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Developing Criteria for Carcass and Meat Pricing at the Slaughter Level

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INTRODUCTION

MEAT scientists in the United States and Britain (Stouffer, 1959) by ultrasonic devices are able to detect in the live animal, the size of the rib-eye area, or more precisely, the area of the *longissimus dorsi* muscle (cross section at 12th rib). Then by special computations they can estimate the weight of the would-be carcass and to some extent its quality. The marketing significance of this cannot, of course, be over-estimated.

The basis of the relationship between the rib-eye area and the size of the carcass is that the rib-eye or more precisely, the *longissimus* muscle which spans the mid-dorsal aspect of the body, developmentally, bears a direct relationship to the general musculature of the animal. Accordingly, knowledge of the cross-sectional area of this muscle at the designated point helps to throw some light on the overall size of the carcass.

Apart from this method (which is evidently very costly), no other simpler and less expensive and objective method exists for the determination of carcass yield *in vivo*, except perhaps in terms of standards used in judging live animals. For our purposes, however, we shall concern ourselves with post-slaughter measurements of yield and quality in the carcass.

QUANTITATIVE ASSESSMENTS

Cut-out yield

For the butcher, one of the most important criteria of yield is the cut-out yield which reflects the most valuable cuts of the carcass. In our local *Zebu* cattle these cuts, known as the primal cuts comprise about 80% of the weight of the carcass and are made up of the loin, round (or leg), rump, rib and the chuck (or shoulder). Evidently our butcher may want to know the approximate (total) yield of these cuts in order to arrive at a price which is equitable to him as well as his customer. Here, relationship studies can help.

Cut-out data on ten U.S. Holstein (Friesian) cattle (Clottey, 1966) indicate that among the various components, the round cut which is regarded as representative of the entire carcass provides a fairly useful index for the estimation of primal yield. Its usefulness exceeds for instance that of the knob fat which is

a relatively smaller component. That is to say, in general, "parts" of a system that are larger constituents of the system or "wholes" provide more meaningful indices for the estimation of these "wholes" where they are unknown.

In attempting to establish the correlation, however, attention must be paid to units of measurement. Experience shows that different units of measurement associated with similar sets of variables give different coefficients of correlation of varying degrees of usefulness. For instance, among the ten Holsteins the following situations developed:

(a) Primal cuts, lb. vs. round cuts lb.: $r = 0.784$;*
(b) Primal cuts, % vs. round cuts %: $r = -0.201$.N.S.

Evidently here, the degree of correlation is a function of the units of measurement.

One U.S. worker, Dinkel (1965) observed that in comparing the traits of animals of different weights, ratios and percentages were much less informative than actual measures of weight. He therefore urged the use of actual weight units in studies of this nature.

Dissection yield or physical composition

Another method by which carcass yield can be measured is in terms of the total quality of edible meat available on the carcass. In the Zebu, this trait, comprising mainly the muscle and fat components make up roughly 70% of the dressed weight of the animal (Clottey, 1972).

On the slaughter floor, total edible meat may be determined by dissecting the carcass and separating the relevant (lean and fat) tissues from bone and ligament. (Total edible meat as a carcass trait is of value in marketing meat intended for processing whereas the cut-out yield is important for purposes of pricing meat intended for retail on the fresh trade.)

An index considered fairly useful in the estimation of the muscle/fat component in the carcass is the muscle/fat component of the rib cut. Again similar rules apply as for the cut-out yield in the simple correlation study of this trait. That is to say, the units selected must, preferably, be expressed in weight measure rather than in percentages. This is because percentage values are in reality contracted values or approximations and hence do not reflect the full biological significance of the parameter under test. Again the Holstein work yielded the following data for comparison:

Muscle-fat in carcass, lb. vs. muscle-fat in rib, lb.: $r = 0.814$*
Muscle fat in carcass, % vs. muscle-fat in rib, %: $r = 0.773$*

Yield by chemical composition

Chemical composition provides yet another basis for the development of a predicting index for yield (Miller *et al.*, 1965).

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* Significant at $P < 0.05$.
NS: Not significant.

