



## A more relevant grading system for Indian pig carcasses

R THOMAS<sup>1</sup>, S BANIK<sup>2</sup>, K BARMAN<sup>3</sup>, N H MOHAN<sup>4</sup> and S RAJKHOWA<sup>5</sup>

ICAR-National Research Centre on Pig, Rani, Guwahati, Asom 781 131 India

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### ABSTRACT

A good grading scheme can lead to improvements in efficiency, as producers have a financial incentive to modify their production methods to produce carcasses that are the most desired by consumers. In India, consumers and producers often do not have a clear understanding of pork grading and are not into practice. The existing Indian Standard for Specification for pork, i.e. IS: 1723-1973 specifies only two grades of pork, i.e. *Grade 1* and *Grade 2*, which is per se insufficient to meet the current marketing requirements. Thus, a more relevant pork grading system was developed with distinct yield grades (*Grade 1, 2, 3 and 4* in case of gilt/barrow and *Grade 1, 2, 3 and C* in case of sow) and quality grades (*Grade P, I, N and D*). Different classes of grades for gilt/barrow and sow carcasses was necessitated due to distinct difference observed in the pattern of change among the parameters, which directly affected the carcass yield, viz. chilled carcass weight, back fat thickness and percent yield of primal cuts. Data were collected from 1,017 pigs of different breeds and varieties over a period of 9 years and critically analyzed before assigned them to the respective grades. Also, to ensue uniformity in the dressing operations of different pig carcass and to facilitate grading, standard dressing specifications were developed based on chilled carcass weight, separately for gilts/barrows and sows. The new grading system has elements of both classification and grading schemes and is simple to understand and perform.

**Key words:** Carcass grading, Dressing specifications, Hot carcass rebate, Pig, Pork

The compositional evaluation of the pig carcass and its subsequent grading is the inherent tool to establish its commercial value. Carcass grading has been directly associated with carcass value since the early 1960s (Doornenbal 1967) and this still applies in many countries, whether the carcasses are evaluated by their lean content (e.g. European Union, Busk *et al.* 1999), saleable meat (e.g. Canada, Engel *et al.* 2006), standardized fat-free lean (e.g. United States, Kauffman 1992) or backfat and loin muscle depth (e.g. United Kingdom, New Zealand, Australia) (Commission of the European Communities, 2008). A good grading scheme can lead to improvements in efficiency, as producers have a financial incentive to modify their production methods to produce carcasses that are the most desired by consumers. The overall objective of pork carcass grading is to identify the commercial value of a carcass by segregating carcasses based on different quality and or yield related parameters. In the current context of pig carcass grading in India, the adjusted prices paid to producers do not reflect the variation in the market carcass value and it mostly fails the production of carcasses whose composition meets consumer demand (Thomas *et al.* 2016a). The

possibility of use of sophisticated objective grading methods, viz. computer vision system, digitized three-dimensional ultrasound system etc. is minimal in India under the existing conditions, as the pork supply chain is highly fragmented and availability of highly trained carcass classifiers are almost absent. Thus, an effective national pig carcass segregation system should not only have elements of both classification and grading schemes, but also be simple to understand and perform.

In order to facilitate commercial pig rearing practices in India, to bring the pork to the mainstream market, to promote the availability of quality pork to the consumers and to facilitate export of pork from India, ICAR-National Research Centre on Pig in collaboration with Agricultural and Processed Foods Export Development Authority (APEDA), has developed the 'guidelines for export of fresh pork and pork products from India' (Thomas and Sarma 2015). The existing Indian Standard for Specification for pork, i.e. IS: 1723-1973 specifies two grades of pork, i.e. *Grade 1* and *Grade 2*, irrespective of sex and age of the pigs, which is based only on 2 parameters, viz. weight of the dressed carcass and fat thickness at the loin (BIS 1973). In order to compete in the international market and to meet the current marketing requirements, it is high time for the country to have a better grading system in place. The present paper describes a pig carcass grading system developed by ICAR-National Research Centre on Pig through in-depth

Present address: <sup>1</sup>Senior Scientist (thomasrlpt@gmail.com), <sup>2,3,4</sup>Principal Scientist (sbanik2000@gmail.com, barman74@gmail.com, nhmnh@gmail.com), <sup>5</sup>Director (swaraj.rajkhowa@gmail.com).

