SELECTION RESPONSE FOR HIGHER BODY WEIGHT IN NIGERIA'S INDIGENOUS CROSSBRED PIGS

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ABSTRACT

Six generations of population selection from 2 lines of improved indigenous pigs "NIGERHYBS" comprising pigs born from the year 1984 - 1990 were evaluated. Continued selection for higher body size resulted in observed increases in 150 day body weight of 26% in the white line A and 41% in the black and white line B from the average weight of the foundation stock and 76 to 84 per cent at 12 month of age for these lines of pigs respectively. Moderately high heritability estimates of 0.36 to 0.69 were reported for both lines for the 150 day weight and 0.58 to 0.76 for the yearling weight. Response to selection was highest in the first generation of the B line and the third generation of the A line. Overall response value of $5.79 \pm 1.28\text{kg}$ during the first generation declined to $5.01\text{kg} \pm 1.08$ during the second generation although this subsequently increased from the third to fifth generations. With the plateau not reached within this 6 generation of selection, further response may still be expected in these lines of pigs

Keywords - indigenous pigs; selection response; body weights.

INTRODUCTION

Although most of the efforts in pig improvement have been made through the use of breeds of Europe and North America, there are opportunities to utilize traits such as prolificacy and adaptation to climatic and nutritional stress in indigenous breeds peculiar to pigs in other parts of the world. The vast majority of crossbred pigs were developed through systematic use of two or more breeds to produce slaughter pigs of high merit. The performance characteristics of crossbred pigs are generally superior to those of pure bred parents (Johnson *et al* 1973; Mikami *et al* 1977;

Wheat *et al* 1981; Harley *et al* 1986; Avalos 1987). Whilst Fetuga *et al* (1976) reported poor growth rate with declining lean deposition after 34kg in the Nigerian indigenous pigs, other scientist reported increases in the rate of lean deposition and growth rate until 91kg weight in the exotic pigs. Live weight and growth rates were reported to correspondingly decline after 56.8kg in the indigenous pigs (Ilori 1974; Nwakalo 1981).

With considerable variability among indigenous pigs their potentials are highly subjective to selection procedures to attain higher level of performance. Where individual selection is difficult to practice due to time constraints, mass selection has been used effectively to improve animal performance (Falconer, 1960). Although in most experiments, no plateau have been reported up to ten generations of selection (Glodek, 1982), the response to mass selection for a quantitative trait such as growth cannot be expected to continue indefinitely, hence the number of generations that would elapse before response ceases and the magnitude of total response can only be determined by experiments (Falconer, 1960; Dettmers *et al* 1965; Smith and McLaren, 1967; Nelson and Robinson, 1976).

Since the animal breeder is faced with the problem of recognising when a selection limit is reached, this study was evaluated to determine the effectiveness of recurrent mass selection for increased body size in the 2 lines of developed improved exotic-indigenous crossbred pigs in Nigeria.

MATERIALS AND METHODS

The data for this study were from the last 6 generations (1984-1990) of a project initiated

at the Institute of Agricultural Research and Training of Obafemi Awolowo University, in which selection was practiced for 10 successive generations in an effort to develop an improved breed of pigs from the small sized indigenous pigs of Nigeria for the commercial producer. Report from earlier generation of selection was given by Adebambo (1986) whilst the hybrid formation and reproductive traits were reported by Adebambo *et al* (1993). Selection began in 1980 and by 1984 two lines A and B from the Largewhite and Hampshire crosses were formed. The two lines called "NIGER HYBS" had been described by Adebambo *et al* (1993). The selection criteria in each line were body weight at 56, 150 days and 1 year of age. About 20 gilts and 5 boars were selected and randomly mated per line each year, avoiding full and half sib matings. All litters considered were from gilts, so a generation corresponds to a year for both lines. All pigs were farrowed and raised in the same building. Attempts were made to keep environmental conditions of housing and feeding practices and rations as constant as possible over the years

Statistical analysis

Data analysis was on 1681 pigs raised from 125 litters of Largewhite line and 120 litters of the Hampshire line in the seven years. Analysis of variance for a nested classification with unequal subclass numbers (Harvey 1986) was employed to estimate sire, dam and within full sib family components of variance for each line with statistical model

$$Y_{ijklm} = \mu + b_i + p_j + T_k + S_l + (bs)_{il} + (PT)_{jk} + (sbT)_{ilk} + e_{ijklm}$$

where

Y_{ijklm} is the phenotypic observation on the m th pig farrowed by 1th sire in the K th year belonging to j th generation and i th breed of dam.