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It can be established that the separable fat component of the carcass and the chemical fat (ether extract) contained in the edible portion of the rib cut correlate highly and significantly with each other as do the separable muscle of the carcass and the chemical lean (i.e. ash + protein + moisture) of the (same) boneless rib cut. Thus in the Holstein study the coefficient was $r = 0.970$.* Through these relationships therefore, both the muscle and fat yields of the carcass can be determined easily.

Finding an agency to run chemical analyses should not pose much problem, as institutional and research laboratories in Ghana readily conduct chemical analyses of various kinds for nominal fees, and the opportunity offered should be exploited.

QUALITY INDICES

Let us now turn to a consideration of the factors that give quality to meat and therefore influence prices to a marked degree.

Visual attributes (i.e. appeal) and palatability characteristics (or taste) are two factors contributing mainly to carcass and meat quality. Visual attributes include the degree of marbling, the maturity of the carcass, the colour of the lean, the firmness of the lean including its texture or grain. Palatability characteristics refer to the degree of meat tenderness, juiciness and flavour. Both classes of attributes can be determined by the human senses as well as by means of instruments (A.M.I.F., 1959).

Strictly speaking, the relationships between visual characteristics and palatability ones on one hand, and between objective and subjective measurements on the other are not particularly close, nor are they necessarily positive. For instance, a highly desirable marbling trait in beef (as scored by sight) may not in fact, indicate that the meat shall be acceptably flavoured. Nor would, say, the mechanical measurements of shear (which is the force exerted by a machine to cut through a piece of meat) correlate positively with the human score for tenderness. Again we may refer to the Holstein data for an illustration of this point:

(a) Marbling score vs. juiciness score (*l. dorsi* cut): $r = 0.275$ NS;
(visual trait) (palatability trait)

(b) Shear force, lb. vs. tenderness score $r = -0.958$.*
(objective) (subjective)

MULTIPLE CORRELATION

Simple correlation studies, in view of the difficulties they present in prediction work, require to be used with care. In general, where additional dependent

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variables are included in a partial or multiple study, the reliability of the relationship is enhanced. This is because these relationships measure the joint properties of several variables, thereby increasing their value appreciably (Harrington and King, 1963).

Thus if we take the relationship between the human score for tenderness and the mechanical shear force, lb., we find that the addition of a third related factor results in the development of a more useful and positive coefficient which for our purposes would have more value to it:

Thus if x represents the tenderness score; y the shear force in lb., and z the percentage crude protein content of the *l. dorsi* cut, we have:

Correlation	*Coefficient*
Simple	
$r.xy$	-0.958*
$r.xz$	0.765*
$r.yz$	-0.825*
Multiple	
$r–xzy$	0.959*

It is thus quite clear what advantages are inherent in the use of more dependent variables. Generally in selecting indices for relationship studies, the traits that bear strong anatomical, developmental and functional relationships to one another must be considered. This must be done if any information of biological or economic significance can be derived from the study.

ESTIMATING YIELD AND SELLING PRICE: A WORKED EXAMPLE

So much for procedures. I shall now proceed to illustrate by a worked example how the butcher can arrive at yield estimates and a price for his produce—assuming he has done all the necessary ground work and accumulated the relevant data. The data utilized as an example here are purely hypothetical and do not necessarily reflect those of local cattle.

Let us say the butcher wants to market total edible meat (i.e. the muscle and fat components) of a beef carcass. He begins by weighing the live animal. Make this 496.9 lb. He slaughters it, then takes out the wholesale rib from a side to extract its edible portion. Allow 8.9 lb. for this portion. He then secures his predicting equation for the total meat yield in the side of the carcass. Let us say this is $y = -15.776 + 13.130x$, drawn from the Holstein case, where x represents the edible portion of the rib cut. Thus the estimated edible meat in the side would be:

$$\begin{aligned} y &= -15.776 + 13.130. \quad 8.9 \\ &= -15.776 + 106.857 \\ &= 91.081 \text{ lb.} \end{aligned}$$

* Significant at $P < 0.05$.

Hence for the entire carcass edible meat = 91.081 × 2 or approximately 182.3 lb.

To determine the selling price of the yield a few other factors must be known. These include the bone and ligament components of the carcass and the non-carcass (or offal) components. Losses (including gut contents, blood, body fluids etc.) should be accounted for as well. The cost of these items where applicable must also be indicated.

