CARCASS EVALUATION AND COMPARISONS OF ZEBU (NELORE) AND EUROPEAN-NELORE CROSSBRED TYPE CATTLE PRODUCED IN BRAZIL

by

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CHAPTER I

INTRODUCTION

Crossbreeding of cattle for commercial beef production has recently become increasingly important, and as result of this, many European breeds of cattle have been introduced into the U.S. and other countries. The evaluation of these breeds in crossbreeding programs is very important since many of them are multipurpose breeds (milk, meat and/or work) and the information about these breeds is scarce with much of it having been collected under widely different conditions.

In order to improve beef production and also to meet the consumer demands for more and leaner meat, breeds such as Charolais, Limousin, Simmental, Chianina and Marchigiana have been introduced in several countries. In the developing countries where this has been done, research information on these new breeds is extremely scarce.

In these developing countries the exotic breeds are being crossed with traditional breeds which are well adapted to the particular conditions of the country. When the traditional breeds are crossed with these new breeds, these larger framed and later maturing cattle types generally produce larger and leaner carcasses in a shorter period of time.

Faster growing rates, better feed utilization, larger carcass weights as well as leaner carcasses associated with some heterosis effects make the use of these breeds potentially worthwile especially in the developing countries that want to increase beef productivity.

Brazil is such a country and has imported many breeds in search of improved productivity. For this reason, an experiment was conducted at the Instituto de Zootecnia in Sao Paulo, Brazil. The purpose was to evaluate young Nelore bulls compared with ½ Marchigiana-Nelore and ½ Chianina-Nelore crossbred bulls. In response to results observed with this first experiment, another was designed to evaluate the preliminary results as well as to evaluate the ¼ Marchigiana-Nelore crossbreds. Results of the second experiment are presented here.

CHAPTER II

LITERATURE REVIEW

The beef cattle industry exists largely to produce meat for food.

The most important objective of the beef cattle industry is the economical production of beef cattle that yield a high percentage of high quality retail cuts with a minimum amount of excess fat. To attain this objective many factors that influence beef production should be studied in order to sucessfully attain this goal.

The factors that influence the economics of beef production are numerous and it is difficult to understand them and their interrelationships. In this review we attempted to summarize those factors directly influencing beef cattle production.

Influence of genetics on live and carcass traits

Net return or output/TDN input on a herd basis is maximal when cattle of larger potential mature size are slaughtered at older ages and heavier weights than cattle of smaller potential mature size (Cartwright, 1970). But the author concludes that research is needed to answer some vital questions, such as the most feasible point to "bend" the curve, before selection can be expected to be very useful. In the same paper he concludes that crossbreeding utilizing complementary traits appears to be the most effective in selection. Heterosis enhances the attractiveness of utilizing hybrid cattle where complementary traits refers to the advantage of one cross over another or over a purebred resulting from the manner in which two or more characters combine or complement each other.

Gaines et al. (1957) comparing carcasses of steers and heifers found evidence of heterosis in those traits associated directly with growth, carcass weight, loin eye area and carcass length.

Studying Brahman, Angus and Charolais crossbreds, Peacock et al. (1979) observed that Brahman crossbreds exhibited much higher levels of heterosis than the Angus or Charolais crosses.

Comparing Angus, Charolais and Hereford heifers with their crossbreds, Hedrick et al. (1970) observed that crossbreds were superior, on the average, by 7% in loin eye area and about 8% in weight of retail cuts and carcass weight. Hedrick et al. (1975) studied the same breeds and observed that the crossbreds had a slight advantage over straightbreds in weight of retail cuts.

Butler, Warwick and Cartwright (1956) comparing Hereford steers with Brahman Hereford crossbreds concluded that the crossbreds had a definite advantage in dressing percentage and in length of body.

Forrest et al. (1975) observed that crossbreeding of the Zebu and European breeds resulted in cattle that are better adapted to hot environments than are the original European breeds.

O'Mary, Martin and Anderson (1979) observed that Charolais-Angus crosses had heavier birth weights, 205 day adjusted weights, 240 day actual weights and final slaughter weights than straightbred Angus.

Influence of fattening on carcass composition

Callow (1948) concluded that level of fatness of a carcass is the major factor determining percentages of muscle tissue and of bone and tendons in the carcass. Carcass changes in percentages of fat, muscle and bone plus tendons during fattening are the same for cattle, sheep and pigs, and can be expressed using similar curves and equations.

The increase in percentage of some carcass parts of the fattened steers was due to a greater deposit of fat according to Luitingh (1962). He also stated that the largest percentage increase took place in those carcass parts which command the lowest price and least demand. Increasing the proportion of low priced late maturing ventral parts of the carcass decreases the proportion of high priced cuts. He concluded that from the point of view of body proportion, fattening animals should not be considered as a means of improving body proportions.

Butterfield (1963) concluded that level of fatness is the major determinant of carcass composition, and a linear measurement of fat thickness is of more value in estimating proportion for muscle than are linear measurements of the muscles themselves.

Berg and Butterfield (1966) concluded that fat percentage tends to increase with the increase in tissue and carcass weight, as there is a tendency for heavier animals to be fatter and of fat deposition to have been more rapid relative to other tissues.

Total muscle is largely influenced by carcass weight, and can be influenced by choice of slaughter weight (Berg and Butterfield, 1966). Also muscle is correlated with bone weight and they suggest that muscle to bone ratios could be improved by utilizing differences between and within breeds instead of trying to change the proportions of the various groups of muscles within the carcasses.

Studying data from a research project of the Royal Smith Club, London, using Hereford and Friesians steers, Berg and Butterfield (1968) observed that carcass weight showed an expected sigmoid curve with the point of inflection being between 12 and 18 months for both breeds and approximating the stage of increased fat deposition. In early stages there were no marked differences in tissue growth between Hereford and Friesians when compared on the basis of total muscle plus bone weight. However, when the fattening phase began, the two breeds differed in relative tissue growth with the Hereford steers fattening at lighter weights than Friesians.

Allen (1968) studying the carcasses of 80 steers equally divided into light and heavy weight groups and 4 fat thickness cells, observed that carcasses with greater fat thickness yielded more separable fat and fat trim and less separable muscle, bone and retail cuts than carcasses with less fat thickness. Heavier carcasses with the same fat thickness also yielded less separable muscle and greater fat yields. Fat thickness was negatively correlated with measurements of muscling and bone and positively correlated with measurements of fat.

Reviewing the factors that affect body fat content, Lohman (1971) concluded that the variability in the fat and fat-free body content is related to genetic and environmental factors and their interactions. Body fat, as measured by carcass dissection or chemical analysis, was the most variable component of the body in response to variation in genetic and nutritional factors.

Comparing British, Zebu and Dairy cattle steers, Cole et al. (1971) observed that among the breeds studied, fat had a depressing effect on yield of the major wholesale cuts and separable muscle. The fatter breeds had a higher percent of all minor wholesale cuts along the belly and a lower percent of the major wholesale cuts.

Berg and Butterfield (1976), concluded that fat is the most variable tissue in the beef carcass and its excess is trimmed from the carcass after it enters the trade. Since fat is of little commercial value and involves expense in its removal, it may result in considerable elevation of carcass price. Too little fat is undesirable from the point of view of quality and too much fat reduces the percentage of saleable meat due to trimming. Thus, they stated the major objective in attempts to influence carcass composition should be to have a high proportion of muscle combined with an adequate proportion of carcass fat and a minimum of bone.

Kauffman (1978) studying the bovine compositional interrelationships, also concluded that fatness was the dominating variable in determining carcass composition.

Geay (1978), concluded that the main factor affecting dressing percentage is the degree of fatness of the animal, but that other factors that indirectly affect fatness are also important; such as diet, feeding level, length of the feeding and fasting period and age of animal.

Growth and distribution of muscle in the beef carcass

Berg and Butterfield (1968), studied individual muscle weight distribution by anatomical dissection. Muscles were shown to follow differential growth patterns which lead to differential muscle distribution relative to stage of development. Based on these different growth patterns the muscles were classified as low, average and high in growth impetus. A "low impetus" muscle was one which grew at a proportionally slower rate than total muscle and this classification would include most of the muscles which Butterfield (1963) had previously considered as early developing (representing a higher proportion of total muscle at birth than at later stages). Other impetus groups were defined as "average" and "high". Some muscles were found to have a diphasic growth pattern with a change in their pattern of development at some stage usually shortly after birth. Diphasic phases were called "low average", "average high" and "high average". The major tissues of the bovine carcass; muscle, fat and bone, also have differential growth patterns. Bone growth, described as early developing, is better defined as having low growth impetus. Muscle tissue shows intermediate growth impetus and fat tissue shows high impetus, particularly after onset of the fattening phase.

Individual muscles vary in their rates of growth. The larger muscles such as those of the legs and back, have the greatest rate of postnatal growth. The order of tissue growth follows a sequential trend determined by physiological importance of the tissue to animal survival. This begins with central nervous system which is most important and progresses to bones, tendons, muscles, intermuscular fat and subcutaneous fat (Forrest et al. 1975).

Bergstrom (1978) recommends that further studies be conducted with animals that differ in mature size and muscularity, since muscle weight distribution depends on the stage of development at which the animal is slaughtered on the pathway from birth to maturity. In other words, equal physiological age should result in equal muscle distribution.

Effects of breed or type

In a study reviewing the factors affecting body composition Lohman (1971) observed that within several species, genetic differences in body composition - fat content have been found for animals on the same diet. Genetic factors are clearly of importance in determining the amount of body fat at a given body weight, since at the same empty body weight, relative differences in fat of as great as 50% occur between breed types.

Cartwright (1970) suggests that efficiency of producing beef can be increased more by utilizing existing variations between breeds than by selecting within breeds for many generations, and that emphasis on selection between breeds for general and specific production traits will continue to increase.

In a study comparing carcass characteristics of purebred and crossbred steers, Damon et al. (1960) observed that the steers sired by Charolais bulls had significantly lower scores for thickness of external fat and yielded a greater percentage of lean meat than steers sired by other breeds. Charolais crosses also had larger areas of loin eye than the other breeds.

Comparing Angus, Charolais, Hereford and their crossbreds, Hedrick et al. (1970) observed that Charolais bulls produced crossbred calves with lower fat percentages and less external fat thickness. Charolais-Angus crosses were superior in dressing percentage and side weight percentage of total retail cuts and primal retail cuts.

Hedrick et al. (1975) reported that progeny from Charolais sires and dams had heavier carcasses with larger loin eyes, less 12th rib fat thickness, less fat trim and a greater percentage of retail cuts than carcasses of progeny from Hereford or Angus sires or dams. However, he noted that the larger loin eyes were consistent with the heavier carcasses produced by Charolais.

Ferrell et al. (1978) observed that carcasses from Charolais crosses were heavier, contained less fat, greater in loin eye area and had a higher cutability than carcasses from smaller type steers. All carcass traits presented with the exception of loin eye area were influenced by both cattle type and energy density of the diet.

In a series of two experiments, O'Mary, Martin and Anderson (1979) compared carcass characteristics of Charolais-Angus and Angus steers and observed that the heavier crossbred carcasses had less external fat and higher USDA cutability in experiment I, and larger loin eyes, higher percent cutability and heavier slaughter and carcass weights in experiment II. Muscle and bone weights were each heavier in crossbred carcasses compared to Angus carcasses. However, when muscles were compared on a percentage basis the only difference noted was a higher percentage of Semitendinosus in experiment I for Charolais-Angus crosses.

Comparing Hereford and Brahman-Hereford crossbreds, Carroll, Rollins and Ittner (1955) observed that carcasses from crossbreds had more bone and less fat, principally due to less finish.

