 months, 8 months and average daily gain during birth to 42 days, 42 days to 4th month, 42 days to 6th month and 42 days to 8th month of age were found to be 1.001± 0.001 kg, 6.912± 0.011 kg, 9.666± 0.013 kg, 12.207 ± 0.007 kg, 18.324 ± 0.001 kg, 28.349 ± 0.052 kg, 51.177 ± 0.091 kg, 71.229 ± 0.110 kg, 206.299 ± 0.311 g, 237.294 ± 0.773 g, 299.541 ± 0.700 g and 311.206 ± 0.557 g respectively. The effect of season of birth, parity, and sex on body weight at various growth stages and average daily gain (ADG) at various growth periods were found to be significant. Hence, the popularization of this crossbreed pig variety would increase the production, livelihood, and income of the regional farmers.

Keywords: Average daily gain; bodyweight; HD-K75 pigs; least-square analysis; non-genetic factors.

1. INTRODUCTION

Indian pig farming majorly consists of small-scale unorganized rural activity and represents an important part of the diversified agriculture, especially in the tribal area of the country and has been an important source of the livelihood of poor and socially weaker sections of the society, including the tribal people of India [1]. Pigs occupy a unique role among the meat-producing animals of the Eastern Himalayan hill region and are the animal of choice for meat, especially for tribal populations in Northeast India [2]. Crossbred pigs are superior on average to their purebred counterparts under harsh and diverse agro-climatic conditions [3]. Although a considerable pig population is present in north eastern region of India, the productivity of the pigs is low due to the poor productive and reproductive performance of local pigs [4].

The meat production of indigenous pigs is low and inadequate to meet the requirement of pork, the demand for which is increasing every year. The production of indigenous pigs can be improved by crossbreeding and consequent selection utilizing the effects of heterosis [5]. The ICAR-All India Co-ordinated Project (AICRP) on Pigs, C.V.Sc., AAU, Khanapara, Guwahati-781022, Assam was established in 1971. It is one such project that is engaged in improving the production and supply of quality pig germplasm. The AICRP on pig, AAU, Khanapara has developed a variety of pig named HD-K75 with 75% Hampshire inheritance and 25% indigenous inheritance (75% H & 25% I) through 16 generations of *inter-se* mating with concomitant selection, and the same was released as a new variety during October 2016. It has become one of the popular varieties of pig among the farmers not only in Assam but also in the northeastern region for their growth and prolificacy under the prevalent management conditions. The HD-K75 piglets produced at AICRP on pig, Khanapara are distributed among the region's farmers. However, it is necessary to monitor the performance of the HD-K75 pig variety from time to time, estimate the genetic parameters to keep their performance at a desirable level, and plan a suitable breeding strategy for their improvement.

2. MATERIALS AND METHODS

The present study on growth performance of HD-K75 pigs was carried out in the Department of Animal Genetics and Breeding, College of Veterinary Science, AAU, utilizing the body weight records from the progenies of 44 sires and 114 dams maintained over 6 years from 2012 to 2018 bred in the All India Coordinated Research Project (AICRP) on pigs, ICAR (Indian Council of Agricultural Research), located at College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-781022. The average daily gains (ADG) at different periods of growth were calculated as per Brody [6]. The growth traits included in the study were body weight at birth, 42 days, 1 month, 2 months, 3 months, 4 months, 6 months, 8 months, and average daily gain during birth to 42 days, 42 days to 4th month, 42 days to 6th month and 42 days to 8th month of age. The data obtained were classified according to season of birth: March to May (S_1), June to September (S_2), October and November (S_3), and December to February (S_4), sex and parity (1-3) of the

animals. The least squares analysis of variance technique [7] was carried out to study the effects of season of birth, sex, and parity on the traits under study. Duncan's Multiple Range Test (DMRT) as modified by Kramer [8] was used to make all the pairwise comparisons among the means to test the significance of differences among the different subclasses for various traits.