Table 1. Age groups, sex and number of different breeds/varieties of pigs slaughtered during the experiment

Parameter	Age group	Breeds						Varieties		
		Ghungroo	Niang-Megha	Nagaland Local	Mali	Hampshire	Yorkshire	Duroc	Rani *	Asha**
Gilt (n <sub>1</sub> =261)	8–10 M	17	6	3	3	7	9	11	17	19
	11–12 M	6	8	3	3	8	7	10	13	11
	13–15 M	8	6	4	2	6	3	5	12	8
	16–18 M	11	7	3	2	5	5	3	6	4
Sow (n <sub>2</sub> =173)	13–15 M	4	2	2	0	5	3	4	8	0
	16–18 M	3	2	3	1	4	3	4	12	0
	19–24 M	8	4	2	3	6	4	3	7	0
	25–31 M	8	4	3	3	5	3	3	14	0
Barrow (n <sub>3</sub> =583)	32–36 M	6	3	3	2	5	3	5	6	0
	8–10 M	28	4	3	2	9	4	8	59	89
	11–12 M	26	4	3	1	15	6	8	48	76
	13–15 M	18	3	2	2	11	3	6	26	32
	16–18 M	6	3	2	2	5	3	5	9	16
	19–24 M	4	3	3	1	4	3	4	7	7

n (n<sub>1</sub>+n<sub>2</sub>+n<sub>3</sub>) = 1017. \*Rani: A crossbred pig variety for breeding purpose, developed by ICAR-National Research Centre on Pig, by crossing Hampshire with Ghungroo and has 50% inheritance of both the breeds. \*\*Asha: A triple cross pig variety for fattening purpose, developed by ICAR-National Research Centre on Pig, by crossing Duroc with Rani, and has 25% Ghungroo, 25% Hampshire and 50% Duroc inheritance.

research and analysis of data of 1,017 pig carcasses over a period of 9 years.

#### MATERIALS AND METHODS

The experiment was conducted with 1,017 pigs reared at the Research Farm of ICAR-National Research Centre on Pig during 2009–2017. Details of age groups, sex and number of different breeds/ varieties of pigs slaughtered during the experiment are listed in Table 1. Pigs were slaughtered in the R&D Pork Processing Plant of the institute (FSSAI licensed, HACCP and ISO 9001:2008 certified), located at approximately 50 m from the Research Farm. Pigs were electrically stunned (head-only) by low voltage current, shackled on the left leg and exsanguinated in the vertical position on the over head rail. Thereafter, the pigs were scalded at 65°C, followed by hair removal on an automatic dehairing machine. Following slaughter, carcasses were scraped, washed, split, eviscerated and chilled according to standard commercial practices. Carcasses were individually weighed and both hot carcass and chilled carcass weights were recorded. The chilled carcass weights were taken after chilling the carcass to 18 h at 2±1°C. To ensure accuracy when weighing, regular scale and tare checks form an integral part of the weighing process. After chilling for 18 h at 2±1°C, the left side of each carcass was ribbed between 10<sup>th</sup> and 11<sup>th</sup> rib positions. Loin eye area and fat depth measurements (three-quarters of the length of the transverse section of the exposed *M. longissimus thoracis et lumborum*) were taken between the 10<sup>th</sup> and 11<sup>th</sup> ribs. Carcass measurements were taken by the same individual throughout the trial.

Different carcass and meat quality parameters evaluated include a) yield grades -sex and age of the animal, dressed carcass weight (kg), back fat thickness (mm), percent yield

of primal cuts – ham, loin, picnic shoulder and Boston butt (%), loin eye area (in<sup>2</sup>) and yield of lean meat (%), and b) quality grades- meat colour, skin thickness, wrinkles on the skin and presence of hair roots, degree of marbling and firmness of back fat (Thomas *et al.* 2016b). Details of interpretation pattern followed for different quality parameters are listed in Table 2. The data collected for different carcass and meat quality parameters were subjected to statistical analysis using SPSS, version 14.0.

