ESTABLISHMENT OF LIVESTOCK GRADING STANDARDS FOR PHILIPPINES USE: CATTLE AND CARABAOS

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ABSTRACT

Two studies were conducted simultaneously to establish grading standards for cattle and carabaos. Study 1 used 88 cattle 53 bulls and 35 cows weighing 150 to 599 kilograms with age ranged from 1.5 to 12 years old. The study 2 used 75 carabaos 48 bulls and 27 cows, weighing 175 to 567 kg, with age ranging from 2 to 14 years old. Live data such as age, liveweight, body measurements and body conformation score were recorded. The carcass data such as hot carcass weight, dressing percent and rib-eye-area over the 12^{th} rib region were likewise obtained. In both species, dressing percent tended to decrease with age but increase with liveweight. The rib-eye-area also increased with liveweight but not with age. All body measurements were strongly correlated with liveweight on both species, however, only heartgirth and shoulder width were consistently positively correlated with the dressing percent. Dressing percent decreases from BCS 1 to 3 so as with BAI grades 1 to 5, except in cattle in which BAI 3 had higher dressing percent than those of BAI 2. Rib-eye-area was not affected by BCS neither BAI grades in both species.

KEYWORDS: grading standard, body condition score, cattle, carabao

INTRODUCTION

Agriculture is one of the major contributing sectors of the Philippine economy, wherein livestock industry is one of the major players. In 2005, the livestock sub-sector contributed 13.43% to the total agricultural production (BAS, 2005). There is a need to sustain or improve this positive status to increase the local meat production and to make meat available for every Filipinos throughout the year at a reasonable price. In 2004, the local meat production of 119,229 metric tons for beef and 80,369 metric tons for carabeef (BAS, 2004) were not enough to meet the demand of 84.2 million people in the Philippines. Thus, the government resorted to meat importation to fill up the supply and demand gap. Importation filled up 28% and 45% shortage in the local supply of beef and carabeef, respectively (BAS, 2004). The task to meet the needs of our growing population without resorting to importation is really a big challenge to the livestock industry. Thus, several programs to improve the livestock marketing systems were formulated and implemented to attain self-sufficiency.

One of the breakthroughs in the livestock industry is the establishment of the Livestock Oksyon Market (LOM) with the proclamation of Presidential Decree (P.D.) No.7 dated September 1972. Since 1973, the Bureau of the Animal Industry (BAI) leads in establishing LOMs nationwide.

Today, thirty-three years after the establishment of the first LOM, there are still problems in its system that needs to be addressed. One of these is the unfair pricing of the livestock commodities wherein the usual victims are the small farmers. They do not have the technical knowledge to determine the proper price for their produced and also lack access to the market information. Added to this is the insufficiency of the BAI livestock grading system presently used in different Philippine LOMs as basis of livestock pricing. At LOMs, pricing basis is

mainly subjective which opens the room for the traders to dictate the price and completely dominate the trading transaction.

In accordance to its mandate to prescribe standards for the quality of manufacture, importation, labeling, advertising, distribution and sale of livestock, BAI conducted a study to devise a grade classification using grade factors that can estimate not only the liveweight of the animal but the total value of the carcass. This would lead to a more orderly and fair livestock transaction that would encourage the farmers to produce more and better quality animals. This study is a follow-up project of improving the proposed grading guide basically applicable to the current livestock marketing situation, in which animals are usually sold live by the farmers to the traders. The ultimate aim of the proposed grading guide is to have standard system of live animal evaluation that would be fair to both farmers and traders, which will serve as instrument to facilitate pricing and marketing of livestock. Live animal grading is important to (1) facilitate sales on the basis of grades rather than inspection; (2) provide market identification and basis for advertising of the products; (3) increase the utility of market information that enables traders to compare processes of products, and; (4) permit buyers to purchase products without physically inspecting them. A stamp of meat grade provides consumers with reliable guide of quality (Romans and Ziegler, 1977). Through common grading standards implementation, efficient marketing system would be attainable. This notable achievement of the government would be beneficial to the raisers, traders, consumers, and ultimately to the industry as a whole.

OBJECTIVES

The main objective of the project is to formulate and recommend grading standards for live cattle and carabao applicable in the Philippines that will determine price differential in the local markets.