3. RESULTS AND DISCUSSION

3.1 Body Weight at Different Ages

The least-squares mean (LSM) for body weights at birth, 42 days (weaning), 1 month, 2 months, 3 months, 4 months, 6 months, and 8 months of age of HD-K75 pigs are presented in Table 1, Table 2 and Table 3 and graphically represented in Fig. 1. The overall mean body weights at birth, 42 days (weaning), 1 month, 2 months, 3 months, 4 months, 6 months and 8 months of ages were found to be 1.001± 0.001 kg, 6.912± 0.011 kg, 9.666± 0.013 kg, 12.207 ± 0.007 kg, 18.324 ± 0.001 kg, 28.349 ± 0.052 kg, 51.177 ± 0.091 kg and 71.229 ± 0.110 kg respectively. The mean body weights reported in the present investigation at birth, weaning, and various ages were in accordance with the values observed by earlier workers in HxI crosses, LWYxI crosses, and LxI crossbreds [9-15]. Higher body weight at birth, weaning, and various stages of growth in comparison to the present investigation was reported in HxI crossbreds, H x I *inter se* pigs, LWYxI crossbreds, and LxI crosses [16-20]. Lower body weight at birth, weaning, and various stages of growth in comparison to the present investigation were reported in NM, HN-50, HN-75, and HN crossbreds [21].

3.2 Average Daily Gain During Pre-weaning and Post-weaning Period

The LSM for average daily gain **(**ADG) during different periods of growth *viz*. from birth to 42 days, from 42 days to 4th month, from 42 days to 6th month, and 42 days to 8th month of age were obtained as 206.299 ± 0.311 g, 237.294 ± 0.773 g, 299.541 ± 0.700 g and 311.206 ± 0.557 g shown in Table 7, Table 8 and graphically represented in Fig. 2. Similar values of average daily body weight gain during the pre-weaning period, as obtained in the present study, were reported in Landrace pigs and Large White pigs [22,23]. Comparatively lower average daily body weight gain during the pre-weaning period was recorded in LWYxI crossbreds, and HxDesi half-bred pigs [18,19,24].

Lower average daily body weight gain during the post-weaning period was recorded by Aier et al. in HxI crossbreds [24]. On the other hand, higher values of ADG as compared to the findings of the present study were reported in Tamworth x Indigenous pigs, Large White pigs, LWYxI crossbreds, Ghungroo x Hampshire crossbreds, and Hampshire x Ghungroo x Duroc crossbred pigs [25,23, 18,26,27].

3.3 Effect of Season of Birth

In the present study, least-squares analysis of variance revealed a highly significant (P<0.01) effect of season on body weight at birth, weaning, and at different stages of growth in HD-K75 pigs (Table 4, Table 5, and Table 6). The results agreed well with the observations of several studies which also reported a highly significant (P<0.01) effect of season on birth weight in HxI crossbred pigs [17,28,11,24]. LWYxI crossbreds and Landrace x Desi crossbreds also reported a significant effect of season on body weight at birth, weaning, and different ages [29,18,19,14,15]. Crossbred pigs of the coastal Karnataka region, and Duroc and Hampshire pigs on the other hand reported a non-significant effect of season on body weight at birth, weaning, and various stages of growth [30-31]. The results of DMRT (Table 1) revealed that the piglets born during season S_4 *i.e.,* winter season had significantly higher body weight at birth (1.035 ± 0.02 kg), 1 month (7.799 ± 0.035 kg) and at weaning (10.313 ± 0.041 kg) and differed significantly with piglets born during S_1, S_2 and S_3 seasons respectively. The present results revealed a favourable effect of the winter season on body weight at birth and weaning. However, piglets born during season S_3, *i.e*., post-monsoon season had significantly higher body weight during the post-weaning period *viz*. body weight at 2 months (12.384±0.020 kg), 3 months (18.704 ±0.034 kg), 4 months (30.807 ±0.166 kg) and 6 months (56.703±0.286 kg) of age and differed significantly with those born during S_1, S_2 and S_4 seasons respectively. On the other hand, higher body weight at 8 months of age (72.232±0.180 kg) was obtained in piglets born during season S_2 *i.e.*, monsoon season, and differed significantly with those born during S_1 *i.e.*, pre-monsoon season. The findings in crosses of Hampshire and Indigenous pigs revealed that piglets born in the post-monsoon season had higher body weight at various post-weaning growth stages than in other seasons [17,28,11].

