SESSION 1 - PRODUCTION & SLAUGHTER PRACTICES

Production and slaughter practices

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Introduction

The remit of this paper is wide and it is impossible in the time available to do justice to the subject in a formal review. I intend, therefore, to examine the changes taking place in market requirements and their implications for meat research concerned with production and slaughter practices. I shall draw heavily on experience of the British meat industry but also try to take a broader view. If the paper has a simple theme, it is the difficulty of matching output from variable production and slaughter practices with the needs of the meat industry for a raw material of consistent quality.

Factors of change

The competitiveness of the meat industry in general and each of the species types within it depends critically on satisfying consumer demand for quality meat and meat products at an acceptable price. Two aspects are involved, which are not always compatible. These are the general improvement in the efficiency of production (cost/unit output) and the reduction in meat quality variation by minimising the proportion of carcases with meat quality deficiencies (problem carcases). The second aspect could be restated as the improvement in meat quality, but good meat quality is difficult to define because requirements vary, and it is simpler to focus on the carcases with deficiencies and which are unacceptable by anyone's standards. The elimination of such problem carcases will naturally lead to continuing improvements because as the average quality improves and variation is reduced, the frame of reference changes, buyers expectations sharpen and carcases which hitherto were acceptable become probl
carcases.

Overfatness in carcases remains a problem, despite significant genetic and environmental improvements, because consumer demand for leaner meat, powered by concern about health and fitness, continues to strengthen. At the same time there are indications, for pigs in particular, that the trend towards leanness is accompanied by poorer meat quality especially among the ultralean carcases at the leading edge of the frequency distribution (Meat and Livestock Commission, 1983). Many meat traders see this as a confirmation of their belief that moderate fatness levels are necessary for good eating quality but the range of problems is now broader, embracing cutting, presentational and processing quality. The situation is also complicated by the increasing use of entire males for reasons of production efficiency. Their carcases are at the leaner end of the distribution and inevitably the subject of criticism.

However, it is easy to ascribe problems to the most palpable changes in production - fatness and sex - although many changes have occurred in production and slaughter technology. There has been a concentration in all sectors of the pig industry : pigs are produced on fewer, larger units, fed by a smaller number of feed compounders using sophisticated dietary formulations and novel ingredients, and slaughtered at large abattoirs with wider catchment areas. We also know, for example, how important slaughter environment can be in the incidence of pale, soft exudative, notwithstanding the effect of halothane gene fequency (Neilson, 1981). The situation is further complicated because any of these factors might interact one with another or with genotype. It is necessary, therefore, to disentangle the various factors to provide guidance to industry on the most appropriate action to avoid the problem of very lean pigs.

The situation is different for cattle and sheep. These continue to be produced mainly under extensive conditions from more variable genetic material with the main thrust of breed substitution and selection pressure aimed at growth rate, survival characteristics and, in the case of purebred calves from the dairy herd upon which our beef industry substantially depends, milk yield. Production systems, diets and age and weight at slaughter vary to an important degree, as do slaughter practices. The difficulty here is to identify the relative effects of different factors and their interactions on the variability in meat quality and their importance in relation to post mortem factors. Buyers have then to decide how much control to place on production and slaughter practices, bearing in mind that constraints may well increase costs and that it may not be easy to find the best compromise between tighter specifications and a reliable supply of raw material.

Faced with these problems and the need to develop a strategy either nationally or at the level of the individual buyer, one often finds that the scientific information available is inadequate. Insufficient resources for large-scale co-ordinated trials and the need to control environment and to standardise procedures has tended to lead research away from the reality of commercial practices; it has often failed to explore potential interactions between production factors and the range of handling practices experienced.

Coupled with the lack of information is the problem that meat quality deficiencies are difficult to measure in surveys and trials and more so in commercial practice. Carcase classification and grading schemes have, from necessity, concentrated on assessments of external fat cover and carcase shape so there has been little reason for producers, or more significantly, the breeders supplying them with parent stock, to worry about more detailed carcase and meat quality characteristics. Economic transactions and optimisation tend to degrade all aspects of quality which are not included in negotiations and transactions. Even where the meat quality problems have been sufficiently serious to call in experts and use special diagnostic methods, the difficulties involved in tracing causal factors and apportioning responsibility between producer and buyer are often formidable.

