THE PERFORMANCE TESTING OF BOARS

I. Performance testing on Finnish experimental stations and genetic and environmental influences on test results

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Abstract. In 1965 performance testing was initiated in Finland for the selection of boars for A.I. use. In 1965—68 a total of 147 boars were tested on four local testing stations. The following average results were recorded: backfat thickness 21.6 mm (at a live weight of 88 kg), growth rate 699 g/day, feed efficiency 2.69 scand. fu/kg growth and testing score (growth + fat) 99.6. The average testing score for boards selected for A.I. use (43 % of tested) was 99.7. Weakness of the legs was noted in 21 % of the boars.

The varying initial weights of the male piglets influenced the growth rate very markedly ($P < 0.001$), and the effect of the initial age was significant with respect to feed efficiency ($P < 0.01$). The influence of the weight and age at end of test was highly significant with regard to thickness of fat ($P < 0.001$). Moreover, the weight at end of test affected the testing score significantly ($P < 0.001$), but the effect of age was eliminated by use of correction factors. The years as well as the testing stations influenced most of the results in a significant manner.

The thickness of fat for the Yorkshire boars was significantly greater ($P < 0.01$) than for the Landrace boars and the former also had a significantly lower testing score. The effect of the genetic variation, influence of sires within breeds, was highly significant ($P < 0.001$) for all test results. It has thus proved possible to estimate the genetic quality of the boars. The different influences on the test results were analyzed by least squares procedures.

Value of performance test in revealing breeding value of boars

Due to the ultrasonic technique the performance test has become important when selecting pigs for breeding. Kirsch *et al.* (1962) reached the conclusion that when heritability exceeds 0.25, performance testing is preferable to progeny testing. According to the calculations of Johnsson (1968) at least 4 litter groups (16 piglets) are required before the progeny test gives the same result as the performance test. In the opinion of Standal (1968) the performance test can succesfully be used also with respect to characters which can not be measured on live animals, but are strongly correlated to the characters under test.

KIRSCH *et al.* (1962), in support of their calculations, made a study of the inheritance of the back fat thickness obtaining results that were according to expectation. MINKEMA *et al.* (1965) in their studies reached the conclusion that under station conditions a performance test was 1.9 times as efficient as a full sib test. According to the studies of WENIGER *et al.* (1967) a performance test of boars under field conditions provided information on their breeding value with respect to back fat thickness as accurate as a progeny test on an experimental station. SUNDGREN (1967) observed that the correlation between the results for tested boars and their offspring with regard to back fat thickness was statistically highly significant (r = +0.654).

The accuracy of the performance test is mainly dependent on the exactness of the fat measurements obtainable by ultrasonics. According to the studies of UUSISALMI (1967), by use of the three best ultrasonic measurements (mid back, shoulder and side), 73 % of the total variation in back fat thickness was accounted for. In these investigations the best result was obtained for the ultrasonic measurement at the mid back. In the studies of SUNDGREN (1964, 1967) the side fat measurement (s.o.l.) gave the most reliable result. RITTLER (1966) obtained the most accurate results using 3—5 successive measurements near the midline of the back. GLODEK (1969) in his turn obtained the most reliable results using measurements starting from the mid back and proceding vertically to the side, measured at three successive points.

The measurements of the back fat and side fat would be of small value if they did not reflect the fat and meat content of the whole carcass. Significant correlations between ultrasonic measurements and the meat and fat containing parts of the carcass were obtained among others by HAZEL & KLINE (1959), PRICE *et al.* (1960 a), SCHOEN (1964), LAUPRECHT *et al.* (1965), GERWIG (1965 a) and WENIGER *et al.* (1967). GLODEK (1969) reached the conclusion that the side fat measurements indicate the carcass quality as accurately as the cross section of the m.l.d. determined from the carcass. In the studies of UUSISALMI (1969) the fat measurements obtained by ultrasonics were almost as closely associated with the various components of the most valuable part of the carcass (back + ham) as the carcass measurements, i.e. with the skin + fat — and meat + bone — parts. The measurements concerning the meat content have, on the other hand, given such varying results that research workers have not recommended their use (PRICE *et al.* 1960 a, b; WENIGER *et al.* 1967).