Table 1. Least-squares constants (LSC), least-squares means (LSM) with standard errors (SE), and the results of Duncan's multiple range test (DMRT) for various factors affecting body weights at birth, 1 month, and 42 days of age in HD-K75 pigs

Sub-class description	N	Body weight at birth (kg)			Body weight at 1 month (kg)			Body weight at 42 days (kg)		
		LSC	LSM	SE	LSC	LSM	SE	LSC	LSM	SE
μ	2154	-	1.001	0.001	-	6.912	0.011	-	9.666	0.013
Season										
S1	574	-0.029	0.971[a]	0.001	-0.821	6.090[a]	0.022	-0.739	8.926[a]	0.026
S2	673	-0.011	0.989[b]	0.001	0.124	7.036[b]	0.022	0.184	9.850[b]	0.026
S3	467	0.006	1.008[c]	0.001	-0.102	6.809[c]	0.026	-0.092	9.573[c]	0.031
S4	440	0.034	1.035[d]	0.002	0.799	7.799[d]	0.035	0.647	10.313[d]	0.041
Parity										
P1	579	0.015	1.017[a]	0.001	0.092	7.004[a]	0.027	0.250	9.916[a]	0.032
P2	795	-0.033	0.968[b]	0.001	-0.425	6.486[b]	0.025	-0.275	9.390[b]	0.029
P3	780	0.018	1.019[a]	0.001	0.333	7.244[c]	0.021	0.025	9.691[c]	0.025
Sex										
S_M	1149	0.013	1.014[a]	0.001	0.051	6.963[a]	0.014	0.040	9.706[a]	0.017
S_F	1005	-0.013	0.988[b]	0.001	-0.051	6.860[b]	0.015	-0.040	9.625[b]	0.018

LSM = Least-squares means; LSC = Least square constant; SE = Standard errors; N = number of observations; Sub-class means with different superscripts differed significantly (P <0.05)

Table 2. Least-squares constants (LSC), least-squares means (LSM) with standard errors (SE), and the results of Duncan's multiple range test (DMRT) for various factors affecting body weights at 3 months, 4 months, and 6 months of age in HD-K75 pigs

Sub-class description	N	Body weight at 3 months (kg)			Body weight at 4 months (kg)			Body weight at 6 months (kg)		
		LSC	LSM	SE	LSC	LSM	SE	LSC	LSM	SE
μ	1638	-	18.324	0.011	-	28.349	0.052	-	51.177	0.091
Season										
S1	574	-0.107	18.216^{a}	0.020	-1.212	27.137^{a}	0.098	-3.162	48.015^{a}	0.168
S2	673	-0.161	18.162^{a}	0.022	-0.046	28.302^{b}	0.109	0.798	51.976^{b}	0.188
S3	152	0.380	18.704^{b}	0.034	2.458	30.807^{c}	0.166	5.526	56.703^{c}	0.286
S4	239	-0.111	18.213^{a}	0.043	-1.198	27.150^{a}	0.207	-3.163	48.014^{a}	0.356
Parity										
P1	579	-0.586	17.737^{a}	0.021	-0.889	27.460^{a}	0.104	-2.937	48.24^{a}	0.179
P2	279	0.526	18.850^{b}	0.042	2.55	30.900^{b}	0.202	6.359	57.537^{b}	0.348
P3	780	0.060	18.384^{c}	0.019	-1.661	26.688^{c}	0.093	-3.422	47.754^{c}	0.160
Sex										
S_M	875	0.214	18.538^{a}	0.013	0.550	28.900^{a}	0.064	0.769	51.947^{a}	0.111
S_F	763	-0.214	18.109^{b}	0.014	-0.550	27.799^{b}	0.068	-0.769	50.407^{b}	0.117

LSM = Least-squares means; LSC = Least square constant; SE = Standard errors; N = number of observations; Sub-class means with different superscripts differed significantly (P <0.05)