This project specifically aims to:

1. Identify the live parameters that could estimate the total value of the beef and carabeef carcass which can be used as grade factor for cattle and carabao;
2. Assess and validate the proposed grade classification of live cattle and carabao being used in the Livestock "Oksyon" Markets in the Philippines, and;
3. Formulate grade classification of cattle and carabao for common use in the livestock industry**.**

METHODOLOGY

Experimental Design

The project was divided into two studies. Study 1 dealt with the establishment of live grading standard for beef cattle, while study 2 dealt with the establishment of live grading standard for carabaos. The two studies used similar experimental approaches. The same set of live and carcass data were obtained from both studies.

In study 1, 88 cattle coming from ten selected slaughterhouses were used as experimental samples. The age of cattle used ranged from 1.5 to 12 years old, and the liveweight ranged from 150 to 599 kg. The cattle were composed of 53 bulls and 35 cow with breed either Purebred Brahman, Native or their crosses.

The study 2 used 75 carabaos from the same selected slaughterhouses as experimental animals. The age of carabaos ranged from 2 to 14 years old, with liveweight range of 175 to 567 kg. They were composed of 48 bulls and 27 cows with breed either Philippine Carabao or its cross with Murrah buffaloes.

The purposive sampling was used in the conduct of the study. Criteria for the selection of the slaughterhouses follow: (1) volume of cattle and carabao slaughtered; (2) fabrication procedure used wherein the rib-eye-area must be intact to be used as sample; and (3) the willingness of the owner to use their animals as samples.

Evaluation of Live Traits

Live parameters such as age, liveweight, body measurements (heartgirth, body length, body height, round width, shoulder width and paunch girth) and body conformation score (BCS) were taken while the animals were still in the holding pens. General body characteristics such

as proportionality of parts and pliability of the hides were also considered in body condition scoring.

Age. In the absence of reliable records, age was estimated through dentition. This was obtained during weighing of the animals. However, dentitions of the wild animals were observed after their heads were cut- off. Farmers who raised their animals since birth also served as sources of information.

Liveweight. A digital livestock weighing scale (Mettler-Toledo) was used in the study. Animals at weighing time were at different degree of fasting or feed withdrawal.

Body measurements. Body measurements were done following the procedures described by (Ibarra, 1988). Heartgirth was measured by encircling the measuring tape around the chest of the animal, passing through the highest point over the withers and just behind the forelegs. The body length was measured from the point of the shoulder (*tuberosity* of the humerus) up to the pin bone. Body height was measured by allowing the animal to stand squarely on an even plane. The wooden stick parallel was placed to the vertical drop of the animal at the region of the forelegs and the height being the distance from the ground level to the top of the withers Round width was obtained using a wooden caliper by measuring the distance of one side to the other at the point of the pin bone while the animal is standing in a normal position. Shoulder width was obtained using a wooden caliper by measuring the distance of one side to the other at the point of the wither while the animal is standing in a normal position. Paunch girth was measured by encircling the measuring tape around the abdominal region going over and around the back of the ventral midline at about the umbilicus.

Body conformation scoring. Body condition scoring was done by project staffs that have long exposure to LOM operations and are familiar with the animal body conformation scoring. The study used three-point scoring system which was adopted from the five-point scale

system presented by Hidaka (2005) on dairy buffaloes and beef cattle, and Edmonson et al. (1989) on dairy cows. The following describe the characteristics of the animals belonging to each score:

BCS 1 – is characterized by good fat covering indicated by a smooth rounded appearance through out the body. The backbone, hips, shoulders and ribs are smooth. The rounds, flanks and brisket are full. From the rear, the legs are set wide apart and hipbones are slightly prominent.

BCS 2 – has a moderate fat covering, indicated by a rough angular more irregular appearance than BCS 1. The body appears thin with prominent backbone, ribs, hips and shoulders. The round flanks and brisket are sunken. From the rear, the legs are slightly close together and hipbones are prominent.

BCS 3 – is very thin and bony in appearance. The body appears thin with very prominent backbone, ribs, hips and shoulders.

The summary of the description of each body condition score are presented on Appendices 1 and 2.

Evaluation of Carcass Traits

Selected carcass traits related to yield were evaluated and determined whether these traits have correlation with the live traits. The carcass yield traits evaluated were carcass weight, dressing percent, and rib-eye-area.

Carcass weight. Weight of the carcass after the completion of the dressing process (bleeding, removal of head and shanks, flaying, evisceration, and washing) was measured using a digital carcass weighing scale.