- μ = overall mean of all observations
- b_i = additive effect of i th breed of dam
- p_j = effect of j th generation of dam
- T_k = effect of k th year of birth
- S_l = effect of l th breed of sire

$(bs)_{il}$ = effect of interaction between the i th breed of dam and l th breed of sire.

$(PT)_{jk}$ = interaction between j th generation of dam and k th year of birth

$(SbT)_{ilk}$ = interaction between sire, dam and year effects

e_{ijklm} = random error of observation.

Selection differential was calculated as mean gain of the group selected to be parents of the next generation minus the generation mean for that line. Responses to selection were obtained by regression of the generation mean for all progeny on the generation number. Realized heritability was estimated by regression of the generation means on the realized cumulative selection differentials. Four times the sire component of variance was used as an estimate of the additive genetic variance for obtaining heritability estimates (Becker, 1984). Standard errors of estimates were calculated according to Becker (1984). Regression analysis was made on a within line-year basis.

RESULT

Growth Parameter

The yearly means with their corresponding standard deviations for weights measured at 56, 150 days and 12 months are presented in Tables 1 and 2 for lines A and B, respectively. The performance of the two lines was quite variable but an improvement in body size over time is apparent particularly in the 150 days and yearling weights. The pigs weights varied from 6.5 in 1984 to 8.1 kg in 1989 which was not different from 8.0 kg weight recorded in 1990 for average 56 days weight of pig in line A. This was however significantly different ($P < 0.05$) from 7.5kg to 9.5kg individual pig weaning weights from 1984 to 1990 recorded for the Hampshire line B. Whilst the weights of 19.8 ± 6.1 kg to 28.2 ± 4.9 kg in line A is within the range of 22.8 ± 5.4 kg to 29.95 ± 3.9 kg in line B for 150 day weight, highly significant effects ($P < 0.01$) (Table 3) were recorded between the weights at 12 months with values

TABLE 1. PIG PERFORMANCE DATA OVER THE YEARS FOR LARGE WHITE CROSSBRED (LINE A)

Year	No. of Litters	Litters Born	Size Weaned	Weight Mean	(56 d) SD	Weight Mean	(150d) SD	Weight Mean	(12mo) SD
1984	16	7.5	7.1	6.5	0.95	19.8	6.1	65.3	9.4
1985	14	8.1	7.5	6.8	1.21	21.5	5.6	68.9	8.1
1986	16	8.5	7.6	7.1	1.56	23.6	3.5	72.0	7.7
1987	17	8.4	7.6	7.6	1.80	25.4	4.8	76.2	7.9
1988	18	8.6	7.9	7.5	1.71	26.6	4.2	76.4	8.2
1989	20	9.2	8.1	8.1	1.56	28.5	5.1	80.5	5.4
1990	24	8.2	7.6	8.0	2.12	28.2	4.9	82.7	5.6
Overall mean $\pm$ S.D.		8.36	7.63	7.37	1.56	24.8	4.89	74.6	7.5

TABLE 2. PIG PERFORMANCE DATA OVER THE YEARS FOR HAMPSHIRE CROSSBRED (LINE B)

Year	No. of Litters	Litters Born	Size Weaned	Weight Mean	(56 d) SD	Weight Mean	(150d) SD	Weight Mean	(12mo) SD
1984	15	7.4	6.5	7.5	1.8	22.8	5.4	70.5	14.2
1985	17	7.1	6.8	7.4	1.4	25.5	4.6	77.2	16.8
1986	15	7.6	6.9	8.6	1.7	26.6	5.1	78.1	9.9
1987	14	7.3	6.9	8.8	1.1	28.2	6.2	81.4	7.6
1988	20	7.8	6.5	8.2	0.8	28.8	4.8	84.7	5.8
1989	23	7.8	7.1	9.1	1.5	29.8	5.1	85.0	7.6
1990	16	8.2	7.3	9.5	1.2	29.95	3.9	85.7	6.5
Overall mean $\pm$ S.D.		7.6	6.9	8.44	1.36	27.38	5.01	80.37	9.8

ranging from 65.3 ± 9.4 kg in 1984 to 82.7 ± 5.6 kg in 1990 in line A and 70.5 ± 14.2 kg to 85.7 ± 6.5 kg from 1984 to 1990 in the Hampshire crossbred line. The sire component were significant at all ages whilst the dam component was significant only at 12 months of age

