THE RELATIONSHIP BETWEEN BODY MEASUREMENTS AND PERFORMANCE PARAMETERS IN BOARS

by

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TABLE OF CONTENTS

INTRODUCTION

Throughout the history of livestock production, animal breeders have continually sought methods to determine which animals are best suited to supply man's needs. Races, contests, shows, and testing stations are a few examples of the tools used to determine superior animals. As the needs of man have changed, so has the type of animal needed also changed. Swine, because they are perhaps the most plastic farm animal in the hands of skilled breeders, have often been subject to drastic changes in type, going from one extreme to the other. In the early 1900's, two distinct types of swine could be found - the lard type and the bacon type. Both represented extremes in selection for economically important products. In the middle part of the century, a third type of hog, the meat type immerged as a compromise between the two earlier types, taking advantage of both leanness and muscling. In recent years, the push by some packers and people within the industry to carry market swine to heavier weights, has brought a fourth type of hog onto the scene, the so-called "big" type. This "big" type has been described by such terms as big headed, big tailed, deep chested, big boned, deep jawed, etc. The theory is that these traits contribute to or indicate a potential for improved growth rate and efficiency over the smaller type animals. It was the purpose of this study to evaluate these theories and to determine the relationship between body measurements and performance.

This study was divided into two parts:

a) a study of growth patterns and feed usage of boars between 30 kg. and 114 kg. as affected by breed and season.

b) a study of the relationship of body size as determined by various body measurements and certain performance parameters between 30 and 114 kg.

LITERATURE REVIEW

The results of a study to determine the accuracy of three methods of obtaining measurements of swine were reported by Phillips and Dawson (1936). The methods studied included: A) direct body measurements taken with calipers and a steel tape measure, B) using a livestock scaling instrument, and C) photographing the animals and taking measurements from life-size projections of these photographs. Method A gave more accurate results than either method B or C in all but two measurements, those exceptions being length from ear to tail and length from shoulder to tail. Method A also required considerably less time and lent itself to taking circumference measurements.

Cole (1942) took measurements on 32 slaughter lambs to determine the relationship of type to average daily gain. He reported that the average width of lamb (width at shoulder, rib, loin and rump) was the measure having the highest correlation with average daily gain ($r = .969$), while depth of rack, width of forerib, average depth, average length of leg, carcass grade and thickness of fat over the eye muscle only slightly influenced gain.

In 1953, Hetzer _et al_. reported results of a study in which eight body measurements were taken on 141 hogs. Measurements taken included height at shoulder, width of middle, length from ear to tail, depth of chest, and circumference of chest. Repeatability values were found to be higher when an average of four measurements were used versus taking one single measurement. The value of the measurements for predicting carcass yields was found to be low, but it was felt the use of measurements showed some promise of being helpful to the packer and producer.

Working at Iowa State, Holland and Hazel (1958) studied methods of determing fat thickness and muscle thickness in live animals with the use of live animal measurements. Measurements were taken just prior to slaughter. They found that the average of three backfat probes was the most accurate indicator of per cent lean cuts and per cent fat cuts among all the live animal measurements taken.

Orme et al. (1959) found live animal measurements collected from 31 yearling steers were all highly repeatable with the exception of spring of ribs, width of pins and the length from 13th rib to hooks. With constant live weight, circumference of body at fore flank was associated with 81 per cent of the variation in ribeye area, while circumference of middle, rear flank, hind leg above the hock and width of rump were also significantly related to ribeye area.

At the Virginia Agricultural Experiment Station, Flock et al. (1962) took seven linear body measurements on 1425 calves of the Hereford, Angus, and Shorthorn breeds. The measurements were taken within seven hours of birth and were found to be of little value in predicting pre-weaning or post-weaning growth.

Galal et al. (1965) took measurements on 1400 lambs that included metacarpus and metatarsus width and breadth, hook width, birth weight, adjusted 30 day weight and adjusted weaning weight.

They determined that birth weight was the most valuable measurement in predicting weaning weight. This is in agreement with Flock (1962).

Boylan, Rahsefeld, and Seal (1966) studied the relationship between ear size and type with growth in swine. Linear ear measurements and ear type were taken at both weaning and at market weight. Ear size increased by a factor of 1.5 to 2 over that period while body weight increased 6 to 8 times over the same period. It was concluded that ear type or form has little relationship or effect on post-weaning growth rate, age at market, or backfat thickness.

Cundiff _et al_. (1967) used live animal measurements to predict beef carcass cutability. Of the eleven linear measurements taken, only three remained in any of the stepwise regression models: 1) length of rump, 2) length from hip to base of round and 3) length from hip to point of the shoulder. Analysis revealed that slaughter weight was the best single indicator of weight of roast and steak meat. This was in agreement with data reported by Busch _et al_. (1969) in which eighteen body measurements and sixteen subjective scores were taken on 745 Hereford steers to determine the relationship between body type and carcass yield. They found that slaughter weight alone was a better indicator of edible portions of beef cattle carcasses. Slaughter weight controlled approximately 75 to 88 per cent of the variation in edible portion and only 2 to 4 percent increase was obtained when the regression model contained the body measurements. It was concluded that body measurements are of little value in predicting edible portion of beef.

Brown, Brown and Butts (1974) took ten linear body measurements on steers at four and eight months. Regression analysis for predicting test gain and feed conversion, revealed that approximately 25 per cent of the variation in test gain and 15 per cent of variation in feed conversion could be explained by models containing the measurements.

Data collected from the Georgia Swine Testing Station during thirteen years and nineteen tests involving 571 Duroc, 408 Hampshire, and 326 Yorkshire boars were analysed by Neville et al. (1975) to determine breed differences in average daily gain, feed efficiency, and backfat. They reported that the Durocs had the highest average daily gain, were most efficient, and had the greatest backfat thickness of the three breeds while the Hampshires had the least amount of backfat and were the slowest and least efficient growers. They also found that higher initial weights were associated with higher daily gains, less efficient feed utilization and reduced age off test.

Irlam, Hobson and Synder (1975) used crossbred barrows and gilts in a study designed to determine the effect of pig type on nutrient requirements and performance. Pigs were divided into small and large frame classes and fed rations with two protein levels and two calcium - phosphorus levels. Pig type did not significantly affect protein or calcium - phosphorus requirement and ration protein level had no significant influence on calcium - phosphorus requirement at the levels tested.

The large frame pigs tended to grow faster than the small frame pigs particularly during the latter stages of the test.

To determine the correlation of live measurements and gain in swine, Irlam *et al*. (1975) took six live body measurements at 36.1 kg. and again just prior to slaughter at 106.1 kg. Measurements taken included shoulder width, heart girth width, ham width, heart girth depth, heart girth circumference and body length. Pigs were assigned to the large frame or small frame classes based on visual appraisal prior to taking the measurements. Correlations of measurements with average daily gain include initial heart girth circumference (.22), final body depth (.21), backfat (.16), final heart girth circumference (.19), and final body depth (.18).

EXPERIMENTAL PROCEDURE

Boars used in this study were those entered by purebred swine breeders of Kansas in the Kansas Pork Producers Council Swine Testing Station located at Manhattan, Kansas and supervised by Kansas State University. Data were collected from a total of 275 boars representing six different breeds from a total of 66 different purebred breeders. Breeds represented were Berkshire, Chester White, Duroc, Hampshire, Spots and Yorkshire. Data were collected over four test periods starting with the winter test of 1973 through the summer test of 1975, and included data from two summer and two winter tests.

Two littermate boars and a littermate barrow or gilt were housed in a pen 1.2 x 4.3 meters which had a solid concrete floor, one hole self feeder, and an automatic water. Upon reaching an average of 30 kg. the littermate barrow or gilt was removed to another barn where it remained until 100 kg., at which point it was slaughtered and carcass information gathered. Boars remained in the original pen for the duration of the test. Boars were fed a standard 17% crude protein corn-milo-soybean meal diet (TS-51) throughout the test (Table 1). Feed and water were supplied *ad libitum*. Upon reaching an average of 114 kg. (the off-test weight), boars were limit fed 2 kg. per day until sold or removed from the test station by their owners.

Growth parameters studied included:

1) age and weight per day of age *on test* (30 kg.)
2) weight, feed per gain, and average daily gain for the first 35 days of the test.

Table I. Composition of Test Station Diets

Ingredients	TS-51 (Percent)[a]
Sorghum grain	35.65
Yellow corn	36.25
Soybean meal (44%)	22.00
Molasses	2.50
Dicalcium phosphate	1.60
Ground limestone	0.70
Salt	0.50
Vitamin premix[b]	0.50
Trace minerals[c]	0.10
Antibiotic premix[d]	0.20

[a]Crude protein in ration TS-51 - 17.4%.