Dressing percentage. In this study, dressing percentage was based on the hot carcass weight of the cattle and carabao. Dressing percentage was calculated using the formula:

$$\text{Dressing Percent} = \frac{\text{Hot Carcass Weight}}{\text{Slaughter Weight}} \times 100$$

Rib-Eye-Area. The rib-eye-area (REA) was measured at the rib region between the 11^{th} and 12^{th} ribs of the left side of the carcass using a grading grid.

Development of Grading System

The proposed grading systems for cattle and carabao were developed based on the results of the evaluation of the interrelationships between the live parameters and carcass yield traits. Live traits that highly affect carcass yield were used as grade factors.

Statistical Analysis

The correlation analysis was used as the basis to ascertain the degree of strength of the relationship between live and carcass parameters.

In determining the effects of BCS and proposed grades on dressing yield and rib-eye-area, Analysis of Variance (ANOVA) was used.

The study used SAS and SPSS (version 10.1) softwares for statistical analyses.

Scope and Limitations of the Study

The establishment of grading standards focused on cattle and carabaos as priority livestock commodities. The interest of the study is to evaluate live parameters in relation to carcass yield and quality. During the pre-test, it was noted that quality is affected by many factors in the slaughtering process. Quality parameters of the carcass such as meat color,

marbling and meat firmness cannot be predicted from live animal. Thus, the study focused in the yield factors. The breed of the animals was not also considered due to the absence of records that could indicate the correct breed or bloodline of the test animals.

The result of the study will be used in the future LOM operations. However, data gathering was conducted in different slaughterhouses since evaluation entailed live animal parameters, carcass and meat characteristics.

The collections of samples were done only in Luzon area since majority of the animals produced in Visayas and Mindanao are brought in Metro Manila and Luzon for trading and slaughtering. Also, the research team tried to cut the operation costs due to limited funds. The selection of slaughterhouses depends on the volume of cattle and carabao slaughtered, the fabrication procedure used wherein the rib eye must be intact to be used as sample, and the willingness of the owner to use their animals as samples.

In order to obtain data on livestock population, list of abattoirs and other necessary data for the study, Bureau of Animal Industry (BAI) worked in coordination with the different agencies of the Department of Agriculture (DA) such as the National Meat Inspection Services (NMIS) and the Bureau of Agricultural Statistics (BAS).

Other activities include informal dialogue with farm owners and livestock traders/ viajeros, visitation in Livestock "Oksyon" Markets (LOMs), and observation of slaughtering procedures in selected abattoirs. Finally, a dry run of data collection was conducted in Monterey Food Corporation Slaughterhouse located in Dasmariñas, Cavite.

RESULTS AND DISCUSSION

Study 1: Establishment of Live Grading Standard for Cattle

Correlation among Live Parameters and Carcass Traits of Cattle

To determine what live parameters can be used to estimate carcass yield of beef cattle, correlation analyses among the live parameters (age and liveweight) and carcass traits (carcass weight, dressing percent and rib-eye area) were conducted. The correlation coefficients among selected live parameters or measurement and carcass yield and traits of cattle are presented in Table 1. The age of cattle was found to have significant weak positive correlation with liveweight ($P < .05$). The weak correlation between the age and liveweight of cattle indicates that most of the cattle used in the study were already matured or had reached their growth potential. The age of cattle used in this study ranged from 1.5 to 12 years old. There was weak negative correlation ($P < .01$) found between age and dressing percent of cattle. This implies that as the cattle grows older, the dressing percentage tends to decrease. This result corroborated the findings of Sawyer et al. (2004) on their study on culled beef cows.

Liveweight was found to have very strong correlation with carcass weight. But this can be expected since the two parameters are both weight values. There was weak correlation ($P < .05$) observed between liveweight and dressing percent. This means that there is tendency for the larger cattle to have higher dressing percent as compared to smaller ones. The rib-eye area was found to have moderate correlation with liveweight. This indicates that rib-eye-area of cattle cannot be used alone as basis for the leanness of the carcass because it is also dependent partly on the liveweight.

Table 1. Correlation coefficient among selected live parameters and carcass yield and traits of cattle (n = 88)

ITEMS	CORRELATION COEFFICIENT	
	Age	Liveweight
Liveweight	.268*	-
Carcass Weight	.138	.965**
Dressing Percent	-.331**	.337*
Rib-eye Area	.071	.564**

** Correlation is significant at 0.01 level (2-tailed)
* Correlation is significant at 0.05 level (2-tailed)

Correlation between Body Measurements and Age, Liveweight and Carcass Traits of Cattle

There were weak to moderate positive correlations between age and various body measurements except with round width and shoulder width. The results can be explained by the fact that most of the animal used in this study had attained their matured age and size.