In a comparison of Brahman and Brahman-Shorthorn crossbred steers, Carpenter et al. (1961) observed that Brahman carcasses were heavier in forequarter weights and lighter in hindquarter weights than Shorthorn carcasses. Part of the difference was due to a higher percent of foreshank in Brahman carcasses. The Brahman had the highest percent of combined cuts of round, rib and full loin. Brahman and 3/4 Brahman had leaner rib cuts, lesser fat and more bone, higher percentages of feet, shanks and hide than the Shorthorn.

De Rouen et al. (1961) studying Brahman, Angus and Brahman-Angus crossbred steers found the crossbreds possessed larger loin eye areas than those of Angus or Brahmans.

In a study comparing British, Zebu and dairy steers, Cole et al. (1971) observed the highest percent forequarter (50.9) in the Brahman breed. The authors concluded that much of this difference may have been caused by the hump. The Brahmans and Holsteins had the highest proportion of separable muscle (60.1%) with these two breeds among the three with the thinnest fat cover over the loin eye. The side percent separable muscle was least for British type steers. Brahman and Holsteins had the highest percent muscle in the combined major cuts and breeds with longer carcasses tended to yield a higher percent of major wholesale cuts and separable muscle.

Comparing 351 steer carcasses of Angus, Brahman, Charolais and crossbred steers, Peacock et al. (1979) observed that Brahman breeding reduced loin eye area, estimated retail yield and quality grade. This negative effect of Brahman breeding on estimated retail yield was attributed to the small loin eye area in carcasses of Brahman and Brahman cross steers. Straightbred Charolais were higher in estimated retail yield percentage than either Brahman or Angus. The direct effects of Charolais breeding were positive for carcass weight and retail yield but negative for quality grade.

Comparing performance and carcass characteristics of crosses from imported breeds, Adams, Garrett and Ellings (1973) observed that the breeds of French origin (Charolais, Limousin and Maine Anjou) were similar but each had higher cutability, less fat thickness, lower fat percentage and lower carcass quality score than other breeds. The Swiss breeds, Simmental and Brown Swiss, were somewhat intermediate in cutability, fat thickness and fat percentage. Simmental and

Limousin crossbreds had larger loin eye areas than did Angus crossbreds or Hereford crossbreds. The large breeds had heavier carcasses that were leaner while the British breeds had lighter weight carcasses that were fatter.

Allen (1974) observed that although the large European breeds can have some reproductive problems, these problems can be solved by improved management. These breeds as well as their crosses offer advantages in faster growth rate, heavier weights per day of age and leaner carcasses at common slaughter weights than the traditional British breeds and their crosses. These desirable characteristics offset the minor reproductive problems which can be improved. He concluded that the livestock and meat industry, in order to survive, will be forced to improve production efficiency and the exotic breeds provide at least a partial solution.

In a study involving 1121 steers from 14 breed combinations, Koch et al. (1976) and Koch and Dikeman (1977) observed that Charolais, Simmental and Limousin crosses had the lowest percentage of fat trim. Limousin cross carcasses had larger loin eyes, exceeding Charolais crosses, even though retail product was similar for the two breed groups.

McAllister et al. (1976) observed that Charolais sired steers averaged lesser fat thickness and greater loin eyes than Polled Hereford sired steers with Limousin and Simmental sired steers being intermediate. Charolais and Simmental sired steers had a greater percentage of hindquarter and lesser percentage of forequarter than Polled Hereford sired steers with Limousin sired steers being intermediate.

Prior et al. (1977) concluded that large type cattle (Charolais and Chianina) at 403.5 kg carcass weight had a higher dressed yield, larger loin eyes, less 12th rib fat cover and more desirable yield grades than small type cattle (Angus or Hereford) at 319.3 kg carcass weight.

In a complete dissection of 189 bull carcasses of Friesians, Charolais, Limousin and Salers, Robelin (1978) observed that the main particularities of these Continental bulls are their low fat and high muscle content and their greater development of musculature in relation to development of fat, particularly subcutaneous fat. Consequently, these breeds had a lower cost of body weight. In the same work the author observed that the relatively small coefficients of variation of muscle group weights suggest little if any within-breed variation in muscle weight distribution.

Friesian crosses with large European breeds (Charolais, Simmental and Limousin) tended to have more bone in the limb joints at constant total bone weight than Friesian crosses with the traditional early maturing British breeds. These differences likely are to some extent a reflection of mature size concluded Kempster (1978).

Dissecting 1028 carcasses of Simmental and Braunvieh, Kogel and Alps (1978) concluded that bulls of the beefy type dual purpose breeds (Simmental, German Braunvieh and Gelbivieh) and Limousin-Simmental crossbreds show greater percentages of muscle and lesser amounts of fat than Simmentals crossed with breeds of more dairy type.

Luchiari Filho et al. (1979) studying the carcass characteristics of Nelore bulls compared with Chianina-Nelore and Marchigiana-Nelore crossbred bulls observed the larger loin eye areas and thinner fat thickness over the Longissimus dorsi for crossbreds compared to straightbreds. The crossbreds had a higher yield of trimmed special hindquarter than straightbreds. However, straightbreds had a higher proportion of trimmed forequarter, which may have been largely due to the hump of the Zebu Nelores. No differences were observed in total carcass yields of trimmed beef.

Norman and Felicio (1980) comparing Zebu, Charolais and crossbred beef cattle, observed that adjusted special hindquarter weights of the Charolais and Canchim breeds were as much as 2% higher compared with Zebu Breeds. As a consequence, lower forequarter weights were recorded in the Canchim and Charolais. Zebu animals had heavier hide weights compared to the Charolais and Canchim animals. Small but significant differences were noted in weights of bone-in hindquarter, forequarter and ponta de agulha between the Bos taurus and Bos indicus breeds.

Norman and Felicio (1981) observed that Charolais and Canchim animals required less trimming of fat than the Bos indicus breeds. Breed difference were observed in patinho and musculo do traseiro weights. The authors conclude that of all traits studied, the European breeds and crossbreds compared with Zebu cattle ranked as well as or more favorably only in total saleable meat and first quality meat.

Effects of sex

Production of quality lean beef is a goal that involves many aspects of animal production including breeding, feeding and management. Experiments with finishing beef cattle have shown that bulls gain faster, more efficiently and produce leaner carcasses than steers. Since castration retards growth rate, it has been fairly common practice in many countries to feed out bulls rather than steers. In some countries however, the vast majority of beef is still produced by steers, a trend that may change in the future. Considerable research has been conducted to evaluate the differences in production traits and carcass characteristics of bulls, heifers and steers.

Comparing steers and heifers, Breidenstein et al. (1963) concluded that steers have less kidney fat, smaller loin eyes and more total retail product than heifers.

Field, Schoonover and Nelms (1964) studying bulls and steers observed that bulls had larger loin eye areas, less 12th rib fat cover, less estimated kidney knob, heavier forequarters and higher percentages of trimmed bone-in retail cuts from the four major primals.

In a study comparing Holstein-Friesian bulls and steers slaughtered at two different live weight ranges, Nichols et al. (1964) observed that bulls reached slaughter weights faster and required fewer days on feed than steers. Bulls had higher average daily gains, less total feed consumed, greater efficiency of feed conversion, lower dressing percentages and heavier hides than steers. The heavier group of bulls had the largest loin eye areas of any group. Steers were fatter than bulls and the 1000 lb slaughter group was fatter than those slaughtered at 800 lb. Steer had significantly higher percentages of hindquarter and lower percentages of forequarter. However, the advantage in percent hindquarter was due to higher percentages of flank and kidney knob. Bull carcasses contained approximately 3% more lean than steers.

Charlet (1969) concludes that the present trends in French beef production are rapidly changing from traditional methods to production of young bulls and steers. Young bulls may be used even more since the proportion of fat in their carcass is low and the presence of a uniform subcutaneous layer of fat is rare even in a heavy carcass. The ratio of hindquarter to forequarter weight in bulls is the reverse of that for females and castrates.

Harte (1969) observed in many experiments that bulls had lighter hindquarters and therefore, heavier forequarters (as a carcass percentage), but most of the difference between bulls and steers was due to the presence of the greater amount of perirenal and retroperitoneal fat in the hindquarter of steers. Differences between quarters decrease when this fat is removed. Many times the chuck showed the greatest advantage for bulls compared to steers. In all experiments where fat thickness was measured, bulls had less than steers.

Steer average daily gain was 84% of bulls, and they were somewhat fatter at slaughter despite being older and 45 kg lighter in carcass weight. Mean percentage muscle was 73.4 for bulls and 70.5 for steers. Branang (1969) suggests that if these values were corrected for difference in fat percentage the bull carcasses would still have higher relative muscle content.

Comparing carcass traits of bulls and steers, Arthaud et al. (1969) observed that the loin eye area was 5.9 sq cm greater in bull carcasses, or more than steers. Adjusted 12th rib fat thickness was 0.5 cm thicker for steers.

In a study involving male Hereford calves sired by the same bull; one group left intact and the others castrated at 4 different ages (at birth, 2, 7 or 9 months), Champagne et al. (1969) observed that bulls gained faster and more efficiently than all castrate groups except those castrated at 9 months of age. Actual percent cut out revealed an approximate 4 percent superiority and 12.65 sq cm more loin eye area of bulls over castrates.

Reviewing castration effects on meat quality, Field (1971) concluded that many reports have shown an advantage for bulls over steers in average daily gain, feed to gain ratio and decreased amounts of 12th rib fat cover. Bulls have 2.6 percent more boneless round, loin, rib and chuck compared to steers.

Berg and Butterfield (1976) concluded that no concern need be expressed regarding the proportions of bull carcasses relative to steers if slaughter weights are such that the changes associated with sexual maturity in bulls are avoided. Also, it can surely be assumed that the larger the breed, the heavier the bulls can be before becoming subject to the changes associated with their masculinity.

Jacobs et al. (1977), reported that Hereford bulls had larger loin eyes, less trimmable fat, higher retail yields and 16% more edible meat than Hereford steers.

Heifers fatten at lighter weights than steers and steers at lighter weights than bulls, therefore optimum slaughter weights are lighest to heaviest for heifers, steers and bulls, in that order. The rate of fattening of bulls is less than heifers or steers. Therefore, bulls may be slaughtered at a wider range of weights to achieve optimum fat cover. Thus, conclude Berg and Butterfield (1976), at an equal level of fatness, bulls will be superior to steers in muscle to bone ratio because they will be heavier. The higher percentage of muscle in bull carcasses is explained by the fact that they are usually trimmer.

Castration effects on growth

Prescott and Lamming (1964) studying the effects of castration on meat production concluded that when dressing percentage was calculated on an empty live weight basis it was similar for bulls and steers. In the same experiment the authors observed thinner subcutaneous fat cover, less internal fat and less marbling as well as larger loin eyes for bulls. Bulls also had heavier forequarters than steers and larger proportion of their heavier carcasses was in this region. However, some of the hindquarter weight advantages of steers were due to larger amounts of kidney and channel fat. Removal of this fat reduced the differences in relative carcass proportions.

The greater growth rate of bulls over steers combined with an increased yield of total retail product from carcasses of similar weight, suggest advantages of using young bulls for greater economy of beef production. Although bull carcasses were slightly lower in quality than steers as determined by tenderness, grade, marbling, texture and color, Arthaud et al. (1969) concluded that the average quality values of young bulls were still acceptable for a large segment of consumers.

Field (1971), studying the effects of castration on meat quality and quantity, observed that other countries are producing bull meat intensively and succesfully. Branang

(1969) reported that in West Germany 39% of all cattle slaughtered are young bulls and in Sweden about 53%. An increase in the production of meat from bulls mainly from 12 to 16 months of age appears to be of great value to the beef industry. In the less developed countries where the amount of meat produced is still insufficient for consumption bull production may be a possibility.

