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3 The impact of technical advances on hill and upland sheep production

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INTRODUCTION

There are 5.43 million ha of 'hill' land in Great Britain; that is land which is included in 'hill sheep' and 'upland' farms in Scotland, and, in the North of England and Wales, farms classified as 'livestock, mainly sheep', and 'livestock, cattle and sheep'. Of the 5.43 million ha, 3.95 million ha are rough grazings and the remainder grass and tillage.

The land supports some 7.8 million breeding ewes of which 5.5 million are on hill farms and 2.3 million on upland farms. Some 16 500 full time holdings employ an estimated 27 500 workers in addition to the farmers and their wives.

The existing pattern of agricultural land use in the hills and uplands of Great Britain has been set by the interplay of many factors. These include soils, climate, topography, remoteness and economic and social history, as well as changing technical possibilities.

The soils and climate of the hills dictate that the growth of plants for agricultural production, including grazing, tends to be depressed by virtue of short and cold growing seasons. Crop harvesting, including grass conservation, is more difficult and less certain than in the lowlands, and winter weather is a more severe constraint on animal production. Topography acts directly on agricultural possibilities by limiting access, and slope constrains land improvement and contributes to increased machinery costs and interacts with climate to increase exposure.

These basic factors combine to determine that hill and upland agriculture is primarily devoted to livestock production from grazing animals, based on the year round maintenance of breeding flocks and herds whose progeny, except for replacements, are disposed of before winter begins.

The basically less favourable physical input/output relationships are exacerbated in their economic effects by remoteness, both from supply points and markets. Remoteness has tended to disadvantage paid labour relative to family labour and to consolidate the effects of modest profitability (and perhaps of a predominantly animal agriculture) in determining that hill and upland farming is typically family farming, and an industry of comparatively small farm businesses.

Inadequate size of operation is the fundamental source of the economic problems of the hills and uplands and, as Allen (1973) points out, if the difference in land values does not reflect the disadvantages of location, the explanation lies in the number of hill and upland farmers competing with each other for holdings which are commonly too small. At the levels of Government support of the last decade or so farm level input/output relationships are not significantly different from those of other types of farming. The net income disadvantage of the hill and upland farmers is accounted for, in the main, by the generally smaller size of farm business.

Farm business size can be increased by amalgamation and by intensification. Structural change will continue, but on past experience its pace will be comparatively slow. Intensification would appear to offer a more hopeful line of approach and one which is in line with the aspirations for the hills and uplands expressed in *Food from our own resources* (MAFF, 1975).

Government interventions have been, and continue to be, crucial to the modest profitability of hill and upland farming. They help to sustain the stratification system by which hill and upland sheep farming are inter-linked to each other and to lowground sheep production. From time to time the maintenance of the stratified structure of the sheep industry is called into question, usually on the basis of arguments to do with the magnitude of Government payments to hill sheep production or to do with the expansion of forestry in the hills. It has however been calculated (MLC, 1972) that the replacement of the sheep output of the hills by means of a self-sufficient lowland sheep population would require an additional 3 million lowland ewes. In the light of the size of the lowland area which would have to be diverted from other forms of agricultural production it is reasonably safe to assume a continuation well into the future of the present stratification system.

It is important to recognise that home production of mutton and lamb has never even remotely matched the demand. Decreasing imports from New Zealand, together with a growing export of fresh lamb carcasses to EC countries promise to maintain for the sheep industry its almost unique freedom from demand problems. The long term prospects for sheep seem as secure as anything can be in a rapidly changing world, whose few predictable elements include the high value to be attached to indigenous sources of food.

TECHNICAL ADVANCES

There seems little prospect that technical advances will significantly alter the dominant influence of climate on the length of the growing season or on the difficulty of harvesting crops in the hills and uplands. These quite basic constraints will remain to determine that the framework within which the impact of technical advance has to be examined will remain that of livestock rearing.