Strong to very strong correlations between body measurements and liveweight of the cattle were observed. Among the body measurements, heartgirth was found to have the highest correlation with the liveweight (coefficient= 0.934). This was followed by pounchgirth with 0.923 coefficient. This result shows that the heartgirth and pounchgirth can be used to estimate liveweight of cattle in the absence of weighing scale. Using SPSS Stepwise Linear Regression Analysis with liveweight as dependent variable (the heartgirth, pounchgirth, body height and body length as independent variables), the following regression models were obtained:

(1) LW = -524.952 + 5.224(HG); r^2 = .853

(2) LW = -552.262 + 2.779(HG) + 2.314(PG); r^2 = .907

where:

LW = liveweight, (kg)

HG = heartgirth, (cm)

PG = pounchgirth, (cm)

Note that body height and length were excluded from the list of the independent variables. The regression coefficient was higher when the two variables (heartgirth and pounchgirth) were used in predicting liveweight. This is in contrast with the carabao in which heartgirth is a sufficient parameter to estimate the liveweight.

Table 2. Correlation coefficient among body measurement and age, liveweight, and carcass traits of cattle (n = 88)

BODY MEASUREMENTS	**CORRELATION COEFFICIENTS**				
	Age	Liveweight	Carcass Wt.	Dressing %	Rib-eye Area
Heartgirth	.253*	.934**	.909**	.348*	.547**
Body Length	.340**	.843**	.780**	.166	.462**
Body Height	.338**	.852**	.812**	.238	.462**
Round Width	.214	.843**	.814**	.259*	.561**
Shoulder Width	.214	.807**	.791**	.288*	.594**
Pounchgirth	.473**	.923**	.826**	.132	.510**

** Correlation is significant at 0.01 level (2-tailed)

* Correlation is significant at 0.05 level (2-tailed)

Effect of Body Conformation Score (BCS) on Carcass Traits of Cattle

Cattle with body conformation score "1" (BCS 1) had significantly higher dressing percent (53.63%) than those with BSC 2 and 3 (see Table 3). Cattle with BCS 2 tend to have higher dressing percent (49.42%) than those with BCS 3 (47.56%), but the difference was not statistically significant. Cattle with BCS 1, 2 and 3 were statistically similar in terms of rib-eye area. Cattle with BCS 3 however tend to have smaller rib eye area compared to those with BCS 1 and 2. Apple et al. (1999) reported that the improvement in BCS of culled beef cows corresponds with linear increase in dressing percent, fat thickness, *longissimus* muscle area, muscle: bone ratio.

Proposed Grading System

Based on the results of the correlation analysis between live parameters and carcass traits of cattle, considering the effect of BCS and age on dressing yield, and the visual evaluation of the data, a proposed live grading system was developed. The proposed grade designations were "BAI 1, 2, 3, 4, and 5". The grade factors considered were age/maturity and body conformation score (BCS). Liveweight was not used as grade factor since it has minimal effect on the dressing yield of cattle. Cattle with age not more than 42 months and with BCS 1 were graded as BAI 1. The BAI 2 grade was composed of cattle with age not more than 42 months but with BCS 2. Cattle with age more than 42 months were automatically graded either BAI 3, 4 or 5 and not eligible for BAI grades 1 and 2. The BAI 3 and BAI 4 grades were given to cattle with age more than 42 months and with BCS 1 and BCS 2, respectively. The BAI 5 was given for those with BCS 3 regardless of age. Table 4 shows the summary of the proposed live grading system for cattle.

To validate the proposed live grading system of cattle, the data obtained from 88 cattle samples were segregated to fit into the proposed grades. Data set of individual animal was assigned to each grade according to the grade criteria. Table 5 shows the summary of the results of ANOVA of dressing yield and rib-eye-area of cattle classified according to grades.