Turton (1969) concludes that castration modifies body form and composition resulting in differing carcass characteristics. The uncastrated male has a relatively greater development of forequarter musculature, and the amount and distribution of fat in its carcass is altered. Analysing the results of many experiments the author concludes that bulls have superior growth, higher dressing percentages, lower percentage hindquarter and increased percentage of lean meat when compared with castrates.

Jacobs et al. (1977) conducted a consumer test to compare the acceptance of meat from bulls and steers. When color, leanness and marbling were considered, he concluded that over 44% of the consumers felt that leanness was most important in visual selection of retail beef and 47% felt that marbling was least important.

Champagne et al. (1969) did not find differences in Warner Bratzler shear or taste panel tenderness scores comparing male Hereford calves castrated at 4 different ages with bulls when all were slaughtered after being fed for 182 days with a high concentrate diet.

Bergstrom (1978) cited the pronounced development of the neck muscles as a clear source of variation in muscle distribution in bull carcasses.

Kauffman (1978) concluded that current experiments indicate that young bull beef posseses acceptable palatability characteristics. If management practices can be appropriatelly focused on bull production, there is little doubt that faster growing, more efficient bulls will yield larger, leaner and more muscular carcasses that will help satisfy the demand for both fresh retail cuts and processed beef.

In the future concludes Lawrie (1979), young bulls under 15 months of age will increasingly replace steers of this age since they more economically produce the lean flesh now in greater demand.

There seems little doubt that bulls are going to provide the greatest amount of beef from young animals in the future, and many countries already realize the production lost by castration of male animals (Berg and Butterfield 1976).

Effects of age and nutrition

Age like many other factors, also affects carcass composition since different body parts have different growth rates.

The central nervous system is the earliest developing part of the body, followed by bone, then muscle and lastly by fat. Similarly, within the fat depots, kidney fat is the earliest developing, followed by intermuscular fat, then the subcutaneous fat, and finally intramuscular fat.

The relatively greater increase in the ventral parts of the body with age and fattening, as well as the overall increase in fat, affects carcass composition.

Luitingh (1962) found that percentage of carcass hindquarter declined with age and fattening and that dorsal carcass parts formed a greater percentage in unfattened versus fattened steers. He concluded that as an animal grows older, an onset of high growth intensity occurs in the forequarter. Studying 140 steers the author observed that 12th rib fat cover increased with weight increase, due to fattening and age. Fat increased more than muscle, the depth of the "eye muscle" more than medial to lateral length and fat cover over the distal end of the "eye muscle" (over the ribs) more than fat over the proximal end. "Eye muscle" showed a larger percentage increase near the loin and furthermore that muscle grew faster in a young animal, while in the case of fat the reverse was true.

Guenther et al. (1965) observed that dressing percentage increased as the feeding period was extended and favored calves fed high over moderate energy levels on both an age and weight constant basis. In all cases, loin eye area was larger in steers on a higher nutritional level. Fat accumulation was most rapid during the latter half of the feeding period and showed a sharp increase after lean production began to decrease rapidly.

Studying the effects of age, sex and breed on muscle characteristics, Boccard et al. (1979) observed that muscle collagen content was higher in bulls than steers, and solubility decreased markedly between 12 and 16 months of age. Biological differences found to influence muscle characteristics were particularly those of age and breed of animal. Thus, the author suggests that to insure the highest possible degree of tenderness in the meat of young bulls, especially Frieslands, they should be slaughtered as soon after 12 months of age as possible.

Differences in nutritional plane at any age from the late foetal stage to maturity not only alter growth generally but also affect carcass proportions, different tissues and the various organs differentially. It is clear that the percentage of muscular tissue is lower, and that of fat higher, in animals on a high plane of nutrition than in those on a low plane of nutrition (Lawrie, 1979).

Prescott and Lamming (1964) found that intensively fattened young bulls yielded 24 lb heavier carcasses than steers. Bull carcasses had heavier forequarters and were more thinly finished but yielded more lean than steer carcasses. Carrying bulls to heavier weights and older ages before slaughter to achieve more finish might increase the expression of undesirable masculine characteristics.

Preston and Willis (1974) concluded that when carcass weight and fatness are held constant, dressing percentage is not affected by plane of nutrition per se, since fatness is the major determinant of dressing percentage.

Using 247 crossbred steers, Hedrick et al. (1975) observed that carcasses of steers fed longer, compared to shorter time periods, yielded lower percent retail cuts, a greater percent fat trim and lower percent bone. Long compared to short fed steers had larger loin eye areas, greater fat thickness and lesser percent total retail cuts. Also, long fed steers had more fat trim and percent kidney, pelvic and heart fat.

Ferrell et al. (1978) found that fat thickness increased as energy density increased, and a decreased percentage cutability resulted. All carcass traits studied were influenced by both breed type and energy density of the diet with the exception of loin eye area and he concluded that although the high energy diet resulted in improved rates of gain, a very high proportion of the extra gain was made up of fat.

Luchiari Filho et al. (1979) comparing straightbred Nelore bulls, Chianina-Nelore and Marchigiana-Nelore crossbred bulls fed two different levels of energy ration, observed an increased weight in renal and pelvic fat and in flank cuts for the animals fed a high energy level.

Norman and Felicio (1980) observed treatment differences in the adjusted weights of ponta de agulha cuts for animals coming from feedlot or pasture conditions and concluded that under favorable nutritional conditions, fat is preferentially laid down in the ventral parts of the carcass especially in the abdominal region.

In a second paper Norman and Felicio (1981) observed that percentage total saleable meat for animals on pasture was higher than for those from a feedlot, and that the weight of total trimmings were 100% higher from the feedlot animals.

The use of prediction equations in estimating cutability

The presence of muscling differences and lower fat percentages in bull carcasses suggest that different cutability prediction equations may be necessary for bulls.

Cole, Orme and Kincaid (1960) observed that of all variables investigated, separable round lean gave the most precise estimate of total carcass muscling. Separable lean of a particular cut of beef was found to be more descriptive of carcass leanness or muscling than either the loin eye area or other carcass measurements. Bone weight of the entire carcass had a high relation with total separable carcass lean ($r = 0.75$).

Carcass weight alone was more closely related to separable lean ($r = 0.75$) than were combinations of carcass length and loin eye area or carcass length, loin eye area and fat thickness over the loin eye (Cole, Ramsey and Epley, 1962). The authors concluded that probably the most valuable prediction equation is that which included only fat thickness over the loin eye and carcass weight.

Brungardt et al. (1963) observed that percent trimmed round made the largest contribution to the multiple correlation coefficient in predicting percent retail yield. When the loin eye area was used in the equation with a single 12th rib fat measurement, percent kidney knob and left side weight, it made a significant improvement in the precision of estimate. All fat measurements studied had highly significant simple correlations with percent retail yield.

All correlations between fat thickness and percent boneless and partially boneless retail cuts were negative and significant (Hedrick et al. (1965). The subcutaneous fat thickness measurement was associated with two to three times as much of the variation in retail yields as was Longissimus dorsi measurements.

Field, Schoonover and Nelms (1966) used depth of fat, percent kidney fat, loin eye area and carcass weight to predict weight and percent of muscle, bone and fat in bull carcasses. These 4 independent variables accurately predicted weight of fat, muscle and bone (R^2= 0.90, 0.98 and 0.93 respectively). These workers concluded that carcass weight alone was a good indicator of weight of muscle, bone and fat in bull carcasses of varying sizes.

Allen (1968) studying the carcasses of 80 steers equally divided into light and heavy weight groups, and four fat thickness cells, observed that fat thickness was negatively correlated with measurements of muscling and bone and positively correlated with measurements of fat.

Abraham et al. (1968) found that carcass weight was the most important variable in multiple regression equations for predicting weight of boneless closely trimmed loin, rib, rump, cushion round and chuck (boneless steak and roast meat). Fat thickness, kidney fat weight, loin eye area and wholesale round weight also contributed significantly to equations for predicting weight of boneless steak and roast meat. These workers observed that fat thickness was the most important variable in multiple regression equations predicting percent of boneless steak and roast meat.

Epley et al. (1970) studied regression equations predicting total weight of retail cuts using hot carcass weight, loin eye area, fat thickness and kilograms of kidney, pelvic and heart fat as predictors. Variation in hot carcass weight explained more of the variation in total weight of retail cuts than did the other three predictors. Loin eye area was the least valuable predictor of both percent total and percent primal retail cuts, when hot carcass weight, fat thickness and kidney pelvic and heart fat were or were not held constant. Hot carcass weight was the single most valuable predictor of total primal retail cut weights (fat thickness least valuable) but fat thickness was equally as valuable as hot carcass weight in predicting percent retail cuts (loin eye area least valuable).

Nelms et al. (1971) observed that carcass weight, percent kidney and pelvic fat and fat depth were the only variables making a significant contribution in the equation predicting weight of retail cuts, with weight accounting for most of the variation. Fat depth and percent kidney and pelvic fat were the only variables making a significant contribution to the equation for predicting percent retail cuts.

CHAPTER III

BODY AND CARCASS COMPOSITION OF YOUNG NELORE BULLS COMPARED WITH ½ AND ¼ BLOOD MARCHIGIANA-NELORE BULLS: I.

MATERIAL AND METHODS

Four groups totaling 36 young bulls were placed in a dry lot and individually fed a ration of 66% TDN. There were 20 Nelore bulls, 10 each in two groups (Nelore I and Nelore II), a third group of 10 one-quarter blood Marchigiana-Nelore bulls and a fourth group of 6 one-half blood Marchigiana-Nelore bulls (Crossbred I and Crossbred II respectively). The Nelore I group had a mean age on test of 689 days and the other three groups all had mean-ages of 613 days. Group mean on test weights were 294.2, 285.8, 286.4 and 278.3 kg respectively. All animals were randomly assigned to three slaughter time groups (1, 2 and 3) which were slaughtered after 119, 152 and 175 days on feed respectively. The range in ages across all animals at slaughter was from 24 to 28.5 months.

At the conclusion of each feeding period, individual off-test weights were recorded following an 18 hour fast (with access to water). Cattle were then transported to a commercial slaughter plant approximately 60 miles from the feedlot.

Animal slaughter followed a 14 hour resting period (with access to water).

The following weights were obtained during slaughter:-

1) weight of forefeet separated between carpus and metacarpus plus weight of hindfeet separated between tarsus and metatarsus (De Boer et al. 1974).

2) weight of hide after washing and without trimming.

3) weight of head after washing and including tongue, trachea and larynx.

4) weight of kidney and pelvic fat.

Carcasses were split into sides, thoroughly washed with warm water, weighed and side weights were recorded. Then carcasses were placed in a chill cooler at $2^{o}C$.

Following a 24 hour chill, carcasses were measured for length (anterior edge of the symphysis pubis to the mid-point of the first rib) and depth of chest (measured at the fifth rib).

Cold side weights were recorded and one side of each carcass alternated between right and left sides was broken into the Brazilian wholesale cuts of special hindquarter, forequarter and ponta de agulha (Figure 1) as described by Corte et al. (1979). Loin eye area and fat cover over the loin eye were measured at the 12th rib level.

The data were analysed by analysis of variance with unequal sample sizes, by using the General Linear Model procedure on the Statistical Analysis System (1978). Means were compared by using the Duncan's Multiple Comparisons procedure (Snedecor and Cochran, 1967).

Hot and chilled carcass weights were expressed as a percentage of live weight, loin eye area as LEA per 100 kg of side weight and wholesale cuts as percentages of the side weight.

