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Some Aspects of Efficiency in Beef Production

Third Edward Richards-Orpen Memorial Lecture

presented by

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In 1960 he spent a period of study with Dr. T. R. Preston at the Rowett Research Institute in Aberdeen and in 1966-67 he studied under Professor D. G. Armstrong and Professor McG. Cooper at Newcastle-on-Tyne University. In 1969 he was awarded an O.E.E.C. Fellowship and studied beef production in France and Holland.

Dr. Harte has published over 25 scientific papers and has written extensively in the farming press. He has lectured throughout the country and at international meetings at home and abroad. His research work is concerned with efficiency in beef production with special emphasis on calf rearing, breed comparisons and bull beef production.

I would like to thank the Trustees of the Edward Richards-Orpen Memorial Trust for asking me to give this, the third Edward Richards-Orpen Memorial lecture. I did not have the privilege of knowing the late Mr. Edward Richards-Orpen, but the tributes paid to him by Dr. Walsh[1] in the first lecture are ample evidence of his great contribution to Irish Agriculture.

The aim in cattle production should be to produce as efficiently as possible cattle which are capable of yielding meat which is saleable at the right price. This involves the correct use of land, labour and capital. Land will provide the main traditional sources of feed, though soon we may find increasing amounts of feed coming from other sources. Typical examples are urea and proteins from oil. Feed costs as a proportion of total costs in cattle production can vary quite considerably but a figure of 70% is probably a reasonable estimate. Therefore the efficient conversion of feed into liveweight, or lean meat, is most important. We have for long understood the term efficiency in pigs and poultry, and farmers when selecting stock are putting increasing emphasis on the ability of these species to convert feed efficiently. It took the great work of Preston and his colleagues at the Rowett Research Institute in Scotland to emphasise the importance of efficiency in beef production. We must, however, readily admit that the expression of efficiency in terms of feed intake per unit of production in ruminants is not as simple as in the monogastrics —pigs and poultry. It is complicated by the ability of ruminants to utilise roughages (of varying quality) as well as concentrates.

In Ireland our ability to grow good grass means that many of our cattle are born in the spring and finished in the autumn, one, two or three years later. This results in an uneven distribution of the direct produce (milk, beef) throughout the year. Also, the inter-dependence between dairying and beef production in Ireland is not common to all beef producing countries. Yet we all realise that an efficient cattle industry will need to provide the market with a continuous supply of meat of consistent quality at a competitive price.

In this lecture I will discuss three main aspects of my work at Grange associated with biological efficiency in beef production.

1. Systems of calf rearing.
2. Efficiency of different breeds for meat production.
3. Effect of non-castration in cattle on efficiency of production.

I hope to show that a good calf-rearing system, coupled with effects of breed and non-castration on carcass composition, will improve efficiency and profitability of beef production. I also hope to show how we can manipulate our cattle breeds, or perhaps

I should say our cattle of different growth potential, to maximise lean meat production and, in particular, to show how the use of bulls can increase lean meat production.

SYSTEMS OF CALF REARING

Time will not allow a full review of research work on calf rearing carried out in this country and elsewhere. Many of you know that for many years after the State was formed Professor E. J. Sheehy and his colleagues at University College, Dublin, particularly Dr. B. Senior, contributed vastly to our knowledge on calf rearing[2]. Their practical and realistic approach is acknowledged at both national and international level, and much of our present knowledge on this subject is due to their pioneering work. This work is being continued at University College in Professor Ruane's Department and names like Aherne, Caffrey, Cahill, L'Estrange and McAleese[3 4] among others, are well known to you. Preston[5] starting at Newcastle University, later at the Rowett Research Institute and now working in Cuba, Roy and co-workers[6] at the National Institute for Research in Dairying, Shinfield, Alder[7] and Tayler[8] from Hurley, among many others, have all made very valuable contributions to our knowledge of calf rearing for beef.

Calving pattern

In discussing calf rearing in this country one must emphasise that most of our calves are born in the first half of the year. Of the 1.6 million cows in the National Herd[9], 88% calve between January and May inclusive[10]. The remaining 12% of our cows calve in a fairly scattered pattern over the second half of the year but mainly in autumn. This leaves us with two distinct calf rearing situations:—

(a) Spring rearing; where there is whole milk (relatively cheap), skim milk, milk replacers, meals and grass available.

(b) Autumn rearing; where there is little or no grass or skim milk and only milk replacers and relatively expensive whole milk and meals available.

There is unfortunately no one system of calf rearing that I can recommend for either autumn or spring rearing. Obviously much will depend on the cost of the various feed ingredients and their availability to individual farmers. For instance the Government policy of insisting on a minimum inclusion of butterfat in milk replacers caused an immediate increase in prices even though the price of skim milk (one of the main constituents of replacers) was falling.

Feeding value of various foods

I will now discuss the value of the various feeds available for calf rearing. It is, of course, well known to you that for at least the first 3 to 5 weeks of the calf's life the feed must be given in liquid form and it must be milk, milk products or a diet at least almost as good as milk in nutritional value. The importance of feeding colostrum within the first few hours after birth is now well established[11].

Milk replacers

The following table shows the performance of calves fed whole milk and milk replacers[12].

TABLE 1. Liveweight (kg) of calves fed different milk replacers or whole milk and skim milk.