Table 3. Carcass traits of cattle as affected by body conformation scores (BCS)[1]

BCS	**N**	DRESSING YIELD, %		RIB-EYE AREA	
		Mean	S. D.	Mean	S. D.
1	48	53.63[a]	3.62	9.34	2.38
2	24	49.42[b]	4.41	9.32	3.10
3	16	47.56[b]	4.56	7.48	2.11
Mean/Total	88	51.36	4.43	9.06	2.56

[1]Means within the same column with different superscript are significantly different ($P < .05$)

Table 4. Proposed grading system for cattle

GRADE DESIGNATION	GRADE FACTORS	
	Age / Maturity[1]	BCS[1]
BAI 1	$\leq$ 42 mos.	1
BAI 2	$\leq$ 42 mos.	2
BAI 3	> 42 mos.	1
BAI 4	> 42 mos.	2
BAI 5	-	3

Table 5. Dressing percent and rib-eye area of cattle classified according to live grade[1]

GRADES		DRESSING YIELD (%)		RIB-EYE AREA (inch^2)	
	N	Mean	S. D.	Mean	S. D.
BAI 1	35	54.20^a	3.72	8.93	2.34
BAI 2	20	50.40^c	4.44	9.11	3.04
BAI 3	13	52.08^b	2.90	10.31	2.24
BAI 4	11	48.18^{cd}	4.71	9.33	2.88
BAI 5	9	45.44^d	2.24	7.20	1.60
Mean/Total	88	51.38	4.73	9.07	2.56

[1] Means within the column with different superscript are significantly different ($P \leq .01$).

Cattle graded as BAI 1 had the highest dressing percent (54.20%) and it was significantly higher than the rest of the grades. The cattle graded as BAI 3 followed with 52.08% dressing yield and it was significantly higher than the dressing yields of the cattle graded as BAI 2 (50.40%), BAI 4 (48.18%) and BAI 5 (45.44%). Significant higher dressing percent of BAI 1 over the BAI 3 cattle indicates that the age affected the dressing yield of cattle with older animals having the lower dressing percent. The separate studies of Gullett et al. (1986) and May et al. (1992) both indicated that beef from younger cattle were more tender and less chewy than those coming from older cattle.

The higher dressing yield of BAI 3 grade compared to those of BAI 2 can be explained by its better BCS. The dressing percent of cattle graded BAI 2 was significantly higher than those graded as BAI 5 but not significantly different from BAI 4.

Cattle belonging to different grades did not vary significantly in terms of rib-eye-area. This can be attributed also to the influence of liveweight on rib-eye-area that masked the effect of BCS.

Study 2: Establishment of Live Grading Standard for Carabaos

Correlation among Live Parameters and Carcass Traits of Carabaos

Similar to what was done in cattle, correlation analysis among the live parameters (age and liveweight) and carcass traits (carcass weight, dressing percent and rib-eye area) were performed. There were similarities in trend observed in carabaos and cattle (see Tables 1 and 6). The age of carabaos was found to have significant weak positive correlation with liveweight ($P < .01$). This weak correlation between the age and liveweight of carabaos indicates that most of the animal used in the study were already matured or had reached their growth potential. The age of the carabaos used in this study ranged from 2 to 14 years old. Moderate negative correlation ($P < .01$) was found between the age and dressing percentage of carabaos. This implies that as the carabao grows older, the dressing percentage decreases. This can probably be attributed to the increasing proportion of head and feet, as well as the increasing thickness of hide as the carabao becomes older. Unlike in cattle, the negative correlation between age and dressing percent was greater in carabao (-.494 vs. -.331).

Liveweight was found to have very strong correlation with carcass weight. However, this can be expected since the two parameters are both weight values. There was weak correlation ($P < .05$) observed between liveweight and dressing percent. This means that there is tendency for the larger animals to have higher dressing percent as compared to smaller animals.

Table 6. Correlation coefficient among selected live parameters and carcass yield and traits of carabaos (n = 75)

ITEMS	CORRELATION COEFFICIENT	
	Age	Liveweight
Liveweight	.392**	-
Carcass Weight	.123	.927**
Dressing Percent	-.494**	.244*
Rib-eye Area	.213	.742**

** Correlation is significant at 0.01 level (2-tailed)
* Correlation is significant at 0.05 level (2-tailed)

The rib-eye area was also found to have strong correlation with liveweight. This clearly shows that rib-eye area cannot be used alone as basis for the leanness of carabaos because it is also dependent on liveweight. Liveweight must be considered in using the rib-eye area as tool in estimating the leanness of the animal.

Correlation between Body Measurements and Age, Liveweight and Carcass Traits of Carabaos

Correlation analysis were done to determine the relationship between body measurements and age, liveweight and carcass traits of carabaos. The result showed that there were weak to moderate positive correlations between age and various body measurements. The results can be explained by the fact that most of the animal used in this study had attained their mature age and size.