#### RESULTS AND DISCUSSION

*Standard dressing specifications for Indian pig carcasses:* In order to have uniformity in the dressing operations of pig carcass and to facilitate grading, standard dressing specifications were developed, separately for gilts/

Table 2. Numerical scale followed for interpreting the quality parameters

Parameter	Numerical scale
Meat colour	1, Gray; 2, Pinkish gray; 3, Light red; 4, Reddish pink; 5, Dark red
Firmness of back fat	1, Very soft; 2, Soft; 3, Slightly firm; 4, Firm; 5, Very firm
Skin thickness	1, Very thin; 2, Moderately thin; 3, Slightly thick; 4, Very thick
Wrinkles on the skin and presence of hair roots	1, Smooth skin with no hair roots; 2, Smooth skin with few hair roots; 3, Skin with few wrinkles with hair roots; 4, Skin with many wrinkles and hair roots
Degree of marbling	1, No marbling; 2, Slight marbling; 3, Moderate marbling; 4, Slightly abundant; 5, Abundant marbling.

Table 3. Standard pig carcass dressing specifications developed

A. Standard dressing specifications for carcass of gilts and barrows			
Section I (The parts of the pig carcass which shall be removed completely)	a. Hair, b. Liver, spleen, heart and lungs (pluck/race), c. Stomach, d. Leaf fat/mesenteric fat, e. Genito-urinary organs, excluding kidneys, f. Scrotal sac in barrows, g. Nails on each foot	Section III-The tongue may either:	a. Remain attached to the carcass or be removed from the head attached to the pluck, taking with minimum amount of meat attached to jaw
Section II (The parts of the pig carcass which shall not be removed)	a. Head, b. Feet and tail, c. Ear root and eyes, d. No trimming on neck beyond cutting of ragged edges	Section IV-Kidney fat, kidneys and diaphragm (KFKD) may either:	a. Remain attached to the carcass or b. Be entirely removed
B. Standard dressing specifications for carcass of sows			
Section I (The following parts shall be removed, in addition to 'a-e' mentioned in Section I above, for that of gilts and barrows. Other points mentioned in Section II, III and IV above will remain applicable)	a. Head b. Tail c. Front and hind feet d. Udder (to be removed tidily)		

barrows and sows (Table 3). As mentioned in Section III & IV of Table 3, option has been provided to the processors during dressing operations for either including or excluding tongue, kidneys, kidney fat and diaphragm, as to meet the specific requirements of customers in case of domestic market or that of importing countries in case of export. Accordingly, standard dressing coefficient reductions based on chilled carcass weight were developed (Table 4). The procedure demands weighing of the chilled carcasses to the calibration divisions on the scale and recording of the actual scale display. When pig carcasses are weighed 'hot' a 'hot weight rebate' has been calculated, i.e. the hot carcass is reduced in weight by 2%, if weighed within 45 min of slaughter. This is to allow for moisture loss from the carcass during chilling. Dressing coefficients are not in much use in those countries where modern sophisticated equipments are in place for accessing the carcass quality (e.g. USA, Canada, New Zealand and Australia) (Marcoux *et al.* 2007, Vitek *et al.* 2008), however, there are two different methods of pig carcass dressing in UK; the EU method, which involves removal of flare fat, kidney and diaphragm,

whereas the second method is called the UK method, which involves retaining these (Nissen *et al.* 2006).

*Yield grades for Indian pig carcasses:* The grading system mentioned hereunder categorizes carcasses by yield and quality, and provides producers, wholesalers, retail meat operations, and restaurants the information they need to purchase a grade of meat that suits their particular needs. It is also intended to ensure that the consumer has a choice in selecting a consistent and predictable quality of meat. This article describes the parameters and procedures developed for the grading of barrow, gilt, and sow carcasses. Grades were not provided for boar carcasses, as the meat from boar is unacceptable/not-preferred for marketing owing to the boar taint (Thomas *et al.* 2018). A similar practice is being followed in United States (USDA 1985) and EU (Commission of the European Communities 2008). Four distinct classes of yield grades were developed separately for gilt/barrow (Grade 1, 2, 3 and 4; Table 5) and sow (Grade 1, 2, 3 and C; Table 6) carcasses. This different classes of grades for gilt/barrow and sow carcasses was necessitated due to distinct difference observed in the pattern of change

