CARCASE CHARACTERISTICS AND GROWTH OF FARM ANIMALS

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The biology of growth of farm animals, as it relates to carcase composition and attributes of meat, has been extensively researched and documented for at least the last one hundred and thirty years. The classical studies of Lawes and Gilbert (1859) were titled "Experimental Inquiry into the Composition of Some of the Animals Fed and Slaughtered as Human Food". These workers studied the weights and composition of the entire body and internal organs of three cattle, five sheep, and two pigs. Lawes and Gilbert (1859) acknowledge by name the earlier work of other English and European scientists (but gave no references) which indicates that this subject has an even longer history than one hundred and thirty years. It is perhaps of even greater interest that Lawes and Gilbert in 1859 clearly identified what is in 1990 a major problem, i.e. overfatness of meat. They reported in 1859:

'Of the animals "ripe" for the butcher, a Bullock contained rather more than twice as much dry Fat as Nitrogenous substance; a moderately fat Sheep nearly three times as much; and a very fat one more than four times as much. A moderately fat Pig contained in its entire body also about four times as much dry Fat as dry Nitrogenous matter. Even a fat Lamb yielded more than twice as much Fat as Nitrogenous substance. Of the professedly fattened animals, the fat Calf alone contained rather less Fat than nitrogenous matter.'

They also identified what is now termed lipogenesis, i.e. the synthesis of fat from carbohydrate.

'Upon the whole, it is obvious, that a large proportion of the Fat of the fattening animal is produced from other constituents than Fat in the food. Attention* has elsewhere been called to the evidence of this, afforded in the instance of the analysed fat Pig. It was shown that in its case rather more than three-fourths of the Fat of the increase gained on the fattening food, must have been formed in the body from other constituents; and it was pointed out, that if the produced Fat were due to the Starch of the food, it would require about two and one-half parts of that substance, to yield one part of Fat.'

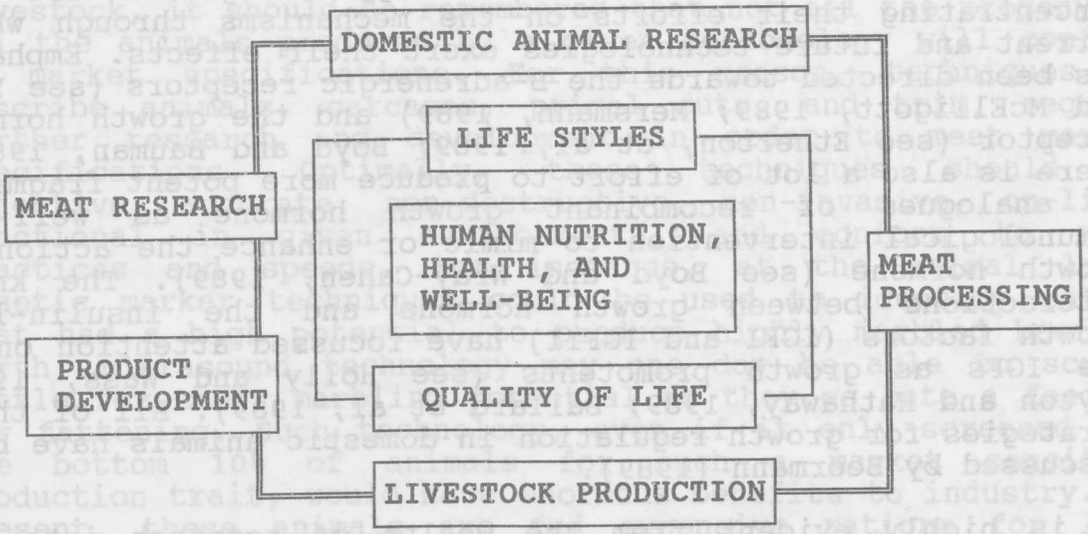
* (Report of the British Association for the Advancement of Science for 1852.)

Studies on the biology of growth and development have become synonymous with other scientists in different eras, such as D'Arcy Thompson, Hammond, and more recently, Butterfield and Berg, all of whom have produced magnificent scientific papers and treatises on the subject. The point from this early literature is that despite all the scientific progress that anatomical, physiological, and biochemical studies, directed towards the biology of growth of farm animals, have made in the last one hundred and thirty years, most of the meat science problems still remain. The question becomes whether meat scientists can continue to rely upon studies of growth biology for basic information, or should they seek information pertaining to meat, as a food and animal commodity, directly from the market chain. For too long have the requirements of the market place been met by "transferring" information from growth studies rather than directly designing experiments and trials to meet market demands. In the USA this process has been changed in recent times by the studies of the Texas A & M Meat Science Group titled "National Consumer Retail Beef Study" and "National Beef Market Basket Survey". Similar consumer attitude and behavioural studies (towards meat) are now in progress in other countries, e.g. Germany (Honikel, personal communication) and Australia.

The new emphasis in growth research on farm animals reflects the role of reciprocal signals in the market chain between producers of livestock and consumers of meat. Diagrammatically, these interactions can be simplified as

Producer ⟷ Processor ⟷ Retailer ⟷ Consumer

There will be variations on this process dependent upon local customs and markets which in a broader sense result from the interactions among animal, meat, and man. The following diagram is a schematic representation of interactions between the animal, meat, and human factors which impact on human health and well-being. (Adapted from National Research Council, Designing Foods, p. 116.)