	Liveweight at		
Days of age	28	56	84
Milk replacer A	44.4	61.5	77.3
Milk replacer B	48.8	65.7	81.5
Milk replacer C	44.9	61.9	75.9
Whole milk to 28 days followed by skim milk	50.0	67.7	82.7

These milk replacers are based almost completely on dried skim milk products plus 10-20% animal fat (tallow and/or butterfat). From this and other experiments at Grange we estimate that 4 litres of whole milk is equivalent in feeding value to 0.5 kg of milk replacer approximately. If milk replacer costs 16p per kg, this suggests that you should use it in preference to whole milk if you are getting more than a clear 11p per 5.0 litres. Costs of heating water, mixing facilities and labour must be taken into account when costing milk replacers. If you are using whole milk you would, of course, need to have a ready supply available. However, to date, at any rate, most calf rearing farms also have cows.[10]

Milk replacers have the great advantage that they are concentrated and are easily stored. They obviously have a most important part to play in autumn calf rearing where either whole milk is not available or is being produced and sold at a relatively high price. Certainly in veal units where the emphasis is on high calf gains, milk replacers have an advantage over whole milk in that the dry matter content of the liquid being fed can be increased; this allows for an increased intake of dry matter and

reduces costs of heating water and feeding. Because of their convenience in feeding systems and likely improved quality due to better formulation, there seems little doubt that milk replacers have a bright future in calf rearing, particularly when milk prices increase.

Skim milk feeding

The Institute's Farm Management Survey[10] shows that 77% of the skim milk returned to farmers is used for calf feeding and in 1969 it was estimated that farmers used 955 million litres in this way. Many nutritionists would suggest that a considerably greater proportion should be fed to pigs but that is one of the privileges of being a farmer — he can still decide for himself. What then is the values of skim milk in calf rearing? Calf performance will be hopelessly low if calves are fed on skim milk before 3-4 weeks of age. However, there are a number of dry fat/protein supplements coming on the market now, and when added to skim milk these are giving most promising results, even in early life. After 4 to 5 weeks of age calves will do quite well on skim milk, provided they have grass and/or meals[13].

Our results show that 5 litres of skim milk are equivalent or somewhat superior to 0.5 kg of rolled barley from approximately 6-8 weeks of age. These results were obtained with calves at pasture. They are not likely to be very different in indoor rearing systems provided the necessary vitamins are added to the feed and the calves are fed either high quality hay or silage. If, for instance rolled barley is worth 3p per kg (or £1.50 per cwt.) then skim milk can be fed if you have it or can buy it cheaper than 1p per 5 litres. It is really up to the farmer and his advisor to work this one out.

When, however, one is feeding a food of low dry matter content such as skim milk there is an important aspect of management to remember. Suppose a farmer has 50 calves and he decides to feed 1 kg of rolled barley/head/day, this means taking out to the field 50 kg of rolled barley. An equivalent of skim milk would weigh 450 kg (i.e. 50×9) plus containers. In the past we have stressed the importance of good grass in calf rearing[14] and without it good calf performance at pasture is almost impossible unless meals are fed. Having good grass available means some form of rotational grazing, resulting in the calves being a considerable distance away from the yard at least for part of the grazing season. Therefore good grassland management and skim milk feeding do not always go together, particularly in big units because of the transport costs involved.

As you move up in scale of operation you can see that a low dry matter food is at a serious disadvantage and here is a case where what is the cheapest food may not be the most economical one to use. Present day costs of drying skim milk would not leave it competitive with meals if used in the dried or reconstituted form.

Meal feeding

Calves should be offered meals from 4 days of age. It will be appreciated that calves could live on meals only from 4 days of age[5 15 16 17]. However, liveweight gains are not just adequate for present day production requirements if calves are weaned at this early age. Nevertheless, you must remember that meals cost about one-third of the price of whole milk on a dry matter basis. So unless you have cheap skim milk you should use as much meals as the calf can digest.

In my opinion, taking the present inputs and returns in cattle production, calves should be off milk (except low-priced skim) by 8 weeks of age.

Multiple sucklings

In many areas in this country prices for whole milk are relatively low. From what I have said earlier about the relative values of whole milk and milk replacer you will appreciate it would be more economical in many cases to feed whole milk, produced on the farm, rather than use milk replacers. Would it be better then to feed the whole milk directly from the cow rather than milk it and then feed it to the calf? It does not seem logical to milk a cow and then feed that milk to the calves, particularly when the cow will give more milk when multiple suckled than when she is machine milked. Of course there is still a considerable amount of work to be done on the effects of plane of nutrition in the calf stage on performance later in life[18 19 20], but in general multiple suckling tends to provide the calf with a higher plane of nutrition than bucket rearing systems.

As a result of five years research work we set up a system at Grange, details of which I described to this Association at a previous meeting[15 21] and elsewhere[22]. You will recall we used eight cows which suckled 48 calves (i.e. 6 calves each) from March to November, and 8 hectares provided the grazing and silage for the cows and calves for the whole year. Table 2 shows the calf performances from our multiple suckling unit during the past 4 years.

TABLE 2. Calf weights in multiple suckling unit 1967-1970. (L.W. (kg) of calves)

Year	Age of calves (weeks)		
	4	16	32
1967	51	129	198
1968	49	116	183
1969	48	113	180
1970	51	118	207

The calves were born in mid-March each year. In the first three years the calves used were Hereford X Shorthorns and all were castrated. In 1970 half the calves were pure Friesians, the other half were Hereford X Shorthorns and half of each group was castrated. The results were quite consistent from year to year. The weight range of calves was narrow and the mortality was never more than 2%.

Economic returns per acre are always difficult to estimate because of the controversy of incoming and outgoing prices and of course gross margins. My estimates for costs and returns in our multiple suckling unit are given in Table 3.

