

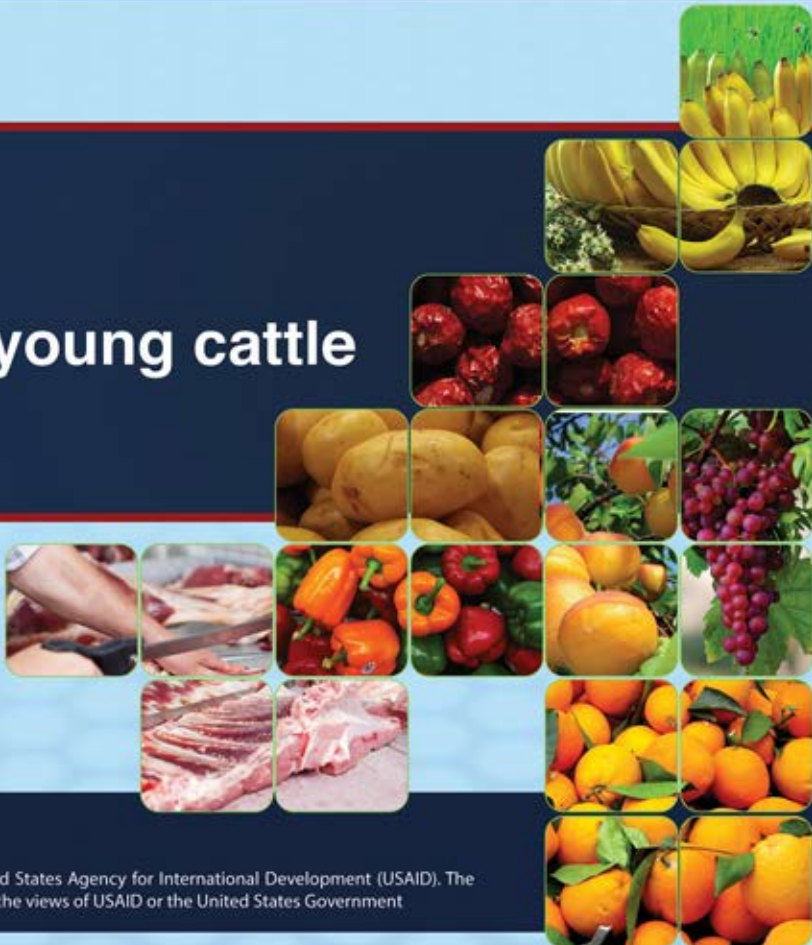


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Together we will create a **ROSHAN PAKISTAN**

Carcass Grading & Meatcut standardization in young cattle



The Agribusiness Project - Agribusiness Support Fund

A company incorporated under section 42 of the companies ordinance 1984.

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Carcass grading and meatcut standardization in young cattle

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© ASF-TAP Carcass grading and meatcut standardization

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This manual is a live document which can be changed/updated as the project progresses. Any suggestions for further improvement are most welcome.

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FOREWORD

A series of Training manuals, Guide Books and Reports have been developed by The Agribusiness Project (TAP) to facilitate the capacity building of farmers involved in TAP's targeted value chains, thereby enabling them to make the requisite transformation from 'subsistence farming' to 'farming as a business enterprise'. The Agribusiness Project is funded by USAID|Pakistan, with the overall goal of supporting improved conditions for broad-based economic growth, enhance profitability and employment opportunities and contributing to poverty alleviation through product and process transformation of selected value chains in horticulture and livestock sub-sectors."The strategy of TAP focuses on:

1. strengthening capacities in horticultural and livestock value chains to increase sales to domestic and foreign markets;
2. strengthening the capacity of smallholders (through farmer enterprise groups-FEGs), individual farmers and agribusinesses to operate effectively and efficiently; and,
3. increasing productivity and profitability through adoption of new techniques and technological innovations (among farmers, agribusinesses and business development services providers).

Through TAP, farmers have been organized as Farmer Enterprise Groups (FEGs) for cultivating the benefits of scale, through optimized production and marketing, and serving as a vehicle for transferring of the benefits of TAP interventions to its stakeholders - the farmers. TAP is providing active support to the FEGs and farmers for improving small producers' positioning in a value chain through support in incorporating producers and their product into stable, profitable market channels, and provision of necessary services and assistance in business development, planning and marketing through inter-linkages. This requires intensive capacity building of the stakeholders placing capacity building at the heart of all interventions.

This report/Manual can be used by anyone involved with the production, cultivation, harvesting and enterprise development training of and for farmers/farmer business groups. The contents have been finalized with the consultation of stakeholders engaged with the value chains.

While these Reports/Manuals/Guide Books are project specific and for a farmer audience, they can also be used for the capacity building of government and non-government agency representatives, processors and exporters who are involved in implementing production/cultivation, enterprise development and value chain programs, through the communities. Finally, I want to thank USAID|Pakistan for funding The Agribusiness Project under which this intellectual capital has been prepared. I would also like to thank ASF for successfully implementing these manuals/guide books across Pakistan for the benefits accrued to the farmers.

Shad Muhammad
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THE AGRIBUSINESS SUPPORT FUND

ASF is a 'not-for-profit' company registered under Section 42 of the Companies' Ordinance 1984 with Securities & Exchange Commission of Pakistan (SECP). ASF has extensive experience in strengthening and supporting demand-driven private sector service delivery mechanisms throughout the agribusiness value chain this includes supply inputs, production and export markets ASF aims to achieve this objective by mobilizing angel investment grant provision and technical assistance support of farmer and agribusiness enterprises. The company supports start-ups as well as existing enterprises, enabling them to employ modern technique and practices and build expertise and markets understanding required by a fast-changing economic environment and to improve their productivity, profitability, competitiveness and creditworthiness

THE AGRIBUSINESS PROJECT

The Agribusiness Project is an initiative of the United States Agency for International Development (USAID) and the Agribusiness Support Fund (ASF) Pakistan. The project aims at enhancing competitiveness of agricultural value chains in Pakistan, with a focus on Horticulture and Livestock including dairy, meat and fisheries. The objective of The Agricultural Project is to support and create improved conditions for poverty alleviation. Since Pakistan's economy is agrarian in nature, The Agribusiness Project aims to invest in interventions at the primary, secondary and tertiary levels of production. Under the International Market Access Program (IMAP), the project supports the creations of linkages between exporters and importers. The objective is to facilitate market access and enable trading linkages which translates into agribusiness through trade.