So the 'state of the art' of meat quality improvement as applied commercially through improved production and slaughter practices is not very advanced. But there are indications that future developments will be more rapid. The static demand for meat, increasing competition from non-meat products and the concentration of the various sectors of the industry is putting increasing strain on the industry. Survival will, therefore, depend on the ability of meat traders to adjust to changing circumstances. The factors of change that will be developed in the rest of the paper are as follows.

(1) The increasing demand by retailers and meat processors for a consistent raw material - not overfat because of waste and not overlean because of concern about quality. This demand is leading to a tightening of procurement specifications and more calls for research and relevant consumer studies aimed at providing the basic information necessary to design quality assurance schemes.

(2) The re-appraisal by breeders and breeding organisations of longer term selection objectives. More emphasis is being placed on the rate of lean tissue gain and in the use of more specialist terminal sire lines which offer advantages in leanness due to lower bone content rather than lower fat content. At the same time, the importance of shape and fine carcase points are being questioned.

(3) Improvements in communication at the production/meat trade interface. Abattoirs and meat plants are now just beginning to take advantage of the telecommunications and micro-computer revolution for more effective on-line data capture and quality control operations. In addition there are increasing calls, particularly by farmer organisations, for market orientation and more producer involvement in operations beyond the farm gate and in meat promotion. Such involvement is seen as an appropriate response to overproduction and low prices.

The control of variation

The key question here is this : Is it relevant to isolate the effect of fatness/leanness on meat quality, in applied research and development?

Harrington (1983) focussed on the problem of meat quality variation and its control by putting himself in the position of the Meat Director of a multiple food retailer, faced with the problem of drawing up a buying specification.

For pigs, his problem is relatively simple because he can obtain his requirements with reasonable confidence by specifying carcase weight and fat thickness. If he is particularly concerned about overleanness, he may decide to increase his specified carcase weight to increase fatness provided this does not compromise his cutting method. Indeed, the overleanness problem in Britain would be reduced considerably if the lightest pigs were slaughtered at heavier carcase weights. There would also be benefits in the overall efficiency of the industry because we estimate that the optimum slaughter point in terms of the overall cost of producing lean meat is in the range of 65 to 80 kg carcase weight (Chadwick and Kempster, 1981) and above the national average weight of 63 kg.

The Meat Director may also decide to eliminate entire male pigs from his specification particularly for bacon. In Britain, where some 45% of male pigs are not castrated, major resistance to their use is centred in the bacon industry and it is unlikely that there will be a significant change until the Danes begin to make some moves themselves. Many retailers who sell British bacon believe that the use of entire males will increase the variability of British bacon quality.

At the moment it is not clear whether entire males per se have a higher incidence of meat quality problems generally (boar taint excepted) or whether the observed differences are simply due to their leanness. There is some evidence to indicate that entire males do have some deficiencies in comparison with castrates in curing yield (possibly associated with fatness) and in joint proportions which have to be set against their superior efficiency of lean meat production (for example, Smith et al, 1983). Tissue composition can also vary (Wood and Enser, 1982). Evidence is also

accumulating that entire males have a greater incidence of skin (rindside) damage, an important factor in quality assurance schemes for rind-on bacon, if they are not handled carefully between farm and slaughter.

It is of interest to note here that the British bacon curers have recently launched a major scheme to improve the overall standard and consistency of British bacon. It includes close monitoring of standards by an independent body - MLC. The question of whether bacon from entires should be allowed to carry the new Charter Quality Mark was debated at length. There were those curers, supported by some of their retail customers, who felt that entires should be excluded, but others were prepared to include them recognising that they could bring advantages in terms of improved lean to fat ratios in rashers and joints. It was decided that entires should not be excluded from bearing the Mark, and that those retailers who did not wish to receive bacon from entires could specify this as one of the factors in their buying specifications.

As far as carcase quality for beef and lamb is concerned, the Director will stipulate weight range, fatness and conformation in an attempt to control weight, size and fatness of individual retail portions according to his preferred method of cutting, and to predict average yield of saleable meat. He will not necessarily wish to maximise meat yield (since this may lead him to carcases which may be too lean for his taste and too high priced because of scarcity) but rather to control the average yield so as to preserve a relationship between buying price, selling price and margin.