RESULTS AND DISCUSSION

Live and carcass trait differences

Despite a lower mean on-test weight, the ½ Marchigiana-Nelore (Crossbred II) bulls finished with heavier mean slaughter (off-test) weights and hot and chilled carcass weights. These results agree with those observed by Hedrick et al. (1975) who reported that carcass weight was greater for crossbreds than straightbreds.

On a slaughter time group basis (Table 1), bulls fed 152 or 175 days had higher ($P<.05$) slaughter weights and hot and chilled carcass weights than those fed 119 days. This would be expected since live weight increases with age and increased feeding time.

Breeds or slaughter time groups were not different for hot and chilled dressing percentages (Table 1). Guenther et al. (1965) observed that dressing percentage increased as the feeding period was increased. Butler, Warwick and Cartwright (1956) observed the advantage of higher dressing percentage for crossbred Brahman-Hereford steers than the straightbred Hereford steers.

Non-significant differences were observed for weight of head, hide or feet between breeds, but as shown in table 1, it was observed that slaughter group 1 had less ($P<.05$) of these indicating that with increasing age and live weight

TABLE 1. BREED AND TIME ON FEED EFFECTS ON SLAUGHTER TRAITS

Breed Groups	Live Weight At Slaughter (kg)	Hot Carcass Weight (kg)	Hot Dressing Percentage	Chilled Carcass Weight (kg)	Chilled Dressing Percentage	Head Weight (kg)	Hide Weight (kg)	Feet Weight (kg)
Nelore I	476.0^{a}	269.78^{a}	56.68	266.30^{a}	55.92	15.28	51.50	8.20
Nelore II	464.5^{a}	264.49^{a}	56.89	259.11^{a}	55.74	15.01	50.54	7.99
Crossbred I	479.0^{a}	264.42^{a}	55.16	260.22^{a}	54.29	15.80	49.85	7.75
Crossbred II	513.5^{b}	291.57^{b}	56.77	286.30^{b}	55.76	15.93	53.55	7.87
Slaughter Groups (Time on Feed)								
Group 1	450.73^{a}	250.44^{a}	55.54	245.53^{a}	54.45	14.88^{a}	47.42^{a}	7.54^{a}
Group 2	481.45^{b}	273.92^{b}	56.88	269.53^{b}	55.97	15.99^{b}	49.45^{a}	8.33^{b}
Group 3	501.57^{b}	283.46^{b}	56.53	279.18^{b}	55.67	15.49^{ab}	55.33^{b}	8.01^{ab}

^{a,b,c}Means within breed groups or slaughter groups without a common superscript differ ($P<.05$).

the weight of these parts increase at least up to the stage where the fat deposition starts to increase. A significant interaction was observed for feet weight but there seems to be no reasonable explanation for this finding.

No differences were observed for depth at fifth rib between breeds or slaughter time groups. Carcasses were longer ($P<.05$) in the crossbred I and II groups than the Nelore I and II (Table 2). These results agree with findings of Gaines et al. (1957) and Butler et al. (1956) who observed longer length of body for crossbred Brahman-Hereford steers than for Hereford steers.

Kidney and pelvic fat (Table 2) expressed as a weight or as a percentage of chilled carcass weight showed no significant differences between breed groups. This agrees with Luchiari Filho et al. (1979) who found no differences in kidney and pelvic fat weights when comparing Nelore purebred with Chianina and Marchigiana crossbreds. Carroll, Rollins and Ittner (1955) and Ferrell et al. (1978) observed lesser fat content for crossbreds than straightbreds or small type breeds. Comparing slaughter time groups, bulls fed 119 days had less ($P<.05$) kidney and pelvic fat weight than the other slaughter time groups but percent kidney and pelvic fat did not differ by group. Increased kidney and pelvic fat weights would be expected with increasing live weight, increasing fatness and longer feeding times. This agrees with findings of Hedrick et al. (1975) who observed greater amounts of fat in long fed steers than short fed steers.

TABLE 2. BREED AND TIME ON FEED EFFECTS ON CARCASS TRAITS

Breed Groups	Carcass Length (cm)	Depth at Fifth Rib (cm)	Kidney and Pelvic Fat Weight (kg)	Kidney and Pelvic Fat (%)	Fat Thickness at 12th Rib Level (mm)	Loin Eye Area (sq cm)	LEA/100 Kg of Carcass Weight (sq cm)
Nelore I	124.13^{a}	40.57	7.57	2.81	4.70^{ab}	70.39^{a}	26.41
Nelore II	123.87^{a}	39.94	7.91	3.06	6.10^{b}	68.57^{a}	26.53
Crossbred I	128.50^{b}	41.37	6.93	2.67	4.60^{ab}	65.93^{a}	25.48
Crossbred II	128.12^{b}	40.85	7.60	2.66	3.50^{a}	79.65^{b}	27.93
Slaughter Groups (Time on Feed)							
Group 1	124.58^{a}	40.44	6.43^{a}	2.61	3.36^{a}	67.61	27.56^{a}
Group 2	---	---	7.90^{b}	2.94	3.91^{a}	71.93	26.56^{ab}
Group 3	126.97^{b}	40.84	8.01^{b}	2.87	6.78^{b}	71.28	25.55^{b}

^{a,b,c}Means within breed groups or slaughter groups without a common superscript differ ($P<.05$).

Fat thickness (Table 2) was less ($P < .05$) for the crossbred II group, higher for Nelore II and intermediate for Nelore I and crossbred I. These results for fat thickness agree with many authors who have observed thinner fat cover for crossbred animals. (Damon et al. 1960, Adams, Garrett and Elings, 1973, Hedrick et al. 1975, Prior et al. 1977, Robelin, 1978, Luchiari Filho et al. 1979 and O'Mary, Martin and Anderson, 1979).

Between slaughter groups fat thickness increased significantly with longer feeding periods. The fact that groups 1 and 2 were not different indicate that they were not depositing increasing amounts of fat up through 152 days of feeding. These results agree with Adams et al. (1973) and Hedrick et al. (1975).

Crossbred II animals were observed to have larger ($P < .05$) loin eyes than the other groups (Table 2). The crossbred I group tended to have the smallest loin eyes. Gaines et al. (1957) comparing crossbred and straightbred steers and heifers observed positive evidence of heterosis for loin eye area and De Rouen (1979) observed that Brahman breeding had a negative influence upon loin eye area.

Between slaughter time groups, even though loin eye area shows a trend to increase with age, the differences were not significant. The larger loin eyes in the crossbred II bulls can partially be explained by their higher average live weight since loin eye area is positively correlated with live weight. The larger loin eyes in the crossbred II group supports by the findings of Hedrick et al. (1970), Hedrick et al. (1975), Koch et al. (1976), Koch and Dikeman, (1977), Luchiari Filho et al. (1979) and O'Mary et al. (1979). Hedrick et al. (1975) observed that loin eye area was greater for steers fed longer time periods than for short fed steers.

When loin eye area was expressed per 100 kg of carcass weight, crossbred II bulls had slightly more and crossbred I bulls the least, but differences were not significant. LEA/ 100 kg of carcass weight was different ($P < .05$) by slaughter time group with group 1 having more than group 2 and with group 3 having the least. Berg and Butterfield (1968) reported that Longissimus dorsi muscle has an average growth impetus thus, in later stages of development weight gain of other carcass tissues surpass that of Longissimus dorsi.

Differences in carcass wholesale cuts

Crossbred II bull carcasses yielded more weight of special hindquarter which would be expected since they had heavier live and carcass weights (Table 3). Slaughter time group 3 had heavier ($P < .05$) special hindquarter weights than group 1 with group 2 being intermediate. This should be expected since hindquarter weight increases with increasing age and weight. When special hindquarter weight was expressed as a percentage of side weight, group 2 and 3 had less ($P < .05$) than group 1. According to Luitingh (1962), since the growth

TABLE 3. BREED AND TIME ON FEED EFFECTS ON WHOLESALE CUT WEIGHTS AND PERCENTAGES.

Breed Groups	Special Hindquarter Weight (kg)	Special Hindquarter (%)	Forequarter Weight (kg)	Forequarter (%)	Ponta De Agulha Weight (kg)	Ponta De Agulha (%)
Nelore I	60.22[a]	45.60[a]	54.94	41.52[a]	17.38	13.13
Nelore II	59.31[a]	46.03[ab]	53.08	41.13[a]	16.73	12.95
Crossbred I	60.77[a]	46.97[b]	52.38	40.45[ab]	16.74	12.94
Crossbred II	67.58[b]	47.37[b]	56.82	39.73[b]	18.03	12.60
Slaughter Groups (Time on Feed)						
Group 1	58.24[a]	47.46[a]	48.76[a]	39.71[a]	15.85[a]	12.90
Group 2	61.14[ab]	45.81[b]	55.41[b]	41.61[b]	17.07[ab]	12.81
Group 3	63.95[b]	46.02[b]	57.07[b]	41.06[b]	18.18[b]	13.07

[a,b,c]Means within breed groups or slaughter groups without a common superscript differ ($P<.05$).

impetus of the hindquarter at later stages of development is lower in bulls than the forequarter, when it is expressed as percentage of side weight it should be expected to decrease as the animals get older and heavier.

Slaughter time groups 2 and 3 had more ($P<.05$) weight and percentages of forequarter than did group 1. Although differences in forequarter weight were not significant by breed groups, a tendency was observed for crossbred I bulls to have a lighter and crossbred II bulls heavier forequarter weights. When expressed as a percentage of side weight crossbred II bulls had less ($P<.05$) than the Nelore I and II bulls.

The higher forequarter weights and lower hindquarter weights obtained from the Zebu breeds has been well documented and the results agree with findings of Carpenter et al. (1961), Cole et al. (1971), Luchiari Filho et al. (1979) and Norman and Felicio (1980). These workers have stated that the hump on the Zebu forequarter exerts a great influence on the weight differences between forequarter and hindquarter. The decrease in special hindquarter proportion and consequent increase in forequarter proportion with age and finish agree with earlier findings of Luitingh (1962), who observed that as the animal gets older an onset of higher growth intensity and fat deposition takes place in the forequarter.

No differences were observed between breed groups for ponta de agulha expressed as weight or as percentage of side weight (Table 3) but ponta de agulha weights increased ($P<.05$) as the animals were fed longer, with slaughter time group 1 being lighter than group 3 and group 2 intermediate. This was expected, since ventral parts of the body increase with age, fattening and ration energy level as observed by Luitingh (1962), Cole et al. (1971) and Luchiari Filho et al. (1979). When the ponta de agulha weights were expressed as a percentage of side weight the difference was not significant. These results indicate that they were not accumulating fat in this part of the carcass more rapidly than other parts were gaining weight up through 175 days on feeding.

From a carcass characteristic standpoint, crossbreeding of Nelore and Marchigiana purebred cattle would be of interest since the crossbreds attained higher gains of the higher priced special hindquarter, and lower gains of the lower priced forequarter and ponta de agulha.

SUMMARY

Four groups totaling 36 young bulls were placed in a dry lot and individually fed a ration of 66% TDN. The groups consisted of 10 Nelore bulls (Nelore I) averaging 689 days of age and 10 Nelore, 10 ¼ Marchigiana-Nelore and 6 ½ Marchigiana-Nelore bulls (Nelore II, crossbred I and crossbred II respectively) averaging 613 days of age at the beginning of the study. All animals were randomly assigned to three slaughter time groups (1, 2 and 3) and fed for 119, 152 or 175 days before slaughtering.

All groups after the feeding period were slaughtered in a commercial slaughter plant and their carcasses were evaluated.

