EFFECTIVENESS OF INDEX SELECTION IN SEVEN SWINE STRAINS

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The effectiveness of index selection for multiple traits in swine was confirmed by several selection experiments[1,2,4] carried out in recent years. However, the indices used in those experiments were the sum of the standardized values for each traits and not designed according to the Smith-Hazel index procedures.

Since 1970 the Smith-Hazel index has been widely used for the closed-herd swine breeding project in Japan and up to the present time, 12 strains has been developed and 15 strains are still being developed by the index selection. The purpose of the present paper is to present the selection results obtained in seven strains of Landrace pigs involved in the project and evaluate the effectiveness of the selection index used for the practical swine breeding.

MATERIALS AND METHODS

The data used in this study were obtained from seven Landrace strains developed by one national livestock breeding station and six prefectural livestock experiment stations. The data consisted of seven generations in each strain. The breeding herd averaged 46.5 females and 11.1 males per generation per strain. Total number of litters analyzed was 2278 and from each litter one male and two or three females were reared for future breeding and other two or three pigs, two castrated males or two castrated males and one females, were fattened and slaughtered at a weight of 90kg.

Selection indices consisting of average daily gain ranging from 30kg to 90kg, backfat thickness measured ultrasonically, loin-eye area between 5th and 6th thoracic vertebrae and percent ham of carcass weight were used in all the strains except that the percent ham was not included in one strain. The information on daily gain and backfat thickness was obtained from each individual record and that on loin-eye area and percent ham from two or three full-sib carcass records.

Since the economic weight of each trait was difficult to assess, the indices were designed from the viewpoint of intended genetic gains of individual traits[5]. The phenotypic and genetic parameters estimated from other populations were used for calculating the selection indices at the start of selection. After two generations, the parameters of each strain were estimated and the indices were

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TABLE 2

Realized and expected heritabilities of the index

Strain	Realized			Expected
	Male	Female	Sexes combined	
A	0.37* ± 0.14	0.30* ± 0.09	0.34** ± 0.09	0.30
B	0.28** ± 0.04	0.35** ± 0.03	0.32** ± 0.03	0.30
C	0.37 ± 0.11	0.44* ± 0.17	0.41** ± 0.09	0.34
D	0.49** ± 0.06	0.44** ± 0.05	0.46** ± 0.04	0.34
E	0.50 ± 0.26	0.39* ± 0.14	0.44** ± 0.14	0.34
F	0.55** ± 0.11	0.66** ± 0.13	0.60** ± 0.08	0.35
G	0.33 ± 0.18	0.33 ± 0.18	0.33** ± 0.12	0.33
Ave.	0.41	0.42	0.41	0.33

* Significantly different from zero at 0.05 level.
** Significantly different from zero at 0.01 level.

The realized correlated responses of the component traits estimated from the regressions to the selection differentials of the index are listed in Table 3, together with the expected ones. The realized correlated responses of backfat thickness and loin-eye area were generally significantly different from zero and higher than the expected responses. In contrast, average daily gain did not show any significant trend and was lower than the expected one except in the C strain. The responses of percent ham were distinctly different among some of the strains. The direction was significantly positive in the B and F strain while in the A strain it was significantly negative. Such different tendencies among the component traits might be due to many factors, for instance, sampling errors with parameter estimation, inbreeding depression on growth rate or liability of leg weakness in the pigs with high growth rate and heavy ham. Further studies into this problem are necessary, but the average responses of the individual component traits were realized in the intended order.

The comparison of the efficiency between the index selection and other methods was not made possible by the present study. The selection results, however, seem to validate the use of the selection index consisting of average daily gain, backfat thickness, loin-eye area and percent ham, to some extent, from a practical point of view.

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modified in all the strains. Population means and selection differentials of the modified index in the first two generations were calculated in retrospect for the analysis of the selection results. The indices were somewhat different among the strains, owing to the differences in the parameters and relative importance of individual traits.

None of the stations could maintain a control line. However, efforts have been made to provide a uniform environment over all generations. Only the first litters farrowed in the period of three months were used for the selection in principle and a new generation was bred to farrow in 12 months' time and so every generation was tested for performance in the same season.

RESULTS AND DISCUSSION

The average proportions selected and standardized selection differentials per generation are shown in Table 1. The selection differentials were considerably fewer than the theoretical ones calculated from the proportions selected. This trend can be ascribed to the fact that some pigs with high index value were not selected due to leg weakness or other apparent physical defects.