In practice considerations of carcase quality and meat quality will not be separated so easily. Most meat traders have views about the importance, for example, of the level of carcase fatness on the eating quality of the lean meat, the importance of 'youthfulness', the impact of breed on eating quality, the influence of the feeding system. Within the range imposed by beliefs about eating quality, the pursuit of a particular weight range, fatness and conformation for control of carcase quality will channel the discriminating Meat Director towards animals from a particular production system. Immediately he finds that it is not simply a matter of differences between breeds, between sexes, between ages, between diets etc., but between breed and production system combinations which will differ in two or more of these individual characteristics. He is also faced with the problem of seasonality of supply and the variation that this introduces in year-round supplies.

The scientific literature abounds with comparisons of all these factors individually and one can easily draw up a balance sheet of trials which have and which have not identified statistically significant differences and decide, for example, that the lean meat of bulls is detectably tougher than that of steers of the same age and that the effect widens with age. But in commercial practice, age effects are confounded with growth rate, feed level, diet, carcase fatness and so on.

Looking more closely at the literature one often finds that the authors do not comment on the commercial importance of the significant differences found or claim that the differences, although big enough to be detected in controlled trials are not big enough to influence consumer attitudes. Harrington (1983) contends that such arguments can be misleading unless supported by detailed consumer and marketing studies, and that they are rarely convincing to people like the Meat Director. He gives an example as follows:

> 'An increase in the incidence of dissatisfaction from 5 to 12% for example, could be very significant in marketing terms; yet this is the increase that would arise if the difference between the means of breed A and breed B was 0.3 standard deviation and B (with the lower mean) was 10% more variable. This is a difference of mean that would be significant at the 5% level if there are about 50 samples of B, yet both means could fall into the 'acceptable' range.

It is this philosophy which underlies the large-scale consumer panel studies now being carried out by the Meat and Livestock Commission in all three species. The first published trial (Hardham et al, 1984; Harrington, 1984) examined consumer response to beef from two contrasting backgrounds :

(A) Aberdeen-Angus cross heifers, not more than 500 lb carcase weight, conformation R or better, fat class 4L. The cattle were slaughtered, as they would normally be, in Scottish abattoirs.

(B) Friesian/Holstein steers, averaging 600 lb carcase weight (not barley beef), conformation O- or P, fat class 3 or 4L. The cattle were slaughtered in English abattoirs.

Cattle of each type were slaughtered at six abattoirs and a comparison of quick and delayed chill was included.

The conclusion was as follows : beef of a traditional 'quality' specification (A) carefully (delayed) chilled and adequately aged, elicited favourable comments from a high proportion of the families in this consumer panel study. Similarly handled beef from systems using calves of extreme dairy type also received a majority of favourable responses - although the incidence of critical comments was detectably higher by 5 to 7%, a difference which might well influence retailer's buying decisions.

Having established that consumer panels can be a useful tool, the question now is how to compare fatness levels bearing in mind that these will inevitably be confounded to some extent with breed and system in commercial practice.

In the longer term, as meat processing techniques advance, it is questionable how important the control of variation in the raw material will be. Given advanced handling, many of the production factors possibly affecting eating qualities under current conditions would be even less important than they are now, technology achieving a greater degree of uniformity that can be achieved more naturally. Cullimore (1984) has emphasised the trends in beef market requirements. He argues that two distinct markets are emerging - a large mass produced (popular) market and a smaller traditional market (quality beef conventionally reared and handled). Profit and success are likely to accrue to those who cease to regard meat in the traditional manner but merely look at it as raw material. The producer concerned with this market will specialise in meat quantity : other characteristics - shape/colour/tenderness/flavour and succulence - need no longer be his concern since these will be dealt with by the techniques of the food chemist and meat manufacturers.