This broader base to research in growth and development of farm animals for meat as a human food and a market commodity should ensure that the next era of research provides more and better answers for meat science.

Growth of farm animals remains a major scientific and economic interest. Increased efficiency of production and a consumer demand for leaner meat are the major incentives for research in this area. In a previous review of the manipulation of growth in domestic animals, Thornton and Tume (1988) have suggested that efficient lean meat production is "a goal only worth achieving if the quality (in terms of flavour, tenderness, colour, texture, water holding capacity, etc.) of the meat from such animals is highly desirable in the market place, i.e. meat quality cannot be sacrificed for rapid growth rates of lean."

These workers went on to review "a continuum of existing, current, and future technologies" that can achieve more efficient lean meat production" (Thornton and Tume 1988) and gave examples of these various technologies in the areas of diet, exercise, sex, breeding, growth hormone, B-adrenergic agonists and immunological control of carcase composition. It is evident from this review (and others) that a whole range of technologies are now available to the livestock producer to enhance the efficiency of lean meat production. However, the producer must get a clear signal from the marketing chain (as opposed to scientists or regulators) if such technologies are to be readily and widely adopted. The clearest signal is as price premiums or discounts.

Scientists interested in the biology of growth are now concentrating their efforts on the mechanisms through which current and future technologies exert their effects. Emphasis has been directed towards the B-adrenergic receptors (see Yang and McElligott, 1989; Mersmann, 1989) and the growth hormone receptor (see Etherton, et al, 1989; Boyd and Bauman, 1989). There is also a lot of effort to produce more potent fragments or analogues of recombinant growth hormone as well as immunological intervention to mimic or enhance the action of growth hormone (see Boyd and Wray-Cahen, 1989). The known interactions between growth hormone and the insulin-like growth factors (IGFI and IGFII) have focussed attention on to the IGFs as growth promotents (see Holly and Wass, 1989; Dayton and Hathaway, 1989; Ballard et al, 1989). All of these strategies for growth regulation in domestic animals have been discussed by Beermann (1989).

It is highly evident from the wealth of research into the regulation of growth in the 1980's that there are now many potential avenues available for market driven manipulation of growth in farm animals. However, despite the success of science in this area and the economic benefits of these technologies (see Meisinger, 1989), not one of these future technologies has been legally adopted by the livestock industries anywhere in the world. The existing social/political climate for the adoption of such technologies does not appear favourable. While this situation exists, and the future looks even more restrictive, there can be little justification for continuing research, on the basis of more efficient lean meat production, in these areas. Further research for the advancement of knowledge and/or the application of such technologies to human medicine (see Ballard et al, 1989) may be better supported by the social/political climate.

The production of transgenic animals is and will continue to be criticised by some sections of the community, but genetic manipulation is not evident in the product which goes into the human food chain, i.e. those animals which are slaughtered are specially bred, rather than treated/implanted/vaccinated during their lifetime. Furthermore, the production of transgenic breeding stock is likely to be confined to very large producer companies (rather than small producers), who are in a stronger position to lobby. For all of these reasons, the identification of genes which determine important aspects of production efficiency and meat quality, and their subsequent expression through recombinant DNA technology in transgenic animals would appear to warrant further research (see Vernon et al, 1989).

Regardless of the technologies used for the production of livestock, it should be remembered that not all the progeny or all the animals produced by a given methodology will conform to market specifications. For this reason, techniques to describe animals, carcases, primal cuts, and trim, require further research and development in order to meet market specifications. Optimally, these techniques should be objective, accurate, non-destructive, non-invasive, on-line, functional in given environments, and conform to work practices and speeds. For instance, at the animal level genetic marker techniques could be used to identify cattle that had a high potential to produce highly marbled beef at birth; ultrasound technology may one day be able to screen cattle for their marbling potential as they go onto a feedlot for fattening. Such technology, even if it only screened out the bottom 10% of animals for such a market sensitive production trait, would have enormous benefits to industry. At present, these animals are fed expensive rations for long periods without producing highly marbled beef. Similar examples can be given for other aspects of other livestock industries, e.g. PSE in live pigs.

On-line automated objective carcase description, classification and payment for pigs is an industry reality in Denmark (Sørensen, 1989), and other devices, e.g. EM SCAN, are being researched for small stock (Forrest, et al, 1989). On-line evaluation of carcases has been reviewed in detail by Kirton (1989), who states "there is little doubt that the lack of transparency of information in the meat production and distribution chain, aimed at allowing some links to achieve a greater financial return at the expense of other links, is one of the factors that has contributed to the decline in per capita consumption of red meat".

Having described the attributes of carcases, it should be possible to manipulate or modify (manually or by machine) those which do not meet market specifications, e.g. selvedge fat trimming. Clearly it is highly desirable that as high a proportion as possible of carcases meet market specifications as operations such as trimming of excess selvedge fat are both wasteful and costly.

Conclusion:

Research and developments in the 1980's has provided an array of biological and technological tools which have the potential to improve the efficiency of high quality lean meat production. The challenge of the 90's will be to implement these technologies in a market driven meat industry.

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