There were strong to very strong correlation between body measurements and liveweight of the carabao. Among the body measurements, heartgirth was found to have the

Table 7. Correlation coefficient among body measurement and age, liveweight, and carcass traits of carabao (n = 75)

BODY MEASUREMENTS	CORRELATION COEFFICIENTS				
	Age	Liveweight	Carcass Wt.	Dressing %	Rib-eye Area
Heartgirth	.367**	.962**	.903**	.270*	.703**
Body Length	.504**	.658**	.559**	.037	.428**
Body Height	.243*	.852**	.818**	.308**	.428**
Round Width	.482**	.789**	.729**	.207	.595**
Shoulder Width	.364**	.702**	.701**	.315**	.562**
Pounchgirth	.443**	.765**	.617**	-.031	.539**

** Correlation is significant at 0.01 level (2-tailed)
* Correlation is significant at 0.05 level (2-tailed)

highest correlation with the liveweight with coefficient of 0.962. This was followed by body height with coefficient of 0.851. The result shows the heartgirth and body height can be used to estimate liveweight of carabaos in the absence of weighing scale as already reported in other previous studies. Using SPSS Stepwise Linear Regression Analysis with liveweight as dependent variable and the heartgirth and body height as independent variables, the following regression model was obtained:

$$LW = -603.231 + 5.579(HG); \qquad r^2 = 0.925$$

where:

LW = liveweight (kg)

HG = heartgirth (cm)

It can be noted that the body height was excluded from the list of the variables.

Very strong correlation was also observed between carcass weight and heartgirth (0.903) as well as between carcass weight and body height (0.818). However, as can be noted, the correlation coefficients were lower compared when the two variables were correlated to liveweight. The lower correlation coefficient between carcass weight and body measurements can be attributed to the effect of gut fill and other factors affecting dressing yield of carabaos.

Using Stepwise Linear Regression Analysis with carcass weight as dependent variables and the heartgirth and body height as independent variables, the following regression formula was obtained:

$$CW = -322.163 + 2.829(HG); \qquad r^2 = .816$$

where:

CW = hot carcass weight (kg)

HG = heartgirth (cm)

The dressing percent of carabaos was found to have weak positive correlation with heartgirth, body height and shoulder width. These results somehow indicated the relationships between body conformation and dressing yield of carabao.

The rib-eye-area was found strongly correlated ($P < .01$) with heartgirth and moderately correlated ($P < .01$) with the rest of the body measurements. However, the relationships between rib-eye-area and body measurements were found as compounded effect of liveweight on the rib-eye-area rather than of body measurements alone. This was proven when partial correlation between rib-eye-area and body measurements was done with liveweight set as controlling factor. The result of partial correlation showed that none of the body measurement has significant correlation with rib-eye-area.

Effect of Body Conformation Score (BCS) on Carcass Traits of Carabaos

Carabaos with body conformation score "1" (BCS 1) had significantly higher dressing percent (49.34%) than those with BSC 2 and 3 (see Table 8). Carabaos with BCS 2 tend to have higher dressing percent (43.44%) than those with BCS 3 (40.50%), but the difference was not statistically significant. Carabaos with BCS 1 tend to have the largest rib-eye-area (7.63 sq. inches), followed by those with BCS 2 (6.97 sq. inches) and BCS 3 (5.43 sq. inches). The differences however were not statistically significant.

Proposed Grading System

Based on the results of correlation analysis between live parameters and carcass traits, considering the effect of BCS on dressing yield, and the visual evaluation of the data, a proposed live grading system was developed. The live grading system was composed of grade designation and grade factors. The proposed grade designations were "BAI 1, 2, 3, 4, and 5".

Table 8. Effect of body conformation score (BCS) on dressing yield and rib-eye-area of carabaos with random age[1]

BCS	**N**	DRESSING YIELD, (%)		RIB EYE AREA, (inch^2)	
		Means	S. D.	Means	S. D.
1	35	49.34[a]	5.27	7.63	1.51
2	36	43.44[b]	3.65	6.97	1.51
3	4	40.50[b]	5.00	5.43	1.56
Mean/Total	75	46.04	5.50	7.20	1.58

[1]Means in the same column with different superscript are significantly different ($P < .05$).