TABLE 3. EXPENDITURE AND RETURNS (£) PER HECTARE AND PER ACRE

	Variable Costs	
	Per hectare	Per acre
Fertilising cost @ £25 per hectare	25	10
Silage making 25 Metric tons @ £0.75 per M. ton	19	7
Barley—1.5 M. tons @ £35 per M. ton	52	21
Medicines etc. £1.5 per calf	9	4
Cow depreciation	10	4
	Gross Output	
	Per hectare	Per acre
Calves 6 @ £27	162	65
Yearlings 6 @ £66	396	158
Variable costs	115	46
Gross margin	119	47

A. Conway, one of my colleagues from our Economics Section[23],

has calculated the effect of buying and selling prices on gross margins per acre. His results are shown in Table 4 assuming variable costs per acre of £47. It is obvious that the differential between buying and selling prices has a very important influence on the gross margin. This differential has been fairly stable over the years particularly if you take into account changes in money values, when we were paying £10 for a calf we were getting about £50 to £60 for it at 2 years and now when we pay £30 per calf we get £80 to £100 at 2years.

TABLE 4. Effect of Buying and Selling price per calf on gross margin per acre (£).

	Selling price —	60	63	65	67	70	73	75
	20	49	56	61	66	73	80	85
	23	42	49	54	59	66	73	78
	25	37	44	49	54	61	68	73
Buying price	27	32	39	44	49	56	63	68
	30	25	32	37	42	49	56	61
	33	18	25	30	35	42	49	54
	35	13	20	25	30	37	44	49

The gross margins are certainly attractive and the labour inputs are not usually high. The capital investment in livestock per acre is probably not too different from that for dairying and of course there is less equipment involved. The livestock investment per acre is of course lower than in an intensive calf unit on its own where in general weight gains per calf will be lower. I have explained on a previous occasion[21] that grassland management is simpler in a multiple suckling unit than in an intensive calf unit because the cows in the former graze the pasture after the calves resulting in high quality grass being available to the calves in the next round of the rotation.

It is important here to emphasise that in all our suckling units at Grange the health of the calves was better than in the non-suckling units. Mortality in calf rearing can vary enormously but it appears from our work to date that calf mortality, which is normally about 4-5% in bucket rearing systems, is 1-2% or less in the multiple suckling systems. Incidentally one obvious source of calves for multiple suckling is the once bred heifer system which I refer to later.

Environment

Very little useful research work has been done on environment

in relation to calf rearing in this country. Let me simply state that our two main disease problems in calf production are virus pneumonia and salmonellosis. The Veterinary Research Laboratory, Abbotstown, is now carrying out some trials at Grange on the possible use of vaccines to control salmonella. While we wait the results of these investigations we feel that the best way to reduce the incidences of these diseases is to rear the calves out of doors, or at least in very open environments.

The organisation of calf feeding

With good farm workers getting scarce and expensive, the organisation and management of calf units are very important and I covered aspects of this work previously[24]. I have already indicated that in some cases the direct value of a feeding stuff like skim milk could be counter balanced by the costs of feeding.

Once-a-day feeding

Our experiments show that if milk is fed at less than 7 litres per head per day there is no point in feeding twice daily after 10-14 days of age. There is also room for reducing weekend work[24]. In an 80-100 calf unit it will take a man at least 2-3 hours to prepare, feed and wash up twice daily. This means if you fed once daily you will obviously save a considerable amount of time. Furthermore there is the important social aspects where the farm worker or farmer would not be committed to feeding his calves on Saturday and Sunday afternoons.

Once-a-day milking in the later part of the lactation in the multiple suckling systems which I have discussed should be considered. John Walsh at Moorepark has shown that once-daily milking in later lactation reduced daily yield by about 40%. This is not a very big reduction since the yield at that stage of the lactation is low.

The possibility of increasing the dry matter in the liquid feed is also an important way of improving efficiency in organisation of feeding. I would suggest however that this should not be attempted before 3 weeks of age.

The calfeteria

The calfeteria system is a very useful way of feeding calves. It consists of a steel ring which holds a series of teats from which tubes drop into a creamery can, and each calf suckles its milk through an individual teat[24]. This is a very suitable way of feeding 10 or more calves of the same age. Obviously if calves vary considerably in age then the older calves tend to get too much of the total milk allowance to the detriment of the younger calves. As

I indicated earlier it is not good economics to feed milk to calves once they have reached the age when they can utilise meals satisfactorily.

From an organisation point of view let me remind you that suckling 32 calves on 8 cows simultaneously, as described in the multiple suckling system, is attractive. It is a fine "automatic milking unit" where the cows need no stimulation.

What then is the best way for a man to rear his calves? As I see it if he is a small farmer with 5-10 cows particularly in an area where the creamery milk price is low then he should multiple suckle. It is an efficient and economical method of rearing calves in areas where milk prices are low. Other factors in favour of multiple suckling (as against bucket rearing or whole milk) are the health of calves, and the fact that cows suckled out fully twice daily can give up to 15% more milk than similarly fed cows machine milked twice daily[25].I believe that the specialised dairy man will not want to rear calves, and consequently there is always likely to be a ready supply of calves for multiple suckling.

The dairy farmer who rears his own calves and who has milking equipment installed may decide that he wants to put all his cows through the plant. But he should consider using those cows that are on their last lactation for multiple suckling. The problems of getting them in calf without a bull do not arise. Much will also depend on the price he receives for whole milk and skim milk and this can vary considerably throughout the country. This farmer may decide to use milk replacer or to feed whole milk and meals at pasture or perhaps skim milk instead of meals.

The farmer producing liquid milk will almost certainly use milk replacer particularly in autumn and winter which will be his main calving time. The ability of meals to substitute milk must always be remembered particularly when milk prices are relatively high and in general calves should be fully off milk replacer and on to meals by eight weeks. Veal producers, because of the special product required, must use milk replacers. Of course any farmer who does not discuss his calf rearing with his Agricultural Adviser is really not using intelligently a service which is available to him.