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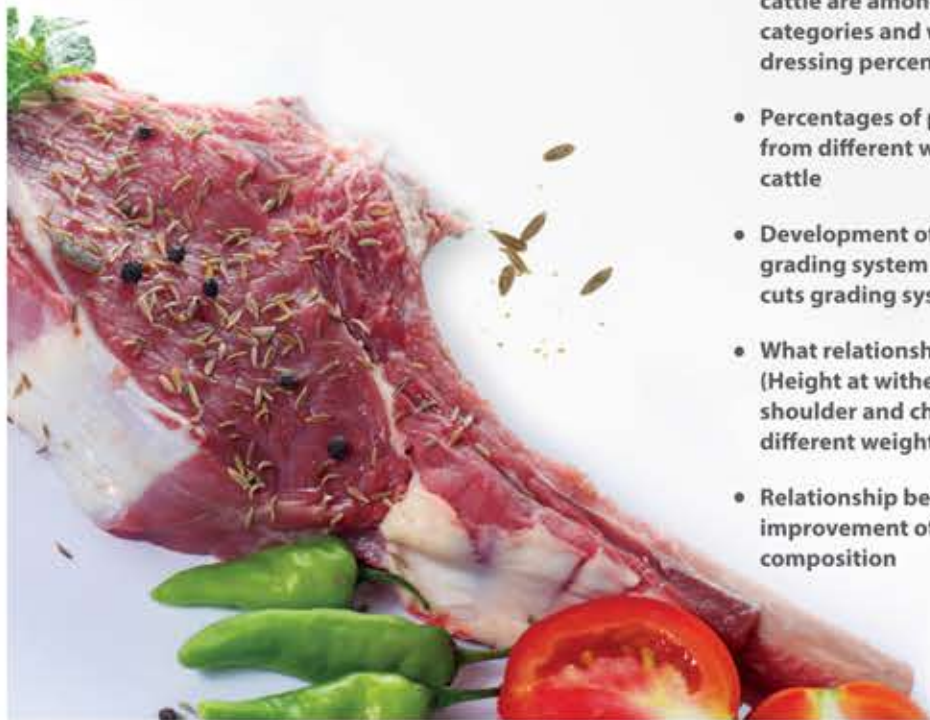


THE PROBLEM

In 2005 Pakistan's meat exports were about 29 million USD while in 2015 are 243.5 million USD. The meat export industry is annually growing at 30%. So far animals being processed and exported are coming from conventional production system i.e. from small hold domestic farms to local and regional markets and from there to markets in Lahore and Karachi, where most of the processing plants exist. These animals have never been finished on high energy rations prior to slaughter, resultantly, their comparative body weight, dressing percentage, carcass characteristics (such as fatness score, conformation, back-fat thickness, marbling, rib-eye muscle area, pH), meat quality parameters and size of the primals are not at par with international standards, followed by leading meat exporting nations like Australia and Brazil.

During the last few years small-scale commercial feedlots emerged who finish the animals for 90-120 days at commercial feedlot ration formulations. These feedlots are quintessential for the survival of meat export industry in Pakistan. Presently, feedlot farmers are not getting reasonable profits as they have direct competition with the animals coming from conventional production system and the processors are not willing to pay premium because 96% of their exports are restricted to chilled carcass which are being sold in the low end markets in Gulf countries. Keeping in view the above mentioned situation, the department of Meat Science and Technology, UVAS, Lahore in collaboration with ASF-TAP, USAID planned a carcass grading and meat cut standardization exercise of feedlot fed local animals. The exercise is first of its kind in Pakistan, will generate essential data base of local animals and will play a pivotal role in the development of traceable meat value chain in Pakistan.





WHAT HAS BEEN ACHIEVED

- What dressing percentages of different weight ranges of cattle are among humped (local) and hump less (cross bred) categories and what are different factors which may affect dressing percentages
- Percentages of primal and sub primal beef cuts obtained from different weight ranges of humped and hump less cattle
- Development of SOPs for the adoption of EUROP carcass grading system and Meat Standards Australia (MSA) primal cuts grading system of feedlot fed Pakistani cattle
- What relationship exists between live measurements (Height at withers, height at pelvis, chest width, width of shoulder and chest girth) and carcass characteristics in different weight categories of local cattle
- Relationship between morphometric measurements for improvement of the prediction accuracy of beef carcass composition

Section 1: How Much Meat expected from a Live Animal and a Carcass?

Dressing Percentage

Dressing percentage is simply carcass weight as a percentage of live weight. Carcass weight can be estimated by multiplying live weight by dressing percentage. Dressing percentage can be calculated by following formula.

$$\text{Dressing Percent (DP)} = (\text{Hot carcass weight} \div \text{Live weight}) \times 100$$

For a 300 Kg beef cattle with 156 kg hot carcass weight, the dressing percentage will be 52%. By putting these values in above formula:

$$\text{Dressing percentage} = \frac{\text{Hot carcass weight}}{\text{Live weight}} \times 100$$

$$\text{Dressing Percentage} = (156 \div 300) \times 100$$

$$\text{Dressing Percentage} = 52 \%$$

There is a common misconception among live animal traders and buyers about dressing percentage. It is being concluded that with 52% dressing percentage of a 300 kg live cattle will yield 156 kg hot carcass, but after chilling and fabrication end user gets only around 93-95 kg beef. The reason is that hot carcass weight includes bones, unnecessary fat and other wastage like tendons which have to be removed during fabrication and deboning process. And loss of moisture during chilling is also an important point to keep in mind.



DRESSING PERCENTAGE

Hump less Cattle

150-200 Kg
51.14%

Humped Cattle

150-200 Kg
49.72%

Average Dressing Percentage for various Types of Cattle

Type/condition of Beef Animal	Relative Dressing Percentage
Humped Cattle (100-150 Kg Carcass weight range)	51.97%
Hump less Cattle (100-150 Kg Carcass weight range)	48.84%
Humped Cattle (150-200 Kg Carcass weight range)	49.72%
Hump less Cattle (150-200 Kg Carcass weight range)	51.14%
Restricted Feed Prior to Weighing	Higher
Cattle Weighed without Gut fill	Higher
Beef Cattle with more number of days on Feedlot	Higher
Beef Cattle with less number of days on Feedlot	Lower
Beef Cattle weighed with Gut fill	Lower

Humped Cattle

100-150 Kg
51.97%

Hump less Cattle

100-150 Kg
48.84%

All beef animals are not the same. Therefore, the dressing percentage will change from one animal type to another. Some of the primary factors that influence the dressing percentage include the type of animal in terms of breed, live weight and how it was finished.

