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DEVELOPMENT OF A PROTOCOL TO RECORD FUNCTIONAL TRAITS AND INHERITED DISORDERS AFFFECTING WELFARE IN PIGS

X. Fernàndez [a*], J. Piedrafita [b], J. Tibau [a], E. Fàbrega [a]

[a] *Institut de Recerca i Tecnologia Agroalimentàries, Centre de Control Porcí, 17121 Monells, Spain. * E-mail: tmp301@irta.es*
[b] *Departament de Ciència Animal i dels Aliments, Universitat Autonòma de Barcelona, 08193 Bellaterra, Spain*

Summary

Genetic selection in most pig breeds has been mainly focused on performance traits. Recently, animal welfare awareness has increased and new concepts, like "functional traits" have received more attention. The first objective of this study was to prepare a protocol to record leg weakness and teat functionality using three pig pure breeds (Duroc, Large White and Landrace), which was applied in two nucleus herds. This protocol was based on the assessment of leg and teat morphology, using a numerical scoring system from 0 to 3 (0= worst and 3=best). The second objective was to record the most common inherited disorders which could affect mortality and welfare. The long-term objective of this study will be to provide technical recommendations to pig breeders to include these traits in their selection schemes.

Preliminary results of the development of this protocol indicate that it is easy to apply at selection day and not very time consuming. Significant differences could be detected between the different breeds or farms, presenting Duroc gilts a higher score compared to Landrace (e.g. 1,45 vs. 0,87, respectively)

1. Introduction

Functional traits like longevity are of importance for swine breeding (Jalvingh et al., 1992), not only because of its relationship with involuntary culling and other economically important traits (Brandt and Henne, 2004), but also because they could be indicators of animal welfare (Barnett et al., 2001). Breeders have applied for some time indirect (and sometimes unintended) selection schemes for exterior traits such as leg and teat conformation, some of which (i.e. leg weakness) have been related to the genetic background of longevity (López-Serrano et al., 2000). However, this selection has resulted in little improvement of sow longevity (Canadian Centre for Swine Improvement, 2001), rather the situation has become worse, with culling rates of breeding females rising up to 50%. It has been argued that one reason for this is the antagonistic genetic correlation of leg weakness with performance traits, especially growth rate and leanness (Rotschild and Christian, 1988, Van Steenbergen, 1989). Some Australian and German studies have shown that 72% (Paterson, 1995) or 66% (Brevern, 1996) of all sow removals were for unplanned or involuntary culling reasons, and amongst these reasons some authors have placed leg weakness as the second most important one in young sows (with an incidence of 10-20% according to Jørgensen and Sørensen, 1992). The reduction of involuntary culling would have several advantages such as a lower annual replacement cost, a higher average number of piglets per litter because number of first parity sows would be decreased, a lower number of non-reproductive days, and an increased opportunity for selection on other traits (Canadian Centre for Swine Improvement, 2001). Moreover, public awareness on animal welfare has been rising up over the last decades, thus, all those breeding strategies focused on reducing the traits with a potential negative effect on welfare, would be in agreement with these new public concerns.

A large number of inherited disorders in pigs which affect viability or general welfare have been reported (Nicholas, 1998). The incidence of these disorders may be higher in closed or small nucleus herds, where matings between relatives are commonly applied. Although most of the affected individuals are early culled, in some cases siblings are used as breeding animals maintaining the problem. Therefore, a fast detection of these disorders and the analysis of the pure breed populations could help to reduce the presence of this problem in the production farms.

The results presented in this paper are part of a bigger investigation entitled "Genetic solutions to welfare problems", which aims at providing technical recommendations to pig breeders to include functional traits and inherited disorders in their selection strategies. The first step was the development of a common protocol for different pig breeders to record such problems. More precisely, this paper will concentrate on the description of a linear scoring system to assess two external traits (leg and teat conformation) and the recording procedure of inherited disorders. Preliminary results on the relationship of the external/morphological appraisal of the sows and performance traits or the morphological appraisal of their ancestors (available through to the Herd Book information) will be presented. These results evaluate the capacity of the scoring system to reveal potential differences between animals bred at different farms or from different breeds.

2. Materials and Methods

2.1. Selection of farms

The database of the Spanish pure breed population controlled by IRTA has the information of a total of 46 pure breed nucleus herds, from which a total of 35 are active at present. From these 35 nucleus herds, those including maternal breeds (Landrace, Large White and Duroc) that contained the information of at least the last 10 years were selected. A total of 20 nucleus herds (aprox. 20.000 sows) presented these characteristics, and from these, two nucleus of each breed chosen for this study. The election was taken based on the census of each farm, because we were interested in nucleus herds with a high monthly replacement rate and, which also provided animals to multiplier farms, able to be evaluated in future phases of the investigation.