TABLE 1

Proportions selected and standardized selection differentials per generation

Strain	Proportion selected		Selection differential (δ)	
	Male	Female	Male	Female
A	0.25	0.48	1.13	0.49
B	0.23	0.50	1.15	0.61
C	0.21	0.46	0.84	0.16
D	0.22	0.49	1.00	0.30
E	0.29	0.65	1.09	0.45
F	0.23	0.46	1.05	0.42
G	0.26	0.72	1.06	0.20
Ave.	0.24	0.54	1.05	0.38

The realized heritabilities estimated from the regressions of responses on cumulative selection differentials in the indices agreed well with the expected heritabilities defined as the ratio of the variance of the genetic index to the variance of the index, $b'Gb / b'Pb$[3]) except in the F strain (Table 2). Although the standard errors were obviously different among the strains, the realized heritabilities pooling the regression coefficients of male and female were significantly different from zero in all the strains. It was very difficult to determine the extent to which the observed trends in each strain were genetic without a control line. However, since yearly trends of environmental effects might be random among the seven stations, most of the phenotypic changes common to the strains could be considered as genetic ones.

TABLE 3

Realized (R) and expected (E) correlated selection responses[§] of the component traits in standard deviation unit per one unit of standardized selection differential of the index

Strain		Daily gain	Backfat thickness	Loin-eye area	Percent ham
A	R	0.06	-o.25**	0.42**	-0.15**
	E	0.11	-0.20	0.31	0.03
B	R	-0.03	-0.27**	0.45**	0.08**
	E	0.11	-0.20	0.31	0.03
C	R	0.45**	-0.13*	0.18**	-0.08
	E	0.10	-0.13	0.24	0.08
D	R	0.15	-0.25**	0.23**	0.09
	E	0.12	-0.20	0.18	0.11
E	R	0.10	-0.10	0.13*	0.03
	E	0.16	-0.19	0.14	0.07
F	R	0.05	-0.27**	0.33**	0.29**
	E	0.15	-0.19	0.18	0.10
G	R	-0.12	-0.09	0.47**	
	E	0.06	-0.22	0.23	
Ave.	R	0.09	-0.19	0.32	0.04
	E	0.12	-0.19	0.23	0.07

§ Sexes combined.
* Significantly different from zero at 0.05 level.
** Significantly different from zero at 0.01 level.

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SUMMARY

Index selections were carried out for seven generations within seven separate closed strains of Landrace pigs. The breeding herd averaged 46.5 females and 11.1 males per generation per strain. From each litter one male and two or three females were reared and other two or three pigs were slaughtered at a weight of 90kg. Selection indices consisting of average daily gain, backfat thickness, loin-eye area and percent ham were used in all the strains except that percent ham was not included in one strain. The information on daily gain and backfat thickness was obtained from each individual record and on loin-eye area and percent ham from records of two or three full-sib carcasses. The indices were somewhat different among the strains, owing to the differences in the parameters and importance of the component traits. The average realized heritability of the index estimated from the regression of responses on cumulative selection differentials and expected one was 0.41 and 0.34, respectively. The average realized correlated responses

estimated from the regression coefficients and expected ones in standard deviation unit were 0.09 and 0.12 in daily gain, -0.19 and -0.19 in backfat thickness, 0.32 and 0.23 in loin-eye area and 0.04 and 0.07 in percent ham per one unit of standardized selection differential of the index.

R E S U M E N

Se llevaron a cabo selecciones de índices durante siete generaciones dentro de siete cepas cerradamente separadas de cerdos Landrace. La piara de cría tuvo por media 46,5 hembras y 11,1 machos por generación y por cepa. De cada camada se criaron un macho y dos o tres hembras y otros dos o tres cerdos se sacrificaron con un peso de 90 kilos. Los índices de selección consistieron en ganancia diaria en peso, espesor de la grasa dorsal, superficie del área muscular y porcentaje de jamón, que se utilizaron en todas las cepas, excepto en el porcentaje de jamón que no se incluyó en una de ellas. La información sobre ganancia diaria y espesor de la grasa dorsal se obtuvieron mediante controles individuales y la del área del músculo y porcentaje de jamón de controles de dos o tres canales. Los índices fueron algo diferentes entre las cepas debido a las diferencias en los parámetros y a la importancia en los caracteres componentes. Las medias demostraron la heredabilidad del índice estimado a partir de la regresión de las respuestas sobre los diferenciales de la selección acumulativa y fueron 0,41 y 0,34 respectivamente. La respuesta media correlacionada realizada, estimada a partir de los coeficientes de regresión y expresada en desviación típica, fueron de 0,09 y 0,12 de ganancia diaria, -0,19 y -0,19 en el espesor de la grasa dorsal, 0,32 y 0,23 en el área del músculo y 0,04 y 0,07 en porcentaje de jamón para una unidad de selección tipo diferencialdel índice.

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