• Most common factors that affect dressing percentage are:

- Live weight
- Off feeding time
- Breed
- Sex
- Age
- Fatness and muscularity.

Percentages of Beef Cuts

After chilling carcass is further processed into cuts of meat. The whole animal carcass will be cut into halves, and then each half will be separated into the hind and frontquarters. Each quarter is then separated into "primal" (or wholesale) cuts. "This process is termed as breaking down the carcass."

Beef cuts in the front-quarter are:

- Chuck
- Blade
- Brisket
- Cube Roll
- Boneless Ribs
- Shin

The hind quarter is composed of following cuts:

- Tenderloin
- Sirloin
- Rump
- Round
- Topside
- Silverside
- Flank
- Shin

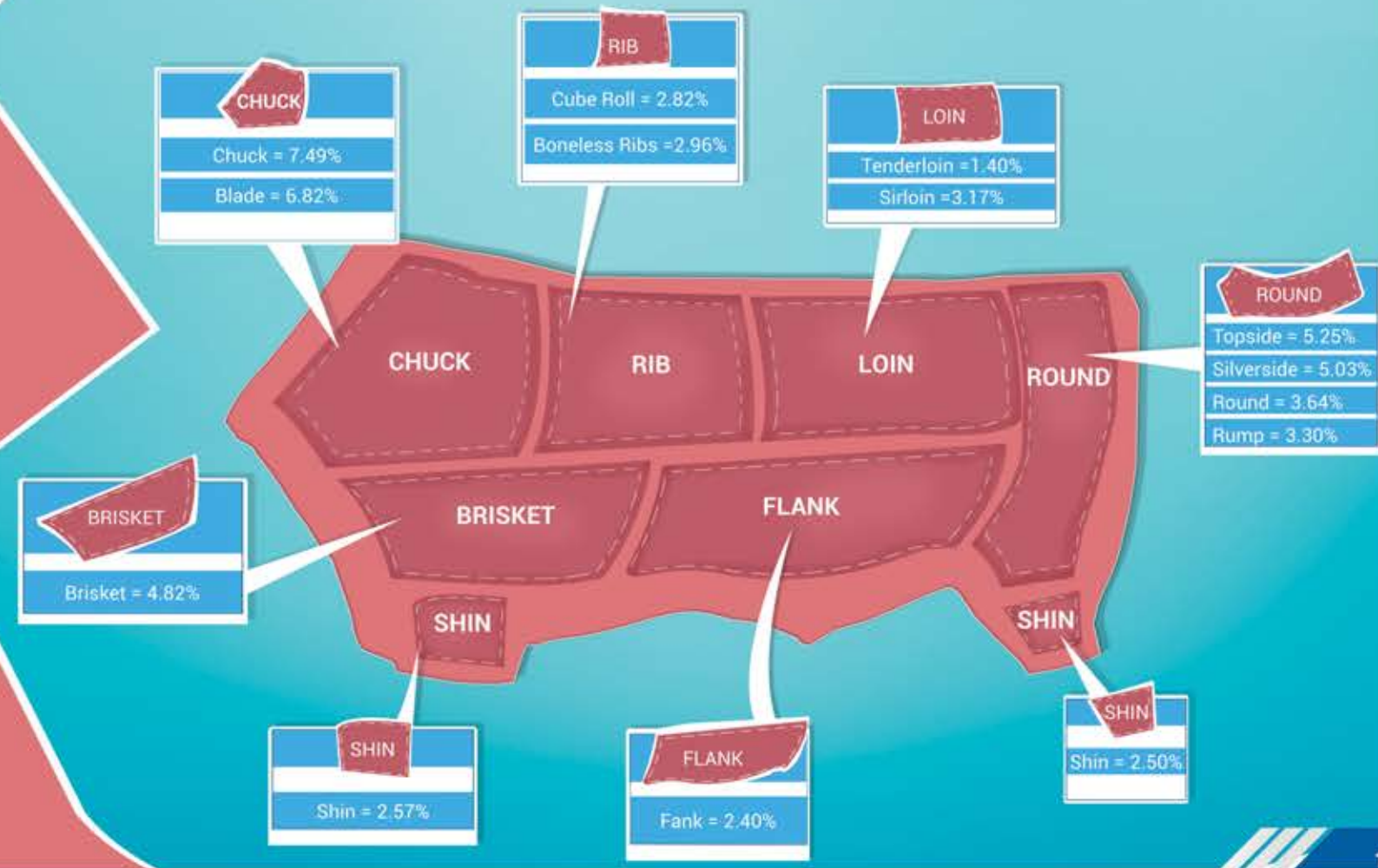
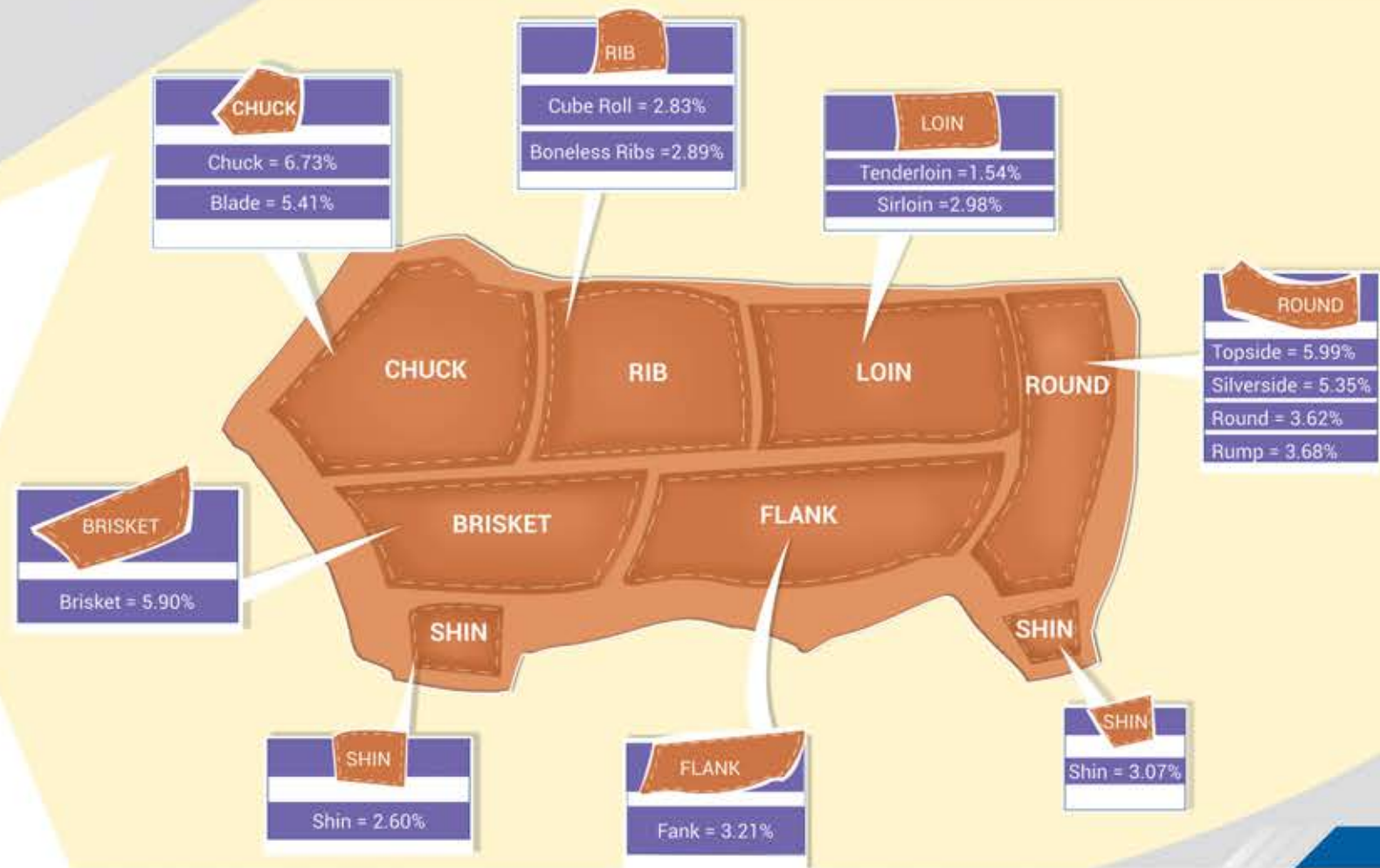
Based on price value, primal cuts can be divided into three main categories;
High, Medium and Low value cuts.

