
THE PROCEEDINGS OF THE
NEW ZEALAND SOCIETY
OF
ANIMAL PRODUCTION
VOLUME 62 2002

New sheep - a catalyst for change

J.N. CLARKE

AgResearch, Ruakura Research Centre, Private Bag, Hamilton, New Zealand.

ABSTRACT

New sheep may be alternative breeds brought in from other environments, new synthetic breeds developed by crossbreeding or as specific crossbred combinations, or new strains of existing breeding populations developed by selection for production traits, identifiable genes or gene complexes. Changing gene frequency is the main underlying feature of all these approaches to genetic improvement. Selection of parents is the common operational ingredient.

New products have been a major factor in changing the breed structure of our sheep industry. New more productive breeds have also been produced utilising the complementary features of existing breeds, but with little widespread development of crossbreeding systems based on first cross ewes.

Improved reproductive rate from selection or use of new fecund genotypes offers much scope for specialised production of quality market lambs, especially when stratified production systems using first-cross ewes and terminal sire breeds are involved.

New breeds have recently provided a major stimulus to the improvement of terminal sire breeds. They are re-focussing the balance of emphasis on lamb growth and carcass quality and encourage a search for unique genetic effects on meat quality traits.

Keywords: Sheep; crossbreeding; breeds, genetic selection.

BACKGROUND

This paper presents some background principles behind genetic improvement; whether this be by breed choice, crossbreeding or by selection within the breeding population. It seeks to provide a framework for topics which follow in this session. Much of what is presented is not new; however, many features and examples are still relevant and need to be re-examined for current industry circumstances. It can also be salutary to look at the ways that our sheep industry has developed in the recent past and to consider these in terms of what is now known about the productive attributes and industry circumstances of the breeds which were involved.

In considering current industry circumstances Robin Campbell points out that we have progressed beyond merely producing "more of the same", and that our production resources are finite, even shrinking in the face of alternative uses for our land. This situation directs attention to profitability and adding value to the products we produce and process - a focus on products rather than on production, and in particular on products that pamper the prosperous worldwide.

Genetic opportunities

There are three main genetic opportunities to reduce production costs and to increase the value of products - by breed choice, crossing or selection. Each seeks to change the gene frequencies of the breeding population; each also requires that the improvement goal be clear for effective choice among alternative improvement strategies.

Breeds

Breeds have unique gene frequencies related to their history of selection by their breeders or by natural evolutionary processes. They represent breeding populations adapted to their production and marketing environments. Chance genetic sampling of gametes and embryos associated with finite population sizes has also played an important role in their evolution. By these processes the frequencies of genes unrelated to our requirements may have changed as well. These changes also offer genetic opportunities. Long evolutionary time scales and a wide range of environments have produced a large international array of genotypes.

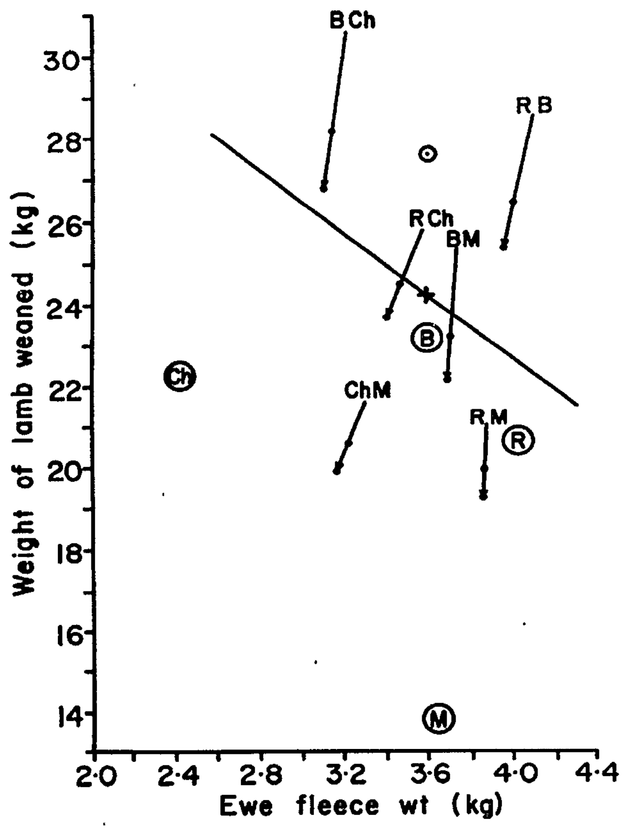
The additive effects of the genes at different frequencies in different breeds, by definition, have a heritability of unity; thus breed differences may be exploited with a very high accuracy of predicting their outcome in characteristics for which they have been described. Seldom, however, do we have a complete understanding of the genetic differences among breeds - there will always be a need to re-examine breed differences from different points of view and especially as new markets and specialist products unfold.

