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Pig carcase assessment in grading and breeding

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INTRODUCTION

In Sweden about 4 mill. pigs are slaughtered annually. With an average carcase weight of 75 kg the total quantity produced is 300.000 tons. This amount exceeds the domestic consumption by more than 50.000 tons, the difference being exported to other countries. The market demands carcases and products with high meat and low fat content. For many years the ambition of both breeders and general producers has been to breed and produce pigs with high meat content.

In this work it is essential to use effective methods for the assessment of carcases. In the commercial grading the use of few classes makes it difficult to use economic means of stimulating the production of meaty carcases. The demand from the producers, that payment should be based on the meat percent of the carcases, has been met by a new grading system. The meat percent concept has been used during the last eight years in the breeding work and thus this approach is familiar to all engaged in the production of pig meat.

This paper describes the system for assessment of pig carcases in Sweden, and shortly summarizes the development during the last five years.

Meat percent in commercial grading

The need of a more accurate evaluation of pig carcases in commercial grading has been met by a new system implying estimated meat percent, based on two fat and one muscle readings. This new system has been in operation since April 30, 1984 and replaces the measuring of backfat with the optical probe and classifying the carcases into four classes. The meat percentage system is the result of development work carried out during the last five years and started essentially because the optical probe, OP, was found to be too sensitive to variations in the handling practices (great variation between operators). Another problem was that the variation in meat per cent within the classes was too great, making it difficult to stimulate the production of pigs with high meat content.

The development comprises a series of steps including test of instruments, measuring sites and development of prediction equations.

Test of the Danish MFA-instrument

In the first test the Danish MFA instrument was used on randomly selected carcases at two abattoirs. It was used according to the Danish measuring schemes (Pedersen & Busk, 1982). The result was in accordance with what was expected from Danish experiences, apart from the muscle thickness measurements. On about 25 percent of the measured carcases the muscle readings diverged too widely from the real value. The reason for this divergence might have been the greater size and weight of the carcases. On larger carcases the measuring probe came too close to the vertebral column.

In the second test the MFA-instrument was compared with the FDI (Fat Depth Indicator). The backfat readings were made with the same reliability with both instruments. The unreliable muscle readings taken with MFA also appeared in this series of measurements. Based on these results it was decided to continue the development. Both instruments were regarded of interest for further development. In order to stimulate the development, both manufacturers were asked to continue with their work.

Hampshire crosses and the significance of muscle thickness

The number of carcases from crossbred pigs has increased during the last year. Carcases from Hampshire crosses seem to be underestimated with regard to meat content, if only the backfat thickness is used in the grading. Based on these facts it was decided to ask the manufacturers to further develop the FDI and MFA to be able to measure the thickness of m. longissimus dorsi. The inside border should then be the inner surface of the muscle, not the inner surface of the carcase as with the MFA.

Development and test of Grading Probe and Fat-o-Meater

The result of this development became the Grading Probe (GP) and the Fat-o-Meater (FoM). These instruments were then intensively tested and also further developed during a preliminary period of about two years. During this period both instruments were programmed with the same preliminary prediction equation.

MATERIAL AND METHODS

The tests were performed at KBS's abattoir in Kristianstad. The instruments were installed alongside the two identical slaughter lines at the place of ordinary grading. After a period of education and training most of the measurements were made by the ordinary graders.

The test period included the following steps:

a) repeated measurements at the same site on a sample of carcases.

b) measurements of backfat and muscle thickness along the back from the 8th rib to the next last lumbar vertebrae.

c) measurements on two random samples of carcases that were dissected into lean meat, fat and bone. Each sample contained 250-300 carcases.

d) measurements with OP, GP and FoM in order to get the distribution in meat percent and number of carcases in each class.

e) a long-term test lasting several months in order to test reliability and sensitivity to the rough environment.

The instruments were connected to printers during the tests. The statistical calculations were done with the Statistical Analysis System (SAS). The project was performed in cooperation between the State Board of Agriculture, Swedish Meat Marketing Organisation and Swedish University of Agricultural Sciences.

RESULT AND DISCUSSION

Measuring sites

Repeated measurements at the same site gave nearly identical readings with both instruments. This result was valid if the second probing was placed very close to the first. If the same incision was used, it seemed to be possible to take two probes at the same place without too great divergences.