High Value Primal	Tenderloin, Sirloin, Cube Roll	Steaks
Medium Value Primal	Rump, Topside, Silverside, Round, Blade, Chuck	Boneless/Mince
Low Value Primal	Flank, Brisket, Boneless Ribs, Shin	Mince



The amount of meat actually available from a beef animal is a frequent matter of concern for processors, retailers and feedlot fattening farmers. An estimated percent yield of each primal and sub primal cut is required in order to complete a specified shipment by an exporter and feedlot fattening farmer who requires this information in order to plan for future beef production based on demand by the exporter and retailer.

Cattle Categories	High Value Primal Cuts	Medium Value Primal Cuts	Low Value Primal Cuts
Humped (100-150 Kg)	6.56 %	28.37%	15.2%
Humpless (100-150 Kg)	7.41%	30.94%	17.71%
Humped (150-200 Kg)	7.35%	30.78%	17.67%
Humpless (150-200 Kg)	7.39%	31.53%	15.25%



Section 2: How a Carcass and Beef Cuts are graded?

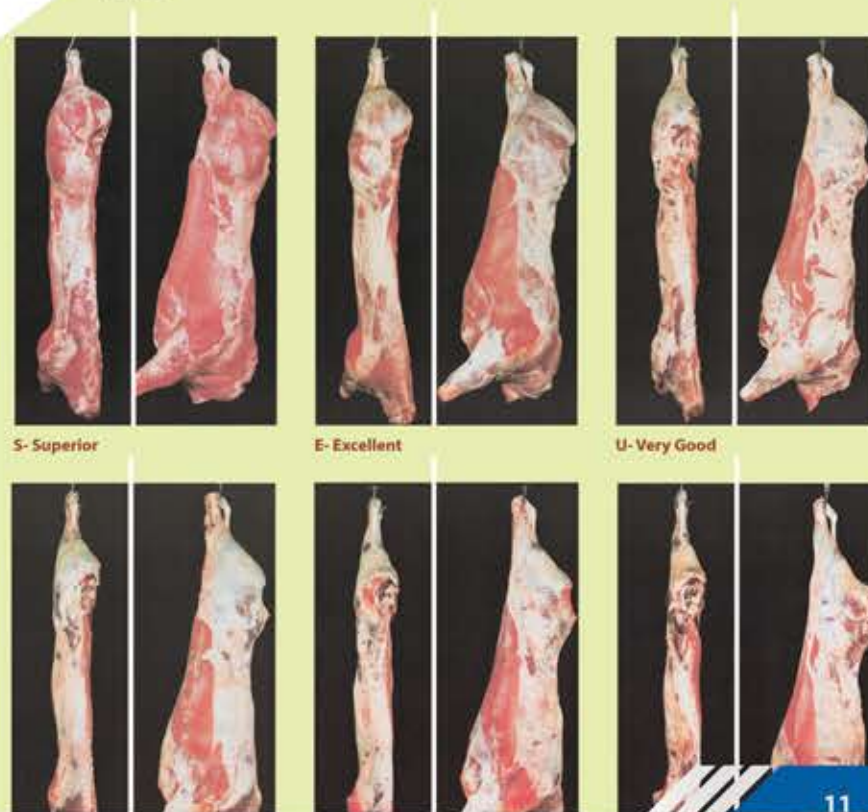
Developing SOPs for the adoption of EUROP carcass grading system and Meat Standards Australia (MSA) meat cuts grading system in feedlot fed Pakistani cattle

Classification is a mean of describing beef carcasses in terms that indicate the suitability and value of a carcass for a particular end usage like retail sale, processor or exporter. The main elements of carcass grading system for beef are conformation and fatness.