RITTLER *et al.* (1964) observed that the development of the back fat is individual and varying. Therefore they emphasized that at least for tested boars the fat should be measured as closely to a live weight of 90 kg as possible or that the ultrasonic measurements be corrected with respect to live weight (RITTLER 1966). On the other hand, in the above studies no improvement in accuracy was obtained by taking the age into account. STANDAL (1962) considered age as well as weight when measuring the fat. SUNDGREN (1965) first corrected the fat measurements with respect to age and later by (1967) using a regression on weight. STANDAL as well as SUNDGREN developed — on the basis of research results — correction tables, by use of which the points for the thickness of the fat can be obtained.

In order to eliminate the influence of varying environmental conditions STANDAL (1962) also included the growth rate in the performance test. He reasoned that if the animals get points for the thickness of fat as well as for growth rate, the effects of a varying level of feeding can be levelled out. SUNDGREN (1967) accepted the reasoning of Standal for the levelling out of the environmental influences. Both research workers developed regression equations for obtaining the points for growth. STANDAL considering age and thickness of fat, SUNDGREN age and weight.

Performance testing of boars on Finnish experimental stations

By keeping the animals under test in experimental stations the environmental influences can best be controlled. However, performance test stations are more expensive than a field test, which makes it difficult to obtain room for all boars. At present there are 4 small testing stations in Finland. The performance test of boars at these is meant to serve as a selection basis for boars to be used in artificial insemination (AI). When selecting other breeding boars individual field records are used.

The purpose of this study is to explore performance testing at these stations, its development, use and results.

M a t e r i a l. On September 15, 1965, performance testing of boars was begun at the Tampere experimental station. In the next few years three more stations went into operation. In Table 1 the numbers of boars tested at the different stations in the period 1965—68 are given. The total number of boars tested is 147, of these 82 were of Landrace and 65 of Yorkshire breed.

Table 1. Number of boars performance tested in 1965—68.

Testing station Year	Tampere	Paimio	Pieksämäki	Panelia
1965	12			
1966	16	23		
1967	15	9	15	12
1968	9	3	21	12
Total	52	35	36	24 = 147

M e t h o d s. The boar piglets for testing were selected from known families of good quality. Special attention was given to the progeny test results of the sires of the boar piglets. From the same litter three boar piglets were simultaneously selected. The feeding and weekly weighings were planned to take place in the interval 20—88 kg live weight. The ultrasonic measurement of the fat thickness at the end of the period was done by personnel of the Finnish Swine Breeders Society. The fat was measured at the shoulder, the mid back and the carre. The uncorrected average of these three measurements was considered as representing the back fat thickness. This uncorrected average has been used when determining the points for fat. In determining the points for fat the Swedish tables (SUNDGREN 1965), where the correction is based on the number of days, has been used. Here the points for growth at the time of measuring the fat are obtained from the relation between the weight and age of the boar. The points for fat and for growth are from the total testing score.

The weight of the piglets at the start of the testing varied considerably even within the same litter. The initial age varied also. Moreover, the ultrasonic measurements had to be done at varying weights of the boars, because the 3 boars belonging to the same litter were measured at the same time. When determining the time of measurement the requirement was that even the slowest growing individual must have reached a live weight of 70 kg.

As regards the comparability of the feeding of the boars one must consider the standards used as well as the feeds given. In view of the possibilities of leg weaknesses a restricted feed standard was accepted in the performance test of boars.

Weight of boars kg	fu/day	Weight of boars kg	fu/day
15.0—19.9	0.70	50.0—54.9	1.90
20.0—24.9	0.80	55.0—59.9	2.10
25.0—29.9	1.00	60.0—69.9	2.30
30.0—34.9	1.20	70.0—79.9	2.60
35.0—39.9	1.40	80.0—89.9	2.90
40.0—44.9	1.60	90.0—	3.10
45.0—49.9	1.80		

The quality of the feeds has been comparable at the different testing stations at the same time. On the other hand the feeds used at different times have varied. When the performance test was started in 1965 the feeds in use at the litter testing were barley, corn and skim milk. This same feeding was practised in the performance test. The ration consisted to one half of barley, to one half of corn and the amount skim milk increased according to the growth from 2 kg/day to 3 ½ kg/day. In the summer 1966 one changed to use of mixed feeds at the testing stations, and also with regard to the feeding of the boars. In the summer 1968 the quality of mixtures changed when the major protein feed stuff, the skim milk, was replaced with herring meal. The nutritive value of the feeds has been checked by obtaining a feed analysis from the State Institute for Agricultural Chemistry for each mixture lot. All of the stations have received feed from the same lot.