[b]Amount per kilogram of premix: 880,000 USP Units of vitamin A 66,000 USP units of vitamin D_3, 990 mg. of riboflavin, 2640.0 mg. of d-Pantothenic acid, 66,000 mg. of Choline, 3,3000 mg. of Niacin, 4,400 I.U. vitamin E, 4.84 mg. of vitamin B_{12} and 12.54 mg. preservative (BHT).

[c]Containing 0.1% cobalt, 1.0 cooper, 0.30% iodine, 10% iron, 10% manganese and 10% zinc.

[d]Supplied as Tylan-10.

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3) Age, feed per gain, backfat, loineye, index[1], and average daily gain to 100 kg.

4) Age, feed per gain, average daily gain to 114 kg.

Backfat and loineye data were taken by the Model 721 Scan-o-gram. These measurements were taken and index calculated at 100 kg. However, in order to study growth patterns to heavier weights, boars were continued on test for this study until they reached 114 kg.

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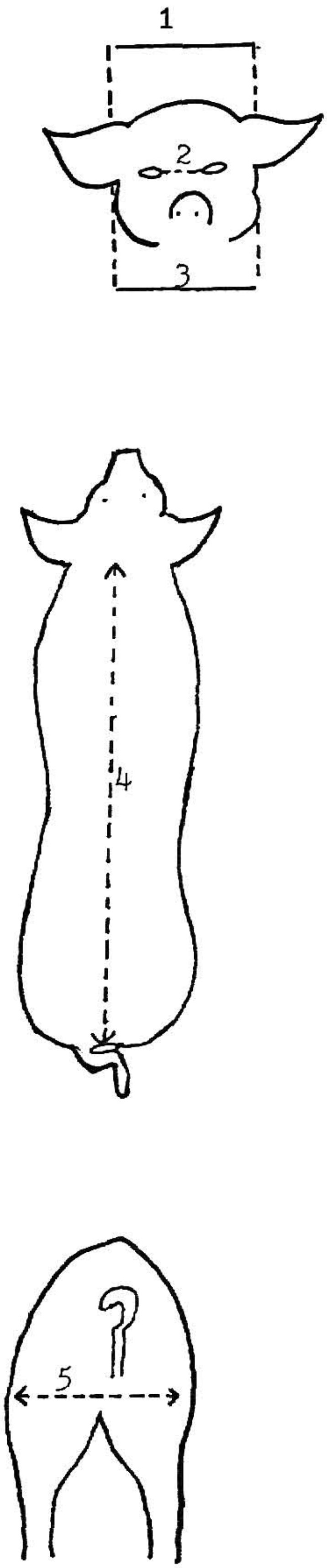
[1]Index = 250 + 50(ADG) - 50(Backfat) - 50(F/G)

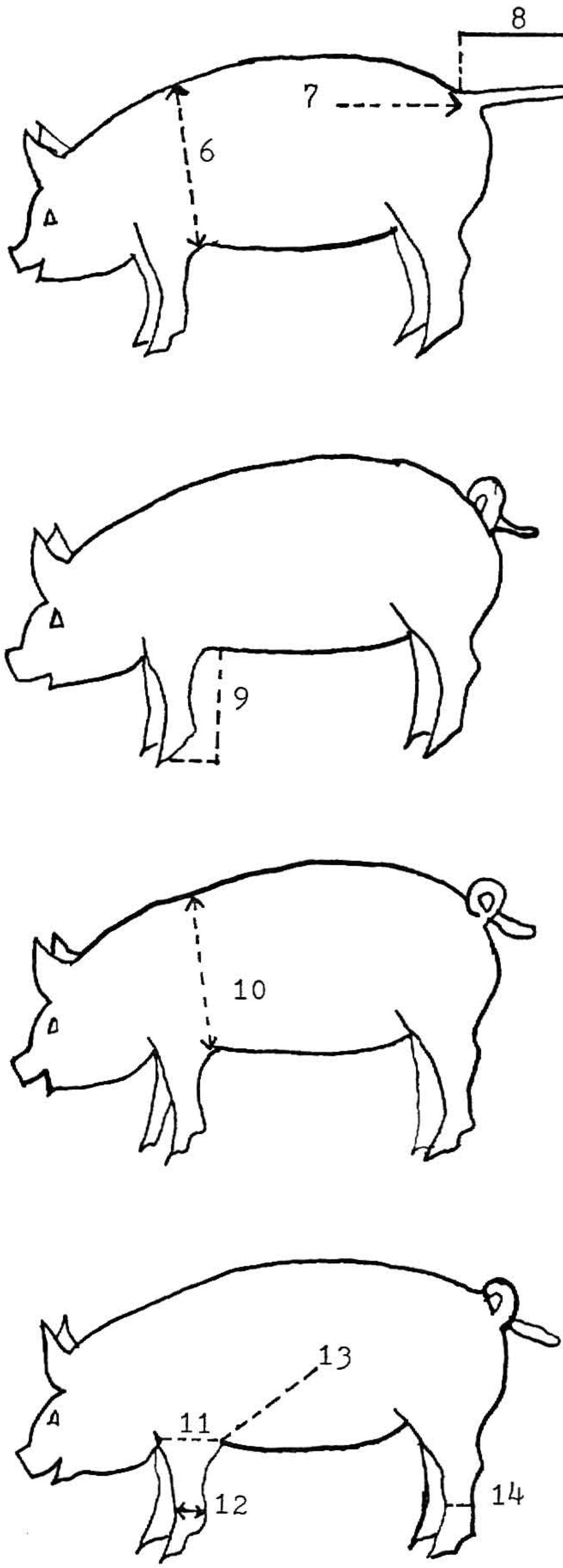
Fourteen body measurements were taken at 30 kg. and again at 114 kg. Instruments used in taking the measurements were a cloth measuring tape, wooden calipers, and a hog snare. Measurements taken (see Figure 1 and 2) included three about the head, nine on the body and legs, and the final two on the tail. Head measurements included width between the eyes taken from the inside corner of one eye to the inside corner of the other eye, width of skull between the ears, and width of jaw taken at the widest part of the jaw directly below the ears. The measurements on the tail included tail circumference taken at the base of the tail as close to the body as possible and tail length, taken from the base of the tail to the tip.

The measurements on the body included length taken from the atlanto-occipital joint to the base of the tail, heart-girth, taken immediately behind the shoulders, and chest depth taken from backbone to sternum just behind the elbow. Width of chest floor was measured immediately back of and parallel to the elbow. Stifle width was measured at the widest point of the ham. Front leg length was taken from the point of the elbow to the base of the hoof with the animal standing as correctly as possible. Forearm circumference was measured around the point of the elbow keeping the tape parallel to the floor and as close to the body as possible. The third front leg measurement, cannon circumference, was taken at the smallest part of the cannon bone equal distance between the knee and the pastern. The circumference of the cannon, midway



1. Width between the ears.
2. Width between the eyes.
3. Width of jaw.
4. Length of body.
5. Width of stifle.

Figure 1



6. Heart girth.
7. Tail circumference.
8. Tail length.
9. Front leg length.
10. Depth of chest.
11. Forearm circumference.
12. Front cannon circumference.
13. Width of chest.
14. Back cannon circumference.

Figure 2

between the hock and the pastern, was also taken on the hind leg. Data were analyzed by the method of least squares.

The experimental design (Table 2) was a 4 x 6 factorial with four tests and six breeds. Compounded in the test difference was not only different groups of boars, but different seasons (tests 1 and 5 were fall - winter tests, while tests 2 and 6 were summer tests), and different operators[2] (person taking the measurements). The sources of variation in the analysis of variance were test, breed, text x breed, pens and pig within pen. Feed efficiency was calculated on a pen basis, so its analysis of variance contained no pig within pen variation.

A numerous amount of missing data occurred in the experiment. (The correct n's for each of the parameters studied appeared in Table 3.) It was felt that the measurements had to be taken at close the same weight on all animals at both the 30 kg. and 114 kg. measuring weights, or most of the variation in the measurements could be explained by differences in weight alone. Some animals were brought into the test station weighing more than the 30 kg. on test weight, so measurements were not taken, but their performance and 114 kg. measurements were included in the analysis. Other missing data occurred in the tail length measurement. Some boars had docked tails and some tail biting did occur so that measuring tail length was impossible. Jaw width was not taken during the first test, but was added for tests 2, 5, and 6.