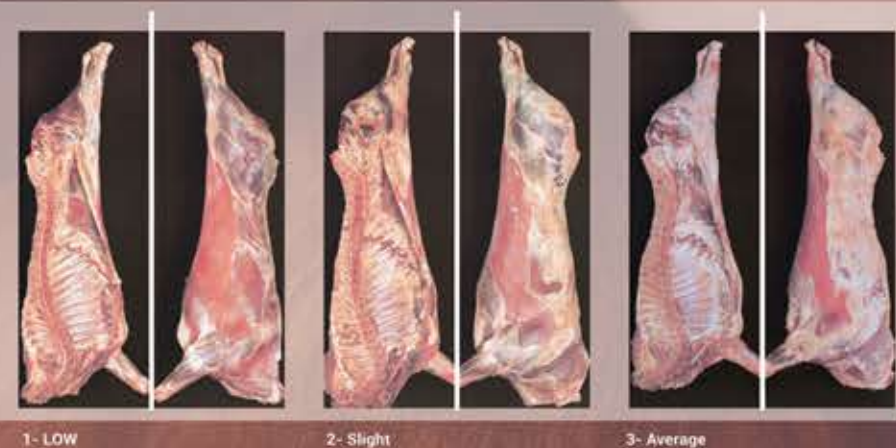
CONFORMATION

- Describes carcass shape in terms of convex / concave profiles
- Indicates the amount of flesh in relation to size of bones



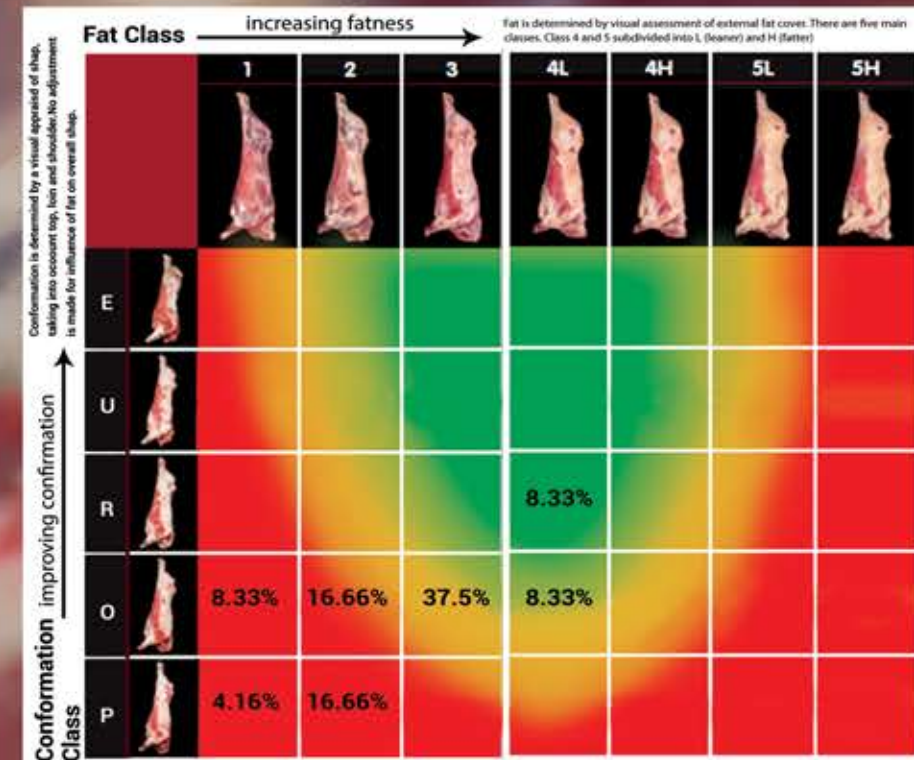
FATNESS

The amount of fat on the outside of the carcass, visible to the assessor



Beef Carcass Classification (Out of 100 Animals slaughtered)

Combining scores for conformation and fat determines the market most suited for each type of carcass i.e. retail or export



Result Outcome:

- Animals with live body weight above 300 kg have the most desirable carcass traits.
- Conformation class O is dominant with fat class 3.
- In international market, Class R (= 'average') with fat class 4L is most common.

Market Signals for Beef Carcasses according to coloring grid



Little or no demand
Discount prices
Poorest returns



Market demand
Average prices
Moderate returns



High market demand
Premium prices
Best returns

Meat Standards Australia (MSA)

The aim of MSA grading is to assure consumers that a cut of beef will eat to the quality shown on an MSA label. This simple description system can form a basis for retail pricing and generate product confidence. This has been lacking, with consumers unable to reliably select beef of the desired quality. Research shows that this lack of product confidence has restricted sales volume and price. MSA is most modern meat grading system currently being accepted internationally in number of countries and easy to adopt. MSA beef is graded based on following main factors:

- Fat Color
- Meat Color
- Marbling
- Back fat thickness
- Rib Eye Muscle Area
- pH



Fat Color

Fat color is the color of intermuscular fat lateral to the rib eye muscle. It is assessed on the chilled carcass and scored against the AUS-MEAT Fat Color Reference Standards. Fat Color is assessed by comparing the intermuscular fat color lateral to the M. longissimusdorsi and adjacent to the M. iliocostalis with the reference standards. Where a Fat color score falls between two of the reference standards, the number corresponding to the more yellow of the reference standards is assigned to the carcass. Following is fat color score reference.



Meat Color

Beef Meat Color is the color assessed at the rib eye muscle against the AUS-MEAT Meat Color Reference Standards that displays the most predominant color.



MSA Marbling

The steps between the MSA marbling standard photographs are judged to tenths for grading, creating a score range from 100 to 1100 in increments of ten.



Back Fat Thickness

- Back fat thickness or Subcutaneous rib fat is a measurement in millimeters of the thickness of subcutaneous fat at 12thrib.
- Back fat thickness required for optimum carcass characteristics like tenderness ranges between 3-5 mm.
- Back fat thickness lesser than 3mm will make carcasses prone to cold shortening
- Back fat thickness higher than 5mm will cause poor boneless yield



Eye Muscle Area

Eye muscle area (EMA) is the Area expressed in square inches (sq. in.) of longissimus muscle (loin muscle) at the ribbing site. EMA is usually measured at the 12th rib. Eye muscle area (EMA) is measured manually using a plastic grid. The average rib-eye size is relatively dependent on weight and averages approximately 1.0 - 1.2 sq. in. per 100 pounds (or 45 kg) of live weight in beef cattle.



Ultimate pH

Measurements are taken from a pH probe that is calibrated daily before each grade. The optimum pH level of meat is 5.3 - 5.7, with levels above this being downgraded to non-MSA product.