S e l e c t i o n o f A. I. b o a r s. Personnel from the Swine Breeders Society made the selection of the boars on the basis of the testing score. According to the test records 43 % of the tested boars were selected for A.I. use the average score for these being 99.7 points. The best boar from groups of three was chosen, but in case of good individuals even two have been approved. Weaknesses of the legs have also resulted in rejection of boars. According to the records notes, 21 % of all tested boars suffered from leg weaknesses. Weak legs were observed in boars with good test results as well as in boars with poor tests (compare WRIGHT 1967, NEBE 1969).

R e s u l t s. In the analyses results for 138 boars were included. The averages and standard deviations are given in Table 2. It appears that the weights at the beginning and end of test are heavier than planned (20—88 kg). The length of the testing period was, on an average, c. 100 days, the boars being 73.4—172.9 days old and weighing 23.9—93.4 kg. The range at start of test was 54—113 days and 16.9—36.5 kg and at end of test (when measuring thickness of fat) 143—204 days and 71.0—114.2 kg.

Table 2. Averages and standard deviations for traits of boars tested in 1965—68 (138 boars)

Character	Average	Stand. dev.
Initial weight, kg	23.9	± 4.4
Initial age, days	73.4	± 10.5
Weight at end of test kg (when measuring backfat)	93.4	± 9.0
Age at end of test days (when measuring backfat)	172.9	± 13.1
Average thickness of fat (at 93.4 kg), mm	22.7	± 3.9
Average thickness of fat/88 kg, mm	21.6	± 3.8
Daily growth, g	698.9	± 84.8
Age/88 kg, days	167.0	± 13.1
Testing score, points	99.6	± 4.1
Fu/20—88 kg	172.9	± 22.2
Fu/kg growth	2.69	± 0.3
Fu during 8 weeks	80.0	± 19.5
Weight after 8 weeks, kg	56.2	± 10.8
Weight after 11 weeks, kg	74.0	± 12.9

The thickness of the fat was corrected to correspond to a live weight of 88 kg, at which weight the average thickness was 21.6 mm. In the correction one kg live weight corresponds to 0.20 mm fat. The lowest value at a weight of 88 kg being 16.0 mm and the highest 36.2 mm. The boars (126) received, on an average, 44.1 points for the fat. The average growth rate, up to a weight of 88 kg, was 698.9 g per day (range 521—896 g/day). The average age at a weight of 88 kg was 167 days (range 138—198 days). For growth the boars received, on an average, 55.5 points, the total score 99.6 points (range 84—107 points).

When selecting the boars the feed consumption was not considered. The feeds were, however, weighed and analysed. On an average the consumption was 2.69 scand. fu/kg growth (range 2.11—3.40 fu/kg growth). Results on the feed consumption and growth of the boars were also obtained at various stages of the testing period. For research purposes the feed consumed during the first 8 weeks of testing (80.0 fu) was recorded as well as the weight reached (56.2 kg). The average live weight at 11 weeks of age was 74.0 kg.

Genetic and environmental influences on test results

Apart from the genetic quality of the boars, a number of factors can influence the test results. These were analysed by least squares procedures (Harvey 1966). The analyses were made on the Elliot 503 computer of the State Computing Center. When analysing the effects of various factors on growth rate and feed consumption, the influence of initial weight and initial age was eliminated by use of regression. The effects of years, stations, breeds and the »nested» class (influence of sires within breeds) were thus obtained. When analysing the results for thickness of fat and testing score the weight and age at time of fat measurement were (in addition to the initial weight) considered as regression variables.

Genetic variation. From Table 3 it is apparent that the influence of the

Table 3. Environmental and genetic influences on test results (analysed by least squares procedures).