The sheep will continue to benefit from its ability to select for itself, from grazed pasture, a winter diet which makes a much greater contribution to its requirements than the beef cow is able to do, particularly in periods of snow cover. The economic value of this attribute will continue to give the sheep a competitive edge over the beef cow on hill farms in particular.

The range of sheep production systems in the hills and uplands varies from those based entirely on rough grazings to systems which largely utilise upland sown pasture. Between these extremes, circumstances are found in which hill ewes spend varying amounts of time between October and June on enclosed pasture at lower elevation. Likewise rough grazings play a widely varying role in upland systems.

Most hill sheep farms utilise self-replenishing stocks of one or other of the pure hill breeds. On some hill sheep farms an attempt is made to utilise hybrid vigour through the periodic use of rams of another hill breed, whilst on some of the better hills another breed may be used to produce a proportion of cross-bred lambs. Upland farms typically use a half-bred such as the Greyface, one of the Mules or the Welsh half-bred. Others may use draft hill ewes either to produce store/fat lambs, or cross-bred females for further breeding. On some upland farms purebreds such as the Clun find favour.

For the purpose of this discussion it is convenient to consider hill sheep and upland sheep systems separately even though such a discrete sub-division over-simplifies what is in fact a continuum, and ignores the variations which take place around these two major themes.

HILL SHEEP SYSTEMS

Very great advances have been made in the last two decades or so in our understanding of hill sheep, the indigenous pastures which provide the major part of their food supply and the interactions between them.

It is now well recognised that the major determinant of sheep performance in the hills is nutrition. The significance of improving nutrition in pregnancy to lamb mortality and subsequent lamb growth (Russel, 1967); the importance of better quality ingested pasture feed to improving milk yield (Peart, 1970) and lamb growth (Armstrong & Eadie, 1973); and the role of previous and contemporary nutrition on reproductive performance (Doney & Gunn, 1973) are all now well understood and documented. Current research is consolidating this understanding and contributing to a quantification of response and improved predictability.

Major advances have also been made in the evaluation of the productivity and nutritive value of the economically important indigenous pasture types and in understanding their ecology. An analysis of the biology of the hill sheep problem and a synthesis of the available knowledge leading to improved systems of hill sheep production has been made (Eadie, 1970). These improved systems are currently being evaluated in practical-scale tests in the Hill Farming Research Organisation (HFRO) and elsewhere (eg Redesdale EHF).

A central feature of these improved systems is hill land improvement. The various constraints on land improvement arising out of topography – access and slope – and out of economic considerations which have to do with the short-term cash flow consequences of capital expenditures, (Maxwell, Eadie & Sibbald, 1973) dictate that the improved pasture component of any development scheme is comparatively small. The management strategy of these two-component systems aims to maximise the impact on individual sheep performance of the comparatively small amount of improved land.

Very substantial improvements both in total output and animal performance have been demonstrated in widely contrasting hill environments. Table 1 summarises the output and performance changes which have followed from the minimal improvement of some 190 ha of indigenous *Agrostis-Festuca* pasture by fencing in a unit of 283 ha in the Eastern Cheviots. A second phase of improvement involving the addition of 7.2 ha sown pasture and further upgrading of one of the indigenous pasture enclosures began in 1974 (Eadie, Armstrong & Maxwell, 1976).

Table 1
PRODUCTION DATA FROM A TWO-PASTURE YEAR-ROUND GRAZING SYSTEM AT SOURHOPE FARM (283 ha)

	Pre-development	1969	1970	1971	1972	1973	1974	1975
Ewe numbers	387	398	451	518	528	573	600	601
Weaning proportion (per cent)	90.6	84.7	86.5	103.3	104.7	99.5	91.5	102.7
Weight of weaned lambs (kg)	7 924	7 785	9 189	14 178	14 046	14 193	14 329	16 042
Weight of wool (kg)	869	850	1 017	1 253	1 369	1 561	1 454	1 535
Increase in lambs (per cent)	–	– 1.8	16.0	78.9	77.3	79.1	80.8	102.4
Increase in ewes (per cent)	–	2.8	16.5	33.9	36.4	48.1	55.0	55.0
Lamb ha^{-1}	28.0	27.5	32.5	50.1	49.6	50.2	50.6	56.7