Effect of breed and castration on efficient meat production

I have talked on some aspects of calf rearing to this association previously[21 24] and have discussed the finishing of cattle. Now I wish to turn to efficiency of lean meat production. What are the main factors which will influence the yield of lean meat per animal? I believe that maximising yield of acceptable meat per animal is going to be extremely important in the future. Because of problems of selling dairy products, it appears that the day is

fast approaching when the dairy industry will no longer be giving us calves as a by-product for the beef industry. Indeed the returns from calf sales are now a most important part of the total returns for a dairy herd. If cows have to be kept just to produce calves alone obviously the yield of lean meat per animal is going to be of critical importance. Assuming that the calf price is an indication of the costs of producing a new-born calf (although this is not always the case) then Table 5 is of interest. Carroll in a paper to this Association stressed this point[57].

TABLE 5. Spread of calf prices on slaughter weights.

Calf price (£ per head)	Charge (p) on carcass at (kg)*		
	100	200	400
10	10	5	2.5
20	20	10	5.0
30	30	15	7.5
40	40	20	10

*new pence per kg carcass

One hundred kg is approximately the carcass weight of a veal animal while very many of the cattle killed in France have carcass weights as high or higher than 400 kg. The cost of slaughtering a small as against a big animal is also worth thinking about. Preston and Willis[28] in an excellent book on beef production, just published, rightly stressed the importance of the biological efficiency of the animal and therefore come down in favour of killing animals young. We must however also take into account the feed costs of bringing the animal into this world, i.e. maternal costs. Obviously, on the other hand, no animal should be kept to an old age as its efficiency will be uneconomical and its meat quality will not be acceptable. The two approaches must be "married" as regards optimum yield of edible meat per animal.

Different feed ingredients and level of feeding[18 19 20 29] will, of course, influence carcass composition but at this stage I want to talk about the effect of breed and castration on performance of lean meat production.

EFFECTS OF BREED ON EFFICIENCY OF MEAT PRODUCTION

Growth rate

Let us look now at some of the results obtained when we compared the performances of different breeds and crosses of cattle

for beef production. There was little or no difference in growth rate between Hereford X Shorthorns and pure Friesians. Aberdeen Angus-cross Shorthorns were slower growing than either of the other two types. The results of these experiments have already been published[29] [30] [31] [32]. In another series of experiments[33] the crosses of Friesian, Hereford and Charolais bulls on Friesian and Shorthorn cows were compared. In the first one of these experiments pure Friesians, Hereford X Shorthorns and Charolais X Shorthorns were compared. The Charolais bulls used in this experiment were imported from the U.S. In the second experiment the Charolais bulls used were imported from France, and Hereford X Shorthorns, Charolais X Shorthorns and Hereford X Friesians were compared. In both of these experiments there was no significant difference between the various breeds and crosses in growth rate. The tests were carried out over an average of 445 days and the mean growth rate was 0.75 kg per day and ranged from 0.73 to 0.80 kg per day. Vial[34], in a large-scale experiment comparing nine different breeds or crosses, showed that there was little difference between Charolais crosses and pure Friesians, the Charolais in fact having the slower growth. The results of his experiment are not fully analysed. The Meat and Livestock Commission in England reported that the Charolais crosses performed somewhat better than the Hereford crosses but it must be remembered that their results were from suckler herds where a full expression of growth performance was allowed.

Feed efficiency

Table 6 shows the feed consumed per kg of liveweight gain in the Charolais series of experiments. All the animals were fed individually. These results are not fully analysed[33] but there appears to be no major difference between breeds and crosses as regards feed efficiency per unit of gain.

TABLE 6. Feed intake per kg liveweight gain—start of experiments to slaughter.

	Experiment 1		Experiment 2	
	Meal	Silage	Meal	Silage
H. × Sh.	2.99	27.8	3.42	28.7
H. × Fr.	—	—	3.32	28.2
Ch. × Sh.	2.94	27.4	3.16	27.1
Friesians	3.28	30.4		

The feed measurements in experiment 1 were taken from 200 to 635 days and in experiment 2 from 150 to 603 days.

Carcass yield

Dressing out percentage is taken here as the number of units of carcass per 100 units of liveweight at slaughter. When we slaughtered Friesians at 545 kg, Hereford X Shorthorns at 500 kg and Aberdeen Angus X Shorthorns at 455 kg we found no difference in dressing out percentage but when these breeds were killed at the same liveweight the Friesians killed out worst[30]. Table 7 shows the carcass weights and the dressing out percentages in the experiments when Charolais crosses were used.

TABLE 7. Slaughter liveweight (kg) and dressing out percentage of different breeds and crosses.

	Experiment 1		Experiment 2	
	Slaughter Wt.	D.O.%	Slaughter Wt.	D.O.%
H. × Sh.	490	57.2	488	59.4
H. × Fr.	—	—	484	58.8
Ch. × Sh.	508	57.0	487	60.1
Friesians	514	54.2		

The Friesians killed out less than the cross-breeds but this is likely to occur only when the slaughter weights are low. Our other experiments showed that when Friesians were allowed to go to fairly heavy weights they kill out just as well as beef crosses[30]. Differences in dressing out percentage between the two experiments (Table 7) serve to stress the weakness of comparing dressing out percentage between experiments. In experiment 1 the figures are based on full body weights while in the other experiment carcass weights were expressed as a percentage of a fasted body weight. These results serve a warning to those who tend to compare breeds without determining the circumstances under which dressing out figures were calculated. The results also help to explain why some farmers get different dressing out figures when they bring their cattle to the factory. Transport conditions, distance and type of feed will all influence dressing out percentage because of their effects on gut fill.