Thus far a live animal weighing 496.9 lb. valued say at 28 pesewas per lb., the total cost prior to slaughter would be ₵139.13. A dressing percentage of 47 will yield a total carcass weight of 233.5 lb. Now if the potential edible offal and the useful but inedible offal amount respectively to 23% and 9% of live weight then losses of up to 21% must have occurred in the slaughter and dressing.*

All this information can be put together conveniently in what is called a *yield test*, which furnishes at a glance all other information pertinent to the livestock and its products so that it can, in future, serve as a guide in filling other orders (Levie, 1963).

Yield test of a 496.9 lb. animal

Live animal	*Wt. lb.*	*%*	*Unit cost* ₵	*Total cost* ₵
	496.9	100.0	0.28	139.13
Edible meat (boneless meat)	182.3	36.7	0.72	103.82
"Soft" edible offal	54.7	11.0	0.23	12.58
"Hard" edible offal	59.6	12.0	0.17	10.13
Inedible but useful offal	44.7	9.0	0.11	4.92
Bone and ligament*	51.2	10.3	0.15	7.68
Losses	104.4	21.0	0.00	0.00
	496.9	100.0	—	139.13

* From carcass.

As can be observed from the table the total cost of the animal is ₵139.13. This, minus the value of all offal (₵27.63) bone and ligament (₵7.68) gives a net value of ₵103.82 for the edible meat—which for a 182.3 lb. yield would work out to 72 pesewas per lb. Thus if the butcher were to set aside 33% of this value as overheads (which is a fair figure in the local meat trade) then the

* The offal yields in terms of live weight may be broken down as follows:
Potential edible offal:
"Soft" variety, comprising spleen, liver, heart, G.I. tract (empty), lungs, kidneys ... 11% or 54.7 lb.
"Hard" variety; made up of tail, head, shanks 12% or 59.6 lb.
Inedible offal (mainly hide) 9% or 44.7 lb.
Losses—comprising blood, gut contents, discards, body fluids and losses through shrinkage, cutting etc. 21% or 104.3 lb.

estimated selling price would be ₵103.82 + (103.82 × 33%) which is equal to ₵130.08 for the 182.3 lb. meat or 76p/lb. The required pricing thus accomplished represents the value of boneless meat as received by the customer.

QUALITY PARAMETERS

This example may seem not to have taken quality parameters into consideration, but these are supposed to have been worked into the live weight value on the basis of live animal judging.

For instance a young, stocky thick set, well-finished steer will most likely have a redder, lean meat (breed differences apart). On the other hand, the underfinished or the rangy type of animal may have a darker-cutting, tough, somewhat drier tissue. Accordingly such judgment should influence the butcher in determining the value of the live animal. For one way or the other, such traits reflect the degree of conversion of production inputs into product which hence cannot be ignored in the end.

A more objective measure of quality, however, is the assessment of the degree of marbling of the carcass which throws light on variety traits as mentioned before. In a study of the Holstein the author found that there is a direct and positive correlation between the marbling score and the fat content of a uniform slice ($\frac{1}{4}$ in. thick) of the marbled rib-eye muscle ($r = 0.898$).* A predicting equation drawn from that study is as follows:

$$y = 0.759 + 0.729x$$

where y = marbling score and x = percent fat content of *l. dorsi* slice. Thus in terms of the equation, a fat content of 8% in a given slice would indicate a marbling score of 7.0 which in descriptive terms would be "moderate" (marbling scores range from 1 for "Devoid" to 10 for "Abundant"—Wellington and Stouffer, 1959).

CONCLUSION

From this review, it should be evident that the pricing of livestock and meat products should take cognizance of technical factors as an aid to the development of the economic parameters which determine the ultimate value. Far too often, and for too long, producers and importers have offered to the Ghanaian public meat at prices or profit margins far in excess of their legitimate entitlements. Perhaps the time has come when controls can now come into meat marketing to put the trade on a fair basis. If that should happen, the local industry may not only be stimulated into the much desired competitive spirit, but would further be encouraged to supply meat of acceptably high quality and at prices producers and consumers alike will accept without quibbling.

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* Significant at $P < 0.05$.

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