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LINKING SCIENCE AND TECHNOLOGY TO SOCIETAL BENEFITS

TECHNOLOGICAL STATUS OF VALUE BASED MARKETING

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Introduction

The value of a carcass is mainly determined by weight, composition and meat quality traits. Formerly, most of the meat animals were marketed alive. The traits listed above cannot, however, be very accurately evaluated on the live animal. This is even more true for swine than it is for cattle and sheep. For this and for many other reasons marketing habits have changed. Nowadays prices are mainly based on carcass weight and grading particularly in pigs.

Carcass weight is determined quite accurately, since it is not influenced by gut fill as it is in live animals. But it is the matter of definition which parts belong to the carcass, and whether cold or hot carcass wgt. is the price basis. Carcass classification in terms of composition and conformation is the major concern of most classification systems and will be the main subject of this paper. In addition, there is a growing interest in the composition of retail cuts. Meat quality traits referring mainly to palatability, tenderness, and juiciness cannot be determined directly on the slaughter line. They are influenced by breed, age, sex, marbling, and energy status at the time of slaughter. So far classification systems also refer to meat quality traits indirectly, and as part of the pricing system. Other traits, however, which are directly related to sensoric characteristics can be measured, e.g. pH, colour brightness or conductivity in particular in pork.

While carcass composition and conformation are directly reflected in price differences between classes, meat quality has hardly any influence. Since some years, however, consumers are more aware of quality criteria. Therefore in Europe numerous meat quality programs have been established. In these systems producers will receive premiums for high quality meat if it fulfils certain requirements including objectively measured traits. In addition, rules for the production process are outlined. This standardisation helps not only to obtain a high quality level, but also to produce a high proportion of carcasses in the premium range.

Classification systems

For general valid discriptions of carcasses and transparency of the market, the European Union (EU) has agreed on carcass classification systems for beef, sheep, and pig carcasses. Commissions of the European Community regularly visit all member countries to inspect the handling of the classification regulations.

Originally all systems based on subjective evaluations and/or very simple linear measurements. During the last two decades, however, an increasing number of technical devices were developed to assess carcass composition. At present, this is further advanced for pigs than it is for beef and sheep.

The beef classification system is compulsory since January 1st 1992 in all EU countries. It does not apply for veal. Within categories the two traits "conformation class" and "class of fat cover" are obligatory.
In the EC-regulations the following categories are differentiated:

A   Young bulls less than two years of age

B   Bulls more than two years of age

C   Steers

D   Young cows and cows

E   other females (heifers).

In some countries classes are subdivided or additional classes are attached, and some countries apply the classification scale to veal as well.
The term conformation and fleshiness are most often used synonymically, even though conformation refers to shape mainly including intermuscular and subcoutanious fat, whereas fleshiness does not. There is a scale of 6 conformation classes "SEUROP" S stands for "Superior" pertaining to an extremly high degree of muscling, e.g. of double muscled animals. Conformation deminishes stepwise from S to P being real poor in the latter one.
Class S is only applied in some countries. For fat cover a 5 score scale discribes increasing amounts of fatness from 1 = low to 5 = very high.
Fat and conformation classes may be divided into up to the three subclasses -; 0; + .
This way it is handled in the following EU-countries: Belgium, Denmark, France, Netherlands and Luxembourg.
In the United Kingdom and Northern Ireland conformation classes and fat classes 4 and 5 may be supplemented by L(ow) or H(igh).
No subdeviding is practiced in: Germany, Greece, Italy, Spain, Ireland and Portugal (VAN RIET, 1995).
In most of the EU-countries classification is performed by visual assessment. Recently, photographic standards were printed in addition.
In Denmark, however, a technical divice was developed to classify beef carcasses objectively in the so called Beef Classification Center (BCC). This method is officially approved in Denmark now on a volontary basis.
In the BCC most measurements are performed automatically. The carcasses are positioned in a cabinet for weighing, video imaging for conformation and measurement of fat and muscle depth with a probe. These informations are introduced into a neural network where the classification results are processed by the best fitting algorithms. The system has been improved continuously. At present prediction of conformation and fat class by BCC is very accurate as compared to visual assessment by well trained operators. Results for coefficients of determination (R^2) and standard errors of prediction (SEP) for conformation and fat cover are R^2 = 90 %, 63 % and SEP = 0.74, 0.52 respectively (MADSEN and THODBERG, 1994).
In addition to classification further information on carcass traits can be obtained from the BCC as summarised in the table 1.