Table 4. Dressing coefficient reductions developed based on chilled carcass weight

Chilled carcass weight (kg)	Deductions in kg			
	Tongue out, KFKD out	Tongue in, KFKD out	Tongue out, KFKD in	Tongue in, KFKD in
< 50	0	0.25	0.60	0.85
50.5–74.5	0	0.30	0.80	1.10
75 – 99.5	0	0.30	1.30	1.60
> 100	0	0.30	1.80	2.10

\*The coefficients are applied in addition to the 2% hot carcass weight rebate. n=1,017; KFKD – Kidney fat, kidney and diaphragm.

Table 5. Yield grades for gilt and barrow carcasses

Primary criteria		Secondary criteria/ additional criteria	
Grade	Based on chilled carcass weight	Grade	Based on back fat thickness
Grade 1	< 44.9 kg	Grade 1	<14.9 mm
Grade 2	45 kg–54.9 kg	Grade 2	15–19.9 mm
Grade 3	55 kg–64.9 kg	Grade 3	20–24.9 mm
Grade 4	> 65 kg	Grade 4	>25 mm

Note: The final grade may be determined according to chilled carcass weight, and adjusting up or down one grade for back fat thickness.

among the parameters which were directly affect the carcass yield, viz. chilled carcass weight, back fat thickness and percent yield of primal cuts. In case of gilt/ barrow carcasses, it was observed that the chilled carcass weight increased linearly with increase in the back fat thickness (Fig. 1). Also, a proportionate linear increase was observed in the 'yield of primal cuts' with increase in the 'chilled carcass weight'. Therefore, to facilitate ease of documentation at processors level, only the 'chilled carcass weight' parameter had been considered for gilt/ barrow carcasses. However, an additional/ secondary criteria, viz. back fat thickness, was taken into account to give more credibility to the final grading (Table 5). In other words, the final grade may be determined according to chilled carcass weight, and adjusting up or down one grade for back fat thickness. For example, barrow and gilt carcasses with 45–54.9 kg 'chilled carcass weight' will be graded as 'Grade 2' if their back fat thickness between 10<sup>th</sup> and 11<sup>th</sup> rib positions, is in between 15–19.9 mm. However, if the back fat thickness is less than 14.9 mm, carcasses with 'chilled carcass weight' of 45 kg – 54.9 kg will be graded as 'Grade 1' instead of 'Grade 2'. In case of sow carcasses, it was observed that the 'percent

yields of primal cuts' were similar in carcasses with similar back fat thickness (Fig. 2). However, they had shown wide differences in 'chilled carcass weight' as the back fat thickness changed (Fig. 2). Therefore, back fat thickness for a particular grade was kept constant in similar 'percent yield of primal cut' groups to take into account the variations observed in 'chilled carcass weight' (Fig. 2; Table 6). Also, an additional/ secondary criteria, viz. back fat thickness, was taken into account (Table 6) and the final grade may be determined according to chilled carcass weight, and adjusting up or down one grade for back fat thickness, as described in case of gilt and barrow carcasses. In contrary to the simple grading system mentioned in this article, the yield grades for pig carcasses established by USA (US Grade 1, 2, 3 and 4), South Africa (PORCUS) and other leading pork producing countries are mostly based on percent of lean meat yield which in turn requires sophisticated equipments to measure carcass and meat quality parameters (Strzelecki *et al.* 1998, Judas *et al.* 2007, Wang *et al.* 2012). Also, these grades are assigned based on prediction equations. Under the current circumstances, such a system will not be viable in India until and unless

