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THE EFFICIENCY OF FOOD CONVERSION IN FARM ANIMALS

23 July, First Session

Chairman: PROFESSOR W. CHARLES EVANS, M.Sc., Ph.D., F.R.I.C., *Department of Agricultural Chemistry, University College of North Wales, Bangor*

Food Conversion in Dairy Cattle

By J. EDWARDS, *Milk Marketing Board, Thames Ditton, Surrey*

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23 July, Second Session

Chairman: E. T. HALNAN, ESQ., M.A., *School of Agriculture, University of Cambridge*

Beef Production

By M. McG. COOPER, *Wye College, University of London*

The present national emphasis on beef production reflects the change in our nutritional circumstances that has taken place over the past 5 years. Brody (1945) rates beef cattle as the least efficient of farm animals in converting their food into human food, and it seems strange after conditions of food stringency to be moving into a less intensive agricultural economy. One cannot help but regard with some suspicion this optimistic prospect in view of our precarious economic position. Though the terms of trade are in our favour at present we have dissipated many overseas investments as a result of the war and we are much more dependent now on a capacity to export in order to secure food and raw materials from abroad. Industrial competition from Japan and Western Germany or a price recession in the United States and Canada, which control most of the world's apparent surplus of food, could very quickly return us to the position of being once again highly dependent on our own agriculture. With very limited land resources, this would mean that the main effort would have to be directed to crops for direct human

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consumption and such animal production as is dietetically important. The production of beef and mutton, in the absence of any great technical advances in farming, would have to be confined to the use of land that was marginal to more intensive farming or it would have to be a by-product of such intensive farming. This of course is the situation in most countries in western Europe where mature beef is a by-product, either of the dairy byre or of the plough. Britain is alone in having a high proportion of her beef coming from special-purpose breeds.

At the present time consumption of beef is at the rate of about 18 million cwt. annually, which is about three-quarters of the prewar level. Home production at 12 million cwt. has now returned after the wartime recession to the prewar volume of output. The deficit in supplies is accounted for mainly by reduced imports from the Argentine and there seems to be little prospect of these being increased or of any substantial contribution coming from another source (Cooper, 1953). The only possibility is that New Zealand may be forced by competition from improved margarine to swing from butter to meat production. This, however, would probably take the form of intensive fat-lamb production with beef as a by-product. Wallace (1953) believes that something of this nature may be the role of New Zealand grassland in world economy.

Quality-beef production, in this country and abroad, is based on a one cow—one calf system of rearing. Godden (1948) has pointed out how inefficient this system is in terms of use of gross digestible energy when compared with dairying with milk as a main product and veal and cow beef as by-products. It is a form of production that can be sustained only where land is plentiful and cheap and where there is good grazing over a long season. If we in Britain were to aim at raising the supply of beef to its prewar level by fattening 1 million additional stores annually and these stores were obtained by the one cow—one calf system we would, on present standards of grass production, require not less than 5 million acres of additional grassland for this purpose. This of course is out of the question. It seems that the only places where such a policy can be developed are uplands where cattle are essential as tools in pasture improvement for sheep production (Evans, 1949) or the medium categories of grassland where breeding cows may have a similar function with intensive fat-lamb production in securing a greater output of meat per acre.

Another factor operating against an expansion of this form of store production is the small size of British farms, especially those in the grassland areas which are best suited for this purpose. The output from 100 acres of average land could be no more than forty weaners per year, and unless prices were ridiculously high the net return per acre would be too low to provide a reasonable living for the small farmer. Furthermore, it is a form of income, coming as it does in one lump, that is ill-suited to a farmer with limited capital resources. In the absence of a twinning strain of beef cattle or effective multiple ovulation induced by hormone treatment, a much more appropriate type of production for such farms is a system of multiple rearing in which a cow with a milk yield of 600–800 gal. annually is used to suckle six to eight calves in place of one cow with a yield of 300–400 gal. which is lavished on the one calf. Work at Cambridge (Brookes, 1951) and the experience of a large number of farmers have established beyond doubt the efficacy of this system of rearing. Figures are not available to establish its calorific superiority over the single-calf system, but it would appear that on a basis of self-sufficient farming the output of stores (at 8 months of age) would be more than doubled on a given area of land. Labour requirements would be higher, but labour is not usually a limiting factor on the small family farm.