Heritability estimates

Heritability estimates for weights at the different ages are shown in Table 4. While heritability of 56 days weight both for regression and paternal half sib was negative and not significantly different from zero in line A (-0.01), it was 0.16 and 0.35 from regression and paternal halfsib correlations respectively in the line B. Both were positive though not significant. Heritability estimates for 150 day weight obtained from mid parent offspring regression of 0.69 ± 0.12 and 0.65 ± 0.09 for lines A and B respectively were higher than

corresponding estimates obtained by paternal half sib correlations of 0.36 ± 0.16 and 0.40 ± 0.18 . In calculating the effective selection differentials, estimates of the paternal halfsib correlations in both lines were pooled. The heritability value of 0.38 ± 0.11 was hence obtained by weighting the estimate inversely by its variance. The average effective selection differential weighted by the number of offspring produced by each parent resulted in 6.7kg weight for males and 2.7kg for females in line A and 7.3kg for males and 2.5kg for females in line B. Using this average estimates of heritability of 0.38 ± 0.11 , the expected progress was 16.1kg for line A and 20.8kg for the B line in the 6 generations of selection.

Regression analysis

The mean 150 day and 12 month weight of both lines by year along with their fitted regression lines are shown graphically in

figures I and II. The average increases per year were 0.71 ± 0.32 kg and 1.01 ± 0.20 kg for the A and B lines at 150 days and 5.25 kg and 6.18 kg at 12 months of age, respectively.

The observed increases over the 6 years

Response to selection

The response to selection expressed as the regression of generation means on generation number and the realized heritability of growth traits are shown in Table 5. The selection

TABLE 3. LEAST SQUARE ANALYSIS OF VARIANCE FOR 56, 150 DAYS AND 12 MONTHS WEIGHTS.

Source of variation	Line A df	56 days	df	150 days	df	12 months
Breed of dam	1	1295.76	1	2695.55	1	13361.88*
Breed of sire	1	4925.16*	1	5699.11	1	22291.63 *
Year effect	6	1176.4*	6	1675.52	6	11245.25*
Dams generation	5	1476.11	5	1825.76	5	3114.22
Breed of dam x breed of sire	1	621.25	1	996.15	1	1121.75
Sire x year	29	8.96	29	192.18	27	9112.76*
Dams generation x year	30	16.25	30	81.76	30	219.28
Dams/sire/year	91	6.21	85	91.21	82	5141.08
Error variance.	657	141.03	634	220.73	632	2288.01

*P < 0.05

**P < 0.01

Source of variation	Line B df	56 days	df	150 days	df	12 months
Breed of dam	1	1575.18	1	2895.26	1	21234.56*
Breed of sire	1	5675.82*	1	8114.19**	1	25921.64
Year effect	6	1037.76	6	1967.55	6	14912.01**
Dams generation	5	1896.7	5	2575.26	5	16295.82
Breed of dam x breed of sire	1	875.04	1	1021.88	1	1588.27
Sire x year	29	14.72	28	156.03	28	10201.16
Dams generation x year	30	24.75	30	101.21	30	1165.18
Dams/sire/year	96	9.65	84	112.54	84	7255.38
Error variance	643	111.65	613	131.44	562	4124.13

TABLE 4. ESTIMATES OF HERITABILITY OF 56, 150 DAYS AND 12 MONTHS WEIGHTS.

Method	Line A			Line B		
	56	150	12 mon.	56	150	12mon
Sire component	$-0.01 \pm .14$	$0.36 \pm .16$	$0.58 \pm .22^*$	$0.35 \pm .18$	$0.40 \pm .18$	$0.61 \pm .36^*$
Offspring on parent	$-0.01 \pm .10$	$0.69 \pm .12$	$0.71 \pm .186^{**}$	$0.16 \pm .10$	$0.65 \pm .09$	$0.76 \pm .21^{**}$

*P < 0.05

**P < 0.01

estimated from regression was 4.8 kg in line A and 7.9 kg in line B at 150 days. This was followed by corresponding increases of 31.50 kg and 37.08 kg at 12 months of age which represent an increase of 26 and 41 per cent in lines A and B at 150 days, and 76 to 84 per cent at 12 months of age from the average weight of the indigenous foundation herd.

response in this 6 generations was almost linear averaging 4.7 ± 1.21 and 4.9 ± 1.48 per generation for lines A and B, respectively. Realized heritabilities ranged from 0.51 ± 0.28 to 0.71 ± 0.36 in line A and 0.62 ± 0.32 to 0.75 ± 0.33 in line B. High selection pressures reported were as a result of the high growth rate and the mass recurrent selection practiced in this herd of pigs. Average selection

Fig 1.: Mean 150 days weight of lines A and B with fitted regression lines.
 $Y(A) = 18.1 + 0.71X$; $Y(B) = 21.4 + 1.01X$

Fig. 2: Mean yearling weights of lines A & B with fitted regression lines.
 $Y(A) = 41.5 + 5.25x$; $Y(B) = 44.3 + 6.18x$.