Character	Regression variables initial weight[1])	initial age[2])	at end of test (when measuring backfat) weight[3])	at end of test (when measuring backfat) age[3])	Classes years	Classes stations	Classes breeds	»nested» class
Daily growth	***				***	**		***
Age/88 kg	***	*			***	**		***
Fu/kg growth		**				**		***
Fu/20—88 kg	***	**				***		***
Weight after 8 weeks	***	**			***			***
Weight after 11 weeks	***	**			**			***
Fu/8 weeks	***				**			***
Weight at end of test (when measuring backfat)	***	*			***	***		***
Age at end of test (when measuring backfat)	***	***			***	***		***
Fat, average			***	***	***	***	**	***
Fat/88 kg				***	***	***	**	***
Testing score			***		***	***	**	***

*** = $P < 0.001$, ** = $P < 0.01$, * = $P < 0.05$

1) Effect of variation in initial weight eliminated from all results

2) Effect of variation in initial age eliminated from results concerning growth and feed consumption

3) Effect of weight and age at end of test eliminated from backfat measurements and testing score

»nested» class is highly significant with respect to all test results. Thus it has been possible to disclose that the variation is genetic in origin, when the environmental influences have been mathematically eliminated. Some sires have transmitted a fast growth rate, some a thin back fat, some a favourable feed efficiency. On the other hand, no sire proved excellent in every respect. Only with regard to back fat thickness and test score were there significant differences between the two breeds. The back fat was thicker in the Yorkshire boars than in the Landrace and because of this the former breed were given a lower test score.

Environmental influences. Table 3 shows that the influence of years was significant with regard to all characteristics except feed efficiency. The differences between stations are partly associated with the differences between years as the stations started operating at varying dates (Table 1). The test results for 1965 deviate significantly from the other results in that the daily growth was much higher than in later years. The continuous decrease of the growth over the years is probably connected with the change in feeding. The effect of stations is significant with regard to all characteristics except for weights at 8 and 11 weeks and for the 8 week feed consumption.

From Tables 3 and 4 it is apparent that the initial weight has significantly influenced growth and weight at 8 and 11 weeks. On the other hand initial weight has not significantly affected feed efficiency. Initial age has significantly influenced feed efficiency and weights at 8 and 11 weeks. Weight at end of test (when measuring the fat) has influenced the average thickness of fat and the test score in a highly significant manner. This influence was eliminated by calculating the thickness of fat per 88 kg live weight. The influence of age at the time of measurement was negative so that only with boars reaching the defined weight at a later age was the fat thinner than normal. The influence of the age was eliminated by use of correction tables and it did not affect the test score.

Table 4. Influence of initial weight, initial age and weight and age at time of ultrasonic measurement on test results (coefficients of regression).

Character	Initial		At end of test (when measuring backfat)	
	weight	age	weight	age
Daily growth	+13.70***	+2.56		
Age/88 kg	—2.95***	+0.40*		
Fu/kg growth		—0.02**		
Fu/20—88 kg	—2.51***	—1.07**		
Weight after 8 weeks	+2.30***	+0.24**		
Weight after 11 weeks	+2.62***	+0.34**		
Fu/8 weeks	+3.76***	+0.12		
Weight at end of test (when measuring backfat)	+1.77***	+0.32*		
Age at end of test (when measuring backfat)	—1.23***	+0.87***		
Fat, average	—0.20		+0.17***	—0.15***
Fat/88 kg	—0.17		—0.03	—0.15***
Testing score	+0.14		+0.18***	+0.06

*** = $P < 0.001$, ** = $P < 0.01$, * = $P < 0.05$

Discussion

The average phenotypic level of the tested boars must be considered quite good (growth 699 g/day, feed efficiency 2.69 fu/growth kg and thickness of fat 21.6 mm at 88 kg). The most efficient feed converters (2.11 fu/growth kg) are of top class boars. When evaluating the feed efficiency and the thickness of fat one should, on the other hand, take into account that the boars were fed according to restricted standards, and this may have resulted in a better feed utilization and a thinner fat layer. In spite of the restricted standard the average growth rate was good, which suggests that the boar material was very fast growing.