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[2]Data collected from tests 1 and 2 were analyzed and reported by Orwig (KSU 1974) in his Masters thesis.

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Table 2. Experimental Design

BREEDS

Operator	Test	1	2	3	4	5	6	Total
A	1	1[a] 2[b]	2 4	13 22	8 12	2 4	5 9	31 pens 53 pigs
	2	1 2	2 4	16 26	7 14	2 4	9 16	37 pens 66 pigs
B	5	0 0	3 6	17 34	8 15	0 0	12 24	40 pens 79 pigs
	6	0 0	3 6	17 34	7 13	2 4	10 20	39 pens 77 pigs
		2 4	10 20	63 116	30 54	6 12	36 69	147 pens 275 pigs

Operator: A = Orwig (1974)
B = Conley

Test: 1 = Winter '73
2 = Spring & Summer '74
5 = Winter '74
6 = Spring & Summer '75

Breeds: 1 = Berkshire
2 = Chester White
3 = Duroc
4 = Hampshire
5 = Spots
6 = Yorkshire

[a]top number is number of pens.

[b]bottom number is number of pigs with no more than two per pen.

Because of insufficient numbers in the Berkshire and Spotted breeds, these two breeds were not considered in the final analysis.

Correlations were determined within each breed and over all breeds. Regression analysis was performed using the 100 kg. performance and the 114 kg. measurements as the dependant variables and twelve of the 30 kg. measurements (tail length and jaw width were omitted because of missing observations) as the independent variables.

A set of correlations and final regression models are included in the Appendix.

Table 3. Number of Observations for Parameters Studied by Breed and test

	Breed				Test				Total
	C	D	H	Y	1	2	5	6	
35 Day and 30-100 kg. ADG	20	116	54	69	47	60	79	73	259
100-114 kg. and 30-114 kg. ADG	18	105	50	61	47	60	58	69	234
35 Day and 35D-100 kg. F/G	10[a]	56	25	33	19	29	40	36	124
100-114 kg. and 30-114 kg. F/G	9[a]	50	23	28	19	29	29	33	110
30 kg. Measurements[b]	20	112	53	69	47	60	77	70	254
114 kg. Measurements[b]	18	110	52	60	47	60	69	64	240
30 kg. Jaw	16	90	41	60	-[c]	60	77	70	207
114 kg. Jaw	14	88	40	51	-[c]	60	69	64	193
30 kg. Tail Length	20	107	50	65	45	54	77	66	242
114 kg. Tail Length	18	104	49	53	45	54	66	59	224

[a]pens are observations for this parameter

[b]excluding jaw width and tail length measurements

[c]jaw width was not taken during test 1

RESULTS AND DISCUSSION

A. Performance

Average Daily Gain. A significant ($P<.01$) breed effect on average daily gain from 30 to 100 kg. was found with the Yorkshires and Durocs gaining 0.92 and 0.91 kg. respectively, while the Chester Whites and Hampshires gained 0.85 and 0.88 kg., respectively (Table 4). However, this difference in gain occurred the first 35 days on test, as 35 day average daily gain differed ($P<.05$) by the same groups, but no significant breed variation occurred in average daily gain from 35 days to 100 kg. or from 100 to 114 kg. No significant difference in average daily gain from 30 to 114 kg. was found between breeds. This suggests a longer minimum adjustment period is needed than the manditory three days at this station. Average daily gain was not affected by season.

Ages. The age on test - age at 30 kg. - was not affected by breed, but was significantly affected ($P<.05$) by seasonal differences. The average on test ages for tests 1 and 5 (the winter tests) were 78.1 and 79.6 days and 73.7 and 74.3 days for the summer tests (tests 2 and 6). Boars were older ($P<.05$) at 100 kg. in the winter tests than in the summer test, but this seasonal difference was reduced by the end of the test period and was nonsignificant at 114 kg. age.

Feed Efficiency. Feed per gain the first 35 days on test was not affected by breed or season, but boars tended to be more efficient in the summer tests (Table 6). Feed efficiency

Table 4. Average of Performance Parameters by Breed and Season

	35 Day ADG[1]	35D 100 kg. ADG	100- 114 kg. ADG	30- 100 kg. ADG	30- 114 kg. ADG
Chester	0.804[a]	0.886[a]	1.068[a]	0.850[a]	0.864[a]
Duroc	0.864[b]	0.950[a]	0.914[a]	0.909[b]	0.914[a]
Hamp	0.791[a]	0.954[a]	0.932[a]	0.882[a]	0.891[a]
York	0.886[b]	0.950[a]	0.950[a]	0.923[b]	0.932[a]
Probability	P=.004	P=.386	P=.211	P=.007	P=.065
Test 1	0.877[a]	0.918[a]	0.991[a]	0.895[a]	0.909[a]
Test 2	0.786[a]	0.959[a]	0.995[a]	0.882[a]	0.895[a]
Test 5	0.845[a]	0.904[a]	1.027[a]	0.877[a]	0.895[a]
Test 6	0.845[a]	0.954[a]	0.845[b]	0.904[a]	0.900[a]
Probability	P=.078	P=.235	P=.023	P=.616	P=.80
Overall Ave.	0.850	0.945	0.936	0.904	0.909
S.D.	0.137	0.130	0.246	0.096	0.090

[a,b,c]Means within the same cell with different superscripts differ significantly at the given level.

[1]Kilograms

Table 5. Average of Performance Parameters by Breed and Season

	On Test Age	100 kg Age	114 kg Age	Back-fat	LEA[1]	Index[2]
Chester	74.4[a]	175.8[a]	170.3[a]	2.20[a]	35.03[a]	166.1[a]
Duroc	79.0[a]	158.1[a]	170.8[a]	2.20[a]	35.03[a]	173.9[a]
Hamp	75.7[a]	156.5[a]	170.0[a]	2.02[b]	37.74[b]	175.7[a]
York	76.6[a]	154.2[a]	167.9[a]	2.23[b]	34.71[a]	173.2[a]
Probability	P=.171	P=.467	P=.657	P=.001	P<.001	P=.569
Test 1	78.1[a]	159.3[a]	171.2[a]	1.95[a]	35.03[a]	171.2[a]
Test 2	73.7[b]	154.1[b]	167.9[a]	2.18[b]	35.62[a]	177.0[b]
Test 5	79.6[a]	160.8[a]	171.1[a]	2.30[c]	36.20[a]	162.8[c]
Test 6	74.3[b]	152.4[b]	169.7[a]	2.25[c]	35.68[a]	178.1[b]
Probability	P=.031	P=.029	P=.732	P<.001	P=.297	P=.011
Overall Ave.	77.3	156.5	170.4	2.20	35.60	172.9
S.D.	8.43	11.35	10.73	0.28	2.57	19.4

Means within the same cell with different superscripts differ significantly at the given level.

from 35 days to 100 kg. showed a significant ($P<.001$) seasonal affect, with feed conversion ratios of 3.15 and 3.12 in the winter and 2.73 and 2.75 in the summer. The start to 100 kg., start to 114 kg., and 100 to 114 kg. feed efficiencies were also affected ($P<.01$) by seasonal differences. These differences in feed efficiency ratios are a result of increased feed consumption in the winter tests, and not because of decreased gains. This data supports the theory that swine eat to fulfill an energy requirement. In the winter as the net energy for maintenance increases, the pig consumes more energy so that his net energy for production is not reduced. As stated before, gain was not affected by seasonal differences.

Toward the end of test 6, many boars were affected by pneumonia that greatly reduced gains and increased feed per unit of gain in the 100 kg. to 114 kg. stage.

Carcass information. (Table 5) Backfat and loineye area were both significantly affected ($P<.01$) by breed. The Hampshires had less backfat and larger loineyes than the other breeds. Season had no affect on backfat or loineye ($P<.05$), however, test 1 had lower backfat readings ($P<.01$) than the other tests.

Breed differences had no significant affect on index although the Chester White breed tended to have lower index scores due to their lower average daily gain from 30 to 100 kg. The Hampshires also had a lower average daily gain, but compensated for this with less backfat so they ended with the highest index average.