The measurings along the back showed that the sites may be placed in the area from first lumbar vertebrae and about 20 cm forward (4th to 5th ribs). The variation in backfat thickness increased greatly if the measurings were made outside this given area. The lowest absolute value was obtained at the last two ribs. Going forwards, the fat thickness increased, especially anterior of the 4th rib. The measuring sites were therefore decided to be made at the tip of the last rib and between 3rd and 4th last rib. These sites correspond with those used in grading with OP (last rib) and the Danish MFA system (3/4 last rib) respectively (Pedersen & Busk, 1982).

Basis for prediction equations

Two samples of carcases were dissected. The carcases in the first were cut according to commercial routines. The yields of boneless cuts were used as an estimate of total meat content. Both instruments were severely affected by failures during the time of sampling, which makes it difficult to interpret the result. Nevertheless it was concluded that if the muscle thickness can be measured with high reliability, it should be used in the grading system. It increases the R^2-value by 2-4 percentage units. Together with two backfat and one muscle measurements, about 65 percent of the total variation in meat percent was described. The question of muscle measurements mainly involves the possibility to obtain an optimal estimation of meat content in carcases from Hampshire crosses or other types that differ from the white breeds. When only backfat is used the meat content will be underestimated. Hampshire crosses have a 2-4 mm thicker longissimus dorsi muscle at the place of measurement, and the use of muscle thickness may therefore diminish the underestimation.

In the second sample (taken one year later) the carcases were totally dissected into lean meat, fat and bone. The intension was to measure fat and muscle thickness with both GP and FoM at the time of slaughter, according to the measuring principles worked out earlier. Once again FoM suffered from failures during this test and less than one-third of the carcases could be measured using this method. The results of fat and muscle measures taken with GP and the total dissections are summarized in table 1.

The average meat content was 58 per cent, which is only one percentage unit below the meat content of progeny tested pigs. The dissected Hampshire crosses were about 1 per cent meatier than the "white" pigs. These results were used for the calculation of the prediction equation for estimation of meat content.

Table 1. *Fat and muscle thickness taken with Grading Probe (GP) and means and standard deviations for meat and fat percent in totally dissected carcases*

	"White" pigs		Hampshire crosses	
	x	S.D.	x	S.D.
Number of carcases	144		42	
Fat thickness mm, GP				
Last rib	17.1	4.2	17.0	3.5
3/4 last rib	17.0	3.9	17.5	3.4
Muscle thickness	46.2	7.3	50.1	7.3
Meat percent	58.0	3.7	58.7	3.4
Fat percent	29.1	4.1	28.6	3.6

The results of the stepwise regression procedure are presented in table 2. The calculations were performed with all carcases included (both "White" breeds and crosses).

Table 2. *Result of stepwise regression procedure for estimation of meat percent. Equations, coefficient of determination (R^2) and residual standard deviation (RSD)*

Parameters and equation	R^2 %	RSD
a) Backfat at 3/4 last rib (f_2)		
Meat % = 70.59 - 0.73 * f_2	57	2.40
b) Backfat (f_1) and muscle (m) thickness 3/4 (last rib)		
Meat % = 65.08 - 0.69 * f_2 + 0.11 * m	61	2.28
c) Backfat at last rib (f_1) and 3/4 last rib (f_2) and muscle at 3/4 last rib (m)		
Meat % = 66.05 - 0.20 * f_1 - 0.54 * f_2 + 0.10 * m	64	2.21

Carcase weight was not included in the calculations, as it did not decrease the residual standard deviation. In routine use it is difficult to combine weight with the grading measurements as weight is recorded after the grading.

It was discussed whether the type of pig (white breeds or Hampshire crosses) should be used in the equation, but such a routine was regarded not practically possible.

Test in routine use on line

The Hennessy Grading System was used routinely for about 4 months, including measurings on more than 100,000 carcases. During this time some modifications were made. Results and experiences from this comprehensive test were used in the education programme.

Test of Grading Probe and Fat-o-Meater in other countries

During the period the tests were being made in Sweden, both instruments have been used in extensive tests in other countries. When the results are compared one must, however, be aware of the fact that the instruments might have been in different phases of development.

In the last test in the U.K. (Kempster et al., 1984), comprising both GP and FoM on about 5.000 carcasses, the FoM performed better on the slaughterline. It also provided a marginally better prediction of lean content. The Canadian tests led to much the same conclusion (Fortin et al., 1982), that the choice of probe must depend on cost and performance under industrial conditions. In the tests mentioned, as well as in tests in other countries (Pommeret et al., 1983, Puntilla, 1984), the backfat and muscle thicknesses in the area of the last rib have been used in the applied routines.