It is surprising that the test score for the boars selected for A.I. use (43 % of the total) was only 99.7 points, the average being 99.6 points. Apparently this is mainly due to the method of selection. When the best individual from each group of 3 boars has been chosen, he has not necessarily had a high test score. In fact it may have been poorer than the scores of all individuals in some other group. The leg weaknesses have also to a certain degree influenced the selection so that the best boar has not always been available. At present the minimum score for breeding pigs is set at 100 points (Anon. 1969), which is absolutely essential. The first prerequisite for development of the selection intensity is to raise the minimum score for A.I. boars substantially. This would be possible if larger numbers of boars could be raised simultaneously which might require one big testing station instead of several small ones. According to Norwegian experiences this is a good but expensive solution (Brekke 1967). The 8 week testing period was included in this study in order to find ways of reducing the costs.

The fact that the effect of the stations was significant in respect of many results also speaks in favour of one single testing station. However, the different times at which the stations started operating and the changes in the feeding may also have affected the results. Apparently it is of first rate importance to provide the boars under test with a feed of good quality that is not changing. Whether it is possible to start using more ample feed standards in order better to reveal the maximum growth capacity of the boars should also be studied.

The variation in the initial weight influenced the growth rate very significantly, regardless of whether it was given as growth per day or as number of days required to reach 88 kg. The influence of the initial age was not as pronounced and applied mainly to the feed efficiency. The weight and age at end of test had a marked influence on the thickness of the fat. The effect of the weight at end of test was, moreover, highly significant with regard to the testing score. The variations noted in weight and age at end of test are due to the fact that the personnel of the Swine Breeders Association had to travel rather long distances to do the ultrasonic measuring. Thus it was not possible to make a separate trip for each boar. Accordingly, each boar testing station should have its own apparatus and a person trained in its use. The variation in initial weight could be reduced by bringing the piglets to the station when the biggest individual weighs 20 kg.

The genetic variation in the boar material influenced the test results most of all. This is apparent from the highly significant effect of the »nested» class, which gives the influence of sires within breeds, on all test results. In other words, in the performance test it has been possible to measure the genetic quality of the boars, which in fact is the main purpose of the test.

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SELOSTUS
KARJUJEN FENOTYYPPITESTAUKSESTA

I. Karjujen yksilökokeet suomalaisilla testausasemilla sekä perinnöllisten ja ulkonaisten tekijäin vaikutus testaustuloksiin

ELSI ETTALA

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Keinosiemennyskarjujen valitsemista varten aloitettiin Suomessa v. 1965 karjujen yksilökokeet koeasemaolosuhteissa. Neljän maakunnallisen koeaseman yhteyteen rakennetuilla testausasemilla on vuosina 1965—68 testattu kaikkiaan 147 karjua. Karjut ovat saaneet seuraavat keskimääräiset testaustulokset:

silavan paksuus 88 kilon painoisena 21.5 mm, kasvunopeus 699 g/pv, rehunkäyttökyky 2.69 ry/kasvu kg sekä testauspisteitä (silava + kasvu) 99.6. Keinosiemennykseen valittujen (43 % testauskarjuista) karjujen keskimääräinen testauspistemäärä oli 99.7. Heikkojalkaisuutta on esiintynyt 21 %:lla karjuista.

Karjuporsaitten vaihtelevat alkupainot ovat vaikuttaneet erittäin merkitsevästi ($P < 0.001$) kasvunopeuteen ja alkuiät merkitsevästi ($P < 0.01$) rehun käyttöön. Painon ja iän vaihtelevaisuus kokeen lopulla on vaikuttanut erittäin merkitsevästi ($P < 0.001$) silavan paksuuteen. Loppupainon vaikutus testauspisteisiin on myös ollut erittäin merkitsevä ($P < 0.001$), mutta iän vaikutus testauspisteisiin on eliminoitu käyttämällä korjaustaulukoita. Vuodet ja koeasemat ovat vaikuttaneet erittäin merkitsevästi useimpiin testaustuloksiin.

Yorkshirekarjuilla on ollut merkitsevästi ($P < 0.01$) paksumpi silava ja vähemmän testauspisteitä kuin maatiaiskarjuilla. Perinnöllinen muuntelu, isien vaikutus rotujen sisällä, on vaikuttanut erittäin merkitsevästi ($P < 0.001$) kaikkiin testaustuloksiin. Yksilökokeilla on siis onnistuttu mittaamaan karjujen perinnöllistä laatua. Eri tekijöitten vaikutus on saatu esille pienimmän neliösumman menetelmää käyttäen.