New products have been a major factor in the changing breed structure of our young industry (Carter & Cox 1982). Some of the major features of the breeds studied in large crossbreeding trials carried out at the Templeton and Woodlands Research Stations from 1970 to 1978 (Clarke 1982a) are summarised in Figure 1 (from Clarke, 1984). This highlights the wide variation in the balance of meat and wool attributes for the genotypes studied, indicating the wide potential that breed resources and hybrid vigour offer for focusing production in particular directions.

Complementarity

Breed complementarity has been the main basis for choosing breeds for crossing. These include specific cross-breeding in which different genotypes are produced anew each

FIGURE 1: Average meat and wool production of purebred and first-cross ewes (Clarke 1982a, 1984). Symbols: R = Romney, B = Border Leicester, C = Cheviot, M = Merino. Average linear relationship among genotypes indicated by the line through population mean (+); lower (arrowed) ends of lines for each first-cross indicate expected performance of two-breed synthetics (assuming 50% loss of hybrid vigour); dots on these lines indicate expected performance of 2-breed rotational crosses; = expected average for a R, B, C rotation.



generation, rotational crossbreeding where the parental genotypes are of different breed constitution in each generation, and the creation of new synthetic crosses by interbreeding. Thus complementarity is the opportunity to combine the features of different breeds. The aim is to maximise the good and minimise the unfavourable genetic features of different breeds. Genetic theory predicts that additive merit of the crossbreds is the average of the parental breeds - it is simple to apply, provided that there is good information on the genetic merit of the parental genotypes in terms of the performance of their progeny in commercial environments and without any undue biases from the ways that they were managed.

Hybrid vigour

Hybrid vigour is often seen in crossbreds and is due to the non-additive effects of genes at different frequencies in their purebred parents. It is defined as the deviation of the first-cross from the average of the genetic merit of their two parents (the average of their purebred progeny) for the particular environment. Hybrid vigour is most marked for maternal performance, especially fertility and lamb vigour (Clarke 1982b). While it is often shown in other traits, such as growth and wool production, its lower magnitude means that complementarity decisions can often usefully be based on the relative performance of their crossbred progeny. This is often convenient in on-farm evaluations seeking to develop new genotypes as the evaluations proceed. The development of the Perendale and Coopworth breeds by NZ farmers in the 1960's and 1970's was largely based on complementarity considerations. The fact that much of their productive advantage was due to hybrid vigour in maternal traits affecting weaner lamb production was not clear until this industry move was well under way.

Crossbreeding systems

Despite the high levels of hybrid vigour in reproductive rate and lamb vigour, Cheviots and Border Leicesters have stimulated the development of new breeds rather than crossbreeding systems. For Perendales, this development was to improve meat and wool productivity under hard hill country conditions. For both breeds it became part of farmer demand for a more easily managed flock that included the effects of natural selection on productivity under commercial conditions. It was also associated with the development of performance recording and group breeding schemes in these commercial environments. Indeed, these new breeders and breeding associations had a strong focus on the ongoing supply and improvement of rams for a new generation of producers (MacKay 1982).

For specific industry-wide crossbreeding systems, changes in the characteristic features of market lambs can be especially rapid. Ch'ang & Atkins (1982) describe the situation that exists in Australia where crossbreeding plays a pivotal role in the transfer of breed resources from the wool to the meat producing sectors of their industry. Complementarity considerations affecting product quality had little impact on the initial development of the Perendale and Coopworth. The high wool bulk advantage of Cheviots was passed on to the Perendale (albeit with some cost in fleece weight) and has assumed some importance subsequently.