2.2. Description of database information of the selected nucleus farms and animals used for the present survey

The 5 nucleus farms selected came from 4 breeding companies (one for Duroc breed, and the other three companies having Landrace or/and Large White Nucleus). Only in one company, breeding of Landrace and Large White breeds was performed at the same farm. As a part of a preliminary study, a detailed description of the information available was carried out, including:

- Mean value of the morphological appraisal of the breeding animals (i.e. morphological index) per year, according to our technicians 9-point-scale (similar to those used by other European countries, e.g. Sweden, Van Steenbergen, 1989).
- Evolution of the morphological index and longevity of all the breeding animals of the farm throughout time (10 years minimal).
- Productive and reproductive parameters of the females per farm and year, and correlations of these parameters with the morphological index.

In general, few correlations between morphological index and reproductive or productive traits could be found. The expected results were that animals with a low extremities index would be those with a shorter longevity. This lack of relationship may be probably attributed to the fact that our technicians qualify the animals after the pig breeding companies have already carried out a selection of the animals to be kept as breeding animals. Therefore, most of the gilts with leg disorders had already been discarded when our technicians did undertake the morphological evaluation. Moreover, scores for exterior traits have been said to be strongly influenced by the inspector (Van Steenbergen, 1989). Therefore, it was decided that the first evaluation of exterior traits in the present investigation would be carried out by the same person and before the breeding companies carry out their own selection. Since November 2004 the scoring system explained in section 2.3 has been applied to all gilts subjected to a selection test by technicians of the four different breeding companies. Table 1 summarises the number of gilts per breed evaluated up to now.

2.3. Recording protocol for leg and teat condition

The criteria to assess leg and teat condition used in the present study are based on the 9-point scoring system used by our technicians and modified following literature review. On practical grounds, our system is reduced to categories 6-9, since categories 1 to 5 are seldom seen. The Canadian Centre for Swine Improvement (2001) suggested 5 as the ideal number of classes to allow an easy but accurate recording and to facilitate the following genetic evaluations. Therefore, in the present study the Canadian proposal was reduced to 4 categories, so that comparisons with data already existing at our database would be easier. Figure 1 summarises the different classes of the linear scoring system for leg conformation.

Furthermore, if a gilt was given a 0 or 1 in the first qualification and was culled, a second and third qualification were added, in order to record the specific reason for culling (qualification two), specially if this was due to a feet problem (qualification 3). Figures 2 and 3 summarise these second and third qualifications.

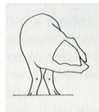
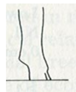
Figure 1. Linear Scoring system for leg conformation (with a graphic example)

CLASS		DEFINITION
3: **Good condition**		No anomalies are present neither in the claws or joints, nor in gait nor in the way to lean feet on the floor. No bumps, serious abrasions or lesions/injuries, deformations can be seen.
2: **Regular condition**		Slight alteration (e.g. small scar or scratch…) of the previously defined criteria. However these alterations shouldn't imply a reason for culling.
1: **Bad Condition** and potential reason for culling		Mild alteration of the previously defined criteria, with a certain compromise in movement or an obvious lesion or deformation. These alterations may or may not be a reason for culling.
0: **Very bad condition** and reason for culling		Obvious alteration of the previously defined criteria, which can affect the ability to stand or restrict movement. Presence of important bumps, lesions, injuries affecting gait. These alterations will be certainly a reason for culling.

Figure 2. Second qualification added to specify the reason for culling, with graphical example (in animals given a 0 or 1 in previous scale)

FIRST QUALIFICATION	SECOND QUALIFICATION	REASON FOR CULLING	
0 OR 1 (and culled)	1	Claw problems	
	2	Feet problems	
	3	Leg problems	
	4	Presence of serious bumps, injuries, scars…	

Figure 3. Third qualification added to specify the feet problem (in animals given a 2 in the second qualification, drawings from Van Steenbergen, 1989)

FIRST QUALIFICATION	SECOND QUALIFICATION	THIRD QUALIFICATION*	
0 OR 1 (and culled)	2 (feet problem)	**1**: Legs in "X" form because the feet are open	
		2: Plantigrade animal	
		3: The opposed situation to plantigrade animal	

A similar linear scoring system was used for the assessment of teat condition (Figures 4 and 5). It must be said that the criteria for the Duroc breed were slightly different, since it is considered a more rustic breed and 12 teats are considered fine instead of 14.