But while technology is developing (and the time-scale of application will be determined by profitability and investment opportunities in the meat industry), there is likely to be a contrary trend in the beef and lamb industry with an increasing emphasis on 'quality' in freshmeats and a range of developments from national attempts to introduce quality assurance schemes to individual processor and retailer attempts to establish their own brands. An important point in this context is the extent to which specifications to achieve quality assurance and involving age at slaughter, electrical stimulation, speed of chilling etc., will require support from measurements taken in national/international classification schemes. Reference will be made to this later.

Re-appraisal of breeding strategies

The key question in this section is this:'Is selection for characteristics other than the efficiency of lean meat gain a realistic objective?' The whole area of developing breeding objectives for livestock improvement has been very much neglected by geneticists, but a recent review by James (1982) has focussed some of the unresolved issues. The breeder who originates changes in the genetic potential responds to predictions of future price differentials. But, it is important to recognise that sire improvement through selection is a long-term process: for example, the time lag for pigs is 7 to 10 years between decisions taken and the impact on production. The breeder should only react when he is confident that the changes required have some long term validity.

The quantity of meat in the carcase and the cost of its production are clearly important, but long term decisions about fatness/leanness ratios and more subtle considerations of shape and meat quality in general may be difficult to justify as economic objectives if the market is to develop as indicated earlier. However, leanness itself is a complex trait and improvements can be achieved in different ways with different implications for other characteristics. Long term objectives can also be confused by short term market requirements and the effectiveness of techniques available to identify differences in carcase quality in classification and grading schemes as illustrated below.

For some time we have known that important genetic variation exists in meat to bone ratio and hence in lean content at the same level of fatness, although the British perspective on this and the role of conformation (muscling) in its assessment have been quite different to that in other European countries because of limited variation in our native livestock populations coupled with more variation in fatness. For pigs, the differences between breeds were thrown into focus by the recent international study carried out by the Commission of European Communities (1979).

Pig breeding organisations clearly see an important market in Britain for blockier specialist sire lines with higher meat to bone ratio and many of them have developed and are promoting these despite the fact current grading methods cannot identify their carcase advantage satisfactorily, relying as they do on fat thickness measurements. If the proportion of meat sire line pigs increases it may become necessary, therefore, to include muscle thickness or a conformation score in classification and grading schemes to segregate them.

However, it is certainly not yet clear whether such pigs are in the best interest of overall efficiency of meat production. Their carcases might be meatier but is the meat cheaper to produce and of the same quality as that from a conventional back-crossing system involving Large White and Landrace breeds and their crosses? The incorporation has, therefore, to be organised to minimise the risk of meat quality damage and with continued reference to economic merit. Whatever happens, it is important to avoid the distortion effect of market demand for conformation as in Germany where the premium Grade E carcases with exceptional conformation and meat to bone ratio have meant that other characteristics - growth rate, feed efficiency, sow productivity etc., - and the overall efficiency of production have suffered.

Although meat quality has received relatively little attention from breeders of any meat species and unlikely to do for economic/time scale reasons, there has recently been a re-awakening of interest in one area which in microcosm illustrates the problem of balancing production efficiency and meat quality characteristics. Possibilities of genetic improvement in pig meat quality have been greatly increased by recent advances in understanding of porcine stress syndrome (PSS) brought about by the identification of the halothane gene. Manipulation of this gene can reduce genetic liability to pale, soft exudative muscle (PSE) much faster than conventional selection methods (Webb, 1981), and may be cost effective. It is also worth remembering that the increased mortality associated with PSS and the drip loss associated with PSE are components of the long term objective, cost per unit weight meat produced.

One of the most important questions for future research is the extent to which genetic variation in meat quality will remain in the absence of the halothane gene. Would elimination of the gene completely remove the relationship between quality and quantity. Quantitative tests such as activity and mitochondrial calcium efflux could provide a measure of variation in meat quality independent of the halothane gene. But, for the most rewarding challenge will be to separate the beneficial effects of gene on meat quantity from the harmful effects on meat quality and other

Improvements in communication at the producer/meat trade interface

The key question in this section is this: 'How will future developments in communication influence carcase and meat quality measurement techniques

Considerations of the various topics above indicates that requirements for consistent meat quality are likely to continue at least in the medium term. Any significant deterioration in carcase or meat quality, or increased variability will cause buyers to become more discriminating - the large retailers have the power to tighten requirements and expect wholesalers to comply. Inevitably this will lead wholesalers to examine more closely the carcase and meat quality characteristics of carcases from different producers and identify those whose products are not up to standard.