Carcass shape

Considerable importance has been put on the shape of the live animal in the past and it is reasonable to assume that the shape

of the live animal would be reflected in carcass shape. Carcass shape in turn might be expected to be related to the proportion of high-priced cuts in the carcass. Whether there is in fact much relationship between these various factors is now open to great doubt[28]. Obviously the really important thing is the proportion of total carcass lean meat occurring in the high-priced cuts. There is considerable variation in defining what is a high-priced cut. Where we used a slightly modified version of the London and a slightly modified version of the American box beef method of carcass cutting[40]. Only in experiments where the same method of cutting is used is it valid to compare the results from different experiments. It is not valid to compare breeds which have been cut in different ways but unfortunately many people tend to do this.

The percentage of total carcass lean meat occurring in the high-priced cuts was 50.2, 48.7 and 50.5 in one experiment and it was 48.8, 47.7 and 47.9 in another experiment[31], for Friesians, Hereford X Shorthorns and Aberdeen Angus X Shorthorns respectively. In the second experiment, particularly, the Friesians appeared to have poor confirmation compared to the Aberdeen Angus crosses, yet there was no major difference in the proportion of high-priced cuts, the advantage, if any being in favour of Friesians. Table 8 shows the proportion of carcass lean meat occurring in the high-priced cuts in the series of experiments involving Charolais crosses[36].

TABLE 8. Meat in high-priced cuts as percentages of total carcass meat.

	Experiment 1	Experiment 2
Hereford X Shorthorns	33.76	31.38
Hereford X Friesians		31.79
Charolaise X Shorthorns	32.41	32.68
Friesians	32.98	

There was in fact no major difference between any of the breeds or crosses in this respect.

Carcass composition

In our first experiment[31] with Friesians, Hereford X Shorthorns and Aberdeen Angus X Shorthorns, the figures for the percentages of lean meat in the carcass were 71.1, 65.8 and 67.0 respectively. In the second experiment using the same breeds and crosses[31], the figures were 70.7, 67.7 and 65.3 and in that experiment the

Friesians would not be regarded as finished by present-day commercial standards. The Friesians had therefore significantly more lean meat in their carcasses than beef crosses in the first experiment, and in the second experiment, even though they had a lower dressing out percentage (2 units), they had more lean meat per animal than the Aberdeen Angus crosses and similar amounts to the Hereford crosses (Table 9).

TABLE 9. Mean final liveweights (kg), dressing-out percentages and yield of lean meat (kg) per animal.

	Final Liveweight	Dressing-out percentage	Lean meat per animal
Fr.	472.4	56.6	188.8
H. X Sh.	476.1	58.8	189.5
A.A. X Sh.	442.4	58.6	169.4

In the group of experiments involving Charolais crosses the figures for carcass composition are given in Tables 10 and 11. The method of carcass analysis used in the Charolais series of experiments was different from that used in the earlier experiments involving Friesians, Hereford X Shorthorns and Aberdeen Angus X Shorthorns[31]. Comparisons therefore are only valid within the experimental series.

TABLE 10. Meat, fat and bone as percentage of carcass weights, and meat to bone ratios.

	Experiment 1			
	Meat	Fat	Bone	Meat: Bone
Hereford X Shorthorns	64.1	20.4	15.5	4.13
Charolais X Shorthorns	69.3	14.7	16.0	4.34
Friesians	68.3	14.7	17.0	4.01

The carcass weights of the H. X Sh., Ch. X Sh., and Friesians were 280, 290 and 279 kg, respectively.

TABLE 11. Meat, fat and bone as percentages of carcass weights, and meat to bone ratios.

	Experiment 2			
	Meat	Fat	Bone	Meat: Bone
Hereford X Shorthorns	64.8	20.6	14.6	4.45
Hereford X Friesians	65.4	19.1	15.4	4.24
Charolais X Shorthorns	67.4	17.2	15.5	4.35

The carcass weights of H. X Sh. H. X Fr. and Ch. X Sh. were 290, 285 and 293 respectively.

The Charolais crosses had one percentage unit more lean meat than the pure Friesians and over 4 percentage units more than the Hereford X Shorthorns in the first experiment (Table10). There is, however no evidence of the Charolais crosses having this extra lean in the high-priced cuts (Table 8). This experiment suggests that using a Hereford sire on Friesians reduces the lean meat content (Table 11) of the carcasses of the progeny.

Table 7 shows that the pure Friesians had lower dressing-out figures (3 units) than the H. X sh. or Ch. X Shorthorns. The important thing is yield of lean meat per animal and this is set out in Table 12.

TABLE 12. Mean final liveweights (kg), dressing out percentages, lean meat per animal.

	Final liveweight	Dressing out %	Meat per animal
H. X. Sh.	490	57.2	179.7
Ch. X Sh.	508	57.0	201.0
Fr.	514	54.2	190.6

You can see that the low dressing out percentage in the Friesians compared to the Hereford X Shorthorns is counter-balanced by the higher lean meat content of the Friesian carcasses. The Charolais crosses had a significantly higher yield of meat per unit of liveweight than the Friesians and Hereford X Shorthorns This is likely to be important when transport, killing and production costs are taken into account. However, the differences between Charolais crosses and Friesians are likely to be much less (if they exist at all) in situations where Friesians are taken to heavier weights.

Meat: Bone ratios

Too much emphasis on meat to bone ratio can be misleading. This can be seen clearly from the results of one of our experiments[31] on breed comparisons (Table 13).

TABLE 13. Carcass weights, yield of meat, fat and bone (kg) and meat to bone ratios.