Table 1:
    Carcass compostion traits, means, standard deviation, SEP and R^2 from either visual or BCC model, BCC SEP advantage over visual classification %, n = 230 (MADSEN and THODBERG, 1994)

	Mean	Std.	EUROP		BCC		BCC advantage
			SEP	R^2	SEP	R^2	SEP, %
Saleable meat %	76,59	2,33	1,32	0,70	1,23	0,75	7
Bone %	17,83	2,33	1,15	0,77	1,06	0,82	9
Fat trim %	7,12	2,62	1,14	0,82	1,04	0,86	9
Hind quarter %	45,84	1,69	1,21	0,52	1,08	0,63	11
L.D. area, cm^2	61,37	12,53	7,24	0,68	6,26	0,78	14
Hind quarter cuts %	33,68	1,63	1,09	0,57	1,00	0,67	8
L.D. %	5,54	0,57	0,43	0,48	0,40	0,57	7

For future perspectives it is planed to extend the system to measuring other characteristics, e.g. meat colour and marbling. It could also be adapted to sheep carcasses.

The distribution of beef categories in Germany is seen from table 2.

From these figures it is obvious that "young bulls" is the dominant category in beef production (46,6 %).

Table 2:   Categories of beef carcasses in Germany 1993 (in %)

A	young bulls	46,61
B	bulls	0,39
C	steers	0,91
D	cows	37,02
E	heifers	13,81

In table 3 proportions of conformation classes are listed for the "young bull" category.

Table 3:   Classes in young bulls (1993)

E	-
U	23,4
R	42,1
O	30,0
P	2,8
Remainder	1,6
	99,9

Since in Germany beef production derives mainly from dairy breeds, hardly any class E carcasses are available. The majority is graded in class R.

Sheep

Sheep carcass classification (since January 1st 1993) allows two systems. One is for regular carcass weights of approximately 15 kg and more, the other one is applied for weights of 13 kg and less. In the first system carcasses shall be devided at least into the two categories:
- carcasses of sheep under twelve months old
- carcasses of other sheep.

The carcasses shall be classified by assessment of:
conformation and fat cover.

The six conformation classes are S (superior), E, U, R, O, P (poor) in muscularety.

The five fat classes are 1 (low), 2, 3, 4, 5 (very high).

The system for light lamb (≤ 13 kg) carcasses includes the three categories: A: ≤ 7 kg; B: 7,1 - 10,0 kg; C: 10,1 - 13,0 kg.

In each category two quality traits are assessed:
- meat colour (clear pink, pink, other colour)
- fat class (low, slight, average, high).

The second alternative is mainly applied in the South European countries.

Both systems rely on visual assessment only. Attempts for the development of more objective measures are rare and not effective as yet.

Prices for lamb depend very much on season (springlambs), therefore there is a large variation. In 1993 on the German market approximately 80 % of the lambs were sold on a carcass weight basis, but for only 22 % the price was based on classification. The rest was marketed on an average price, 20 % were sold alive.

Pigs

Objective classification of pig carcasses is far more advanced and sophisticated than in beef or lamb. The current classification scheme is compulsory from January 1st 1989.

The major factor in the classification system is proportion of lean as it is evaluated by instruments, which need aproval by the national and EU authorities. Requirements for certification is a relation of lean meat measurement result as compared with the "true" lean meat % of at least $r \geq 0.8$ and a maximum residual standard deviation of RSD ≤ 2.5 %. The true lean % is determined by complete tissue separation of at least 120 carcasses by a standard procedure. The pork carcasses dissected should be representative for the country or area of approval. Since January 1, 1995 an additional regulation allows the dissection of a minimum of 50 carcasses by a simplified method if the result is as accurate as with the method mentioned above.

In Germany the aproval of instruments is based on the "Ultrasound-Scanner (SSD 256)" which is not used itself for classification routine. Each other apparatus used for classification must be calibrated and must give single values of the measurements equivalent to those of the SSD 256.

The lean meat content is calculated by the same equasion:

$$\hat{y} = 54{,}139 - 0{,}71062\, x_1 + 0{,}21842\, x_2$$

in all instruments. The components involved are:

$\hat{y} =$ the estimated % of lean meat in the carcass

$x_1 =$ the thickness of backfat (incl. skin) in mm, measured at 7 cm off the midline of the split carcass, between the 2nd and 3rd last ribs

$x_2 =$ the thickness of the muscle in mm, measured at the same time and in the same place as x_1.