Fat Colour Grading (out of 100 animals slaughtered)

Cattle Categories	Fat Color								
	0	1	2	3	4	5	6	7	8
100-150 kg Humped			16.66%						
100-150 kg Hump less			37.5%	12.5%					
150-200 kg Humped			4.16%	4.16%	8.33%				
150-200 kg Hump less			12.5%	4.16%					

- Most of the carcasses graded between 02 and 03 which is acceptable limit.
- Overall results suggested that Pakistani feedlot fattened cattle are having good grades regarding fat color.



Back Fat Thickness (out of 100 animals slaughtered)

Cattle	Back fat thickness (mm)								
Categories	0.1-1.0	1.1-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-7.0	7.1-8.0	8.1-9.0
100-150 kg Humped		6.25%	6.25%						
100-150 kg Hump less	25.0%	12.5%			6.25%				
150-200 kg Humped	6.25%	6.25%	6.25%	6.25%					
150-200 kg Hump less	12.5%			6.25%					

Eye Muscle Area (out of 100 animals slaughtered)

Cattle Categories	Eye Muscle Area (sq. in.)								
	1.1-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-7.0	7.1-8.0	8.1-9.0	9.1-10.0
100-150 kg Humped				12.5%					
100-150 kg Hump less			12.5%		31.25%				
150-200 kg Humped						18.75%	6.25%		
150-200 kg Hump less						12.5%	6.25%		

Meat Colour Grading (out of 100 animals slaughtered)

Cattle Categories	Meat Color							
	1A	1B	1C	2	3	4	5	6
100-150 kg Humped			12.5%	4.16%				
100-150 kg Hump less		8.33%	8.33%	25.0%	8.33%			
150-200 kg Humped		8.33%		8.33%				
150-200 kg Hump less			8.33%	8.33%				

- According to Meat Standards Australia (MSA) grading compliance, carcasses having meat color grade 4 and above are ungraded.
- Results reveals that overall meat color grade lies within acceptable range i.e. 1B-03 with most carcasses graded at grade 02.

Marbling Grading (out of 100 animals slaughtered)

Cattle Categories	Marbling store									
	0(100)	0(200)	1(300)	2(400)	3(500)	4(600)	5(700)	6(800)	7(900)	8(1000)
100-150 kg Humped		12.5%		4.16%						
100-150 kg Hump less	8.33%	20.83%	20.83%							
150-200 kg Humped		12.5%	12.5%							
150-200 kg Hump less		12.5%		4.16%						

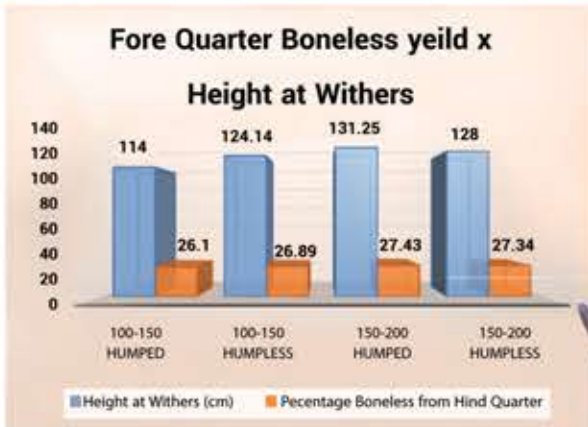
- Meat marbling is a matter of concern for feedlot fattening cattle farmers in Pakistan
- Results also suggested that most of the carcasses having very low marbling score.
- Only two cattle were graded as MSA 2 (400) which is reasonably acceptable grade.
- Based on the results it is suggested that feedlot fattening farmers have to improve genetics of their cattle along with diet regimes in order to get good marbling scores. This area requires extensive research in order to develop good grades for meat marbling.

Section 3: Live Animal and Carcass Measurements

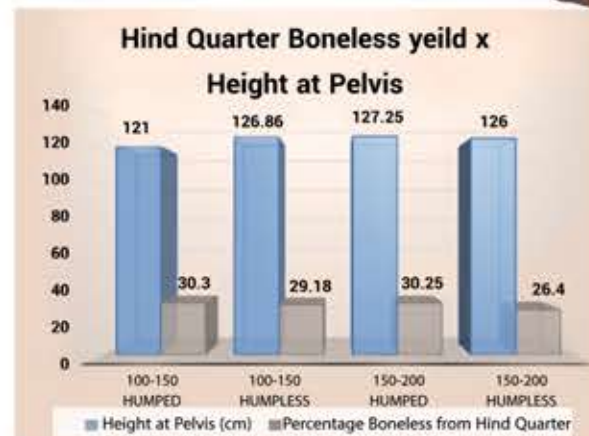
a- Live Animal Measurements

Live animal measurements are important parameters in order to predict carcass and boneless yields from any breed or weight category of cattle. During this study, live measurements like height at withers, height at pelvis, chest width, width of shoulder and chest girth were measured.

Data analysis depicts a positive correlation between height at withers and boneless yield from forequarter (Graph-1). But there is no specific pattern found while correlating height at pelvis and boneless yield from hind quarter (Graph-2).



Graph-1 Height at Withers and Boneless yield from Fore Quarter



Graph-2 Height at Pelvis and Boneless yield from Hind Quarter

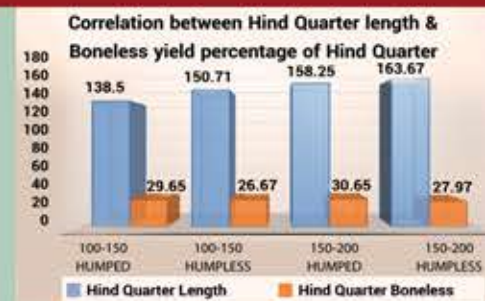


b- Relationship between morphometric measurements for improvement of the prediction accuracy of beef carcass composition

A Morphometric measurement refers to the quantitative analysis of form, a concept that encompasses size and shape are used for prediction of meat cuts. The objective of this study was to evaluate and estimate carcass yields, and yield of commercial cuts of carcass of beef on the basis of morphometric measures. Morphometric traits measurements can be a vital tool for local farmers to make decisions of selection and breed improvement. The value of beef cattle lies in their ability to efficiently produce a carcass composed of optimal proportions of muscle, bone, and fat at market weight or market specifications.