The crossbred II bulls had a heavier ($P<.05$) live weight (513.5 kg) at slaughter than the Nelore I, Nelore II and crossbred I groups (476.0, 464.5 and 479.0 kg respectively). Consequently, crossbred II bulls showed heavier ($P<.05$) hot and chilled carcass weights than the other groups. Also the crossbred II bulls had thinner ($P<.05$) 12th rib fat cover (3.5 mm) with Nelore II bulls having the thicker 12th rib fat cover (6.1 mm) and Nelore I and crossbred I groups being intermediate (4.7 and 4.6 mm respectively). Loin eye area was larger ($P<.05$) for crossbred II (79.65 sq cm) than for Nelore I, Nelore II and crossbred I groups (70.39, 68.57 and 65.93 sq cm respectively).

Also, crossbred II bulls had a heavier ($P<.05$) special hindquarter weight (67.58 kg) than for Nelore I, Nelore II and crossbred I bulls (60.22, 59.31 and 60.77 kg respectively). When special hindquarter weight was expressed as a percentage of side weight, those of the crossbred groups I and II were heavier (46.97 and 47.37% respectively) than Nelore I (45.60%) with Nelore II (46.03%) being intermediate. On the other hand, a lower ($P<.05$) percentage of forequarter was observed for the crossbreds.

These characteristics are very desirable since the special hindquarter contains the retail cuts of higher commercial value and the forequarter those with lower values.

Larger framed and later maturing cattle used in a crossbreeding program with the traditional Nelore breed of cattle, increased significantly the amount of carcass produced with the benefit of a higher proportion of special hindquarter to forequarter.

CHAPTER IV

CARCASS AND MUSCLE DISTRIBUTION OF YOUNG NELORE BULLS COMPARED WITH ½ AND ¼ BLOOD MARCHIGIANA-NELORE BULLS: II.

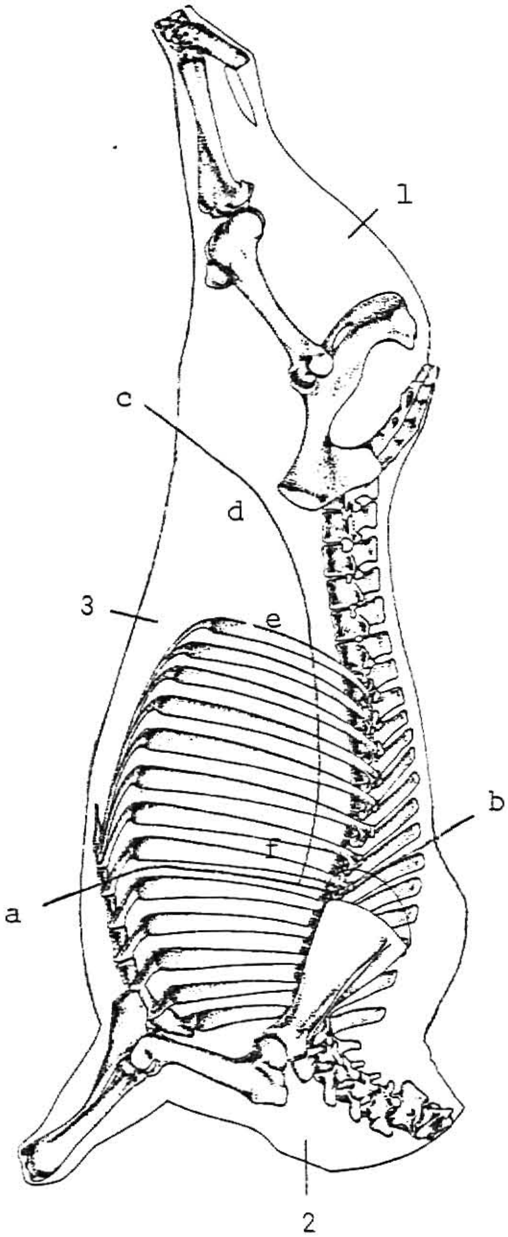
MATERIAL AND METHODS

Feeding and slaughtering procedures have been described in chapter III. Following a 24 hour chill, carcass sides were weighed and weights recorded. One side (alternately right and left sides) of each carcass were cut into the traditional Brazilian cuts of special hindquarter, forequarter and ponta de agulha (Figure 1), each cut weighed and the weights recorded. The wholesale cuts were then fabricated into retail cuts in accordance with the retail market cutting procedure common in Brazil, with each cut being trimmed of excess fat to approximately 0.5 cm of fat cover. Trimmed retail cuts represent the total amount of edible meat and will be designated hereafter as edible portion from each quarter and the total side. Total bone from each quarter was weighed without scraping.

Following is a list of the retail cuts by quarter accompanied by major muscles in each:-

Special hindquarter

FIGURE 1



1. Special Hindquarter

line c-d-e is cut starting posterior to and then through the precrural lymph node and adjacent to the major leg muscles (Quadriceps) to point d which is just ventral to the most anterior tip of the ilium. The cut is then continued parallel to the vertebral column to point e (20-22 cm from the ventral tip of the 13th thoracic vertebra) and on to point f located at the 6th thoracic vertebra 4 cm from the lateral edge of the Longissimus muscle.

2. Forequarter

separated along line a-b between the 5th and 6th ribs, perpendicular to the carcass ventral column.

3. Ponta de Agulha

the area outlined by points a,c, d,e and f and that part of the carcass remaining after removing the forequarter and special hindquarter.

1) File mignon = Psoas major

2) Contra file = Longissimus dorsi

3) Alcatra = Tensor fascia latae and Gluteus medius

4) Coxao mole = Semimembranosus, Adductor and Gracilis (Inside round)

5) Coxao duro = Biceps femoris (Outside round)

6) Patinho = Quadriceps femoris

7) Lagarto = Semitendinosus

8) Musculo do traseiro = Extensor group and Gastrocnemius

<u>Forequarter</u>

1) Acem + Peito + Pescoco = Trapezius cervicalis and thoracis, Pectoralis superficialis and profundus, Serratus ventralis thoracis, Latissimu dorsi, Brachiocephalicus, Omotransversarius and Sternocephalicus

2) Paleta + Musculo do dianteiro = Deltoideus, Triceps brachii, Infraspinatus, Supraspinatus and Extensor group

<u>Ponta de agulha</u>

1) Ponta de agulha = Obliquus internus abdominis and externus abdominis, Rectus abdominis, Pectoralis profundus and Latissimu dorsi (Butterfield and May 1964).

Data were analysed using analysis of variance with unequal sample sizes, using the General Linear Model procedure on the Statistical Analysis System (1978). Means were compared by using Duncan's Multiple Comparisons procedure (Snedecor and Cochran 1967).

RESULTS AND DISCUSSION

Differences in special hindquarter retail cut weights and percentages

All trimmed retail cuts from the special hindquarter were heavier ($P<.05$) for the crossbred II group than for other groups (Table 4). The crossbred II carcasses had heavier coxao duro (outside round) weights than Nelore II bulls. Also the musculo do traseiro (Extensor group and Gastrocnemius) from the crossbred II was heavier ($P<.05$) than all other groups with crossbred I musculo do traseiro being heavier than from Nelore II. Norman and Felicio (1981) observed that Charolais crossbreds had heavier weights for patinho and musculo do traseiro cuts than did Zebu breeds.

Comparing slaughter groups, some muscles did not differ ($P<.05$) in weight with time on feed (Table 4). File mignon (Psoas major), Contra file (Longissimus dorsi), Alcatra (Tensor fascia latae and Gluteus medius)and Lagarto (Semitendinosus) all followed this pattern. Berg and Butterfield (1976), studying the pattern of post natal muscle development in steers, classified these muscles as high-average growth impetus muscles (Diphasic growth). The results from our experiment agree with this classification since in later stages of development with small differences in age, as in these groups, limited change should be expected in these

TABLE 4. BREED AND TIME ON FEED EFFECTS ON RETAIL CUT WEIGHTS FROM SPECIAL HINDQUARTER (kg)

Breed Groups	Special Hindquarter	File Mignon	Contra File	Alcatra	Patinho	Coxao Mole	Coxao Duro	Lagarto	Musculo Do Traseiro
Nelore I	60.22^{a}	1.98^{a}	8.58^{a}	6.82^{a}	5.05^{a}	8.54^{a}	5.16^{ab}	2.52^{a}	3.80^{ab}
Nelore II	59.31^{a}	2.07^{a}	8.29^{a}	6.72^{a}	4.92^{a}	8.21^{a}	4.78^{a}	2.41^{a}	3.64^{a}
Crossbred I	60.77^{a}	2.12^{a}	8.50^{a}	6.62^{a}	5.21^{a}	8.59^{a}	5.07^{ab}	2.45^{a}	3.99^{b}
Crossbred II	67.58^{b}	2.40^{b}	9.71^{b}	7.60^{b}	6.02^{b}	9.64^{b}	5.39^{b}	2.77^{b}	4.42^{c}
Slaughter Groups (Time on Feed)									
Group 1	58.24^{a}	2.13	8.84	6.84	4.99^{a}	8.26^{a}	4.58^{a}	2.48	3.81^{a}
Group 2	61.14^{ab}	2.06	8.54	6.70	5.05^{a}	8.65^{ab}	5.08^{b}	2.43	3.75^{a}
Group 3	63.95^{b}	2.15	8.62	7.02	5.53^{b}	8.95^{b}	5.45^{b}	2.61	4.12^{b}

^{a,b,c}Means within breed groups or slaughter groups without a common superscript differ ($P<.05$).

muscles assuming bulls follow similar growth patterns. Significant differences were observed for Patinho (Quadriceps femoris) and musculo do traseiro with group 3 being heavier ($P<.05$) than groups 1 and 2 (Table 4). Coxao duro was heavier ($P<.05$) for the second and third slaughter time groups than for group 1 and coxao mole (Inside round) was heavier ($P<.05$) for group 3 than for group 1 (Table 4).

Percentage of patinho was greater ($P<.05$) in crossbred II bulls than in Nelore I and II with the crossbred I group being intermediate. Crossbred I and II bulls had higher ($P<.05$) percentages of musculo do traseiro than did Nelore I bulls and Nelore I had more than Nelore II (Table 5). O'Mary et al. (1979) in a study of Angus and Angus-Charolais crossbreds reported that only the Semitendinosus percentage was different being higher in the crossbreds.

Comparing slaughter time groups, the only cut that increased in percentage with increased age was the coxao duro with group 3 having more ($p<.05$) than group 1 (Table 5). File mignon and contra file percentages decreased for carcasses from bulls fed 152 or 175 days. The alcatra and coxao mole followed this same trend but differences were not significant. Slaughter time group 1 had a greater percentage lagarto and musculo do traseiro than did group 2 (Table 5), while percentage patinho remained largely unchanged across slaughter groups. The decrease in percentage of most of the special hindquarter cuts would be expected since the special hindquarter percentage decreases significantly with age.

TABLE 5. BREED AND TIME ON FEED EFFECTS ON RETAIL CUT PERCENTAGES FROM SPECIAL HINDQUARTER

Breed Groups	Special Hindquarter	File Mignon	Contra File	Alcatra	Patinho	Coxao Mole	Coxao Duro	Lagarto	Musculo Do Traseiro
Nelore I	45.60[a]	3.29	14.27	11.34	8.38[a]	14.16	8.56	4.24	6.31[b]
Nelore II	46.03[ab]	3.50	13.98	11.38	8.30[a]	13.88	8.05	4.07	6.13[a]
Crossbred I	46.97[b]	3.50	13.99	10.91	8.55[ab]	14.10	8.34	4.03	6.56[c]
Crossbred II	47.37[b]	3.56	14.37	11.26	8.90[b]	14.27	7.98	4.12	6.54[c]
Slaughter Groups (Time on Feed)									
Group 1	47.46[a]	3.67[a]	15.16[a]	11.76	8.58	14.16	7.86[a]	4.25[a]	6.53[a]
Group 2	45.81[b]	3.37[b]	13.92[b]	10.95	8.24	14.14	8.32[ab]	3.96[b]	6.12[b]
Group 3	46.02[b]	3.35[b]	13.47	11.00	8.62	13.98	8.53[b]	4.11[ab]	6.43[a]

[a,b,c]Means within breed groups or slaughter groups without a common superscript differ ($P<.05$).