Important developments are now taking place in the area of automatic which are likely to make carcase classification and grading simpler in The situation is most advanced in pigs with the testing and initial of reflectance-based recording probes for measuring fat and muscle thi The principle lends itself to the measurement of muscle colour and the assessment of PSE (drip loss) in classification and grading (Barton-Gad Olsen, 1984).

Visual assessments are an essential element of 'the state of the art' and sheep classification and it is clear that they will be with us for time to come. Video-based approaches seem unlikely to provide a cost-e alternative in the immediate future. The principles are sound and the techniques show considerable promise but the difficulties involved in

sophisticated measuring equipment for routine operation in the harsh environment should not be underestimated. Even the experience with indicates that the lag time between research protypes and large-scale commercial application is substantial. However, evidence is accumulat indicate that some objective measurements may be complementary to the scores (Kirton and Johnson, 1979). To encourage and facilitate greater flexibility will be required in classification and grading sc base line in terms of lean/fat bone content is required. This case argued recently by Kempster, Cuthbertson and Harrington (1984) in rela the EEC Beef Carcase Classification Scheme.

The main challenge is to make international classification schemes su EEC schemes receptive to innovation and any special needs of individua because of their market requirements or their particular livestock po The elucidation of these requirements depends on detailed evaluation carcase composition of these populations and the measurements for pred composition. Indeed, it is salutary that developments in automation robotics, which are likely to fundamentally change the abattoir flood next decade still depend on the precision with which measurements pr composition and value : the robot is still likely to require a fat pro clear definition of carcase shape for its video-image analyses to dir

Developments in computer technology are also leading to better methods capture and handling. Although the abattoir sector has been slow to this computer revolution, there are signs that attitudes are changing There are several computer systems available which can prove highly handling in abattoirs. Linked with the new measuring equipment and tags which can identify live animals, carcases and cuts at various p the slaughtering/processing chain, carcase and meat quality problems recorded relatively simply.

Further integration of production and slaughtering/wholesaling, follo poultry industry's example, would also have major implications and in influence the strategies adopted in national classification schemes. are problems of producer independence. Producers may continue with traditional independence, exercising their freedom to move their prod buyers according to short-term changes in the prices offered. If so accept that grading will be quick and cheap and, therefore, somewhat Alternatively, producers may become much more closely integrated with buyers so that the buyer comes to know a great deal about each produce stock as a result of very detailed examinations, which might even inc separation. Information would then flow much more freely in both dir each side could then appreciate the problems and the cost consequence actions on the other. In this way our Meat Director will be succes avoiding such taints, flavours, soft tissues or unusual tissue distri if he considers them undesirable. It implies vetting of producers production practices in some detail in advance of purchase of their or sheep. It also raises questions about the long term future of c and grading as we know them today.

Some general points

The general indications are that the period when reduced fat thickness important is coming to an end and that other more detailed factors a the value of carcasses to the processing industry and the retailer wil more important, in the medium term at least. The speed with which th

changes will depend on the development and commercial application of new measurement techniques. Given the measurement capability, wholesalers are likely to react by introducing more demanding specifications, this trend being emphasised by the demands of the large multiples for consistency of product and facilitated by the data capture and processing revolution. This means that breeders and producers will become increasingly concerned with carcase and meat quality characteristics beyond weight and fat thickness.

But the important question is how these more demanding schedules will interact with the overall efficiency of meat production in the medium term. It would not be in the best interests of the meat industry for the advances in technology to constrain producers to such an extent that there is a serious reduction in cost per unit output. Rigid specifications for fatness, muscle colour and texture will need to be tempered with an understanding of the importance of flexible production methods which allow optimum production efficiency. Buyers must also realise the effect they are likely to have on the overall distribution of carcase fatness and the impossibility of compressing variation below the inherent biological variation.

The objectives appear clearer in the long term if projections about the requirements of a meat industry centred on processing are correct. However, the time span of these developments is crucial for any decision making on research needs because the pay-back period for investment in production-orientated meat research may be limited.

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