The ability of the producer and buyers of livestock to relate objective live animal characteristics to carcass characteristics is essential for optimum production and value based trading systems. This ability will also enable processors to more accurately determine returns from meat processing and it may increase the rate of genetic gains in meat quantity traits in breeding herds. Morphometric study is based on live animal measurements; height at withers, height at Pelvis, width of chest, depth of chest, chest girth, width of pelvis and carcass measurements; carcass length, hind quarter length, fore-quarter length, hind limb length, sacrum length, lumbar vertebrae length, thoracic vertebrae length, cervical vertebrae length, foreleg length, length of longissimus thoracis. The effect of the breed may determine different relative importance of the beef carcass measurements in their contribution to carcass composition due to possible differences in carcass composition and tissue distributions.

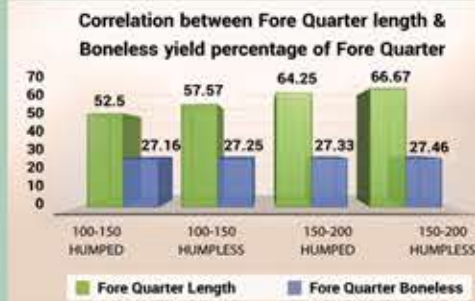
Based on the results of this study, it was revealed that there are some interesting relationships between different morphometric measurements and boneless yield. Graph-3 shows there is positive relationship between hind quarter length and boneless yield percentage obtained from hind quarter. The correlation is positive for 100-150 kg humped and humple varieties and 150-200 kg humped cattle but hump less cattle of weight category 150-200 kg is negatively correlated.



Graph-3 Correlation between hind quarter length and boneless yield percentage obtained from hind quarter

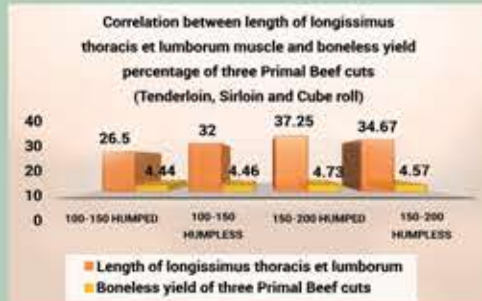


However, there is positive correlation between fore quarter length and boneless yield percentage for all weight categories in humped and hump less varieties of local Pakistani cattle (Graph-4).



Graph-4 Correlation between Fore Quarter length and boneless yield percentage obtained from fore quarter

Prediction of primal cuts like tenderloin and sirloin is also a part of morphometric study in local cattle. According to published data primal beef cuts like tenderloin, sirloin and cube roll are part of longissimus thoracis et lumborum muscle. Results of this study shows that length of this muscle and three primal cuts (tenderloin, sirloin and cube roll) has a positive correlation as shows in Graph-5.



Graph-5 Correlation between length of longissimus thoracis et lumborum muscle and boneless yield percentage obtained from three primal cuts (tenderloin, sirloin and cube roll)

Section 4: Product Costing for Beef Processors and Marketers

A processor and a marketer want to know the ins and outs of how to cost out products efficiently and effectively. In retail market, different beef items are being demanded like lean mince, mince with added fat, steaks from high value cuts and boneless diced or stir fry beef. On the same time the processor wants to get good returns based on Hot Carcass Weight (HCW) per kilogram basis for example Rs. 300, 325, 350 or 375. Following tables provides an idea about product costing for different price ranges based on carcass weight and demand of beef product in the local market. For example, if a processor or marketer wants to sell all lean mince from one carcass to the market and expects to get Rs. 350 per kg on HCW basis, the quoted prices should be between Rs. 575-580 per kg of lean mince. In the same way different projected prices are given in the following table in order to give an idea to processors and marketing personnel regarding quoting rates for different beef products for better returns. Following categories have been classified for retail beef segment:

- Whole carcass sold as all Lean Mince (About 3-5% Fat) (Table 4.1)
- Whole carcass sold as Mince with 20% Added Fat (Net Fat 23-25%) (Table 4.2)
- Whole carcass sold as mix of Steaks and Lean Mince (3-5 % Fat) (Table 4.3)
- Whole carcass sold as mix of Steaks and Mince with 20% Added Fat (Net Fat 23-25%) (Table 4.4)
- Whole carcass sold as mix of Steaks, Boneless and Lean Mince (3-5 % Fat) (Table 4.5)
- Whole carcass sold as mix of Steaks, Boneless and Mince with 20% Added Fat (Net Fat 23-25%) (Table 4.6)

Please note that all assumptions are being made on basis of carcass weighing 175 kgs.

Table 4.1 Whole carcass sold as all Lean Mince (About 3-5% Fat)

Expected Profits on basis of HCW (Rs. Per Kg)	Calculated Rate (Per Kg Mince)
300	494
325	535
350	576
375	617

Table 4.2 Whole carcass sold as Mince with 20% Added Fat (Net Fat 23-25%)

Expected Profits on basis of HCW (Rs. Per Kg)	Calculated Rate (Per Kg Mince)
300	422
325	456
350	490
375	524

Table 4.3 Whole carcass sold as mix of Steaks and Lean Mince (3-5 % Fat)			
Expected Profits on basis of HCW (Rs. Per Kg)	Calculated Rate (Per Kg Mince)	Calculated Rate (Per Kg Tenderloin)	Calculated Rate (Per Kg Sirloin and Cube rill steaks)
300	457	800	740
325	489	900	840
350	522	1000	940
375	559	1100	1000

Table 4.4 Whole carcass sold as mix of Steaks and Mince with 20% Added Fat (Net Fat 23-25%)			
Expected Profits on basis of HCW (Rs. Per Kg)	Calculated Rate (Per Kg Mince)	Calculated Rate (Per Kg Tenderloin Steaks)	Calculated Rate (Per Kg Sirloin and Cube rill steaks)
300	391	800	740
325	418	900	840
350	445	1000	940
375	476	1100	1000

Table 4.5 Whole carcass sold as mix of Steaks, Boneless and Lean Mince (3-5 % Fat)				
Expected Profits on basis of HCW (Rs. Per Kg)	Calculated Rate (Per Kg Mince)	Calculated Rate (Per Kg Tenderloin Steaks)	Calculated Rate (Per Kg Sirloin and Cube roll steaks)	Calculated Rate (Per Kg Boneless Beef)
300	367	800	740	500
325	415	900	840	525
350	463	1000	940	550
375	526	1100	1000	575