The formula shall be valid for carcasses weighing between 50 and 120 kg.

In this procedure, for each individual instrument it has to be proved to a states authority that the single measurements are correct. The various apparatuses licenced for the EU countries are listed in table 4.

Due to the large variety of technical devices also the number and positions of measurements are variable.

Lean meat percentage is converted into classes according to table 5.

Table 5: Classification scale

class	lean meat % of carcass wgt
(S	≥ 60 %)
E	≥ 55
U	50 - 54,9
R	45 - 49,9
O	40 - 44,9
P	≤ 40

The class of S ≥ 60 % may be applied. If needed additional criteria of conformation may be applied for subclasses (e.g. three in Germany, four in the Netherlands). The class distribution for German pig carcasses in 1993 is summarised in table 6.

Table 4: Approved Apparatus in Various European EU-Countries

	HGP₂	FOM	Intro.	SKG_II	Intra.	CBS	U-FOM	Ulster	DEST	SPC	Man.	CGM	SSD	PG	KC
Netherlands															
Ireland	x														
Belgium	x		x	x											
United Kingdom (Northern Ireland)	x	x			x	x	x								
Spain		x				x									
France	x	x					x								
Luxembourg									x	x	x	x			
Italy	x														
Greece	x	x							x						
Germany	x	x							x						
Denmark	x	x										x	x	x	
Portugal		x				x									x
	x	x			x										

HGP₂: Hennessy Grading Probe
FOM: Fat-O-Meater
Intro.: Introscope/midline
SKG_II: Schlachtkörperklassifizierungsgerät
Intra.: Intrascope (Optical Probe)
CBS: CBS Ultra-Meter
U-FOM: Ultra FOM
Ulster: Mark II Ulster Probe

DEST: Destron PG-100
SPC: SPC-Sydel
Man.: manual method
CGM: Capteur Gras/Maigre-Sydel
SSD: Ultrasound-Scanner (SSD 256) (reference)
PG: PG 200
KC: Klassificeringscenter

Table 6:   Results of carcass classification in pigs - Germany 1993 (in % lean)

E	52,7
U	34,6
R	8,3
O	1,1
P	0,1

The high quality standard is indicated by the large proportion of class E carcasses (52,7 %).

Even though the same rules for approval are valid for all EU countries the systems do not allways obtain the same results on the same samples.

BRANSCHEID et al. (1995) calculated a difference of 1.0 - 1.5 % lean when comparing the Dutch and German procedures. In international trade this may cause problems.

From the apparatures mentioned up to now, only information for meat content in the entire whole carcass are received. In Denmark two systems have been developed to obtain additional evaluations for the composition of the mayor cuts.

In a classification centre (CC) several items are determined automatically (see figure 1).

Besides length and weight measurements the most important information obtained are several fat depth and muscle thickness values evaluated by monochromatic optical probes.
Originally 17 insertions were made (3 muscle thickness, 17 fat depth, 5 belly thickness).
The utilization of current neural network allowed to reduce the number of probes to 9 without loss of accuracy.

The locations of the insertions are shown in figure 2.

Figure 1:   Schematic plan of the classification centre
                  (JENSEN, 1992)
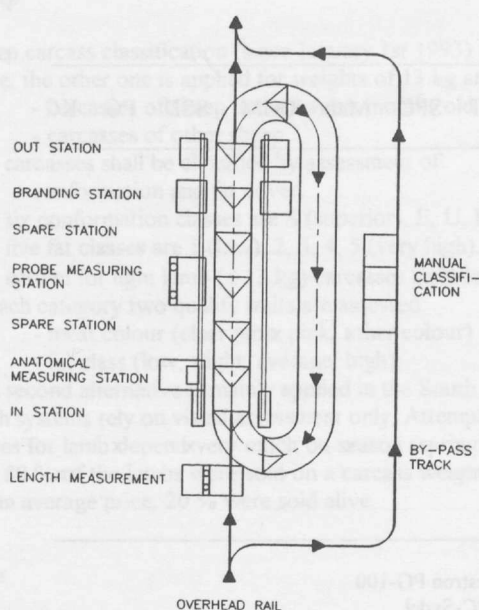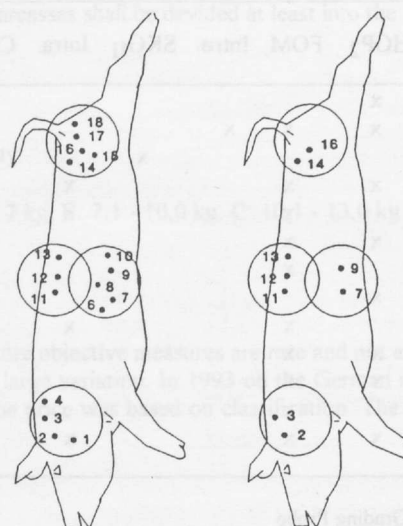
Figure 2:   The original probe positions in the classification centre
                  (left) and the revised positions after application of neural
                  network (right) (JENSEN, 1992)