The grade factors considered were age/maturity and body conformation score (BCS). The BAI 1 carabaos were characterized by age not more than 42 months and with BCS 1. It was further sub-categorized into "1 (+)" and "1 (-)" to separate heavier animals to lighter ones, though they have similar expected percent dressing yield. BAI 1 (+) were carabaos weighing 400 kg or more, while BAI (-) were those weighing less than 400 kg. The BAI 2 grade was composed of carabaos with age not more than 42 months but with BCS 2. Carabaos with age more than 42 months were automatically graded either BAI 3, 4 or 5 and not eligible for BAI grades 1 and 2. The BAI 3 grade was given to carabaos with age more than 42 months and with BCS 1 regardless of weight, while BAI 4 was assigned for those with BCS 2. BAI 5 was given for those carabaos with BCS 3 regardless of age. Table 4 shows the summary of the proposed live grading system for carabaos.

To validate the proposed live grading system, the data obtained from 75 carabaos were segregated to fit into the proposed grades. Data set of individual animal was assigned to each grade according to the grade criteria in Table 9. Table 10 shows the summary of the results of

Table 9. Proposed grading system for carabaos

GRADE DESIGNATION	GRADE FACTORS		
	Age / Maturity[1]	Liveweight	BCS[1]
BAI 1 (+)	$\leq$ 42 mos.	$\geq$ 400 kgs.	1
BAI 1 (-)	$\leq$ 42 mos.	< 400 kgs.	1
BAI 2	$\leq$ 42 mos.	-	2
BAI 3	> 42 mos.	-	1
BAI 4	> 42 mos.	-	2
BAI 5	-	-	3

Table 10. Dressing percent and rib-eye-area of carabaos classified according to live grade[1]

GRADES	N	DRESSING YIELD (%)		RIB-EYE AREA (inch^2)	
		Means	S. D.	Means	S. D.
BAI 1 (+)	18	53.33[a]	3.88	7.86	1.55
BAI 1 (-)					
BAI 2	17	45.15[b]	3.79	7.35	1.46
BAI 3	8	46.48[b]	3.45	6.77	1.26
BAI 4	28	42.53[c]	5.00	7.10	1.60
BAI 5	4	40.54[c]	5.10	5.44	1.56
Mean/Total	75	46.04	5.50	7.22	1.58

[1]Means within the column with different superscript are significantly different ($P < .01$).

the comparison among carabaos belonging to different grades.

Carabaos graded as BAI 1 had the highest dressing percent (53.33%) and it was significantly higher than the dressing percent of those graded as BAI 2 (45.15%), BAI 3 (46.48%), BAI 4 (42.53%) and BAI 5 (40.54%). The dressing percent of carabaos graded BAI 2 and 3 were similar and were significantly higher than those graded as BAI 4 and 5. The BAI 4 graded carabaos tend to have higher dressing percent than those graded BAI 5, however the difference was not statistically significant.

The carcasses of carabaos belonging to different grades have similar rib-eye-area. This can be attributed to the large effect of liveweight on rib-eye-area that probably supersedes the effect of BCS.

CONCLUSION AND RECOMMENDATION

Two studies were conducted to formulate and recommend grading standards for live cattle and carabaos using 88 cattle and 75 carabaos. Correlation analysis among the live parameters (age and liveweight) and carcass traits (carcass weight, dressing percent and rib eye area) were conducted to determine what live parameters can be used to estimate carcass yield of beef cattle. The age of cattle had weak positive correlation with liveweight, which indicates that most of the cattle used in the study were already matured or had reached their growth potential. There was weak negative correlation between age and dressing percent of cattle. This implies that as the cattle grows older, the dressing percentage tends to decrease.

Larger cattle tend to have higher dressing percent as compared to smaller ones. The rib-eye area was found to have moderate correlation with liveweight, indicating that the rib-eye-area of cattle cannot be used alone as basis for the leanness of the carcass because it is also partly dependent on the liveweight.

Among the body measurements, heartgirth was found to have the highest correlation with the liveweight (coefficient= 0.934). This was followed by pounchgirth (coefficient= 0.923). Two regression models were developed to predict liveweight using body measurements.

Cattle with body conformation score "1" (BCS 1) had higher dressing percent (53.63%) than those with BSC 2 and 3. Cattle with BCS 2 tend to have similar dressing percent (49.42%) with BCS 3 (47.56%). Cattle with BCS 1, 2 and 3 were statistically similar in terms of rib-eye area.

Based on the results of correlation analysis between live parameters and carcass traits of cattle (considering the effect of BCS and age on dressing yield and the visual evaluation of the data), a proposed live grading system was developed. The proposed grade designations

were "BAI 1, 2, 3, 4, and 5". Whereas the grade factors considered were age/maturity and body conformation score (BCS).