	Carcass Wt.	Meat	Fat	Bone	Meat: Bone
Friesians	267	188.8	37.7	40.1	4.7
Hereford X Sh.	280	189.5	54.3	35.5	5.3
A.A. X Sh.	259	169.4	60.7	30.1	5.7

The Friesians had an inferior meat to bone ratio compared to the Hereford crosses. Both groups produced similar yields of meat (189 kg) although the Friesans had lighter carcasses. Consequently, comparing meat: bone ratios in different experiments is a waste of time unless exactly the same measurements are used.

In summary then it can be stated that Charolais crosses did not grow significantly faster than the Friesians or Hereford crosses. They did have a better killing out percentage than the Friesians. This might not happen if all animals were allowed to go to heavier weights—something which I feel will be essential in the future, though at present it does leave the Charolais crosses with this advantage. The Charolais crosses had advantages over the Hereford crosses and to a considerably lesser extent over the Friesians as regards absolute yield of lean meat and percentage yield of lean meat in the carcasses. However there is no evidence that this extra lean meat occurred in the high-priced cuts. The Charolais also has the advantage of being a 'beef' breed and to date at least that seems to be important in the store trade which does not lack its share of traditionalism and conservatism.

In this country there is obviously a place for the various breeds. The pure Friesian has the big advantage that it is dual-purpose and also that a cross-breeding programme is not needed to ensure its survival. A real dual-purpose breed has the further advantage that greater selection for milk potential is possible. There are simply more females to select from and I understand from my colleague Cunningham[37] that there is no antagonism between selecting for milk and beef simultaneously. To maintain any advantage the Charolais may have over the Friesian it will be necessary to dispel any fears that are associated with the Charolais cross as regards calving difficulties. I understand however this is being investigated in France and of course the Milk Marketing Board in England are also looking at this problem. I have only discussed a few of the breeds available to us. The importation of the fast growing South Devon, and I hope many other breeds, will soon present us with an opportunity to test the lean meat production potential of these various breeds.

EFFECT OF CASTRATION ON PERFORMANCE

Some aspects of our work on effect of castration of cattle on performance has been submitted to a previous meeting of this Association[38], and the whole subject of meat production from entire male animals was discussed at a recent conference in Bristol[39]. Our work at Grange[29 35 38 39 40 41 42] agrees quite well with world literature on the subject and is summarised as follows:

1. Bulls grow 8-15% faster than steers.
2. Bulls convert food into liveweight, carcass or lean meat more efficiently than steers.
3. Bulls yield more lean meat and less fat per unit of body weight than steers.

Table 14 shows the difference in growth rate between bulls and steers, slaughtered at either 17 or 23 months of age.

TABLE 14. Liveweight performances (kg) and differences between groups of bulls and steers slaughtered at different ages.

	Bulls	Steers	Bulls	Steers
Age at slaughter (months)	17	17	23	23
Liveweight at birth	42	41	40	41
Liveweight at start of trial	119	118	114	121
Total liveweight gain	299	255	459	391
% difference in favour of bulls	17.5		17.4	

The final liveweight of the bulls and steers slaughtered at 23 months of age was 613 and 552 kg respectively (Table 14) a difference of 61 kg (nearly 1¼ cwt.). All the animals were fed similarly. In effect 20 animals kept under these circumstances as bulls would yield over 20 cwt more liveweight than if they were steers—equivalent to almost 2 extra bullocks.

Feed efficiency

Bulls are more efficient than steers in converting feed into liveweight or lean meat (Table 15).

TABLE 15. Feed conversion efficiency; weight (kg) of meals hay and T.D.N. per kg liveweight gain.

Period	Feed	Bulls	Steers
Experimental	Meals	4.86	5.50
	Hay	0.21	0.24
	T.D.N.	3.76	4.26
Lifetime	Meals	4.09	4.50
	Hay	0.24	0.27
	T.D.N.	3.52	3.90
	T.D.N. per kg 'meat' produced	7.72	9.12

All animals were slaughtered at 13 months.

Bulls grow more efficiently than steers because firstly they grow faster (they use less of their food for maintenance per unit of gain) and secondly because they lay down less fat in their carcasses than steers. It is well known that it is 6 to 7 times more expensive, in terms of energy, to lay down fatty rather than lean tissue.

Breed effect

I would like to emphasise at this stage that all this work was done on Friesian cattle. We have now some evidence, coming to hand, which suggests that growth in favour of bulls may not be as great in Hereford X Shorthorns as in the Friesians. Further work is now in progress at Grange on this subject.

Carcass yield

Steers tended to have somewhat better dressing out figures than bulls (Table 16) except in one of the groups in the 1964 experiment where the bulls were much heavier than the steers at slaughter. There is considerable evidence to show that dressing out percentage improves as liveweight increases[28],

TABLE 16. Dressing-out percentage of bulls and steers killed at various liveweights.

	Final liveweight (kg)		Dressing-out %		Difference in favour of steers
Year	Bulls	Steers	Bulls	Steers	
1962	378	347	50.7	51.4	0.7
	384	357	51.9	52.1	0.2
1963	401	368	58.3	58.2	–0.1
	397	380	54.4	54.6	0.2
1964	418	373	52.5	53.7	1.2
	573	512	55.9	54.4	–1.5
1965	423	408	53.5	53,5	0.0
	426	392	52.9	54.0	1.1

Carcass shape

Table 17 shows that bulls tend to have heavier four-quarters and lighter hind-quarters than steers.

TABLE 17. Hind-quarters as percentages of carcass weight.

Year	Cold Carcass wt. (kg)		Hind-quarters as % cold carcass wt.		Difference in favour of steers
	Bulls	Steers	Bulls	Steers	
1963	233.8	214.5	46.1	47.2	1.1
	215.6	207.6	45.6	46.9	1.3
1964	219.5	200.5	46.5	47.6	1.1
	319.9	278.4	43.8	46.8	3.0
1965	228.0	212.4	47.5	48.5	1.0

However, most of these differences are due to the extra yield of kidney and channel fat in the steers[41] and kidney and channel fat is a poor seller.