In addition manual classification (MC) by the FOM probe is practiced in exceptional cases if, for some reason, a carcass cannot be assessed in the CC.

The accuracy of the CC in the original and the revised version are compared with the FOM measurement in table 7.

Table 7: Coefficient of determination (R^2) and residual standard deviation (RSD) for Danish carcass classification as compared to total tissue separation (JENSEN, 1992)

	R^2	RSD
FOM (MC)	0.70	1.66
CC original	0.81	1.34
CC revised	0.82	1.29

The CC also provides information about the composition of individual cuts. This may be utilized in trade as well as in selection programs. The agreement with the EU regulations the CC is approved for all Danish slaughter plants.

The CC also contains two spare stations for facilities to measure colour or automatic sampling e.g. for boar taint analysis (JENSEN, 1992). The second method mentioned is the automatic ultrasonic classification system - Auto FOM - that is currently developed in Denmark. In this equipment 16 ultrasound transducers are assembled in a half-circle. The intact carcass is pulled over these transducers directly after dehairing while it is still whet. A computerised system calculates the lean content of the carcass and individual cuts (MADSEN, 1993). Results are not published as yet. The first equipment outside Denmark has been installed for test in Hatfield Quality Meats Inc., Hatfield, Penn., USA (OVESEN, 1995; personal communication) and will be tested in Germany (Westfleisch).

Payment Systems

The pricing systems vary between European countries substantually. In beef marketing there are hardly any fixed differences inbetween categories or classes for conformation or fatness, except in Denmark. For pig carcasses there are some regulations on a volontary basis in trade which again vary between and within countries.

Beef

Price variation exists between categories. In Germany steers are a little more expensive than young bulls followed by heifers and cows. Higher conformation score also increases the price. Higher degree of fatness, however, causes reductions in young bulls and heifers but additions in cows. Price level and differences between categories or classes solely depend on market situation. In contrast, Denmark practices a detailed differentiation. In all categories (some are subdivided into weight classes) there exist fixed differences between conformation classes and weight groups, as well as between categories. For fatness deductions are made on the upper and the low end of the scale. Also colour is comprised, expecially in young bulls and heifers (OVESEN, 1995; personal communication). In Germany (1993) in commercial slaughtering approximately 98 % of the beef cattle are sold on a carcass weight basis, for 79 % the price is based on classification, the remaining carcasses on an average price basis. Only 2,1 % are marketed alive.

Pigs

In pigs weight and percent lean meat are the dominating factors in price differentiation. The Danish system can be seen from figure 3 and 4.

Figure 3: Danish pig payment scheme - carcass weight payment (JENSEN, 1992)
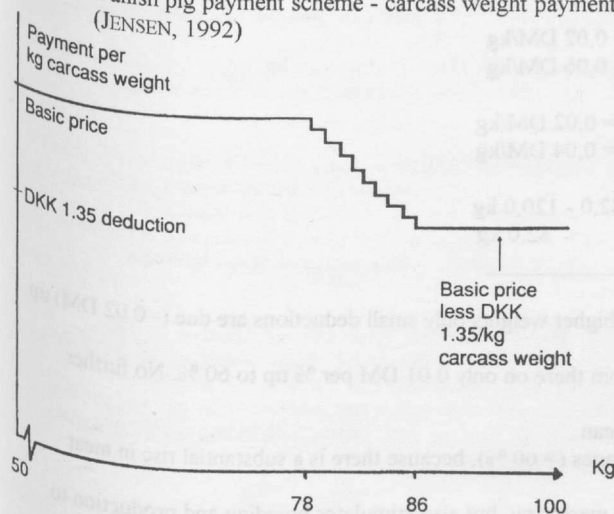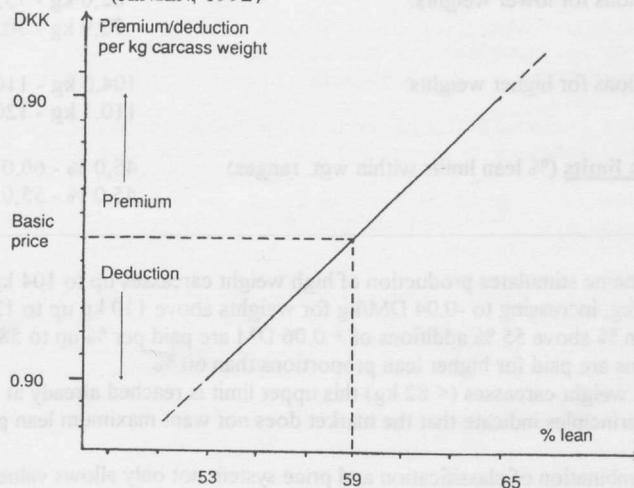
Figure 4: Danish pig payment scheme - payment for lean content (JENSEN, 1992)