Table 3. Least-squares constants (LSC), least-squares means (LSM) with standard errors (SE), and the results of Duncan's multiple range test (DMRT) for various factors affecting body weights at 2 months and 8 months of age in HD-K75 pigs

Sub-class description	N	Body weight at 2 months (kg)			Sub-class description	N	Body weight at 8 months (kg)		
		LSC	LSM	SE			LSC	LSM	SE
μ	1937	-	12.207	0.007	μ	853	-	71.229	0.110
Season					**Season**				
S1	574	-0.328	11.878[a]	0.015	S1	534	-1.003	70.225[a]	0.131
S2	673	0.068	12.275[b]	0.016	S2	319	1.003	72.232[b]	0.180
S3	250	0.177	12.384[c]	0.020	S3	-	-	-	-
S4	440	0.083	12.290[d]	0.026	S4	-	-	-	-
Parity					**Parity**				
P1	579	0.155	12.362[a]	0.018	P1	365	-2.426	68.803[a]	0.172
P2	578	0.070	12.278[a]	0.021	P2	488	2.426	73.655[b]	0.137
P3	780	-0.225	11.981[b]	0.015	P3	-	-	-	-
Sex					**Sex**				
S_M	1034	0.109	12.316[a]	0.010	S_M	452	1.747	72.977[a]	0.147
S_F	903	-0.109	12.097[b]	0.010	S_F	401	-1.747	69.481[b]	0.156

LSM = Least-squares means; LSC = Least square constant; SE = Standard errors; N = number of observations; Sub-class means with different superscripts differed significantly (P <0.05)

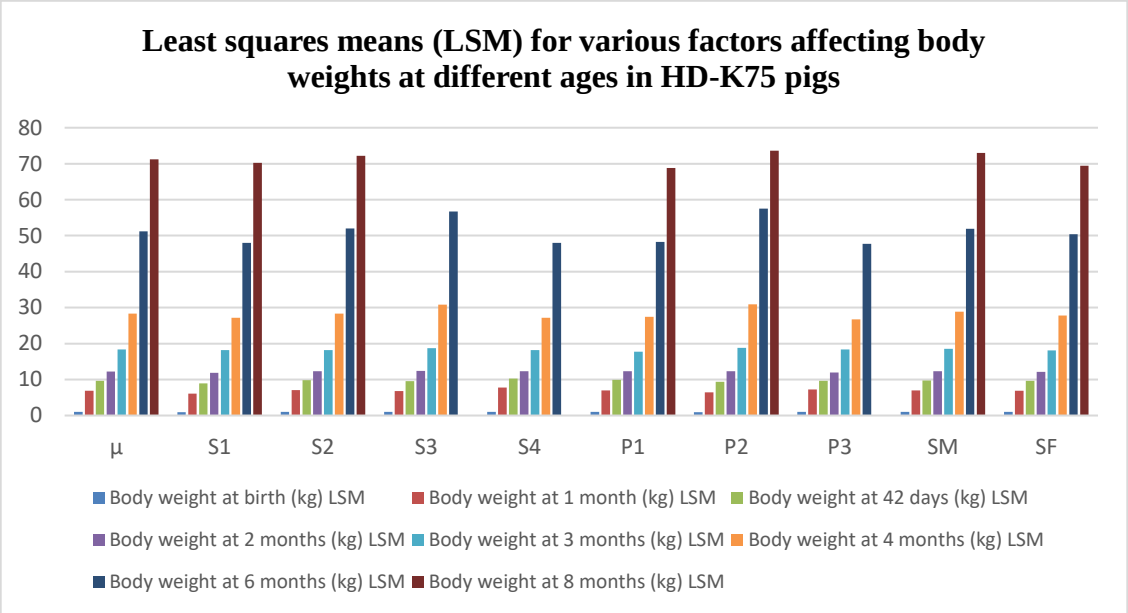

Fig. 1. Graphical representation of the effect of season of birth, parity, and sex on body weights at different ages in HD-K75 pigs