Breed evaluation trials are seldom definitive, initial emphasis often ignoring many qualitative features of the wool and carcass, and major changes to the production system (e.g. out-of-season breeding). In his paper, David Walpole mentions deliberate attempts to exploit the milk and lamb growth features of Poll Dorsets. For these reasons, on-farm testing and experience will remain important and will require access to flexible performance recording schemes with associated data-processing services capable of providing unbiased estimates of breed and crossbred performance using modern analytical techniques. Simulation studies can be useful in exploring alternative genetic specialisation possibilities.

Imported breeds

NZ has only a small array of the wide variety of breeds that are available internationally. Those which we have were determined mainly by tradition, familiarity and availability. Availability includes issues associated with animal health where ongoing technological improvements are being made to importation and quarantine procedures. Recently several new breeds with unique features have been introduced from overseas - the Finnish Landrace with a high production of lambs per ewe, Oxfords with a high growth rate and Texels with a high lean and low fat content in their carcasses (Clarke

1984). More recently, we have seen the Awassi (a fat-tailed breed), the East Friesian (a specialised high milk producer with good fecundity) and the American Suffolk.

Because of the limited animal numbers, initial evidence on the local performance of these breeds tends to be as sires of first-cross sheep from local breeds. The Finn has demonstrated its high fecundity expectations in many countries throughout the world. Current on-farm experience in this country shows that the reproductive performance of young Finn crossbreds is especially encouraging under high stocking rates and difficult nutritional conditions. It has also displayed some carcass leanness advantages (Clarke *et al.*, 1988) and evidence of resistance to facial eczema (Morris *et al.*, 1994).

Terminal sire breeds

Terminal sires offer a very high degree of industry flexibility for specialist meat production and allow utilisation of hybrid vigour in traits associated with lamb survival and growth. First-cross ewes in particular offer a high level of "excess fertility" over that needed to generate purebred replacements to maintain their parental dam lines (Clarke 1982a; Pitchford 1993).

The greater importance of meat relative to wool and the greater industry stratification that has developed for meat production in the sheep industries of most northern hemisphere countries, focus attention on these countries as a source of genotypes for special-purpose meat production. A summary of important results from an extensive series of NZ trials, conducted in the 1960's and 1970's was presented by Clarke (1982) and Bennett and Kirton (1983). The latter emphasised that no one sire breed was best for all performance traits of importance to meat production, and showed how the optimum balance of these attributes could depend on market preferences and individual farm circumstances.

Selection

There is great scope for improvement of reproductive rate in sheep by virtue of the large amount of genetic variation and ease of measurement for effective capture in large recorded and commercial flocks (Baker *et al.*, 1987). Such developments are likely to bring a redirection of selection emphasis towards growth and wool production. Genetic specialisation for extending the seasonal supply patterns for export lamb and accommodating the different maternal needs of high reproductive rates are also likely to challenge existing management systems.

Special-purpose sire breeds are now being developed, as discussed later by Geoff Nicoll and John McEwan, utilising the scope for early selection in the live animal offered by ultrasonic measurement of carcass composition indicators (Waldron *et al.*, 1992; Clarke and Binnie 1994). The new Texel breed has provided a major stimulus to other breeds in this regard. Texels have also adapted well to grazing in large mobs and displayed good maternal instincts, features which favour its separate development as a dam-line if maximum advantage is to be taken of its lean and muscling attributes.

Selection at the genetic level may also result from a more specialist focus on particular breed attributes. A good NZ example is the Drysdale for which selection for a particular single gene attribute was the predominant ingredient in the development of this new breed, but not without emphasis on productive adaptation to environmental conditions as well. Other examples include the Booroola and Inverdale genes. The *Callipyge* gene recently discovered in the U.S. Dorset breed provides a topical example relevant to meat production from sheep. It has a large impact on eye muscle area and the yield of saleable meat from hindquarter cuts (Jackson *et al.*, 1993), and encourages a search for similar outlier genotypes in this country using phenotypic selection or new molecular technologies.