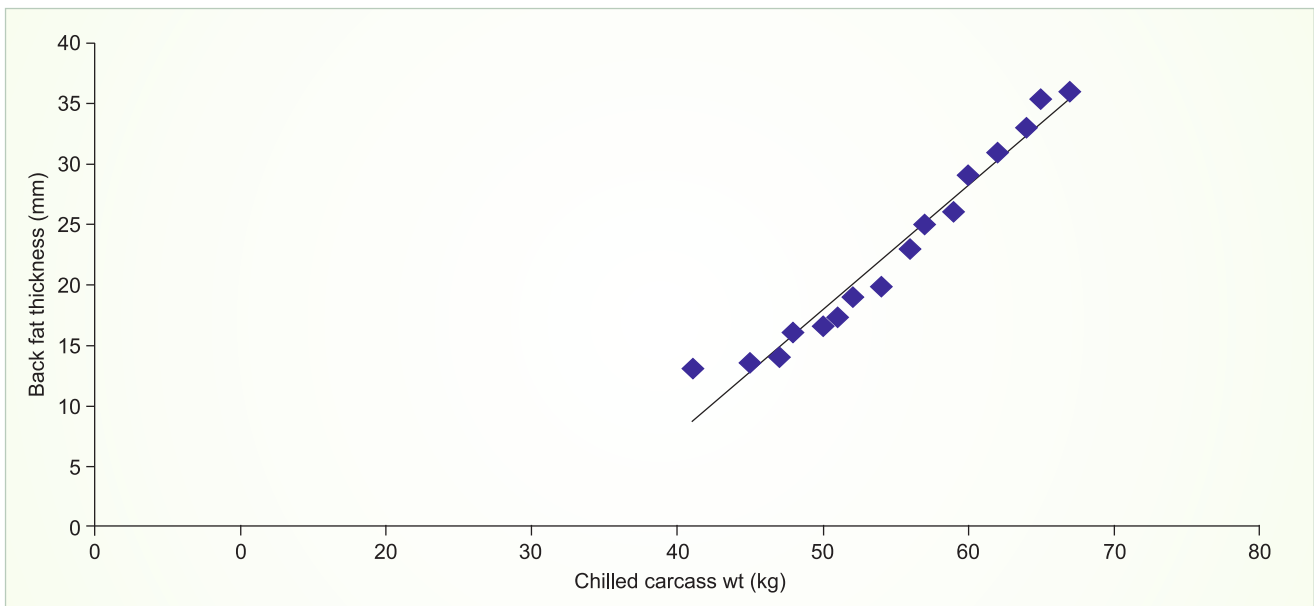


Fig. 1. The pattern of change of carcass weight with respect to back fat thickness in gilts and barrows.

Table 6. Yield grades for sow carcasses

Primary criteria		Secondary criteria/ additional criteria	
Grade	Percent yield of primal cuts	Grade	Based on back fat thickness
Grade 1	≥ 70%	Grade 1	25 mm – 34 mm
Grade 2	65%–69.9%	Grade 2	35 mm – 44 mm
Grade 3	60%–64.9%	Grade 3	45 mm or more
Grade C*	≤ 59.9%	Grade C*	24 mm or less

\*'C' represents 'cull' grade. Note: The final grade may be determined according to chilled carcass weight, and adjusting up or down one grade for back fat thickness.

Table 7. Quality grades for Indian pig carcasses

Grade	Meat colour	Firmness of back fat	Degree of marbling
Grade P	Light red-Reddish pink	Firm	Moderate – Slightly abundant marbling
Grade I	Pinkish gray	Soft to slightly firm	Slight marbling
Grade N	Gray	Very soft	No/negligible marbling
Grade D	Dark red	Very firm	Abundant marbling