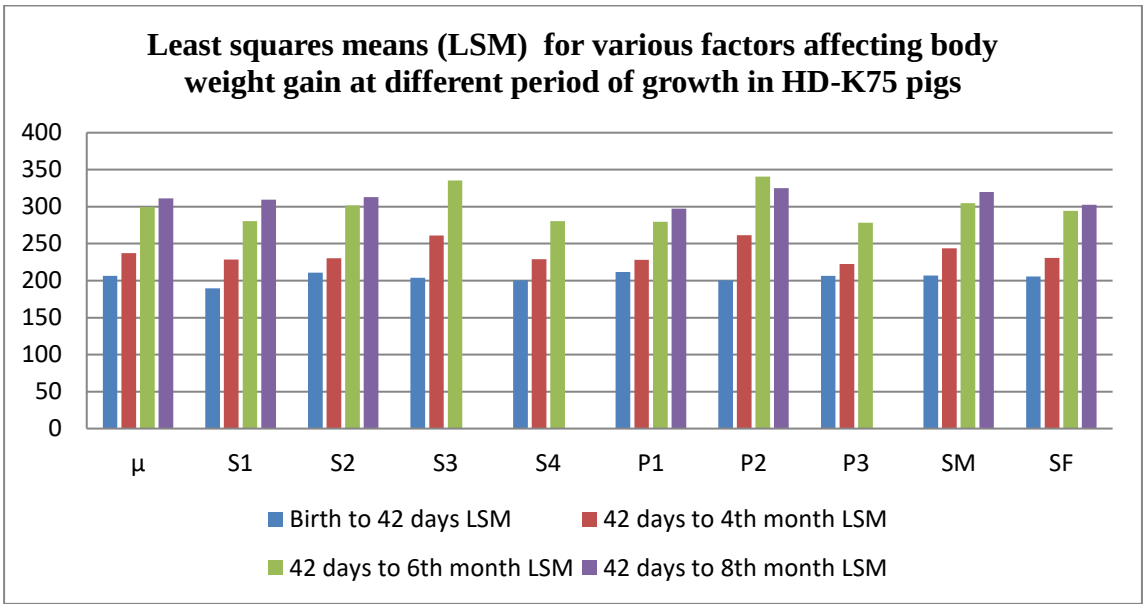

Fig. 2. Graphical representation of the effect of season of birth, parity, and sex on ADG at different periods of growth in HD-K75 pigs

In respect of ADG during birth to 42 days, 42 days to 4th month, 42 days to 6th month, and 42 days to 8th month of ages in HD-K75 pigs, least-square analysis of variance showed a highly significant ($P<0.01$) effect of season of birth (Table 9). The significant effect of season on daily body weight gains during the pre-weaning period of growth in HD-K75 pigs has also been reported in earlier studies [18,19]. In the present research, significantly higher daily body weight gain during the pre-weaning period and post-weaning period of growth were observed in animals born during monsoon (S_2) and post-monsoon (S_3) seasons respectively, which implicated that the dams showed superior farrowing rates during these seasons for better production which was also similar to an earlier study [18].

Table 4. Least-squares analysis of variance for body weight (kg) at birth, 1 month, and 42 days of age in HD-K75 pigs

Sources of variation	df	Body weight at birth (kg)		Body weight at 1 month (kg)		Body weight at 42 days (kg)	
		MSS	F	MS	F	MS	F
Season	3	0.1385	230.8333**	157.7634	740.6732**	132.0800	434.1880**
Parity	2	0.1798	299.6666**	45.3085	212.7159**	15.4713	50.8589**
Sex	1	0.3647	607.8333**	5.7062	26.7897**	3.4539	11.3540**
Error	2147	0.0006		0.2130		0.3042	

*Highly significant**P (<0.01); Significant*P (<0.05); NS = Non-significant*

Table 5. Least-squares analysis of variance for body weight (Kg) at 3 months, 4 months, and 6 months of age in HD-K75 pigs

Sources of variation	Df	Body weight at 3 months (kg)		Body weight at 4 months (kg)		Body weight at 6 months (kg)	
		MS	F	MS	F	MS	F
Season	3	11.3743	97.2162**	489.5654	184.3243**	3134.8890	398.2480**
Parity	2	74.5162	636.8905**	356.0056	134.0383**	1720.5770	218.5776**
Sex	1	75.1337	642.1684**	493.5531	185.8257**	965.9302	122.7092**
Error	1631	0.1170		2.6560		7.8717	