Weight and bad fat thickness at day of selection test were also recorded for all gilts.

Figure 4. Linear scoring system for the assessment of teat condition

CLASS	DEFINITION
3: Good condition	Minimum of 14 teats, correctly distributed, with appropriate size and absence of inverted teats, blind teats, intercalary teats, infantile teats.
2: Regular condition	Minimum 14 teats, but with a little defect, for example: difference between size of teats, bad distribution, presence of one or two inverted and/or blind teats, presence of one or two infantile and/or intercalary teats.
1: Bad Condition and potential reason for culling	Less than 14 teats or 14 teats with more than one of the previously described defects
0: Very bad condition and reason for culling	Less than 14 teats and with serious defects that will make lactation difficult.

Figure 5. Second qualification added to specify the reason for culling associated with teat disorder (in animals given a 0 or 1 in previous scale and culled)

FIRST QUALIFICATION	SECOND QUALIFICATION	REASON FOR CULLING
0 OR 1 (and culled)	**1**	Blind or inverted teats
	2	Infantile or intercalary teats
	3	Other (low number, too big or small, bad distribution...)

2.4. Recording protocol for inherited disorders

Although a large number of inherited disorders in pigs have been described (Nicholas, 1998), it was decided to concentrate this study on those with a higher incidence according to the breeding companies participating in the study: hernias (umbilical, scrotal and/or inguinal) and splay-leg. The recording of this data is currently undertaken by trained farm stockpeople working at the six nucleus farms. All incidences of this inherited disorders, together with the identification of both parents are being recorded.

2.5. Statistical analysis

The results presented in this paper may be considered as a preliminary analysis, because only a partial collection of data has been carried out up to now. The main objective of this analysis was to assess whether the present system of evaluation was feasible and easy to apply and whether it could reveal differences between farms or breeds. A general comparison of breeds was not possible, since each breed was not represented in each farm, and a confounding effect could be expected. However, as mentioned previously, in one company Large White and Landrace gilts are bred in the same nucleus farm, so the effect of breed was evaluated with these data.
The effect of farm on the score given for teat and leg condition was analysed by means of a General Linear Model. Growth rate was considered a covariable in the model since it proved to have a significant effect.
Spearman correlations between the teat and leg condition score and the "sexual characters" score or the leg score assigned to the ancestors (mother and father) were calculated. This last score has been obtained from our database, and corresponds to the evaluation carried out by our technicians. The "sexual characters" score does not only include teat condition, but also other sexual characters (reproductive organs and abdomen shape).
A Chi square was applied to compare the distribution of the frequencies of specific reasons for culling (i.e. related to the second and third evaluations in the leg condition score system and the second evaluation in the teat score system) in the Landrace and Large White gilts bred at the same farm.
All the analysis have been carried out with the SAS statistical package, version 8e.

3. RESULTS AND DISCUSSION

3.1. Animals evaluated and mean values of leg and teat condition.

A total of 671 Large White gilts, 952 Landrace gilts and 696 Duroc gilts have been evaluated up to present. Mean scores for leg condition per breed and farm are summarised in Table 1.

Table 1. Mean score (s.d.) of leg condition for the different farms and breeds

	N	Farm 1[1]	N	Farm 2	*P value*
Large White	414	1,28 (0,73)	257	1,15 (0,79)	*
Landrace	115	0,87 (0,78)	837	1,35 (0,72)	**
Duroc	474	1,45 (0,68)	222	1,23 (0,76)	*

** p<0,05; ** p<0,01*

[1]Farm 1 and 2 are not the same for each breed (see material and methods)

There were significant differences of the mean leg score assigned in each farm per breed. Even though it is not the objective of the present study to discuss the effects of the breed itself, but to evaluate the scoring system, some speculations can be drawn. The lowest values obtained in the present experiment (one nucleus of Landrace and one of Large White) correspond to the same genetic company, which traditionally has applied a higher selection pressure based on performance traits, rather than on functional trails. In opposition, the gilts of the other nucleus of the Landrace breed come from a breeding company, which has given a high importance to functional traits. Moreover, farm conditions in this company could also explain in part the high value obtained by Landrace gilts, since they are grown either on straw or on partially slated floor, but with a wide slat dimension. Duroc gilts in one of the nucleus farms presented the highest value, and this could be explained both for the selection strategy of the company on functional traits, and to the rusticity of the breed. The differences between the two farms evaluated for Duroc could be related to floor conditions, since gilts are kept on a plastic slatted floor during transition in the farm with the lowest value, being gilts more prone to slipping on this type of floor.