These results and experiences support the decision to use two backfat and one muscle measurement in the Swedish system.

During May 1984 tests with both probes are being performed in Finland and West Germany.

Official system for classification of pig carcases

The final decision to approve the Hennessy Grading System to be used for the official classification of pig carcases was taken in June 1983. The decision about the design of the system, measuring routines and prediction equations was taken some months earlier. The installation of the system began in Febr. 1984. By April all abattoirs with an yearly slaughter of more than 2000 pigs had been equipped with the system. From April 30, 1984, the system is being used on all carcases from pigs except young pigs (carcase weight less than 40 kg) and older boars.

The system consists of the Grading Probe, GP2, the Grading Co-ordinator GC262 and a printer. The technical description of the system is given in separate manuals (FTC, 1983, 1984). Communication between GP2 and GC262 is continually carried out in serial half duplex. The GP2 is powered by GC262 but can also be powered by a battery box. The GC262 contains control and production statistic programs.

The grading system includes the following measures:

Backfat thickness at the tip of the last rib, 8 cm from the dorsal midline (f_1); backfat thickness at 3/4 last rib, 6 cm from the dorsal midline (f_2); thickness of m. longissimus dorsi at 3/4 last rib (m). Taken at the same place as f_2.

The prediction equation for ordinary slaughter pigs and young boars has the form:

$$\text{MEAT \%} = 65.10 - 0.20 * f_1 - 0.54 + f_2 + 0.12 * m$$

Compared to the result in table 2, the coefficient for muscle is increased to 0.12 in order to enhance the influence of muscle thickness.

During the testing year 1983/84 the prediction equation has the following for for pigs of the Landrace breed:

$$\text{Meat percent} = -12.3067 + 0.5883 \cdot m_1 + 0.3033 \cdot m_2 + 0.3060 \cdot m_3 - 0.0067 \cdot \text{length in mm} + 0.5426 \text{ (for gilts)}$$

where

m_1 is percent of meat + bone in ham

m_2 is percent of meat + bone in back

m_3 is percent of ham

The equation describes 88% (R^2=0.88) of the total variation in meat percent. The prediction equations for the other breeds are built up in the same way with the same parameters included.

The meat percent is marked on the carcases and used as base for payment to the producers and in the market with whole carcases.

The same system is also valid for carcases from young and older sows, with small modifications in the constants in the equation.

ASSESSMENT OF CARCASES IN THE PIG PROGENY TESTING SCHEMES

The progeny testing of pigs in Sweden comprises about 5,000 pigs per year. The pigs, one gilt and one barrow from each of at least four litters from each boar, are reared at four stations. The pigs are sent to slaughter at the nearest abattoir when they have reached the live weight of 103 kg. The evaluation of the carcases is performed at two cutting stations.

During the period before 1976 (the progeny testing started in the late twenties), the assessment of the carcases was based on linear measurements of the backfat thickness. During the last 10 years the area of longissimus dorsi at last rib was included in the method but in the early seventies it was found that this method did not estimate the lean meat content sufficiently accurate (Andersson, 1980).

The Danish evaluation method (Clausen et al., 1968, 1971), comprising jointing of the carcass and defatting ham and back, was used for a two-year test period, with minor modifications, on about 7,800 carcases from progeny tested pigs (Andersson, 1980). The result of this testing period was used for the development of the method that has been officially used since October 1st 1976. The jointing and defatting operation is carried out in the following steps.

The head is cut of from the rest of the carcase by a perpendicular cut immediately cranial to the first cervical vertebrae. This gives the definition of the carcase. The carcase is then divided in joints by four perpendicular cuts:

1. Between the 4th and 5th vertebrae
2. Behind the tip of the last rib
3. Immediately anterior the hip bones leading edge
4. 6 cm anterior the os pubis.
   The middle parts, between the first and third cuts, are divided by a cut along the length axis in such a way as to touch m. longissimus dorsi, resulting in back and streak joints.

On the section surface at the last rib, the colour of the muscle and the thickness of backfat are measured.

5. All subcutaneous fat is trimmed from the back and ham
6. All the joints are weighed separately.

Among all the assessed carcases, about 400 each year are randomly selected for total dissection into lean meat, fat and bone. The results of these dissections are used for the calculation of the prediction equations. The calculations are done separately for the four relevant breeds. Three years of dissections are included in the calculations, the effect of year being also included in the model. The equations are recalculated each year.

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