*Highly significant**P (<0.01); Significant*P (<0.05); NS = Non-significant*

Table 6. Least-squares analysis of variance for body weight (kg) at 2 months and 8 months of age in HD-K75 pigs

Sources of variation	Df	Body weight at 2 months (kg)		Sources of variation	df	Body weight at 8 months (kg)	
		MS	F			MS	F
Season	3	20.7434	210.1662**	Season	1	729.1169	79.0576**
Parity	2	24.3125	246.3273**	Parity	1	4456.1930	483.1819**
Sex	1	23.0711	233.7497**	Sex	1	2596.3340	281.5187**
Error	1930	0.0987		Error	849	9.2226	

*Highly significant**P (<0.01); Significant*P (<0.05); NS = Non-significant*

Table 7. Least-squares constants (LSC), least-squares means (LSM) with standard errors (SE), and the results of Duncan's multiple range test (DMRT) for various factors affecting body weight gain at different periods of growth in HD-K75 pigs

Sub-class description	N	Birthto42 days			N	42 days to4thmonth		
		LSC	LSM	SE		LSC	LSM	SE
μ	2154	-	206.299	0.311	1638	-	237.294	0.773
Season								
S1	574	-16.900	189.399^{a}	0.621	574	-8.563	228.730^{a}	1.431
S2	673	4.673	210.972^{b}	0.619	673	-6.868	230.425^{b}	1.597
S3	467	-2.370	203.929^{c}	0.736	152	23.840	261.134^{c}	2.435
S4	440	14.597	200.530^{d}	0.972	239	-8.409	228.884^{a}	3.024
Parity								
P1	579	5.580	211.880^{a}	0.761	579	-9.173	228.121^{a}	1.523
P2	795	-5.768	200.530^{b}	0.688	279	24.128	261.422^{b}	2.954
P3	780	0.188	206.487^{c}	0.597	780	-14.955	222.338^{c}	1.364
Sex								
S_M	1149	0.645	206.945^{a}	0.406	875	6.516	243.810^{a}	0.948
S_F	1005	-0.645	205.653^{b}	0.429	763	-6.516	230.777^{b}	0.997

LSM = Least-squares means; LSC = Least square constant; SE = Standard errors; N = number of observations; Sub-class means with different superscripts differed significantly (P<0.05)

Table 8. Least-squares constants (LSC), least-squares means (LSM) with standard errors (SE), and the results of Duncan's multiple range test (DMRT) for various factors affecting body weight gain at different periods of growth in HD-K75 pigs

Sub-class description	N	42 days to 6thmonth			N	42 days to8thmonth		
		LSC	LSM	SE		LSC	LSM	SE
μ	1638	-	299.541	0.700	853	-	311.206	0.557
Season								
S1	574	-18.966	280.575^{a}	1.295	534	-1.718	309.488^{a}	0.660
S2	673	2.246	301.788^{b}	1.445	319	1.718	312.924^{b}	0.909
S3	152	35.709	335.250^{c}	2.203	-	-	-	-
S4	239	-18.989	280.552^{a}	2.736	-	-	-	-
Parity								
P1	579	-20.024	279.518^{a}	1.378	365	-13.900	297.305^{a}	0.870
P2	279	41.242	340.784^{b}	2.673	488	13.900	325.106^{b}	0.694
P3	780	-21.218	278.322^{a}	1.234	-	-	-	-
Sex								
S_M	875	5.274	304.816^{a}	0.858	452	8.663	319.870^{a}	0.743
S_F	763	-5.274	294.266^{b}	0.902	401	-8.663	302.542^{b}	0.787

LSM = Least-squares means; LSC = Least square constant; SE = Standard errors; N = number of observations; Sub-class means with different superscripts differed significantly (P<0.05)

Table 9. Least-squares analysis of variance for factors affecting average daily gain at different periods of growth in HD-K75 pigs