When we cut the bull and steer carcasses into the various commercial cuts we found that bulls have heavier chucks (neck region, a cheap cut) than steers.

TABLE 18. Commercial cuts as percentages of cold carcass weights.

Commercial cut as % of cold carcass	A (Steers)	B (Bulls)	C (Steers)	D (Bulls)
Inside round	6.15	6.19	5.84	6.02
Outside round	3.28	3.37	2.89	3.10
Strip loin	2.15	2.16	1.93	2.09
Tender loin	1.67	1.48	1.36	1.36
Butt	4.27	4.30	4.64	5.21
Knuckle	3.83	3.74	3.33	3.38
Eye of round	1.59	1.75	1.47	1.79
Hind shank	2.94	3.02	2.47	2.97
Perirenal and retroperitoneal fat	3.16	2.42	4.00	2.10
Flank	3.70	4.07	3.55	4.10
Hind fat trim	4.94	3.69	7.45	4.63
Hind lean trim	1.60	2.13	1.18	1.24
Plate	7.25	7.68	7.82	8.14
Fore shin	3.17	3.68	3.46	3.67
Chuck	12.57	13.27	11.67	15.73
Cube roll	2.78	2.76	2.66	2.83
Brisket	2.19	2.52	2.20	2.64
Clod	4.85	4.58	4.69	5.04
Chuck tender	1.02	1.04	0.91	0.91
Fore fat trim	4.06	3.34	7.37	4.22
Fore lean trim	1.60	1.66	1.88	2.36

Bulls have however proportionately heavier rounds than steers as shown in Table 18[41]. The animals in groups A and B were slaughtered at 17 months and these in groups C and D at 23 months of age.

Carcass composition

Table 19 shows the percentage yield of the 3 components of the carcass[41]. In this instance "meat" is taken as the carcass less subcutaneous fat and bone. Fat is taken as subcutaneous fat plus kidney and channel fat.

TABLE 19. Carcass data: separable portions as percentages of cold carcass weight and 'meat' to 'fat' and 'meat' to 'bone' ratios.

Age at slaughter (months)	17	17	23	23
'Meat' as % of cold carcass	66.2	69.0	64.1	71.8
'Bone' as % of cold carcass	20.5	20.4	16.3	15.7
'Fat' as % of cold carcass	12.0	9.3	18.6	10.7
Eye muscle area (sq. cm.)	65.9	73.1	70.6	84.1
Eye muscle area/45 kg cold carcass (sq. cm.)	15.0	15.2	11.6	12.0
'Meat' as % of cold carcass minus kidney	66.5	69.3	64.4	72.1
'Meat' to 'bone' ratio	3.2	3.4	3.9	4.6
'Meat' to 'fat' ratio	5.6	7.5	3.5	6.8

You will note that the bulls and steers were killed at either 17 or 23 months of age. The percentage meat content of the carcasses from the older animals (71.8% of carcass) is particularly significant. This suggests that there was no tendency for the bulls to grow fatter with age compared with similarly managed steers.

TABLE 20. Carcass weights, yield of 'meat' (kg) and percentage differences in yield between similarly treated bulls and steers.

	Carcass Wt.		Yield of meat		% difference in
Year	Bulls	Steers	Bulls	Steers	favour of bulls
1962	194.1	175.9	142.1	126.1	12.7
1963	233.8	214.5	164.6	140.5	17.1
	215.6	207.6	153.3	137.4	11.6
1964	219.5	200.5	151.4	132.7	14.1
	319.9	278.4	229.7	178.4	28.7
1965	228.0	212.4	156.6	138.5	13.1

The ability of bulls to yield ' meat"

Table 20 compares the ability of bulls to produce "meat" with that of similarly fed steers.

The figure of 28 per cent more meat than in a comparable steer is especially significant. It is particularly worth emphasising here again that this extra "meat" is obtained with almost no extra food costs. There remains the question of the quality of bull meat compared with steers. At present the Institute's Meat Research Department is doing some work in this field. The World literature comparing bull and steer meat suggests that there is little difference in meat quality with some very slight evidence in favour of steers[28] [39].

Behaviour of bulls

I have discussed this at a previous meeting of this Association. It is indeed difficult to evaluate scientifically whether bulls are more difficult to manage than steers. Certainly the average individual's view of bulls is biassed by the behaviour of stock bulls — but do let us remember that this animal is expected to live a more restricted, perhaps frustrated life compared with one kept for beef production. After our ten years' experience there is no doubt that we are now much more happy about keeping bulls. We don't see any major problems in handling bulls for beef production and of course the mains electric fencing system has really solved the problem of confining bulls at pasture. This is important since most of our cattle whether they are bulls or steers spend at least part of a second season at pasture.

In this section I have purposely refrained from making reference to the possible use of hormones as a method of bringing steer performance up towards that of bulls because I believe, firstly, that non-castration is the logical way to get the extra growth and, secondly, I think definite reactions against additives are increasing throughout the world. This is certainly the case in Europe. Spend a moment sometime in thought, as the late E. R. Orpen would have done, as to why people started castrating animals many years ago. Was it because: (i) man was working harder physically then and therefore needed a diet high in energy, (ii) cattle were used as draught animals, (iii) fencing and control of livestock were poor or (iv) husbandry was poor, resulting in low nutrition and animals had to be kept until they were quite old before they were slaughtered or perhaps combinations of all these. You will probably agree that none of these reasons prevail to-day.