Table 6. Average of Performance Parameters by Breed and Season

	35 Day F/G	35D-100 kg F/G	100-114 kg F/G	30-100 kg F/G	30-114 kg F/G
Chester	2.42[a]	2.95[a]	3.23[a]	2.72[a]	2.79[a]
Duroc	2.40[a]	2.94[a]	3.39[a]	2.70[a]	2.77[a]
Hamp	2.47[a]	2.82[a]	3.29[a]	2.68[a]	2.76[a]
York	2.37[a]	3.04[a]	3.25[a]	2.73[a]	2.79[a]
	P=.580	P=.088	P=.720	P=.838	P=.953
Test 1	2.48[a]	3.15[a]	3.38[a,b]	2.87[a]	2.94[a]
Test 2	2.35[a]	2.73[b]	2.97[c]	2.57[b]	2.63[b]
Test 5	2.47[a]	3.12[a]	3.53[a]	2.82[a]	2.85[a]
Test 6	2.35[a]	2.75[b]	3.28[b]	2.58[b]	2.70[b]
	P=.204	P<.001	P=.033	P<.001	P<.001
Overall Ave.	2.39	2.93	3.32	2.69	2.76
S.D.	0.28	0.35	0.64	0.25	0.22

Means within the same column with different superscripts differ significantly at the given level.

B. Measurements

30 kg. Measurements. Analysis of variance revealed that the Yorkshires had longer bodies and longer front legs with a smaller tail circumference than the other breeds. The Durocs has the deepest chest, ($P<.05$) while the Hampshires had the smallest ($P<.05$) heartgirth and smallest front cannon circumference ($P<.05$).

All measurements except jaw width showed significant test differences of which most can be accounted for by the differences in ages between tests.

114 kg. At 114 kg., the Chesters were smallest between the eyes, ($P<.01$) widest between the ears ($P<.01$) and had the largest front and back cannon bones. Having the largest heartgirth, largest tail circumference but shortest tails were the Durocs. The Yorkshires had the longest body length ($P<.01$) and were tallest ($P<.05$) but also had the smallest tail circumference, ($P<.001$) and the smallest back cannon circumference ($P<.01$). The Hampshire had the shortest front legs ($P<.05$) and least chest depth ($P<.01$). Test differences occurred in all measurements except jaw width and tail length.

More of the measurements showed significant breed differences at 114 kg. than at 30 kg. indicating that breed differences in body size, generally express themselves at later ages.

C. Correlations.

30 kg. Measurements with performance. The leg measurements at 30 kg., front cannon circumference, forearm

Table 7a. Measurement Averages by Breed[1]

At 30 kg.	Eyes	Ears	Length	Cannon	Forearm	Back-leg	Heart-girth
Chester	8.60[a]	7.68[a]	69.9[a]	13.18[a]	23.94[a]	13.67[a]	68.84[a]
Duroc	8.88[a]	7.68[a]	71.2[a]	13.52[b]	24.22[a]	13.44[a]	69.68[b]
Hamp	8.83[a]	7.63[a]	71.4[a]	12.75[c]	24.01[a]	13.18[b]	67.69[c]
York	8.86[a]	7.37[a]	72.7[b]	13.11[a]	24.09[a]	13.29[b]	68.89[a]
Probability	P=.260	P=.099	P=.030	P=.004	P=.55	P=.042	P=.022
At 114 kg.							
Chester	11.92[a]	11.62[a]	114.5[a]	19.71[a]	38.17[a]	20.10[a]	109.3[a]
Duroc	12.80[b]	11.93[a]	114.0[a]	19.40[b]	39.27[a]	19.97[a]	113.3[b]
Hamp	12.60[b]	11.21[b]	114.2[a]	18.94[c]	38.78[a]	19.69[b]	109.1[a]
York	12.60[b]	11.08[b]	117.2[b]	19.10[c]	38.81[a]	19.38[c]	109.1[a]
Probability	P<.001	P<.001	P<.001	P=.006	P=.073	P<.001	P<.001

[1]Measurements taken to the nearest one-half centimeter

[a,b,c]Means within the same cell with different superscripts differ significantly at the given level.

Table 7b. Measurement Average By Breed[1]

At 30 kg.	Front Leg Length	Tail C.	Tail L.	Chest Width	Chest Depth	Stifle	Jaw
Chester	24.76[a]	8.19[a]	20.48[a]	14.78[a]	22.30[a]	20.48[a]	12.47[a]
Duroc	24.52[a]	8.37[a]	19.48[a]	15.03[a]	22.53[b]	20.35[a]	12.11[a]
Hamp	24.47[a]	8.27[a]	20.35[a]	15.10[a]	21.94[c]	20.58[a]	11.75[a]
York	25.16[b]	7.96[b]	19.57[a]	15.06[a]	22.25[a]	20.56[a]	12.24[a]
Probability	P=.03	P=.016	P=.185	P=.622	P=.04	P=.411	P=.699
At 114 kg.							
Chester	34.92[a]	13.34[a]	30.85[a]	20.76[a]	35.56[a]	35.67[a]	18.97[a]
Duroc	35.12[a]	13.72[b]	29.72[a]	21.73[a]	35.74[a]	32.69[a]	18.82[a]
Hamp	34.51[b]	13.34[a]	31.05[a]	21.63[a]	35.10[b]	32.38[a]	18.66[a]
York	35.51[c]	13.00[c]	30.80[a]	21.58[a]	35.35[a]	32.18[a]	18.71[a]
Probility	P=.019	P=.003	P=.081	P=.48	P=.012	P=.122	P=.609

[1]Measurements taken to the nearest one-half centimeter.

[a,b,c]Means within the same cell with different superscripts differ significantly at the given level.

Table 8a. Measurement Averages by Test

Test at 30 kg.	Eyes	Ears	Length	Cannon	Forearm	Back-leg	Heart-girth
1	8.93[a]	8.60[a]	71.4[a]	13.16[a]	22.71[a]	13.62[a]	70.2[a]
2	8.96[a]	6.73[b]	72.2[a]	13.49[b]	24.24[b]	13.62[a]	68.4[b]
5	8.40[b]	7.32[c]	71.9[a]	12.67[c]	24.19[b]	13.00[b]	68.2[b]
6	8.88[a]	7.68[c]	69.6[b]	13.08[a]	25.11[c]	13.31[c]	69.3[a]
Probability	P=.001	P<.001	P=.020	P<.001	P<.001	P<.001	P=.013
at 114 kg.							
1	12.67[a]	12.93[a]	114.1[a]	19.84[a]	38.84[a]	20.22[a]	114.4[a]
2	12.70[a]	9.75[b]	113.0[a]	19.20[b]	39.63[b]	19.74[b]	106.7[b]
5	12.31[b]	11.90[c]	118.0[b]	19.33[b]	38.94[a]	19.74[b]	111.3[a]
6	12.31[b]	11.24[c]	114.8[a]	18.79[c]	39.63[b]	19.40[b]	109.3[b]
Probability	P=.016	P<.001	P<.001	P<.001	P<.001	P=.003	P<.001

Means with different superscripts in the same cell differ significantly at the given level.

Table 8b. Measurement Averages by Test

Test at 30 kg.	Front Leg Length	Tail C.	Tail L.	Chest Width	Chest Depth	Stifle	Jaw
1	25.93[a]	9.11[a]	21.17[a]	15.82[a]	22.73[a]	21.15[a]	-
2	24.52[b]	8.63[b]	19.64[b]	14.52[b]	21.89[b]	19.30[b]	12.62[a]
5	24.91[a]	7.48[c]	19.74[b]	17.05[c]	22.22[b]	20.15[b]	11.88[a]
6	23.55[b]	7.53[c]	19.66[b]	12.90[d]	22.17[b]	21.38[a]	11.98[a]
Probability	$P<.001$	$P<.001$	$P=.048$	$P<.001$	$P=.03$	$P<.001$	$P=.427$
at 114 kg.							
1	36.28[a]	13.57[a]	30.18[a]	22.02[a]	35.05[a]	32.64[a]	-
2	36.33[a]	14.16[b]	30.36[a]	21.25[b]	35.30[a]	31.77[b]	18.64[a]
5	33.97[b]	12.54[c]	30.69[a]	22.30[a]	36.17[b]	33.41[c]	19.43[b]
6	33.46[b]	13.13[d]	31.18[a]	20.15[c]	35.23[a]	32.10[b]	18.30[a]
Probability	$P<.001$	$P<.001$	$P=.62$	$P<.001$	$P<.001$	$P<.001$	$P<.001$

[a,b,c]Means with different superscripts in the same cell differ significantly at the given level.

circumference and back cannon circumference, were negatively correlated (P<.01) with age at 100 kg. with correlation coeficients of -.22, -.22, and -.22, respectively. They were also negatively correlated (P<.05) with 30 kg. to 100 kg. feed efficiency (-.17, -.21, and -.38, respectively), but were not significantly correlated with average daily gain the first 35 days on test or from 30 to 114 kg. Heartgirth, chest width and chest depth were positively correlated (P<.01) with daily gain the first 35 days on test (.29, .17, .27), however none of the chest measurements were significantly correlated with average daily gain from 35 days to 100 kg. or gain from 100 kg. to 114 kg. Heartgirth was negatively correlated (P<.05) with feed efficiency from 30 to 100 kg. and 30 to 114 kg. (-.17 and -.19, respectively) while chest width was positively correlated (P<.01) with feed conversion over the same periods (.42 and .41, respectively). Chest depth was significantly correlated (P<.01) with 30 to 100 kg. average daily gain (.21) but showed no relationship with feed efficiency over the same period. Width between the eyes was negatively correlated (P<.01) with feed efficiency at every stage (-.19, -.20, -.31 and -.25 for the first 35 days on test, 35 days to 100 kg., 30 to 100 kg., and 30 to 114 kg.) but was not significantly correlated with average daily gain over any of the same periods. Tail circumference showed a negative correlation (P<.01) with backfat at 100 kg. (r = -.40), but was not significantly correlated with gain or efficiency.