Table 4.6 Whole carcass sold as mix of Steaks, Boneless and Mince with 20% Added Fat (Net Fat 23-25%)				
Expected Profits on basis of HCW (Rs. Per Kg)	Calculated Rate (Per Kg Mince)	Calculated Rate (Per Kg Tenderloin Steaks)	Calculated Rate (Per Kg Sirloin and Cube roll steaks)	Calculated Rate (Per Kg Boneless Beef)
300	317	800	740	500
325	357	900	840	525
350	397	1000	940	550
375	449	1100	1000	575

Annexures



Annexure 1: Percentages of Beef Cuts Beef Cuts in Fore-Quarter

	Beef Cuts	Shin	Blade	Brisket	Chuck	Cube Roll	Bonless Ribs
Carcass Percentages	100-150 Humped	2.53%	4.61%	3.24%	7.37%	2.46%	3.97%
	100-150 Hump less	3.06%	6.06%	5.26%	5.91%	2.93%	3.67%
	150-200 Humped	2.60%	5.41%	5.90%	6.73%	2.83%	2.89%
	150-200 Hump less	2.57%	6.82%	4.82%	7.49%	2.82%	2.96%

Shin



Blade



Brisket



Chuck



Cube Roll



Bonless Ribs

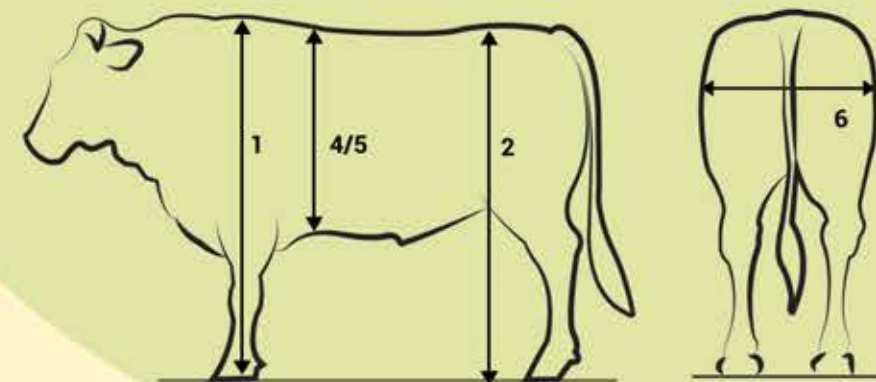
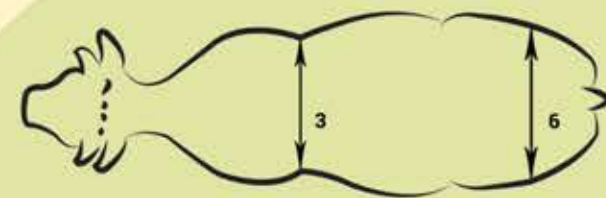


Beef Cuts in Hind-Quarter



	Beef Cuts	Flank	Sirloin	Tenderloin	Rump	Round	Topside	Silverside	Shin
		●	●	●	●	●	●	●	●
Carcass Percentages	100-150 Humped	2.76%	2.83%	1.28%	3.23%	3.13%	5.29%	4.74%	2.70%
	100-150 Hump less	2.89%	2.95%	1.53%	3.62%	3.84%	6.21%	5.30%	2.83%
	150-200 Humped	3.21%	2.98%	1.54%	3.68%	3.62%	5.99%	5.35%	3.07%
	150-200 Hump less	2.40%	3.17%	1.40%	3.30%	3.64%	5.25%	5.03%	2.50%

Annexure II: Diagrams and details of Live Animal Measurements



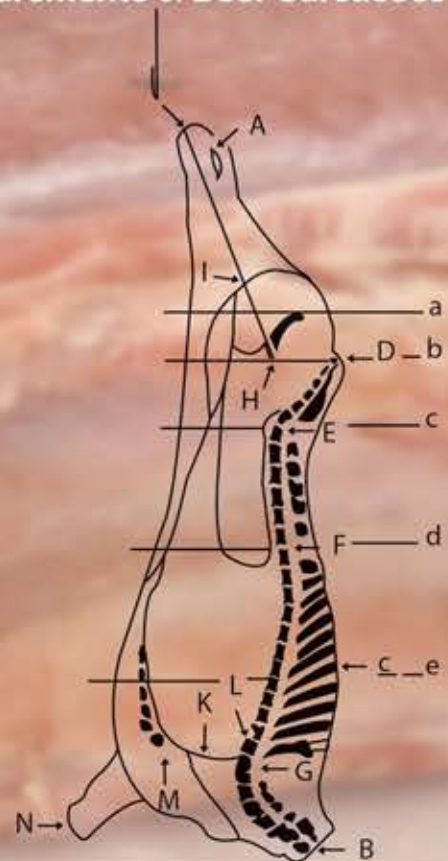
Live Animal Measurements

1. Height at Withers: measured from the highest point of the withers, between the shoulders.
2. Height at Pelvis: measured from the anterior edge of the sacrum between the hips.
3. Width of Chest: width immediately behind the shoulder blades.
4. Depth of Chest: measured behind the shoulder at the same level as width of chest.
5. Chest Girth: smallest circumference measured behind the shoulder at the same level as width and depth of chest.
6. Width of Pelvis: measured at trochanters.

Annexure: III

Morphometric

Measurements of Beef Carcasses



A-B (carcass length)

A-C (hind quarter length)

B-C (fore-quarter length)

A-D (hind limb length)

D-E (sacrum length)

E-F (lumbar vertebrae length)

F-G (thoracic vertebrae length)

G-B (cervical vertebrae length)

J-H [distance between distal end of Tarsus (J) and the pointed end of Sacrum (H)]

J-I (distance between J and crossing point I of line J-H and inner splitting line of thigh)

H-K [distance between H and the center of the first rib bone (K)]

H-G [distance between H and the anterior edge of the first thoracic vertebra (G)]

H-F (distance between H and the anterior end of the first lumbar vertebra)

E-L (length of *M. longissimus thoracis et lumborum*)

M-N (foreleg length)

Girth, thickness (width between medial and lateral surfaces of side carcass) and Width (width between dorsal and ventral ends of side carcass) measured horizontally at the upper edge of

Os-Coxae (a line: thigh position)

At the posterior end of Sacrum (b line: sacrum position)

6th lumbar (c line: loin position)

13th (d line: belly position)

5th (e line: chest position) thoracic vertebrae



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