Musculo do traseiro percentage was lower ($P < .05$) for slaughter time group 2 than for groups 1 and 3. A significant interaction for musculo do traseiro percentage seems to indicate that the effects of breed and time on feed combined influence the percent yield of this cut. These findings agree with those of Berg and Butterfield (1968) who state that muscles in the hindquarter largely develop at an average to below average rate compared to the forequarter. Also, as fattening increases with increased feeding, percentages of hindquarter and hindquarter cuts decrease due to greater fat deposition occuring in the forequarter and ventral carcass parts.

Differences in forequarter retail cut weights and percentages

Forequarter weight showed an increase ($P < .05$) with increased age and slaughter weight (Table 6) with groups 2 and 3 being heavier than group 1. Forequarter weight differences between groups were not statistically significant. Crossbred II bulls had more ($P < .05$) weight for the combined retail cuts, acem, peito and pescoco, than Nelore II and crossbred I (table 6). Slaughter time groups 2 and 3 showed heavier ($P < .05$) weights for these cuts than group 1. This is probably due to the increased age and sexual maturity of the second and third groups. This same trend is observed with the retail cuts paleta and musculo do dianteiro where

TABLE 6. BREED AND TIME ON FEED EFFECTS ON FOREQUARTER RETAIL CUTS AND PONTA DE AGULHA COMPONENTS (kg)

Breed Groups	Forequarter	Acem + Peito + Pescoco	Paleta + Musculo	Cupim (Hump)	Ponta De Agulha	Ponta De Agulha (Trimmed)
Nelore I	54.94	24.48^{ab}	15.45^{b}	2.97^{a}	17.38	13.81
Nelore II	53.08	23.77^{a}	14.27^{a}	2.96^{a}	16.73	13.63
Crossbred I	52.38	23.10^{a}	14.82^{ab}	2.05^{b}	16.74	13.24
Crossbred II	56.82	27.23^{b}	16.84^{c}	2.20^{b}	18.03	14.80
Slaughter Groups (Time on Feed)						
Group 1	48.76^{a}	21.34^{a}	14.15^{a}	2.22^{a}	15.85^{a}	12.80^{a}
Group 2	55.41^{b}	25.17^{b}	15.20^{ab}	2.80^{b}	17.07^{ab}	13.43^{a}
Group 3	57.07^{b}	26.09^{b}	15.97^{b}	2.69^{b}	18.18^{b}	14.82^{b}

[a,b,c]Means within breed groups or slaughter groups without a common superscript differ ($P<.05$)

slaughter group 3 had more (P<.05) than group 1 with group 2 being intermediate (Table 6). Comparing breed groups for these muscles the crossbred II bulls showed more (P<.05) of these than Nelore II and crossbred I bulls while Nelore I bulls were intermediate. As slaughter age increased these retail cut weights increased with slaughter group 3 having more (P<.05) than group I while slaughter group 2 was intermediate but not significantly different from either of the other two groups.

Francis (1965) stated that on Zebu cattle and their crosses, the hump (cupim), is an enlargement of the thoracic part of the muscle rhomboideus. As would be expected the weights of this cut was significantly heavier in the Nelore groups than in the crossbred groups. Similar results were described by Cole et al. (1971) and Luchiari Filho et al. (1979). Comparing slaughter time groups, groups 2 and 3 had heavier (P<.05) cupims than did group 1. This would indicate that this cut increases in weight just as do the other forequarter cuts with increasing age and fattening. Slaughter group 2 showed a slight but non-significant difference from group 3 with group 2 being slightly heavier than group 3.

Forequarter percentage showed a significant increase with increased time on feed (Table 7) with groups 2 and 3 being heavier than group 1. Crossbred II bulls had a lower (P<.05) forequarter percentage than Nelore I and II bulls with crossbred I intermediate. The combined retail cuts, acem,

TABLE 7. BREED AND TIME ON FEED EFFECTS ON FOREQUARTER RETAIL CUTS AND PONTA DE AGULHA COMPONENTS (PERCENTAGES)

Breed Groups	Forequarter	Acem + Peito + Pescoco	Paleta + Musculo	Cupim (Hump)	Ponta De Agulha	Ponta De Agulha (Trimmed)
Nelore I	41.52^{a}	44.50^{ab}	28.17^{ab}	5.42^{a}	13.13	79.38
Nelore II	41.13^{a}	44.64^{ab}	26.98^{a}	5.54^{a}	12.95	81.99
Crossbred I	40.45^{ab}	44.01^{a}	28.34^{ab}	3.87^{b}	12.94	79.10
Crossbred II	39.73^{b}	47.62^{b}	29.70^{b}	3.92^{b}	12.60	81.95
Slaughter Groups (Time on Feed)						
Group 1	39.71^{a}	43.68	29.07^{a}	4.53	12.90	80.79
Group 2	41.61^{b}	45.42	27.36^{b}	5.07	12.81	78.84
Group 3	41.06^{b}	45.50	28.03^{b}	4.73	13.07	81.46

^{a,b,c}Means within breed groups or slaughter groups without a common supercript differ ($P<.05$).

peito and pescoco were higher (P< .05) for the crossbred II bulls than for crossbred I with Nelore I and II being intermediate when these cuts were expressed on a percentage basis. Comparing slaughter time groups, the percentage of these cuts increased slightly with age, but the differences were not statistically significant. Crossbred II bulls had a higher (P<.05) percentage paleta and musculo than Nelore II with Nelore I and crossbred I bulls being intermediate. Comparing slaughter time groups, group 1 had a higher (P<.05) percentage of these cuts than group 2 with group 3 differing from neither. Percentage cupim was higher (P<.05) for Nelore I and II bulls than crossbred I and II bulls as expected. Carcasses from cattle fed 119 days were lower (P<.05) in percentage cupim than those fed longer.

No breed group differences were observed between the weights or percentages of intact ponta de agulha either intact or after boning and trimming (Table 6). However, when slaughter groups were compared the intact ponta de agulha was significantly heavier (P<.05) in group 3 than 1 with group 2 differing significantly from neither. Trimmed ponta de agulha follows this same pattern except group 3 was significantly heavier than either of the other groups. On a percentage basis (Table 7) the differences were not significantly different between slaughter time groups. This concurs with the findings of Luitingh (1962), Cole et al (1971) and Luchiari Filho et al. (1979) who stated that carcass ventral parts increase in weight mainly as a result of increased fat deposition.

Differences in weight and yield of bone

Total bone weight from the special hindquarter was heavier ($P<.05$) for crossbreds I and II than Nelore I and II. On a slaughter time group basis it was observed that bone weight increased with age with that from slaughter groups 2 and 3 being heavier ($P<.05$) than group 1 (Table 8).

Nelore II had less ($P<.05$) total bone weight from the forequarter than did the other breed groups (Table 8). Comparing slaughter time groups, group 2 had heavier ($P<.05$) forequarter bone weights than group 3 and group 3 than group 1.

Total bone weight from the ponta de agulha was heavier ($P<.05$) for crossbred II bulls than the Nelore II bulls. Slaughter time group 1 had less ponta de agulha bone weight than groups 2 or 3 ($P<.05$).

Crossbred II bulls, having heavier slaughter and carcass weights, also had more ($P<.05$) total side bone weight than did the Nelore II bulls. They also had more total side weight of bone than the other two groups but differences were not significant (Table 8). Comparing Hereford and Brahman-Hereford crossbreds, Carroll et al. (1955) observed that crossbred carcasses had more bone than those from straightbreds. From a slaughter time group standpoint, groups 2 and 3 had heavier ($P<.05$) total bone weights than group 1.

Expressing total bone weights as a percentage of half carcass weight (Table 8), crossbred I carcasses had higher

TABLE 8. BREED AND TIME ON FEED EFFECTS ON WHOLESALE CUT AND SIDE BONE WEIGHTS AND PERCENTAGE

Breed Groups	Special Hindquarter Bone Weight (kg)	Forequarter Bone Weight (kg)	Ponta De Agulha Bone Weight (kg)	Total Bone Weight (kg)	Total Bone (%)
Nelore I	10.66[a]	9.28[a]	2.80[ab]	22.74[ab]	17.25[a]
Nelore II	10.56[a]	8.53[b]	2.58[a]	21.67[a]	16.85[a]
Crossbred I	11.54[b]	9.23[a]	2.83[ab]	23.60[b]	18.25[b]
Crossbred II	11.67[b]	9.25[a]	2.95[b]	23.87[b]	16.74[a]
Slaughter Groups (Time on Feed)					
Group 1	10.40[a]	8.15[a]	2.49[a]	21.05[a]	17.17[a]
Group 2	11.51[b]	9.75[b]	2.98[b]	24.25[b]	18.24[b]
Group 3	11.18[b]	9.21[c]	2.83[b]	23.22[b]	16.74[a]

[a,b,c]Means within breed groups or slaughter groups without a common superscript differ ($P<.05$).

total bone percentages than the other groups. From the standpoint of meat to bone ratio, these animals possibly were not as mature at the time of slaughter as the other breed groups. This hypothesis is also supported by the smaller LEA and LEA per 100 kg of carcass found in the crossbred II bulls which also indicates they had not reached a comparable stage of maturity of the other breed groups.

Slaughter group 2 had a greater percentage of total bone than did the other two slaughter groups (Table 8). This difference may well have been the result of experimental error resulting from poor carcass splits. Upon reviewing the data, it was observed that the side from group 2 that were fabricated were consistently heavier in weight than their opposite sides which was not the case in slaughter groups 1 and 3. The only plausible explanation for this was the chance selection of those sides with more total bone resulting from poor carcass splits. Comparing groups 1 and 3, although the difference was not stastically significant, it was observed that the percentage of bones decreased slightly with age. It is well documented that bone has a low growth impetus at later stages of development and the proportion of bone in a carcass should decrease as the animal gets older. These results agree with earlier results reported by Tulloh (1963) and Kempster (1977).

Differences in quarter and side retail cut weights and percentages

Total closely trimmed retail cut yield (edible portion) from special hindquarter expressed as percentage of the side weight was more ($P<.05$) for the crossbred II bulls than the Nelore I and II bulls but not greater than the crossbred I bulls (Table 9). These results agree with the results previously reported by Luchiari Filho et al. (1979). This increased percentage of trimmed hindquarter cuts is an obvious advantage of crossbreeding, since these are the high priced cuts which are in greatest consumer demand. On a slaughter time group basis the weight of total trimmed retail cuts from special hindquarter tended to increase with increasing age and weights of each group. Increasing time on feed resulted in decreased percentages of hindquarter total retail cut yields (Table 9). This same pattern was observed in most of the percentage yields for the individual retail cut yields from the hindquarter and should be expected.