This system of store raising is spreading rapidly, and judging by the prices currently being paid for suitable rearing calves the problem is one of calf supply. Cambridge experiments have established that Friesian and Dairy Shorthorn calves, provided they have a high plane of nutrition during their early rearing period, up to 8 months of age, will make reasonable beef. Fortunately these two breeds dominate the national dairy herd. Pure-bred calves of these two breeds, however, do not compare with calves derived from crossing with special-purpose beef bulls, and herein lies the greatest hope of expanding the supply of suitable rearing calves. If the national dairy herd were stabilized at about 3 million cows of which $2\frac{1}{2}$ million were other than Channel Island cattle or the smaller type of Ayrshire, which are not considered to have a beef function, and if the average herd life were increased to $4\frac{1}{2}$ years, only 60% of these $2\frac{1}{2}$ million cows would need to be mated straight to provide dairy replacements. The remaining 1 million cows, preferably the lower yielders and heifers calving for the first time, could be mated to beef bulls for the purpose of providing suitable calves for rearing. Rather more than one-third of the calves born in the dairy industry (over 1 million annually) are now slaughtered as bobby veal and make an ineffectual contribution to our meat supplies. A development on the scale envisaged above would reduce the volume of unrearable calves to no more than half a million annually consisting mainly of bull calves of the Channel Island and Ayrshire breeds and the unsuitable calves of the Friesian and dual-purpose breeds.

The most appropriate breeds for this top-crossing function would appear to be the Hereford and the Aberdeen Angus because they transmit dominant characteristics, the white face in the Hereford and the black coat colour and absence of horns in the Angus, to give the offspring distinct labels which not only provide evidence of beef ancestry for the rearer but minimize the danger of heifers of such breeding being drafted into dairy herds. Nationally it is very important that the dairy industry's efficiency is not impaired either by loss of yield or by the use of cows that require a large amount of nutriment for each gallon of milk they produce, which appears to be a characteristic of dual-purpose cows. The colour-marking bull can, therefore, be useful in two ways in this campaign for fuller land use. Not only does it fulfil a function, akin to that of a Down ram on mountain cross or longwool ewes in the sheep industry, by putting substance into the produce of 'shelly' cows, but also it is potentially a tool in herd improvement if its services are confined to the poorer-producing cows in the herd.

Unfortunately there is scanty information on the best type or breed of bull for mating with the various breeds of dairy cattle to secure the most suitable type of store. There are experiments at a number of the Ministry of Agriculture's husbandry farms but their measurements to date have covered only weight for age and carcass yield, and there is no information on the balance of the side, on the proportion of bone, or the overall suitability of carcasses for the requirement of the trade. Weight for age is an important consideration for there is a marked correlation ($\bar{r}$ = 0·64) between rate of gain and economy of food use (Baker, Colby & Lyman, 1951). Rate of gain is not a characteristic for which there has been deliberate selection in this country and it is one which has been shown by Knapp & Clark (1950) to have a high heritability, so that in a reasonably controlled environment rapid progress can be made by phenotypic selection combined with progeny testing. Within three generations Knapp & Clark (1950) using this method of selection raised the daily rate of gain in the feed lot from 1·75–2·0 lb. for the offspring of the foundation Hereford bulls to 2·0–2·4 lb. daily. The main endeavour in Britain has been to breed bulls that conform to the pattern imposed by the show ring and export sales, and there is no precise information on characteristics that are important economically.

Despite the valuable Cambridge contribution (Brookes, 1951) there is insufficient knowledge on the economically optimum diets for the rearing of calves for beef production. Blaxter (1950) has established the high efficiency of food conversion of the young calf and has suggested that a production of 2½ lb. live-weight increase per day could be an ideal method of producing high-quality veal and utilizing surplus summer milk. Work at Ruakura indicates that early weaning of dairy calves provided they go on to good feeding, in this instance rotational grazing of clean pastures, will not be to the detriment of their growth, and Wallace (1953) questions strongly the wisdom of extravagant double processing of food through the animal, i.e. feeding a cow or a ewe to produce milk for its offspring when the offspring could make better direct use of that food. The results obtained with the artificial rearing of pigs, after they have had a start from the mother, suggest a promising avenue of research with the rearing of beef calves. In this connexion the very considerable surpluses of dried, separated milk and buttermilk now available may have an important function.