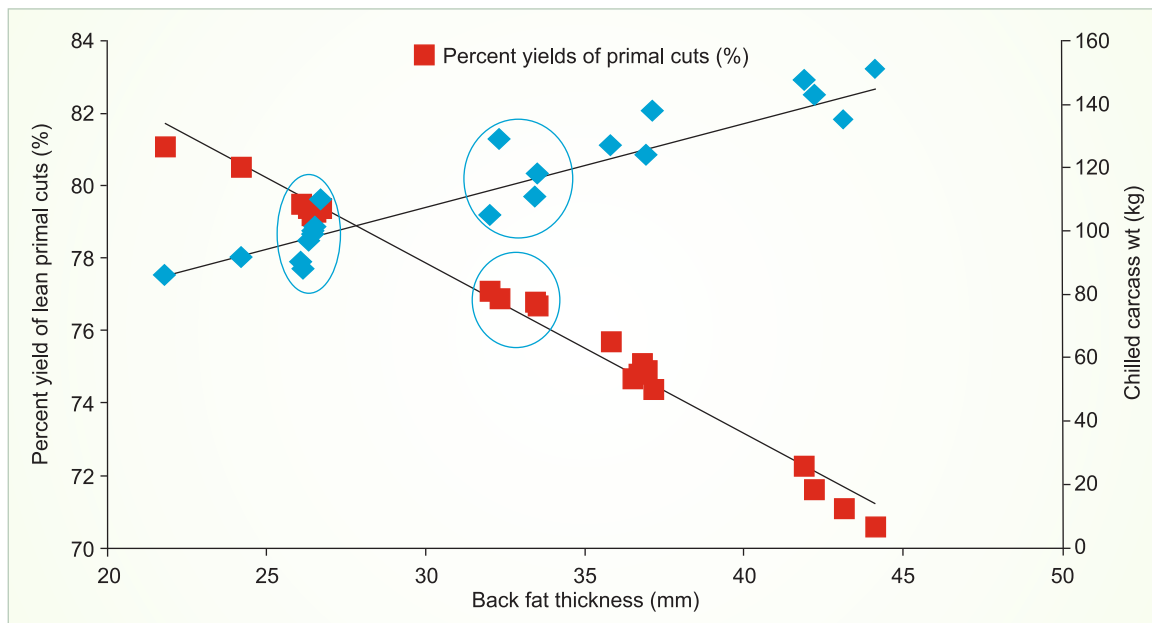


Fig. 2. Pattern of change in percent yield of lean primal cuts and chilled carcass weight with respect to back fat thickness in sow carcasses.

the quality of raw material (pig/pork), in terms of body conformation and meat quality, improves substantially. Further, the need of using equipments to measure the carcass parameters will not be practicable under the current pig slaughter system.

*Quality grades for Indian pig carcasses:* Pork quality refers to the expected eating characteristics (tenderness, juiciness and flavour) of the cooked product. The quality grades mentioned hereunder are developed to reflect differences in expected eating quality among slaughter pigs and their carcasses. Conventional methods for carcass quality measurement, such as meat colour, degree of marbling and firmness in back fat were considered for developing quality grades for Indian pork carcasses. Four different quality grades (Grade P-IND) were developed (Table 7), wherein Grade P and Grade I indicate pork carcasses with highly acceptable characteristics while Grade N and Grade D indicate carcasses with less acceptable characteristics. For example, pork carcasses (irrespective of age and sex) with reddish pink colour, firm back fat and moderate marbling, which are indications of good quality, will be graded as 'Grade P'. Similarly, those carcasses with very soft back fat, gray colour and no/ negligible marbling will become 'Grade N' while those with dark red meat, very firm back fat and abundant marbling will be graded as 'Grade D'. In other words, eating quality will be most desirable for "Grade P and Grade I" and least desirable for 'Grade N and Grade D'. The uppercase letters used in the naming of grades, i.e. P, I, N and D were selected in order to indicate the pork (P) from India (IND). The quality classes of pig carcasses established by EU (SEUROP) encompass both quality and yield parameters and are based on objective carcass data (Huff-Lonergan *et al.* 2002, Rosenvold and Andersen 2003, Hugo and Roodt 2015). The quality grading system described in this article is based on both objective

and subjective evaluation of the carcass.

In India, consumers and producers often do not have a clear understanding of pork grading and are not into practice. The existing Indian Standard for 'Specification for pork', i.e. IS: 1723-1973 specifies only two grades of pork, i.e. *Grade 1* and *Grade 2*, which is insufficient to meet the current marketing requirements. Thus, a more relevant pork grading system was developed with distinct quality grades and yield grades. Quality grades will be of more important to most of the consumers as they may use them as a selection criterion when purchasing at retail. However, yield grades have less direct impact on consumer selection decisions. Producers could depend greatly on both quality and yield grades as a marketing tool for pork carcasses.

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