When comparing the Landrace and Large White gilts, which have been produced at the same nucleus farm, Large White gilts showed a higher leg score (1,16 vs. 0,87, *P<0,05*, respectively). This difference could be associated to the fact that the Large White breed traditionally, like Duroc, has been considered more robust compared to Landrace. Other studies have also reported significant differences on leg condition between these two breeds. Webb et al. (1983) found a significantly poorer overall leg condition in Landrace than in Large White boars. Lopez- Serrano et al. (2000) reported that legs were scored according to their 9 point-scale 0,23 points higher in Large White sows compared to Landrace.

Mean score for teat condition at the different farms is summarised in Table 2. A significant difference between farms was also found, except for Duroc breed. The highest values obtained by the Duroc breed could be related to the less strict criteria applied to this breed in terms of teat number. When comparing the Landrace gilts of the two nucleus farms, the higher value of one of them could be explained again by the importance given to this character in this company compared to the other company. In a study carried out by McKay and Rahnefeld (1990), the heritability of the total number of teats in the Landrace breed was found to be lower than for Yorkshire and Hampshire sows (0,39 vs. 0,44 and 0,45, respectively). Although no straightforward comparisons are possible because of the different breeds used, it could be argued that genetic progress in teat number (and teat condition in the long term) may be easier or more advanced in some breeds.

Table 2. Mean score (s.d.) of teat condition for the different farms and breeds

	N	Farm 1[1]	N	Farm 2	*P value*
Large White	414	1,95 (0,85)	257	2,09 (0,81)	*
Landrace	115	1,89 (0,82)	837	2,11 (0,75)	**
Duroc	474	2,70 (0,79)	222	2,79 (0,68)	NS

[1]Farm 1 and 2 are not the same for each breed (see material and methods)

In relation to the scoring system itself, our results are in agreement with those of the Canadian Centre for Swine Improvemente (2001) in that functional traits like leg and teat condition can be recorded easily at the time of the selection test, taking about 1 minute/pig. As suggested by Van Steenbergen (1989) a linear scoring system reduced into a small number of categories, what was intended with the present system, may be easier to apply on selection programs.

3.2. Correlations with performance traits and reasons for culling

The different correlations calculated for each breed are summarised in Table 3. In general, most of these correlations were low, although some of them presented significant results.

Table 3. Correlations between leg score of the gilts and performance traits or leg score of father in the different breeds

	Weight	Age	Growth rate	Fat depth	Father leg score
Large White	-0,025	-0,12*	0,06	0,05	0,11**
Landrace	0,09*	-0,03	0,11**	0,07*	0,04
Duroc	0,09*	-0,03	0,12**	0,009	0,13**

The most unexpected result was the positive correlation between growth rate and leg evaluation. It has been argued that a fast growth rate between 25 and 100kg presents, in general, a negative genetic correlation with conformation traits (Canadian Centre for Swine Improvement, 2001). It must be stressed that Table 3 presents phenotypic correlations, and no analysis has been carried out for genetic correlations at present. On the contrary, a positive relationship between the value assigned to the ancestors for leg condition and the value obtained by the gilts was found, as expected, in Large White and Duroc breeds. Furthermore, a low but significant correlation between backfat thickness and leg condition in Landrace gilts was found. Previous studies have also reported a genetic correlation of –0,43 between leg weakness and lean percentage (Lundeheim, 1987). Rothschild and Christian (1988) showed that selection for leaner pigs can lead to the loss fo the adequate front-leg structure in Duroc swine. Further analysis will be required to contrast the present results more accurately with other studies.

Table 4 summarises the frequencies of two of the potential reasons for culling in gilts which received a low leg score (0 or 1), in the two breeds which were grown in the same farm. The Landrace breed presented a higher incidence of several of the defects studied. This could be related again to a higher rusticity of the Large White breed.

Table 4. Frequencies (%) of presence of claw defects or plantigrade gilts given in the second evaluation, in gilts given a 0 or 1 in the first evaluation.

	Large White	Landrace
Claw defects	18,29	42,61
Plantigrade	5,84	18,26

4. Conclusions

The protocol applied to record leg and teat condition has proved to be easy to apply. Differences between farms with different environmental conditions and between breeds grown in the same farm have been detected. This protocol will be applied in the future to evaluate the main objective of this project, i.e. the effects of functional traits on longevity and welfare and to finally provide recommendations to pig breeders to include these traits to a larger extent in their breeding schemes.

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