Total forequarter closely trimmed retail cut weights increased ($P<.05$) with age (Table 9). This can be largely attributed to increased fat deposition and muscle growth in the forequarter since the results show a significant increase in weight from slaughter group 1 to slaughter group 2 with slaughter group 3 being heavier than group 2 but not

TABLE 9. BREED AND TIME ON FEED EFFECTS ON TOTAL CLOSELY TRIMMED RETAIL CUTS FROM SIDES AND WHOLESALE CUTS

Breed Groups	Closely Trimmed Retail Cuts From Special Hindquarter (kg)	Closely Trimmed Retail Cuts From Special Hindquarter (%)	Closely Trimmed Retail Cuts From Forequarter (kg)	Closely Trimmed Retail Cuts From Forequarter (%)	Trimmed Ponta De Agulha (kg)	Trimmed Ponta De Agulha (%)	Total Side Retail Cuts (Edible Portion) (kg)	Total Side Retail Cuts (Edible Portion) (%)	Total Fat Trimmings (kg)	Total Fat Trimmings (%)
Nelore I	41.98^{a}	32.26^{a}	42.90^{ab}	32.42	13.81	10.42	97.76^{a}	75.03^{ab}	9.96	7.63^{ab}
Nelore II	41.04^{a}	31.89^{a}	41.00^{a}	31.75	13.63	10.60	95.71^{a}	74.24^{b}	11.57	8.91^{a}
Crossbred I	42.54^{a}	32.87^{ab}	39.97^{a}	30.84	13.24	10.23	95.75^{a}	73.94^{b}	10.07	7.81^{ab}
Crossbred II	47.95^{b}	33.65^{b}	46.27^{b}	32.32	14.80	10.33	109.02^{b}	76.30^{a}	9.97	6.96^{b}
Slaughter Groups (Time on Feed)										
Group 1	41.93	34.16^{a}	37.72^{a}	30.69^{a}	12.80^{a}	10.42^{ab}	92.45^{a}	75.27	9.27^{a}	7.55
Group 2	42.24	31.63^{b}	43.17^{b}	32.39^{b}	13.43^{a}	10.07^{a}	98.84^{b}	74.10	10.23^{ab}	7.66
Group 3	44.26	32.02^{b}	44.75^{b}	32.15^{b}	14.82^{b}	10.65^{b}	103.41^{b}	74.75	11.64^{b}	8.49

[a,b,c]Means within breed groups or slaughter groups without a common superscript differ ($P<.05$)

significantly (44.75 vs. 43.17 kg). Comparing breed groups, it was observed that crossbred II bulls had more forequarter or forequarter retail cut yield than crossbred I and Nelore II bulls with Nelore I bulls not being different from any of the other groups. Crossbred I bulls showed the least trimmed forequarter retail cut weights which may be desirable due the comparative lower commercial value of these cuts. This lower yield in crossbred I bulls may be due their not being in as advanced maturity stages when slaughtered as the other breed groups.

Total retail yield from ponta de agulha was not different by breed group either on a weight or on a percentage yield basis, but with age and fattening the weight of this cut was significantly higher for group 3 than groups 1 and 2. On a percentage basis, group 2 had less than group 3 with group 1 differing from neither.

Crossbred II bulls yielded more ($P < .05$) total retail cuts (total edible portion) than the other breed groups (Table 9). This breed group had heavier live and carcass weights (chapter III). When expressed on a percentage basis, crossbred II bulls had more ($P < .05$) total edible portion than crossbred I and Nelore II bulls but not more than Nelore I (Table 9). This is very desirable since much of this advantage is composed of special hindquarter yield. Since Marchigiana cattle mature later, slaughtering these type animals at an average slaughter weight of the Nelore will bring the advantage of producing leaner and heavier muscled carcasses. The advantages of these larger framed European cattle in producing larger and leaner carcasses is well documented and many researchers agree that due to a greater body size, these animals can be slaughtered at heavier weights and still have an adequate amount of fat deposition. (Hedrick et al. 1970, Damon et al. 1960, Adams et al. 1973, Hedrick et al. 1975, Robelin, 1978, Ferrell, 1978, Luchiari Filho et al. 1979, Peacock et al. 1979 and O'Mary et al. 1979).

Comparing slaughter time groups, group 2 and 3 had heavier total retail cut weights (Table 9) than group 3, which should be expected due their increased weight. When yields were expressed as a percentage of side weight, they were not stastically different (Table 9), but they did decrease slightly with age of slaughter group. This agrees with other worker findings who have observed that with increased age and finishing percentage yields of edible portion decline. (Cole et al. 1962, Brungardt and Bray, 1963, Ramsey et al. 1962 and Allen et al. 1968).

Total weight of trimmings from side were not different between breeds, but when expressed as a percentage of side weight were lower ($P < .05$) for crossbred II than Nelore II bulls (Table 9). Nelore II bulls had heavier kidney and pelvic fat weights as well as thicker external fat cover. On a slaughter time group basis, weight of trimmings increased with age and finishing mainly due to the higher impetus of fat growth at later stages of development. When expressed on a percentage basis, the differences were not significant.

SUMMARY

A marked advantage was shown for the crossbred II group (½ Marchigiana-Nelore) from the standpoint of producing greater quantities of lean meat without excess waste fat. This group had higher proportion of closely trimmed retail cuts from the special hindquarter (33.65%), higher proportion of total closely trimmed retail cuts (edible portion) (76.30%) and lesser amounts of trimmable fat (6.96%).

Crossbred I (¼ Marchigiana-Nelore) bulls had the lowest proportion of total closely trimmed retail cuts (73.94%) as well as a higher proportion of bone (18.25%), suggesting that bulls of this breeding should be fed longer to attain a higher muscle to bone proportion.

On a slaughter time group basis, total trimmed retail cut weights increased ($P < .05$) with age and finishing, but when expressed as percentage, these yields tend to decrease. A significant increase in weight of trimmings was noted due to increased fat deposition.

CHAPTER V

PREDICTION EQUATIONS FOR ESTIMATING CARCASS YIELDS IN NELORE TYPE CATTLE

MATERIAL AND METHODS

Data from an earlier experiment (Luchiari Filho et al. 1979) were combined with the data from this experiment for the purpose of calculating some regression equations to be used in estimating cutability and other carcass traits of interest in Nelore type cattle.

Data was obtained from 72 animals raised under similar environmental conditions from birth to slaughter. These animals consisted of 32 Nelore purebred bulls, 18 ½ Marchigiana-Nelore, 12 ½ Chianina-Nelore and 10 ¼ Marchigiana-Nelore crossbred bulls.

Feeding and slaughter procedures have been described in chapter III and IV and in Luchiari Filho et al. (1979).

After a 24 hour chill period, one half of each carcass was separated into retail cuts, fat trim and bone. All yields obtained from the fabrication of each side were doubled to represent the total amount of product in a carcass basis. Carcass length was measured from the anterior edge of the first rib to the anterior edge of the aitch bone. Loin eye area was measured at the 12th rib and fat thickness over the

12th rib at three-fourths the distance from the medial to the lateral end of the Longissimus dorsi muscle. Kidney and pelvic fat was weighed and expressed as a percentage of the chilled carcass weight.

The models were built using the Backward Elimination Stepwise Regression procedure on the Statistical Analysis System (1978).

RESULTS AND DISCUSSION

The mean, standard deviation, minimum and maximum values for each trait studied are presented in table 10.

Several prediction equations were developed in which chilled carcass weight, kidney and pelvic fat percentage, loin eye area, fat thickness over the 12th rib and carcass length were used as independent variables to estimate several carcass traits of economic importance.

The dependent variables that were predicted using these equations were: 1.) weight of total carcass trimmed retail cuts (Y1); 2.) weight of trimmed special hindquarter retail cuts (Y2); 3.) weight of forequarter trimmed retail cuts (Y3); 4.) weight of total carcass bone (Y4) and weight of trimmed special hindquarter and forequarter cuts (Y5).

Equations 1, 2 and 3 predict weight of total carcass trimmed retail cuts (Table 11). Equation 1 was the most accurate equation developed considering the use of the independent variables chilled carcass weight, kidney and pelvic fat percentage, loin eye area and 12th rib fat thickness. Equation 2 is presented since it includes only chilled weight and kidney and pelvic fat percentage and thus, may be the easiest to be applied. With only these independent variables, the coefficient of determination for this equation is very high (R^2= 0.95). Including carcass length as an independent

TABLE 10. OVERALL MEAN, STANDARD DEVIATION AND RANGE FOR DEPENDENT AND INDEPENDENT VARIABLES

Variables	N	Mean	Standard deviation	Minimum value	Maximum value
Live weight (kg)	70	466.10	39.20	310.00	568.00
Hot carcass weight (kg)	68	267.61	27.56	171.90	332.50
Kidney and pelvic fat weight (kg)	70	8.01	1.88	4.20	12.60
Fat thickness at 12th rib (mm)	70	3.84	2.32	1.00	11.00
Loin eye area (sq cm)	69	72.36	9.96	42.90	95.50
Carcass length (cm)	58	124.98	3.62	113.70	133.50
Total carcass closely trimmed retail cuts	69	192.01	21.18	120.90	240.44
Total special hindquarter closely trimmed retail cuts (kg)	69	87.58	9.11	56.20	108.32
Total forequarter closely trimmed retail cuts (kg)	70	78.40	10.56	44.40	97.64
Total bone weight (kg)	70	43.97	4.09	31.80	54.46
Chilled carcass weight (kg)	70	259.01	25.71	170.20	318.00
Kidney and pelvic fat percentage	70	3.09	0.66	1.64	4.82
Closely retail cuts from special hindquarter plus forequarter (kg)	69	165.70	18.29	100.60	205.16

TABLE 11. PREDICTION EQUATIONS FOR ESTIMATING CARCASS TRAITS

Equation number	Dependent variable	Intercept	Chilled carcass weight (kg)	Kidney and pelvic fat percentage	Loin eye area (sq cm)	Fat thickness (mm)	Carcass length (cm)	Error mean square	R^2
1	Y1	-6.8074	+0.8021	-3.1021		+0.2743		19.1985	.96
2	Y1	-6.9977	+0.8061	-3.0441				19.2994	.95
3	Y1	45.1663	+0.8725	-3.6633	-0.1232		-0.4693	18.5376	.96
4	Y2	6.6075	+0.2731	-1.5499	+0.2273	-0.3374		8.6238	.90
5	Y3	-8.4971	+0.3956	-2.0771	-0.1531	+0.4964		15.9928	.87
6	Y4	20.2877	+0.1414	-1.2975	-0.1101	-0.2477		7.8051	.57
7	Y4	-21.7699	+0.0693	-0.6658			+0.3938	4.1325	.71
8	Y5	-0.3776	+0.6856	-3.6172				20.2194	.94

Y1= Weight of total carcass trimmed retail cuts

Y2= Weight of trimmed special hindquarter retail cuts

Y3= Weight of forequarter trimmed retail cuts

Y4= Weight of total carcass bone

Y5= Weight of trimmed special hindquarter and forequarter cuts variable (equation 3) to estimate weight of total carcass trimmed retail cuts, resulted in an equation of equal value to equation 1 with the same R^2 value (0.96).

Equation 4 predicts weight of trimmed special hindquarter retail cuts and equation 5 predicts weight of trimmed forequarter retail cuts (Table 11). Both equations used chilled carcass weight, kidney and pelvic fat percentage, loin eye area and fat thickness as independent variables with coefficients of determination of 0.90 and 0.87 respectively.

Equation 6 predicts weight of total carcass bone using all independent variables except carcass length (Table 11). When carcass length was included as an independent variable in equation 7, the coefficient of determination was increased considerably (Equation 6, R^2= 0.57; equation 7, R^2= 0.71). Equation 7 may be useful to estimate the weight of bones in a carcass and in conjunction with equation 1, 2 or 3 to estimate carcass muscle to bone ratio.

Equation 8 estimates the weight of trimmed special hindquarter plus forequarter retail cuts and has an R^2 value of 0.94. With the exception of equation 6, all equations presented here would be of practical use to measure the yield traits they respectively estimate due their relatively high R^2 values and the ease with which the independent variables can be measured and obtained. If the yields are desired as a percentage of carcass weight, the predicted values need only be converted to a percentage form.