In the Netherlands lean %, weight group and type determine price, as shown in table 8.

Table 8:   Payment System for Pork Carcasses in the NL

	% lean	addition/deduction
basic price	55 %	
lean meat % 78 - 100 kg carcass wgt.	55 % - 59 %	+ 5 cts / % / kg
> 100 kg " "	56 % ≤ 57 %	+ 5 cts / kg + 10 cts /kg
< 78 kg " "	≥ 56 %	+ 5 cts / kg
78 - 100 kg " "	< 55 - 52 % < 52 - 49 % < 49 - 45 % < 45 %	- 6 cts / % / kg - 7 cts / % / kg - 8 cts / % / kg no further deduction
Typ AA A (70 % of all carcasses) B and C		+ 5 cts / % / kg 0 - 10 cts / % / kg

(WALSTRA 1995)

The weight range with no deductions is 78 - 100 kg, the maximum lean meat % paid additions for is 59 %.
In the lean % below 55 % the deductions increase stepwise.
In North-Western Germany the current "price-mask" was introduced in April 1995 (table 9).

Table 9:   "Price Mask" in North-West Germany

basic price:	at	**55 % proportion of lean**
additions for higher % lean:		55,0 % - 58,0 % = 0,06 DM/% 58,1 % - 60,0 % = 0,01 DM/%
deductions for lower % lean:		54,9 % - 52,0 % = 0,06 DM/% 51,9 % - 45,0 % = 0,08 DM/%
optimum wgt. range:		**82,0 kg - 104,0 kg**
deductions for lower weights:		82,0 kg - 73,0 kg = 0,02 DM/kg 72,9 kg - 50,0 kg = 0,06 DM/kg
deductions for higher weights:		104,0 kg - 110,0 kg = 0,02 DM/kg 110,1 kg - 120,0 kg = 0,04 DM/kg
system limits (% lean limits within wgt. ranges)		45,0 % - 60,0 % at 82,0 - 120,0 kg 45,0 % - 55,0 % < 82,0 kg

This scheme stimulates production of high weight carcasses up to 104 kg. For higher weights only small deductions are due (- 0.02 DM) up to 100 kg, increasing to -0.04 DM/kg for weights above 110 kg up to 120 kg.
For lean % above 55 % additions of + 0.06 DM are paid per % up to 58 %, from there on only 0.01 DM per % up to 60 %. No further additions are paid for higher lean proportions than 60 %.
In light weight carcasses (< 82 kg) this upper limit is reached already at 55 % lean.
These principles indicate that the market does not want maximum lean percentages (> 60 %), because there is a substantial risc in meat quality.
The combination of classification and price system not only allows value based marketing, but also stimulates breeding and production to produce carcasses that meet the demands of retailers, processors and consumers and processors on a high level of uniformity.

Summary

Value based marketing requires an accurate and objective carcass assessment.
In the EU countries carcass classification systems for beef cattle, sheep and pigs are in force. Technical divices for objective beef carcass classifikation are most advanced in Denmark, where the Beef Classification Center was developed, utilizing video image and probe measurements.
In sheep no similar attempts have been made.
In pig carcass classification a large number of instruments is available, applying linear measurements by optical probe or ultra sound technics. In Denmark again alternatives were developed. By means of multiple probes or ultra sound transducers information about the composition of the total carcass can be obtained as well as of retail cuts. On this basis of carcass assessment payment schemes were adapted, which allow value based marketing but also stimulate production courve.

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