Table 9a. Correlation Coefficients for Selected Performance Parameters And 30 kg. Measurements

	Eye	Ear	Length	Cannon	Forearm	Back-leg	Heart-girth
100 kg. Age	-.20**	.09	.08	-.22**	-.22**	-.22**	-.05
114 kg. Age	-.15*	.11	.02	-.21**	-.18**	-.21**	-.03
35 Day Wt.	.11	.10	.19**	.09	.05	.17**	.43**
35 Day F/G	-.19**	.08	-.02	-.11	-.11	-.15*	-.02
35D-100 kg. F/G	-.20**	.18**	-.11	-.17**	-.27**	-.24**	.05
100-114 kg. F/G	-.11	.17*	-.06	-.16*	-.10	-.12	.09
Backfat	-.09	-.13	-.04	-.13*	-.16**	-.19**	.08
30-100 kg. F/G	-.31**	-.14	-.02	-.17	-.21**	-.38**	-.17*
30-114 kg. F/G	-.25**	-.11	.08	-.19*	-.26**	-.35**	-.19*
35 Day ADG	.07	.10	.01	.06	.00	.08	.29**
35D-100 kg. ADG	.08	-.09	.25**	.03	.16*	.12	-.01
100-114 kg. ADG	-.04	-.12	.00	-.01	.01	.01	-.10
30-100 kg. ADG	-.11	-.01	.17**	.09	.13*	.14*	.15*
30-114 kg. ADG	.05	-.05	.13*	.05	.12	.06	.05
L.E.A.	-.11	-.13*	-.02	-.19**	.07	-.12**	-.17**

* P<.05

** P<.01

Table 9b. Correlation Coefficients for Selected Performance Parameters and 30 kg. Measurements

	Front Leg Length	Tail C.	Tail L.	Chest Width	Chest Depth	Stifle	Jaw
100 kg. Age	.17**	-.07	.05	.21**	.01	-.14*	.10
114 kg. Age	.08	-.08	.05	.11	-.02	-.08	.06
35 Day Wt.	.07	.05	.13*	.29**	.42**	.20**	.16*
35 Day F/G	.21*	.00	.12	-.20**	-.01	.04	-.03
35D-100 kg. F/G	.12*	-.13*	.14*	.38**	.04	.02	-.12
100-114 kg. F/G	.02	-.06	.15*	.19**	.11	.21**	.02
Backfat	.12	-.40**	-.11	.02	.00	.00	.01
30-100 kg. F/G	.18*	-.21**	.11	.42**	-.16	-.25**	-.10
30-114 kg. F/G	.16	-.09	.17	.41**	.07	-.23*	-.18
35 Day ADG	-.04	-.01	.05	.17**	.27**	.17**	.04
35D-100 kg. ADG	.04	.10	-.04	-.04	.08	-.01	.08
100-114 kg. ADG	.09	.09	-.06	.02	.01	-.12	.03
30-100 kg. ADG	-.01	.06	-.01	.05	.21**	.09	.05
30-114 kg. ADG	.01	.05	-.03	.08	.14*	.05	.03
L.E.A.	-.10	-.05	-.01	.03	-.18**	-.06	-.09

* $P < .05$

** $P < .01$

Performance with Performance. (Table 10). On test age was positively correlated ($P<.01$) with both age at 100 kg. and age at 114 kg. (.68 and .60, respectively), and with 30 to 100 kg. feed efficiency (.23). However, on test age was not significantly correlated with average daily gain over any part of the test. Average daily gain the first 35 days on test was negatively correlated ($P<.01$) with feed efficiency over the same period and positively correlated ($P<.01$) with backfat at 100 kg. (-.35 and .30, respectively). Thirty-five day average daily gain was positively correlated ($P<.05$) with average daily gain from 30 to 100 kg. and 30 to 114 kg. (.69 and .63) but had correlation coefficients of .13 ($P<.05$) and .04 with average daily gain from 35 day to 100 kg. and 100 to 114 kg. respectively. Average daily gain from 30 to 100 kg. and from 30 to 114 kg. was negatively correlated ($P<.01$) with feed efficiency over the same periods (-.49 and -.40, respectively). Backfat thickness at 100 kg. was positively correlated ($P<.01$) with average daily gain from 30 to 100 kg. (.20), but was not significantly correlated with feed efficiency over the same period.

30 kg. Measurements with 114 kg. Measurements. Correlation of 30 kg. measurements with the same measurement at 114 kg. were generally high except for front cannon circumference (.07), chest depth (.10), stifle width (.00), and width of jaw (.11). A list of the significant correlations ($P<.01$) of 30 kg. measurements with the same measurements at 114 kg. includes: width between the eyes, .32; width between the ears,

.59; length, .22; forearm circumference, .35; heartgirth, .28; front leg length, .31; tail circumference, .50; tail length, .56; chest width, .43; and back cannon circumference, .30.

Regression Analyses. To predict age at 100 kg., all of the 30 kg. measurements (except tail length and jaw width), on test age, on test weight, season and breed were included in the original model for use in stepwise regression with age at 100 kg. as the dependent variable. Dummy variables were inserted into the model to adjust for season (a value of one if winter, zero otherwise) and breed (one if Chester White or Hampshire, zero otherwise). The same model was also used in analysis with 30 to 100 kg. average daily gain as the dependent variable.

Independent variables remaining in the final model ($P<.05$) for predicting age at 100 kg. were breed, on test age, on test weight, and forearm circumference which had regression coefficients of 2.5, 0.98, -0.69, and -0.64. This model accounted for 52 per cent of the variation in age at 100 kg. However, because of the part-whole relationship between on test age and 100 kg. age, it was felt that this R square value was misleading. This was supported by the fact that on test age alone accounted for 47 percent of the variation in 100 kg. age. It was decided, then, that it would be more important to determine the relationship between on test age and days on test. Since weight gain was held approximately constant for all entries, the only parameter that could vary was the length of time it took for the boars to gain from 30 to 100 kg. After stepwise regression with days on test as the

Table 10. Correlations of Selected Performance Parameters

	100 kg Age 1	114 kg AGE 2	35 Day Weight 3	35 Day F/G 4	35D-100 kg F/G 5	100-114 kg F/G 6	B.F. 7	30-100 kg F/G 8	30-114 kg F/G 9	35 Day ADG 10	35D 100 kg ADG 11	100-114 kg ADG 12	30-100 kg ADG 13	30-114 kg ADG 14
1	1.00													
2	.92**	1.00												
3	-.29**	-.29**	1.00											
4	.40**	.32**	-.28**	1.00										
5	.35**	.27**	.19**	.16*	1.00									
6	.05	.23	.05	.01	.24**	1.00								
7	-.08	-.02	.30**	-.16**	.10	.26**	1.00							
8	.59**	.48**	-.15	.58**	.81**	.19*	.01	1.00						
9	.35**	.44**	-.18*	.43**	.66**	.59**	.04	.82	1.00					
10	-.36**	-.37**	.90**	-.35**	.21**	.03	.30**	-.18*	-.28**	1.00				
11	-.43**	-.41**	.17**	-.21**	-.51**	-.04	.06	-.53**	-.28**	.13*	1.00			
12	-.03	-.27**	.00	.02	.01	-.58**	-.18**	-.06	-.31**	.04	.03	1.00		
13	-.55**	-.53**	.65**	-.35**	-.25**	-.02	.20**	-.49**	-.34**	.69**	.80**	.04	1.00	
14	-.51**	-.59**	.55**	-.27**	-.17**	-.22**	.14*	-.38**	-.40**	.63**	.74**	.39**	.92**	1.00

* P<.05

** P<.01

Numbered parameters on the left hand side coincide with the same numbered parameter across top of table.

dependent variable, only breed, on test weight, front leg length and chest depth remained in the final model ($P<.05$) with regression coefficients of 2.44, -.585, and -1.63 respectively. With the intercept of 106.3 included, this model accounted for eleven per cent of the variation in number of days the boars remained on test.