OBSERVATIONS ON THE BEEF INDUSTRY

The beef industry is steeped in a fair amount of tradition and I think it is reasonable to say that many of the people who control it put a lot of emphasis on the colour of the animal's hair. At last it appears the emphasis will soon move away from the hair colour or the head colour of the animal (or indeed whether the animal has calved or not) to a more realistic approach of measuring yield of saleable lean meat per animal and the quality of that lean meat.

The meat factories, and particularly those owned by the producers themselves, have a great responsibility to encourage efficient beef production. The technology of production systems is well advanced, though there is still much work to be done, particularly on efficiency of labour use, and scale of operation. Walshe[43] recently put this concept of labour efficiency very simply by saying "if you pay £1,000 a year to a man to milk 30 cows, this results in a charge of over £30 per cow." The same thing holds in beef, the labour charge per animal is extremely important.

Rationalisation and opportunism in selling are now an important impetus to action. It is short sighted to just find out what the market wants to-day, supply what it wants and do no more. Of course you must supply the market with what it wants but much more emphasis must be put on "trying" new products on the market and these should be related to production costs. These products should be fully processed right to the stage of cooking and flavouring, as it is essential that our main industry gives maximum employment in a country which has few sound basic industries.

Factories must encourage such systems as the bred heifer system which involves increasing cattle numbers without increasing milk production. The operation and economies of this system were discussed by my colleague, Sean Crowley, at a meeting of this Association sometime ago[44]. This system by any standards is an attractive one. It is biologically a very efficient way of producing more calves and beef when milk is not required. In the long run in spite of subsidy intervention, the most efficient biological systems within reason are the important ones. It has the great advantage compared with single suckling and to a lesser extent with multiple suckling that no animal ever reaches its mature size and this has the effect of reducing the maintenance feed costs. Drennan[45] recently reported to this Association that a well-managed single suckling herd can give attractive returns per acre especially since the subsidy scheme came into being. The possibility of combining single suckling, bred-heifer and multiple suckling is

worth thinking about. This could give very substantial increases in cattle numbers without extra milk. It means that every heifer would calve — or at least be given the opportunity to do so. I asked my colleague Andy Conway[46] to work out what this means in terms of numbers. Remember that a single suckling herd of say 1,000 cows will yield annually 450 bullocks, 300 maiden heifers and 150 culled cows assuming 15% replacement and 10% mortality. Combining single suckling and once-bred heifer systems the annual yield of cattle for the base herd of 1,000 cows at full production would on Conway's figures be 645 bullocks, 435 bred-heifers and 150 culled cows. He has assumed in these figures that **all** heifers would calve but this is probably counterbalanced by the high mortality figure (10%) which he used. Multiple suckling the calves for the bred heifers would require another 16 to 20 dairy cows per 100 bred-heifers and this of course would further increase the potential output.

You will recall that I said earlier that non-castration increases lean meat production per animal very considerably (Table 20). This extra lean meat production from bulls is something of supreme importance. An estimate of annual bullock slaughterings in the country[47] is about 320,000. From that data I have shown you that each one of these if kept entire would yield at least an extra 20 kg of meat per animal, assuming that most of the steers are at least 500 kg at slaughter. This represents an extra yield of 640 **M** tons of meat. Taking the data from Table 20 and taking a price of 19p per lb. for carcass, and therefore at least 28p for lean meat, we can estimate that bulls would give returns of from £5 to £16 per head more than similarly treated steers. Indeed it might be argued that factories could afford to give more for bull carcasses than for those from steers because there is less costs involved in removing fat. You will recall (Tables 14 and 20) that the real difference in bulls over steers comes in at the heavier weights. In effect I am saying that where we are keeping 100 bullocks at present, 90 or less bulls would produce the same yield of meat at similar feed costs and less processing costs.

Bulls are an easy way of producing really good yields of meat per animal. New lights are shining at last on their uses — in the factory the cut-up trade is moving, in the field mains electric fencing is the answer to utilising our grassland by an efficient animal. I would not under-estimate the importance of animal breeding, indeed one must stress the lack of adequate beef progeny and performance testing in this country. However, non-castration is a very easy, rapid way of increasing meat production without any major extra food costs. Factories have an important role to play in encouraging bull beef production.

I suggested earlier that the small man in calf rearing should be multiple or single suckling and I could have added that he should have another job outside farming. One would hope that some of these jobs would come from processing meat and its ancillary industries. Processing of all the meat produced in the country would provide extensive and much needed work. The spending power of these extra workers and their increased consumption of agricultural products alone is interesting to think about.

I must concede that it is difficult to organise a sound meat trade as long as the store trade exists in its present form. However, this store trade, in my opinion, cannot continue indefinitely. Firstly, we can not afford to sell compensatory growth any longer. Secondly, it doesn't seem logical to send a beast live by ship when in many instances only about 30 per cent of it will be eaten as meat within 3 months. Shipping costs are just too great. I will not dwell further on the possibilities of the store trade, I will conclude by suggesting that a man of the calibre of the late Edward Richards Orpen would question the logic of importing phosphorus at one end of the production line and paying again for its export in the form of bones at the other end.

Very many people, particularly at Grange, helped me in the research work I have described in this paper, and in its preparation. I would like to thank them sincerely because without their co-operation and enthusiasm research work on this scale would not be possible.

I again thank the Edward Richards Orpen Memorial Trust for inviting me to give this lecture.

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In 1961, the name of the Association was modified, in recognition of the fact that good grassland husbandry is intimately associated with, and inseparable from, good livestock husbandry.

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If you or your organisation would like to join the Irish Grassland and Animal Production Association, the Secretary, An Foras Taluntais, Creagh, Ballinrobe, Co. Mayo, would be pleased to hear from you.