Whatever the method of rearing adopted, whether it be multiple suckling or bucket rearing with differing quantities of whole or separated milk or milk supplement, there is no doubt but that a high plane of nutrition in the early stages of rearing is critical not only in securing an economical use of food but also in determining the final form of the finished carcass. Brookes (1951) advocates for economical beef production a high plane of nutrition with a liberal use of concentrates up to 8 months followed by a moderate plane of nutrition to slaughter based on bulk foods including pasture. His work in this respect parallels that of McMeekan (1941) with pigs. Plane of nutrition in farming practice is a highly relative concept and can only be measured by the progress the animal is making. It is not a function of the animal's calorific intake alone but also of its thrift and freedom from disease. Work at Ruakura with dairy calves ((N.Z.) Director-General of Agriculture, 1953) has shown the considerable advantage during rearing of rotationally grazed as opposed to set-stocked calves. The former calves weighed 396 lb. at 8 months and 744 lb. at 20 months as compared with 291 lb. and 586 lb. respectively for the set-stocked calves. These are very substantial differences, and the rotationally grazed calves had, for Jerseys, a very high rate of growth. There are no comparable figures for beef cattle, but in a preliminary trial at Wye in 1952, a drought year, with twenty-four calves born in January–February and rotationally grazed from May to October on clean pasture, we were able to establish the value of such grass. One-half of the stores received a supplement of 2 lb. crushed oats daily and the other half was unsupplemented. At the end of the feeding period of 120 days the supplemented calves had a weight advantage of 35 lb. each, which represented a gain of 14 lb. for each 100 lb. of the grain supplement. After 60 days on bulk feeding in yards, when differential treatment was discontinued, the weight advantage was lost and the supplemented stores were then indistinguishable from those that had received pasture alone.

This emphasis on the maximum use of pasture in beef production is important, for Hamilton (1952) has shown that grass is the cheapest source of nutriment for bovines, especially when it is consumed *in situ*. Unquestionably we must increase the productivity of grassland if we are to sustain an increased volume of beef production, for it is idle to contemplate the use of concentrates, costing from three to four times as much per ton of starch equivalent as grass, if beef production is to be profitable at prices within reasonable reach of the consumer. It is beyond the scope of this paper to deal with means of improving the output from British grassland, estimated to be not more than 14 cwt. utilized starch equivalent/acre. A figure of 20 cwt. is not an extravagant aim, for it represents no more than is required to carry a store in a forward condition for 8 months and fatten it over a period of 4 months on about $1\frac{1}{2}$ acres of grassland, utilized as grazing and as silage or hay. Work in progress at the Grassland Improvement Station (Hughes, 1954) is establishing that much higher rates of production from grass are possible with special-purpose pastures, including lucerne and grass in drills to provide foggage for cheap and effective wintering, which seems to obviate the spring check normally encountered when yarded cattle go to grass.

Fattening on grass will inevitably aggravate an already serious problem of seasonal production, in which more than half of the beef is being killed in the 4-month period from August to November. The answer to it cannot sensibly be winter fattening in yards, using expensive food that can be more effectively used in rearing young stores at the stage at which they can make best use of such food. It seems that we must follow the example of the exporting countries and store the summer glut, especially the poorer categories of beef. Shaw (1949) has shown that prewar we were our own worst competitors, and over a 4-year period the wholesale price for English longsides fell by 19% in November as compared with the peak June price, whereas Argentine beef showed only a 6% fall in terms of its highest monthly price. The pattern of rearing and fattening envisaged is cheap but adequate, rearing of young stores on the best available food (which includes a minimum of milk), the growing of stores on grassland, supplemented in the winter by hay and silage and the by-products of tillage such as feeding straw and beet tops, and a final fattening on grass. At this last stage they will be preferential feeders having the best available grass on a rotational system of grazing, moving in advance of sheep or growing stores. Earlier on their's may be much more of a scavenging function, assisting sheep or other stock to secure a more effective use of grass or making use of by-products.