Use of the same model to predict average daily gain from 30 to 100 kg., resulted in a final model containing only breed and on test weight (regression coefficients of -0.033 and 0.007, respectively) that account for less than seven per cent of the variation in average daily gain.

Stepwise regression to predict feed efficiency using the same full model left only backleg circumference and chest width in the final model. The regression coefficients ($P<.05$) were -.471 and .03, respectively, with an intercept of 4.66. This model accounted for 28 per cent of the variation in 30 to 100 kg. feed efficiency.

Using backfat thickness as the dependant variable, stepwise regression left breed, season, on test age, tail circumference, and average daily gain the first 35 days on test in the final model. Regression coefficients were -0.038, -0.026, 0.002, -0.119 and 0.081, respectively. This model (intercept = 2.50) accounted for 28 per cent of the variation in backfat, with tail circumference alone accounting for over half of this value.

A complete list of regression analysis results with final models, R square values, and order of deletion is included in the appendix.

Multivariate Analysis. It was felt that an index constructed from the fourteen body measurements that would give some numerical value to size and shape would be of importance to the producer as well as the researcher. To accomplish this, multivariate analysis of the 30 kg. measurements was conducted to yield the principal components that could be used as an index for use in regression and correlation analysis. Principal components as defined by Morrisson (1967) are those linear combinations of the response which explain progressively smaller portions of the total sample variance.

Fourteen principal components were extracted from the data, but none of the components accounted for any large portion of the total variance. The first principal component taken from the 30 kg. measurements accounted for only 26 percent of the total variation. Cumulative proportion of the total variance climbed at a slow rate as the other thirteen principal components were added accounting for 39, 51, 61, 68, 73, 78, 83, 87, 91, 94, 96, 98 and 100 percent of the total variance, respectively. These results suggest that there is no one linear combination of these measurements that can be added into an index that will explain a substantial portion of the variation in animal sizes and shapes.

SUMMARY

A study was conducted to determine the affects of breed and season on such performance parameters as average daily gain, feed efficiency, and certain carcass characteristics. Breed differences in average daily gain occurred the first 35 days on test and this difference carried through to affect average daily gain from start of the test to 100 kg. However, all breeds gained equally from 35 days to 100 kg., and from 100 kg. to the off test weight of 114 kg. Seasonal differences had no affect on gain, but did significantly affect feed efficiency as boars consumed more feed in the winter tests causing them to be less efficient in feed utilization during that time.

Fourteen body measurements were taken at the start of the test (30 kg.) and again at the end of the test (114 kg.) to determine the relationship between body measurements and certain growth parameters. Correlations between the body measurements and growth tended to be extremely low for most parameters and were in agreement with those reported by Irlam _et al_. (1975). Regression analysis using the 30 kg. measurements as the independent variables failed to yield models that could account for the variation in average daily gain, feed efficiency, or backfat. Multivariate analysis produced no one principal component that could account for a substantial portion of the total sample variance.

It appears from this data that selection at early ages on the basis of the body traits studied could result in positive gains in those traits at market weights. The results of

this research, however, fail to support the value of these trails as visual indicators of growth. This study suggests that performance testing is still the best method of predicting a particular animal's genetic potential.

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APPENDIX

REGRESSION ANALYSIS[3]

1. 100 kg. Age.

Model: Y = 116.466 + 2.505 (Breed[1]) + 0.98 (On Test Age) + (-.686) (On Test wt.) + (-.6363) (forearm)

R^2: .52

Order of deletion: Season[2], chest width, cannon, length, back leg, tail circumference, heartgirth, eye, stifle, ear, front leg length, chest depth.

2. 30-100 kg. ADG.

Model: Y = 0.6977 + (-.033) Breed + .007(On Test wt.)

R^2: 0.067

Order of deletion: On Test age, chest width, back leg, cannon, eye, season, ear, stifle, heartgirth, tail circumference, forearm, length, front leg length, chest depth.

3. 35 Day F/G.

Model: Y = 2.082 + (-.12) eye + (0.056) front leg length

R^2: 0.096

Order of deletion: Heartgirth, forearm, ear, season, length, chest width, tail circumference, cannon, back leg, stifle, chest depth.

4. 35 Day 100 kg. F/G

Model: Y = 4.71 + 0.386 (Season) + (-.01) length + (-.065) tail circumference.

R^2: 0.34

Order of deletion: Backleg, front leg length, eye, length, chest width, cannon, chest depth, forearm, stifle, heartgirth.

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[1]Breed = 1 if Chester White or Hampshire; 0 otherwise

[2]Season = 1 if winter; 0 otherwise

[3]$P < .05$

5. 30 to 100 kg. F/G.

Model: Y = 4.66 + (-.184) backleg + 0.03 (chest width)

R^2: 0.28

Order of deletion: Forearm, stifle, eye, season, front leg length, length, ear, heartgirth, tail circumference, cannon, chest depth.

6. Backfat at 100 kg.

Model: Y = 2.50 + (0.097) + (-.067) Season + .005 (On Test Age) + (-.119) tail circumference + 0.456 (35 Day ADG).

R^2: 0.28

Order of deletion: Eye, ear, front leg length, backleg chest depth, chest width, heartgirth, stifle, length, on test wet., forearm, cannon.

7. 114 kg. width between the eyes.

Model: Y = 9.19 + 0.422 (eye) + 0.029 (length) + (-.036) hearthgirth + (-4.33) Breed[4] 2 + 0.284 (Breed 3)

R^2: 0.21

Order of deletion: cannon, Stifle, forearm, Breed 4, chest depth, backleg, front leg length, ear, season, chest width, tail circumference.

8. 114 kg. width between the ears.

Model: Y = 4.065 + 6.40 (Season) + 0.514 (ear) + (-.052) length + 0.091 (heartgirth) + 0.461 (Breed 3)

Order of deletion: Breed 4, tail circumference, eye, cannon, forearm, chest depth, Breed 2, backleg, stifle, front leg length, chest width.

9. 114 kg. Length.

Model: Y = 124.96 + 2.732 (Season) + 0.275 (length) + (-.939) cannon + 0.358 (forearm) + (-.25) heartgirth + (-1.068) tail circumference + (-1.615) Breed 3 + (-2.516) Breed 4

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[4] For regression analysis to predict 114 kg. measurements, each breed was included separately as a dummy variable. Values of one are inserted into the model if Breed 2 (Chester White), Breed 3 (Duroc) or Breed 4 (Hampshire).

R^2: 0.32

Order of deletion: eye, front leg length, stifle, back-leg, ear, chest depth, Breed 2, chest width.

10. 114 kg. Cannon Circumference.

Model: Y = 18.23 + .712 (Season) + 0.441 (Backleg) + (-.243) chest depth + 0.461 (Breed 2) + 0.366 (Breed 3)

R^2: 0.19

Order of deletion: Front leg length, forearm, ear, cannon, stifle, tail circumference, length, Breed 4, heart-girth, eye.

11. 114 kg. Forearm Circumference.

Model: Y = 41.052 + (-2.207) Season + 0.287 (forearm) + (-.845) backleg + 0.207 (chest width) + 0.686 (Breed 3)

R^2: 0.32

Order of deletion: Length, heartgirth, ear, chest depth, tail circumference, eye, Breed 2, Breed 4, stifle, cannon, front leg length.

12. 114 kg. Backleg Circumference.

Model: Y = 14.193 + 0.614 (Season) + 0.582 (backleg) + (-.130) chest depth + 0.507 (Breed 2) + 0.596 (Breed 3) + 0.369 (Breed 4).

R^2: 0.29

Order of deletion: Stifle, elngth, heartgirth, cannon, ear, tail circumference, forearm, chest width, eye.

13. 114 kg. Heartgirth.

Model: Y = 105.51 + 2.895 (Season) + -.218 (length) + (-1.059) backleg + 0.244 (heartgirth) + 0.689 (chest depth) + 1.562 (Breed 3).