TABLE 5. RESPONSE TO SELECTION FOR GROWTH TRAITS

Generation		Response ^a	Realized heritability ^b	Realized selection Differential
1.	Line A	4.29±1.61	0.56±0.21	1.63
	Line B	7.29±0.95	0.65±0.44	2.27
	Average	5.79±1.28	0.61±0.33	1.95
2.	Line A	4.03 ±0.95	0.51±0.28	1.68
	Line B	5.98±1.21	0.71±0.26	1.72
	Average	5.01±1.08	0.61±0.27	1.70
3.	Line A	5.83 ±1.85	0.65±0.33	1.91
	Line B	5.89±1.62	0.72±0.41	1.67
	Average	5.86 ±1.74	0.69±0.37	1.79
4.	Line A	4.60±1.18	0.59±0.38	1.66
	Line B	6.63 ±1.25	0.68 ±25	1.99
	Average	5.62±1.22	0.64±0.32	1.83
5.	Line A	5.50 ±1.48	0.71±0.26	1.65
	Line B	7.39±1.01	0.75±0.35	2.01
	Average	6.45±1.25	0.73±0.31	1.83
6.	Line A	4.82±0.99	0.58±0.41	1.77
	Line B	5.01±0.76	0.62±0.32	1.65
	Average	4.92±0.88	0.60±0.37	1.71
a		Regression of generation mean on generation number $b \pm se$		
b		Regression of generation mean on cumulative realized selection differential		

differentials was consistently higher in line B than in line A except in generations 3 and 6, which resulted in lower responses in this line during the period compared to other generations. Highest response was found in the first and fifth generations of line B whilst it was recorded in the third and fifth generations of line A. The overall response was high during the first generation. Though it declined in the second generation from 5.79 ± 1.26 to 5.01 ± 1.08 , subsequent improvements were recorded till the fifth generation with a value of 6.45 ± 1.25 and a slight decline thereafter.

DISCUSSION

Growth and carcass traits have been the dominant breeding objective in pigs for the last three to four decades in most scientific selection experiments, and in practical pig breeding programmes in countries with intensive pig production. The weight of pigs in this experiment at 56, 150 days and one year of age, which were significantly different from those of pure indigenous pigs (Adebambo 1986, Fetuga *et al* 1976; Ilori 1974) were in general agreement with reports of Johnson *et al* (1993), Young *et al* (1976) and Mikami (1977), where weights of crossbreds were found to be intermediate to those of the

parental breeds. In all experiments reported, significant direct responses in selection were achieved from most traits in early generations. In line with reports of Glodek (1982), plateaux were not reached, though selection response seemed to diminish in later generations particularly in the Hampshire crossbred line. Surprisingly, small breed differences in responses even among such breeds as Duroc, Lacombe, Landrace and Yorkshire were reported (Glodek 1982). Although paternal effects of the Hampshire on pig weights were high and positive from 150 days to 1 year of age and a little bit higher than that of Large white line, the observed increases in weight over the six years showed only slightly diminishing responses. According to reports of Wheat *et al* (1981) no selection plateau have been encountered so far, however, very efficient selection for highly heritable single traits have been found to cause more correlated responses than selection for complex selection indexes. Heritability estimates from the 150 day weight obtained from the mid parent offspring regression were higher than most reports from paternal half sib correlations (Craft 1950, Dickerson 1960). This might be due to some biases introduced over the years through environmental effects

which might have drastically reduced the variation due to genetic or other effects because all small animals are automatically discarded as culls or runts. The crossbreeding effects have resulted in very rapid genetic change due to selection for growth and increased vigor characteristic of crossbreds associated with complementary effects of favourable dominant genes brought into the cross from each parent. The heritability values and genetic variability therefore, suggest that post weaning performance could be improved through crossbreeding and that further response to mass selection may still be expected with the plateau not yet attained in these lines of pigs. Simultaneous improvement in these traits and further selection of individuals based upon performance of test cross progeny could still be more effective, if positive and significant correlations could be found between the different growth traits.

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