SUMMARY

Data from 72 bull carcasses consisted of 32 Nelore, 18 ½ Marchigiana-Nelore, 12 ½ Chianina-Nelore and 10 ¼ Marchigiana-Nelore were used to develop equations for predicting weights of several cut-out yields. Equation 1, used to predict weight of trimmed total carcass cuts (kg= -6.8074 + 0.8021 chilled carcass weight (kg) - 3.1021 kidney and pelvic fat percentage + 0.2743 fat thickness (mm)), would seem to be the most useful, since it utilizes only 3 easily obtainable variables and is highly accurate (R^2= 0.96).

Chilled carcass weight was the independent variable with the greatest contribution in all prediction equations. All dependent variables studied included chilled carcass weight and kidney and pelvic fat percentage as independent variables in the model.

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APPENDIX

TABLE 12. ANALYSIS OF VARIANCE AND STANDARD DEVIATION FOR SLAUGHTER TRAITS

	Live Weight at Slaughter (kg)	Hot Carcass Weight (kg)	Hot Dressing Percentage	Chilled Carcass Weight (kg)	Chilled Dressing Percentage	Head Weight (kg)	Hide Weight (kg)	Feet Weight (kg)
F Values								
Breed	5.17**	3.92*	2.10	3.88*	2.04	2.08	1.34	0.21
Group	14.18**	11.78**	1.54	12.20**	2.24	4.87*	16.05**	2.39
Interaction	0.46	0.22	0.77	0.13	0.75	2.25	1.62	3.63*
S. D.	25.48	17.92	1.78	17.73	1.69	0.84	4.06	0.85

*(P<.05)

**(P<.01)

TABLE 13. ANALYSIS OF VARIANCE AND STANDARD DEVIATION FOR CARCASS TRAITS

	Carcass Length (cm)	Depth at Fifth Rib (cm)	Kidney and Pelvic Fat Weight (kg)	Kidney and Pelvic Fat (%)	Fat Thickness at 12th Rib Level (mm)	Loin Eye Area (sq cm)	LEA/100 kg Carcass Weight (sq cm)
F Values							
Breed	5.47**	1.04	0.64	1.02	2.69	4.96**	1.47
Group	4.83*	0.83	3.84*	0.89	14.81**	1.30	2.95
Interaction	1.02	0.74	0.95	1.17	0.95	0.84	1.00
S. D.	2.60	1.42	1.39	0.50	1.66	7.04	2.11

*(P<.05)

**(P<.01)

TABLE 14. ANALYSIS OF VARIANCE AND STANDARD DEVIATION FOR WHOLESALE CUT WEIGHTS AND PERCENTAGES

	Special Hindquarter Weight	Special Hindquarter (%)	Forequarter Weight	Forequarter (%)	Ponta De Agulha Weight	Ponta De Agulha (%)
F Values						
Breed	5.90**	3.24*	2.34	3.30*	1.10	0.53
Group	6.21**	5.79**	16.29**	7.32**	6.78**	0.71
Interaction	0.11	0.46	0.27	0.22	0.40	0.74
S. D.	4.20	1.27	3.84	1.19	1.69	0.77

*(P<.05)

**(P<.01)

TABLE 15. ANALYSIS OF VARIANCE AND STANDARD DEVIATION FOR RETAIL CUT WEIGHTS FROM SPECIAL HINDQUARTER (KG)

	Special Hindquarter	File Mignon	Contra File	Alcatra	Patinho	Coxao Mole	Coxao Duro	Lagarto	Musculo Do Traseiro
F Values									
Breed	5.90**	6.58*	3.17*	3.05*	7.38**	4.71*	2.46	3.91*	10.40**
Group	6.21**	1.11	0.23	0.69	6.92*	2.31	11.27**	1.77	7.38**
Interaction	0.11	1.11	0.38	0.39	1.16	0.58	0.31	1.05	0.99
S. D.	4.20	0.19	0.94	0.68	0.49	0.77	0.46	0.23	0.29

*(P<.05)

**(P<.01)

TABLE 16. ANALYSIS OF VARIANCE AND STANDARD DEVIATION FOR RETAIL CUTS FROM SPECIAL HINDQUARTER (PERCENTAGES)

	Special Hindquarter	File Mignon	Contra File	Alcatra	Patinho	Coxao Mole	Coxao Duro	Lagarto	Musculo Do Traseiro
F Values									
Breed	3.24*	1.61	0.46	0.41	2.70	0.53	1.45	0.98	10.25**
Group	5.79**	4.90	12.22**	2.15	3.66*	0.96	3.95*	3.05	15.32**
Interaction	0.46	1.51	1.00	0.49	2.42	1.78	0.57	1.13	3.92*
S. D.	1.27	0.26	0.85	1.02	0.44	0.60	0.59	0.29	0.19

*(P<.05)

**(P<.01)

TABLE 17. ANALYSIS OF VARIANCE AND STANDARD DEVIATION FOR FOREQUARTER RETAIL CUTS AND PONTA DE AGULHA COMPONENTS (KG)

	Forequarter	Acem + Peito + Pescoco	Paleta + Musculo	Cupim (Hump)	Ponta De Agulha	Ponta De Agulha (Trimmed)
F Values						
Breed	2.34	3.00	6.41**	9.55**	1.10	1.77
Group	16.29**	11.45**	7.59**	3.81*	6.78**	8.00**
Interaction	0.27	1.42	0.38	1.27	0.40	0.57
S. D.	3.84	2.87	1.20	0.47	1.69	1.41

*(P<.05)

**(P<.01)

TABLE 18. ANALYSIS OF VARIANCE AND STANDARD DEVIATION FOR FOREQUARTER RETAIL CUTS AND PONTA DE AGULHA COMPONENTS (PERCENTAGES)

	Forequarter	Acem + Peito + Pescoco	Paleta + Musculo	Cupim (Hump)	Ponta De Agulha	Ponta De Agulha (Trimmed)
F Values						
Breed	3.30*	1.89	3.28*	10.93**	0.53	2.35
Group	7.32**	2.56	2.80	1.06	0.71	1.72
Interaction	0.22	2.14	0.96	1.41	0.74	1.58
S. D.	1.19	3.06	1.64	0.81	0.77	3.43

*(P<.05)

**(P<.01)

TABLE 19. ANALYSIS OF VARIANCE AND STANDARD DEVIATION FOR WHOLESALE CUT AND SIDE BONE WEIGHTS AND PERCENTAGE

	Special Hindquarter Bone Weight (kg)	Forequarter Bone Weight (kg)	Ponta De Agulha Bone Weight (kg)	Total Bone Weight (kg)	Total Bone (%)
F Values					
Breed	3.57*	3.59*	2.14	4.53*	4.43*
Group	4.08*	21.44**	7.30**	14.45**	5.98**
Interaction	0.83	1.25	0.90	0.61	0.87
S. D.	0.87	0.58	0.31	1.38	1.01

*(P<.05)

**(P<.01)

TABLE 20. ANALYSIS OF VARIANCE AND STANDARD DEVIATION FOR TOTAL CLOSELY TRIMMED RETAIL CUTS FROM SIDES AND WHOLESALE CUTS

	Closely Trimmed Retail Cuts From Special Hindquarter (kg)	Closely Trimmed Retail Cuts From Special Hindquarter (%)	Closely Trimmed Retail Cuts From Forequarter (kg)	Closely Trimmed Retail Cuts From Forequarter (%)	Trimmed Ponta De Agulha (kg)	Trimmed Ponta De Agulha (%)	Total Side Retail Cuts (Edible Portion) (kg)	Total Side Retail Cuts (Edible Portion) (%)	Total Fat Trimmings (kg)	Total Fat Trimmings (%)
F Values										
Breed	7.08**	3.90*	4.34	1.78	1.77	0.74	5.79**	2.76	1.01	2.24
Group	2.10	18.25**	13.52**	4.28*	8.00**	3.08	8.23**	1.28	2.34	0.57
Interaction	0.52	0.78	0.79	1.02	0.57	1.08	0.71	1.31	1.07	1.55
S. D.	3.11	1.05	3.74	1.65	1.41	0.64	7.15	1.71	2.24	1.49

*(P<.05)

**(P<.01)

CARCASS EVALUATION AND COMPARISONS OF ZEBU (NELORE) AND EUROPEAN-NELORE CROSSBRED TYPE CATTLE PRODUCED IN BRAZIL

by

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Four groups totaling 36 young bulls were placed in a dry lot and individually fed a ration of 66% TDN. The groups were made of 10 Nelore bulls (Nelore I) with 689 days of age and 10 Nelore, 10 ¼ Marchigiana-Nelore and 6 ½ Marchigiana-Nelore bulls (Nelore II, crossbred I and crossbred II respectively) with 613 days of age on the average. All animals were randomly assigned to three slaughter groups (1, 2 and 3) and fed for 119, 152 or 175 days before slaughtering.

All groups after the feeding period were slaughtered in a commercial slaughter plant and their carcasses were evaluated.

The crossbred II was observed to have a significantly heavier live weight (513.5 kg) at slaughter than the Nelore I, Nelore II and crossbred I groups (476.0, 464.5 and 479.0 kg respectively). Consequently, crossbred II was observed to have significantly heavier hot and chilled carcass weights than the other groups. Also the crossbred II had significantly thinner 12th rib fat cover (3.5 mm) with Nelore II having the thicker 12th rib fat cover (6.1 mm) and Nelore I and crossbred I groups being intermediate (4.7 and 4.6 mm respectively). Loin eye area was observed to be significantly larger for crossbred II (79.65 sq cm) than for Nelore I, Nelore II and crossbred I groups (70.39, 68.57 and 65.93 sq cm respectively).

Also, it was observed that the crossbred II bulls had a significantly heavier special hindquarter weight (67.58 kg) than for Nelore I, Nelore II and crossbred I bulls (60.22, 59.31 and 60.77 kg respectively). When special hindquarter weight was expressed as percentage of side weight, the crossbred groups I and II were significantly higher (46.97 and 47.37% respectively) than Nelore I (45.60%) with Nelore II (46.03%) being intermediate. On the other hand, a significant and lower percentage of forequarter was observed for the crossbreds.

Also, the results show a marked advantage for the crossbred II group (½ Marchigiana-Nelore) from the standpoint of producing greater quantities of lean meat without the excess waste fat. This group had higher proportion of closely trimmed retail cuts from special hindquarter (33.65%), higher proportion of total closely trimmed retail cuts (edible portion) (76.30%) and lesser amounts of trimmable fat (6.96%).

Crossbred I (¼ Marchigiana-Nelore) bulls had the lowest proportion of total closely trimmed retail cuts (73.94%) as well as a higher proportion of bone (18.25%), suggesting that bulls of this breeding should be fed longer to attain a higher muscle to bone proportion.

On a slaughter group basis, total trimmed retail cut weights increased significantly with age and finishing, but when expressed as percentage, these yields tend to decrease however, not significantly. A significant increase in weight of trimmings was noted due to increased fat deposition.

The data from an earlier experiment were grouped with the data from this experiment and the information obtained for 72 bull carcasses were used to develop equations for predicting weights of several cut-out yields. Equation 1, used to predict weight of trimmed total carcass cuts (Kg= -6.8074 + 0.8021 chilled carcass weight (kg) - 3.1021 kidney and pelvic fat percentage + 0.2743 fat thickness (mm), would seem to be the most useful, since it utilizes only 3 easily obtainable variables and is highly accurate (R^2= 0.96).

Chilled carcass weight was the independent variable with the greatest contribution in all prediction equations. All dependent variables studied included chilled carcass weight and kidney and pelvic fat percentage as independent variables in the model.