R^2: 0.44

Order of deletion: Tail circumference, eye, Breed 2, Breed 4, ear, chest width, stifle, cannon, forearm, front leg length.

14. 114 kg. Front Leg Length.

Model: Y = 24.95 + 0.635 (eye) + 0.088 (length) + 0.414 (cannon) + (-.287) forearm + (-.179) heartgirth + 0.274 (front leg length) + 0.654 (tail circumference) + (-.630) Breed 4.

R^2: 0.37

Order of deletion: Backleg, chest depth, season, Breed 2, Breed 3, stifle, chest width, ear.

15. 114 kg. Tail Circumference.

Model: Y = 9.108 + (-.827) Season + 0.049 (length) + (-.071) heartgirth + 0.718 (tail circumference) + 0.468 (Breed 3).

R^2: 0.43

Order of deletion: Breed 4, front leg length, chest depth, ear, chest width, backleg stifle, eye, Breed 2, cannon, forearm.

16. 114 kg. Chest Width.

Model: Y = 14.638 + .457 (chest width)

R^2: 0.18

Order of deletion: forearm, eye, chest depth, length, Breed 4, Breed 3, tail circumference, heartgirth, cannon, backleg, stifle, season, front leg length, Breed 2.

17. 114 kg. Chest Depth.

Model: Y = 37.68 + 0.643 (Season) + 0.356 (eye) + (-.357) ear + (-.401) backleg + (-.232) tail circumference + 0.182 (chest depth) + 0.681 (Breed 2) + 0.568 (Breed 3).

R^2: 0.21

Order of deletion: Cannon, Breed 4, length, heartgirth, front leg length, chest width, stifle, forearm, Breed 2.

18. 114 kg. Stifle Width.

Model: Y = 41.24 + 1.134 (Season) + (-.722) backleg + 0.64 (Breed 3).

R^2: 0.14

Order of deletion: Ear, eye, Breed 4, cannon, forearm, chest width, heartgirth, front leg length, tail circumference, chest depth, length, Breed 2, stifle.

19. Days On Test (to 100 kg.)

Model: Y = 106.3 + 2.44 (Breed) + (-.585) On Test wt. + 0.824 (front leg length) + (-1.63) chest depth.

R^2: 0.11

Order of deletion: On test age, season, chest width, cannon, tail circumference, backleg, eye, length, heartgirth, stifle, ear, forearm.

Correlation Coefficients for Selected Performance Parameters and 30 kg. Measurements Within the Hampshire Breed

	Eye	Ear	Length	Cannon	Forearm	Back-leg	Heart-girth
100 kg. Age	-.20	.04	.10	-.35*	-.36**	-.32*	-.26
114 kg. Age	-.13	.10	.08	-.27	-.28	-.28	-.[illegible]7
35 Day Wt.	.22	.03	.25	.15	.21	.27*	.59**
35 Day F/G	-.11	-.06	.04	-.30*	-.06	-.19	.03
35D-100 kg. F/G	-.27*	.15	.05	-.33*	-.12	-.28*	.14
100-114 kg. F/G	.02	.07	.21	-.20	.04	-.20	.08
Backfat	-.12	-.14	-.06	-.15	.15	-.13	.06
30-100 kg.	-.22	-.36*	.19	-.33	-.21	-.25	-.28
30-114 kg. F/G	-.32	-.21	.30	-.52*	-.37	-.48*	-.53**
35 Day ADG	.09	-.01	.09	.09	.24	.18	.42**
35D-100 kg. ADG	.02	-.05	-.09	.24	.37**	.24	.05
100-114 kg. ADG	-.14	-.01	-.05	-.11	-.19	.02	.03
30-100 ADG	.07	-.06	.12	.23	.43**	.29**	.34*
30-114 kg. ADG	-.05	-.06	.01	.09	.33*	.18	.28*

* $P<.05$

** $P<.01$

Correlation Coefficients for Selected Performance Parameters and 30 kg. Measurements Within the Hampshire Breed

	Front Leg Length	Tail C.	Tail L.	Chest Width	Chest Depth	Stifle	Jaw
100 kg. Age	.12	-.27	-.04	.39**	-.05	-.23	-.17
114 kg. Age	.02	-.30*	-.05	.34*	-.04	-.16	-.23
35 Day Wt.	-.11	.05	.07	.17	.50**	.50**	.20
35 Day F/G	.35*	-.09	.08	.45**	.07	-.01	-.10
35D-100 kg. F/G	.20	-.40**	.10	.52**	.18	.13	-.11
100-114 kg. F/G	.05	-.30*	.20	.25	.05	.11	.02
Backfat	-.27	-.35*	-.15	.14	-.08	.11	.01
30-100 kg. F/G	.46*	-.32	-.11	.50**	-.04	-.32	.03
30-114 kg. F/G	.62**	-.30	.13	.64**	-.10	-.66**	-.08
35 Day ADG	-.23	-.08	.03	.06	.50**	.50**	.12
35D-100 kg. ADG	.04	.14	.03	-.12	.02	.02	.23
100-114 kg. ADG	.12	.23	-.10	.23	-.01	-.01	.23
30-100 ADG	-.13	.03	.03	-.02	.34*	.34*	.23
30-114 kg. ADG	-.10	.03	-.04	.06	.32*	.32*	.20

* P<.05

** P<.01

Correlation Coefficients for Selected Performance Parameters and 30 kg. Measurements Within the Chester White Breed

	Eye	Ear	Length	Cannon	Forearm	Back-leg	Heart-girth
100 kg. Age	-.35	.09	.08	-.37	.29	-.36	-.16
114 kg. Age	-.03	.07	-.28	-.27	.36	-.28	-.12
35 Day Wt.	.13	.28	.07	.18	.12	.26	.34
35 Day F/G	-.55*	-.23	.28	-.18	-.02	-.45*	-.38
35D-100 kg. F/G	.18	.49*	-.01	.05	-.16	.32	.07
100-114 kg. F/G	.52*	.15	-.07	.35	-.16	.49*	.20
Backfat	-.12	-.63**	-.24	-.01	.23	-.27	-.47*
30-100 kg. F/G	-.37	-.15	.13	-.17	-.11	-.20	-.58*
30-114 kg. F/G	.59	.11	-.44	.50	-.28	.38	-.29
35 Day ADG	.21	.37	-.07	.07	-.17	.17	.32
35D-100 kg. ADG	.18	.04	-.01	.14	-.08	.04	.11
100-114 kg. ADG	-.59*	-.07	.17	-.33	-.11	-.37	-.11
30-100 kg. ADG	.24	.22	-.02	.14	-.15	.12	.23
30-114 kg. ADG	-.01	.22	.22	.11	-.17	.05	.20

* $P<.05$

** $P<.01$

Correlation Coefficients for Selected Performance Parameters and 30 kg. Measurements Within the Chester White Breed

	Front Leg Length	Tail C.	Tail L.	Chest Width	Chest Depth	Stifle	Jaw
100 kg. Age	.28	-.32	-.32	.26	.10	-.01	.37
114 kg. Age	-.08	-.45	-.33	-.38	-.03	.12	.37
35 Day Wt.	.06	.18	.43	.09	.18	.05	-.37
35 Day F/G	.02	-.20	-.39	.52*	.09	-.13	.26
35D-100 kg. F/G	.25	.24	.39	.46*	-.18	-.22	-.07
100-114 kg. F/G	-.25	.22	.40	-.36	-.14	.17	-.05
Backfat	-.52*	-.47*	-.18	-.39	-.46*	-.57**	-.06
30-100 kg. F/G	-.06	-.37	-.37	.63*	-.38	-.48	.25
30-114 kg. F/G	-.61	-.31	-.02	-.40	-.70*	-.36	-.10
35 Day ADG	-.02	.15	.04	-.06	.16	.02	-.55*
35D-100 kg. ADG	-.14	.16	.09	-.32	.20	.26	-.41
100-114 kg. ADG	.28	-.08	-.27	.66**	.13	-.34	-.11
30-100 kg. ADG	-.10	.20	.30	-.25	.21	.18	-.54*
30-114 kg. ADG	.12	.30	.26	.15	.32	.17	-.47

* P<.05

** P<.01

Correlation Coefficients for Selected Performance Parameters and 30 kg. Measurements Within the Yorkshire Breed