Sources of variation	Birth to 42 days			42 days to 4 months			42 days to 6 months			42 days to 8 months		
	df	MS	F	df	MS	F	df	MS	F	df	MS	F
Season	3	70798.090	422.4583**	3	40407.450	71.2544**	3	114889.000	247.4723**	1	2136.824	9.1018*
Parity	2	7610.824	45.4144**	2	28992.100	51.1246**	2	71293.880	153.5679**	1	146261..300	622.9983**
Sex	1	894.310	5.3364*	1	69187.060	122.0043**	1	45328.800	97.6388**	1	63788.960	271.7083**
Error	2147	167.586		1631	567.087		1631	464.250		849	234.770	

*Highly significant**P (<0.01); Significant*P (<0.05); NS = Non-significant*

3.4 Effect of Sex

The least-squares analysis of variance showed a highly significant (P<0.01) influence of sex on body weight at birth, weaning, and at various ages (Table 4, Table 5, and Table 6) which conforms with the findings in HxI crossbreds, Landrace x Indigenous crossbreds, local and crossbred pigs of coastal Karnataka region, and LWY x Desi crossbreds [32,24,15,30,19]. On the other hand, non-significant effects of sex on body weight at birth, weaning, and different ages were reported in Landrace and Desi crosses, HxI crossbreds, and LWY and Desi crosses [9,17,11,18,13].

The influence of sex on ADG was highly significant (P<0.01) as revealed by least-squares analysis of variance (Table 9). These findings were in agreement with the reports which also revealed a significant effect of sex on average daily body weight gain [23,33]. Significant influence of sex on average daily body weight gain during pre-weaning periods has also been found [34]. On the contrary, a non-significant effect of sex on ADG during different periods of growth has also been observed [35].

3.5 Effect of Parity

Parity showed a highly significant (P< 0.01) influence on body weight at birth, weaning, and different ages in HD-K75 pigs in the present study (Table 4, Table 5, and Table 6) confirming earlier findings in HxI crossbreds [17,9,11]. Piglets born in the third parity showed significantly higher body weight at birth and 1 month of age. Piglets born in the first parity showed significantly higher body weight at weaning and 2 months of age respectively. Whereas, piglets born in the second parity showed significantly higher body weight at 3 months, 4 months, 6 months, and 8 months respectively. On the contrary, the non-significant effect of parity on body weight at birth, weaning, and different stages of growth was reported in Hampshire and Desi half-bred pigs [24].

The differences in the ADG during the various stages of growth, *viz*. birth to 42 days, 42 days to 4th month, 42 days to 6th month, and 42 days to 8th month of age in HD-K75 pigs showed highly significant influence (P<0.01) of parity of the dam (Table 9) which conformed with the earlier findings in various breeds of pigs [17,20]. On the other hand, no significant effect of parity on average daily weight gain has also been observed [36]. The DMRT results (Table 7 and Table 8) also showed that the ADG from birth to 42 days was found to be significantly higher in animals born in the first parity (211.880±0.761 g) and the ADG from 42 days to 4th month, 42 days to 6th month and 42 days to 8th months of age were found to be significantly high for animals born in second parity.

In a study, it was found that the 75% LWY-Desi genetic group was able to perform better than the 50% LWY-Desi genetic group [37]. The better performance in the 75% LWY inheritance group of pigs was probably due to the genetic superiority of the higher exotic inheritance [37]. Some recent studies also suggest that cross-breeding of Indigenous pigs in the northeastern regions of the country, as per the availability in local areas can give good returns as was seen in the case of Niang Mega (N) and Hampshire crosses (H) [21]. In this study also it was revealed that HN-75 with 75% exotic inheritance was giving the best results [21].

4. CONCLUSION

The present study's results on HD-K75 pigs maintained at AICRP on Pigs, AAU, Khanapara, showed that their performance was satisfactory under prevailing managemental conditions. Thus, it may be concluded that the HD-K75 pigs are well adapted to the agro-climatic conditions of Assam. However, further study of these animals under the field conditions of Assam and the nearby areas is necessary to evaluate their performance.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during the writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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