The final age and weight of slaughter is something one cannot forecast for they will be very much conditioned by the nature of demand for beef and the extent of the consumer preference for quality beef, a matter on which we are singularly ignorant after 14 years of rationing. Considering food efficiency alone Godden (1948) estimated that baby beef, fattened from birth to 9 cwt. (live), was 11·1% efficient in terms of gross digestible energy as compared with 7·9% for an animal stall-fed from birth to 12·5 cwt. His calculation ignores the overhead of the breeding cow that produces the calf for fattening, and the overhead of its nutritive requirements must be spread over the beef its offspring subsequently produces. The position here is comparable with that between light-weight pork and bacon in pig production. In Denmark it is believed that the optimum use of food with Landrace pigs is achieved at about 200 lb. live weight. One would expect a lower weight for pigs with a propensity for laying down fat. Similarly with cattle the most economical weight for slaughter, disregarding price considerations, will depend on the rate of maturity of the animals concerned. Though the yield of carcass increases with the degree of fatness of the carcass (Callow, 1944) it is animal protein, not animal fat, that the public requires, provided there is a sufficiency of fat to promote tenderness, and to prevent drying out in cooking. It is possible, contrary to the scale of grading adopted by the Ministry of Food, that a leaner-type animal, provided it has the desired carcass proportions, will achieve a premium over very fat animals. Certainly farmers will have to consider seriously the wisdom of producing really prime animals when the last increments require up to 4 lb. of starch equivalent/lb. live-weight increase because mainly pure fat is being laid down.

Wood & Newman (1928) in their experiments similarly determined that a 3-year-old bullock yielding 800 lb. saleable meat was less efficient in terms of dry-matter use than a baby-beef animal producing 600 lb. of beef at 18 months. The production of the baby beef involved a heavy use of concentrates, namely $2\frac{1}{2}$ lb./1 lb. dressed meat, which is completely prohibitive at present-day prices. The authors also ignored the food overhead of breeding stock, which cannot be disregarded in the total estimate of cost for producing a lb. of beef. Possibly there will be some baby beef produced in the years that lie ahead, and possibly it will be quite attractive as an alternative to fresh salmon for the consumer who can afford to pay salmon prices, but it won't be a staple of diet for the ordinary consumer.

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Factors Influencing the Efficiency of Feed Conversion by Sheep

By L. R. Wallace, *Ruakura Animal Research Station, Department of Agriculture, New Zealand*

Although, to-day, we are not supposed to be comparing the efficiencies with which the various classes of farm livestock convert animal feedstuffs to human food, it is worth recalling that dairy cattle are much more efficient in this connexion than are the larger meat-producing animals (Brody, 1945; Leitch & Godden, 1953). Now dairy cattle, beef cattle and sheep do not differ greatly in their digestive capacities, and it is instructive to inquire briefly into the origin of the very considerable difference in their efficiencies as food producers.

Relative efficiency of milk and meat

When the dairy cow producing milk is compared on an annual basis with the breeding ewe producing meat in the form of lamb, there are several important considerations to be noted. First, whereas the cow is normally milking for approximately 10 months of the 12, the ewe is quite unproductive for more than half the time—her lactation period being usually only about 4 months. Furthermore, with the cow the milk produced is the measured end-product, the whole of which is consumed directly by man: the ewe's milk, however, is merely part of the raw material which has still to be converted to human food by the lamb, which again stores some of the energy in organs that are not eaten. Thus, production of fat lamb is relatively inefficient, firstly on account of the high overhead costs of milk production by the ewe, secondly on account of the high losses involved in the double conversion of part of the feedstuffs first to milk and then to meat, and lastly because the lamb itself is not completely edible. Against the comparatively small amount of product represented by the fat lamb carcass must be charged not only the feed consumed by the lamb itself but also the ewe's requirements over the whole year.

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