	Eye	Ear	Length	Cannon	Forearm	Back-leg	Heart-girth
100 kg. Age	-.15	-.06	-.06	-.25*	-.29	-.40**	-.11
114 kg. Age	-.21	-.22	.08	-.30*	-.29	-.39**	-.10
35 Day Wt.	.04	.04	.08	.09	.01	.25*	.28*
35 Day F/G	-.07	.10	-.26*	.02	-.12	.10	.13
35D-100 kg. F/G	-.23	.22	-.21	-.33**	-.42**	-.27*	-.07
100-114 kg. F/G	-.33*	.25	-.12	-.29*	-.11	-.32*	-.02
Backfat	-.02	-.04	-.05	-.21	.14	-.24*	.07
30-100 kg. F/G	-.41**	-.17	-.13	-.47**	-.47**	-.46**	-.24
30-114 kg. F/G	-.59**	-.32	.11	-.63**	-.51**	-.62**	-.38
35 Day ADG	.04	.02	-.06	.01	-.11	.13	.15
35D-100 kg. ADG	.17	-.14	.39**	.30*	.28*	.22	.04
100-114 kg. ADG	.05	-.01	.15	.04	-.01	-.13	-.18
30-100 kg. ADG	.16	-.12	.26*	.25*	.18	.25*	.10
30-114 kg. ADG	.12	-.05	.13	.18	.14	.06	-.08

* $P<.05$

** $P<.01$

Correlation Coefficients for selected Performance Parameters and 30 kg. Measurements Within the Yorkshire Breed

	Front Leg Length	Tail C.	Tail L.	Chest Width	Chest Depth	Stifle	Jaw
100 kg. Age	-.03	-.05	.10	.16	-.15	-.12	-.10
114 kg. Age	.04	-.03	.06	.15	-.10	-.15	-.19
35 Day Wt.	.03	.15	.27*	.35**	.29*	.11	.14
35 Day F/G	.07	-.03	.28*	-.05	.02	.28*	-.15
35D-100 kg. F/G	-.07	-.02	.06	.48**	-.11	.05	-.05
100-114 kg. F/G	.02	.02	.11	.38**	.16	.06	-.07
Backfat	-.25*	-.29*	-.14	.18	.02	.07	-.15
30-100 kg. F/G	-.08	-.02	.15	.61**	-.33*	-.18	-.14
30-114 kg. F/G	.19	-.03	.18	.64**	-.24	-.48**	-.31
35 Day ADG	.02	.13	.20	.36**	.17	.05	.12
35D-100 kg. ADG	.34**	.15	.03	-.12	.29*	-.06	.07
100-114 kg. ADG	.23	.05	-.07	-.10	-.03	-.15	-.06
30-100 kg. ADG	.27*	.18	.11	.08	.32**	-.04	.13
30-114 kg. ADG	.18	.09	.08	.01	.15	-.02	.05

* P<.05

** P<.01

Correlation Coefficients for Selected Performance Parameters And 30 kg. Measurements Within the Duroc Breed

	Eye	Ear	Length	Cannon	Forearm	Back-leg	Heart-girth
100 kg. Age	-.20**	.11	.24*	-.21*	-.18	-.17	.05
114 kg. Age	-.16	.17	.12	-.20*	-.16	-.14	.05
35 Day wt.	.08	.17	.21*	-.03	.07	.09	.36**
35 Day F/G	-.17	.14	.04	-.03	-.12	-.14	.06
35-100 kg. F/G	-.24*	.20*	-.18	-.15	-.28**	-.35	.06
100-114 kg. F/G	-.22*	.17	-.10	-.22*	-.15	-.19	.12
Backfat	-.12	-.05	-.06	-.25**	.15	-.23*	.03
30-100 kg. F/G	-.31*	-.09	-.07	-.06	-.09	-.41**	-.07
30-114 kg. F/G	-.23	-.11	-.05	-.02	-.14	-.21	.15
35 Day ADG	.02	.17	-.05	-.02	-.12	-.01	.17
35D-100 kg. ADG	-.02	-.11	.23*	-.15	-.01	.10	-.08
100-114 kg. ADG	.20*	-.23*	-.06	.10	.18	.22*	-.12
30-100 kg. ADG	.02	.04	.10	-.05	-.07	.07	.04
30-114 kg. ADG	.01	-.07	.06	-.06	.01	.07	-.05

* $P<.05$

** $P<.01$

Correlation Coefficients for Selected Performance Parameters And 30 kg. Measurements within the Duroc Breed

	Front Leg Length	Tail C.	Tail L.	Chest Width	Chest Depth	Stifle	Jaw
100 kg. Age	.33**	-.03	.12	.20*	.04	-.11	.19
114 kg. Age	.24*	.00	.17	.12	.01	-.04	.20
35 Day Wt.	.18	.04	.13	.37**	.42**	.14	.20
35 Day F/G	.30**	.05	.15	.15	-.01	.01	.02
35-100 kg. F/G	.19*	-.15	.27**	.27**	.09	-.03	-.21*
100-114 kg. F/G	.11	-.15	.14	.20*	.15	.35**	.07
Backfat	.01	-.43**	.00	-.03	-.02	.00	.01
30-100 kg. F/G	.25*	-.33**	.16	.27*	-.09	-.27*	-.14
30-114 kg. F/G	.15	-.04	.14	.26	.16	.06	-.08
35 Day ADG	-.01	-.02	-.02	.16	.23*	.08	-.02
35D-100 kg. ADG	-.07	.03	-.13	.06	-.03	-.02	.13
100-114 kg. ADG	-.10	.18	.00	-.17	-.05	-.12	.06
30-100 kg. ADG	-.08	.02	-.11	.09	.11	.04	.03
30-114 kg. ADG	-.07	.02	-.10	.09	.04	-.05	.03

* $P < .05$

** $P < .01$

THE RELATIONSHIP BETWEEN BODY MEASUREMENTS AND PERFORMANCE PARAMETERS IN BOARS

by

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Fourteen body measurements were taken on a total of 259 boars at 30 kg. and again at 114 kg. to determine the relationship of body size and certain performance parameters. Also studied were growth patterns and feed usage between 30 and 114 kg. and at various stages, as affected by breed and season. Boars represented 66 purebred herds and four breeds - Chester White, Duroc, Hampshire, and Yorkshire. Data were collected from two summer and two winter tests. Performance parameters studied included age and weight per day of age taken at the on test weight of 30 kg.; average daily gain, weight, and feed per gain taken 35 days after the start of the test; age, average daily gain, feed efficiency, backfat and loineye area taken at 100 kg.; and age, average daily gain, and feed efficiency taken at 114 kg. Measurements taken included three about the head, nine on the body and legs, and two on the tail.

Breed affected average daily gain from start to 100 kg. ($P<.01$) with the Chesters and the Hampshires gaining .85 and .88 kg. respectively, while the Durocs and the Yorkshires gained .91 and .92 kg. respectively. The difference in gains, however, occurred the first 35 days of the test, as 35 day average daily gain differed significantly ($P<.05$) by the same groups, but no breed difference existed in average daily gain from 35 days to 100 kg. Breed did not affect average daily gain from start to 114 kg. or from 100-114 kg. Season did not affect gain. Feed efficiency was not affected by breed differences, however, a significant seasonal affect ($P<.01$) did occur from start to 100 kg. and 114 kg., but had no effect on feed conversion the first 35 days on test. Overall breed correlations ($P<.01$) for selected performance parameters include: 35 day average daily gain with 35 day feed efficiency, $r = -.35$; start to 100 kg. average daily gain with feed conversion over the same period, $r = -.49$; start to 100 kg. average daily gain with backfat at 100 kg., $r = .20$.

The leg measurements at 30 kg., front cannon circumference, foreman circumference, and back cannon circumference, were negatively correlated ($P<.01$) with age at 100 kg. and with feed efficiency ($P<.05$) from 30 kg. to 100 kg. ($r = -.22$, $-.22$, $-.22$ and $-.17$, $-.21$, $-.38$, respectively). Chest depth, chest width, and heartgirth at 30 kg. were positively correlated ($P<.01$) with average daily gain the first 35 days on test ($r = .27$, $.17$, $.29$, respectively), however, none of the chest measurements were significantly correlated with average daily gain from 35 days to 100 kg. Chest width at 30 kg. was positively correlated ($P<.01$) with feed efficiency from 30 kg. to 100 kg. and 114 kg. ($r = .42$ and $.41$, respectively). Additional measurements taken at 30 kg., width between the ears and eyes, length of body, front leg length, width of stifle, and width of jaw, were poorly correlated with growth or efficiency. Regression analysis using the 30 kg. measurements to predict 100 kg. performance resulted in models with low R square values.