Cattle graded as BAI 1 had the highest dressing percent (54.20%). This was followed by BAI 3 (52.08%); BAI 2 (50.40%); BAI 4 (48.18%); and BAI 5 (45.44%). The higher dressing percent of BAI 1 over BAI 3 cattle indicates that age affected the dressing yield of cattle. Older animals have lower dressing percentage. Cattle belonging to different grades did not vary significantly in terms of rib-eye-area.

There was a moderate negative correlation between age and dressing percentage of carabaos. This implies that as the carabao grows older, the dressing percentage decreases. There was also tendency for the larger carabaos to have higher dressing percent as compared to smaller ones.

The rib-eye-area of carabao had also strong correlation with liveweight. This clearly shows that rib-eye area cannot be used alone as a basis for the leanness of carabaos because it is also dependent on liveweight. Thus, liveweight must be considered in using the rib-eye area as tool in estimating the leanness of the animal.

Among the body measurements, heartgirth was found to have the strongest correlation with liveweight (coefficient= 0.962). This was followed by body height (coefficient= 0.851). The regression model was developed to predict liveweight with only heartgirth as determining factor.

Very strong correlations were also observed between carcass weight and heartgirth (0.903) and between carcass weight and body height (0.818). The correlation coefficients were lower compared to when the two variables were correlated to liveweight.

The dressing percentage of carabaos was found to have weak positive correlation with heartgirth, body height and shoulder width. These results somehow indicated relationships between body conformation and dressing yield of carabao.

The rib-eye-area was found to be strongly correlated with heartgirth and moderately correlated with the rest of the body measurements. However, the relationships between the rib-eye-area and body measurements were found to be the compounded effect of liveweight on the rib-eye-area rather than of body measurement alone.

Carabaos with BCS 1 had higher dressing percent (49.34%) than those with BSC 2 and 3. Carabaos with BCS 2 tend to have higher dressing percent (43.44%) than those with BCS 3 (40.50%), but the difference was not statistically significant. Carabaos with BCS 1 to 3 had similar rib-eye-area.

Based on the results of correlation analysis between live parameters and carcass traits, (considering the effect of BCS and age on dressing yield and the visual evaluation of the data), a proposed live grading system was developed. The live grading system was composed of grade designation and grade factors. The proposed grade designations were "BAI 1, 2, 3, 4, and 5". Whereas, the grade factors considered were age/maturity and the body conformation score (BCS).

Carabaos graded as BAI 1 had the highest dressing percent (53.33%). It was significantly higher than the dressing percent of those graded as BAI 2 (45.15%), BAI 3 (46.48%), BAI 4 (42.53%) and BAI 5 (40.54%). The dressing percent of carabaos graded BAI 2 and 3 were similar and were significantly higher than those graded as BAI 4 and 5. The BAI 4 graded carabaos tend to have higher dressing percent than those graded BAI 5. However, the difference was not statistically significant.

The carcasses of carabaos belonging to different grades had similar rib-eye-area.

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USDA AGRICULTURAL MARKETING SERVICES. 1197. USDA standards for grades of slaughter cattle

APPENDICES

Appendix 1. Description of Body Condition Score Used in Cattle

Body Parts	BCS 1	BCS 2	BCS 3
		Front View	
Chest / Brisket	Wide and tightly muscled	Moderately wide and muscled	Narrow and loose skin
Legs	Wide apart	Spaced	Very close to each other
		Rear View	
Rump	Plump	Flat	Indented
Hip Bone	Rounded	Slightly rounded	Angular
Pin Bone	Not visible	Slightly visible	Visible
Legs	Wide apart	Spaced	Very close to each other
		Whole Body	
Muscling	Thickly muscled	Moderately muscled	Thinly muscled

Appendix 2. Description of Body Condition Score Used in Carabao

Body Parts	BCS 1	BCS 2	BCS 3
		Front View	
Chest / Brisket	Wide and tightly muscled	Moderately wide and muscled	Narrow and loose skin
Legs	Wide apart	Spaced	Very close to each other
		Side View	
Ribs	Not visible	Slightly visible	Visible
Backbone	Not visible	Slightly visible	Visible
Neck	Apparently short	Average	Apparently long
		Rear View	
Rump	Plump	Flat	Indented
Hip Bone	Rounded	Slightly rounded	Angular
Pin Bone	Not visible	Slightly visible	Visible
Legs	Wide apart	Spaced	Very close to each other
		Whole Body	
Muscling	Thickly muscled	Moderately muscled	Thinly muscled

Appendix 3. Descriptive Statistics

A. Cattle

B. Carabao