A similar study is being carried out on blanket peat in Argyll, where the improved pasture component comprises surface seeding both in wholly fenced areas and in a mosaic of improved patches throughout large enclosures of indigenous pasture. A 405 ha unit whose traditional stock carry was some 200 ewes, weaning some 60% of lambs, now carries around 450 ewes weaning around 95% (Eadie, Maxwell & Currie, 1976).

Existing knowledge provides a wide range of techniques for the replacement of indigenous hill vegetation by sown grass and clover (Newbould, 1976). Current and projected work will almost certainly lead to a more accurate definition of the chemical and physical characteristics of soils which limit herbage growth and production. This information, together with advances in plant nutrition, may well lead to better criteria for the selection of sites for improvement and to a reduction in the costs of, and a greater degree of predictability and effectiveness in, land improvement procedures.

Improved varieties of grass may well result from the inclusion of hill and upland sites in herbage evaluation trials, and current attempts to breed clover varieties for hill conditions may result in plants better adapted to the late springs and colder summers of the hills. It seems likely too that current work on clover nitrogen fixation and rhizobia, some of which takes account of hill environments, will also contribute to pasture productivity and nutritive value.

Continuing work on sheep nutrition will contribute to a more precise understanding of the role of both energy and protein nutrition in reproduction, lactation and lamb growth. Active programmes are being pursued in studies of the digestion and supplementation of poor quality hill herbages in winter, and this work together with studies aimed at a more precise knowledge of requirements throughout pregnancy will provide the basis for a more precise use of feed inputs. Advances are also being made in the trace element nutrition of sheep and fundamental work is increasingly being backed by field studies in the hills and uplands (eg Whitelaw *et al,* 1977).

The potential significance of genetic improvement has to be seen in the context of the known large responses to nutritional improvement. A largely unresolved question is the extent to which there is a useful amount of heterosis in crosses between the hill breeds. Recent work suggests that it does exist, but at a rather low level (King, 1976). Perhaps the most significant current trend is the attempt being made to introduce the concept of group breeding schemes. But the rate of development is likely to be slow, not least because it involves a degree of breeder co-operation not previously attempted in the UK.

The increasing attention being given to land improvement, together with the substantial differences between store and fat lamb prices in many areas may well further stimulate the trend towards more lamb fattening on greencrop on hill farms. To the extent to which pioneer cropping is encouraged in the process, so land improvement will benefit from a reduction in costs, as the returns from lamb fattening can be set against these costs.

There appear to be good grounds for believing that whilst these various areas of investigation will contribute to the future of sheep production in the hills there is little to suggest a major departure from the development framework now being tested at HFRO and elsewhere with some success. The ideas upon which this is based seem capable of application in a wide range of hill environments and of accommodating many of the regional variations in practice, as well as providing for hill cattle stocks across the possible range of sheep/cattle ratios.

UPLAND SHEEP SYSTEMS

Upland sheep production systems are based importantly, and sometimes exclusively, on enclosed sown pasture. The role of hill land resources in such systems is extremely variable; it is often limited to providing grazing for ewes after lambs are weaned, and in the winter.

The sheep are often crossbreds derived from one or other of the hill breeds, though draft ewes from the hills are also widely used.

A considerable amount of research has been carried out in recent years in increasing litter size and/or lambing frequency in sheep. The application of this knowledge to commercial sheep production in the uplands is unlikely in the near future for a variety of reasons. In particular the nutritional implications of such highly productive systems require substantial increases in the use of feeds of higher energy concentration than grass can provide. It seems very unlikely that the relativities of grass and concentrate costs and lamb prices will conspire to make such systems sufficiently attractive to supplant grass based systems of sheep production on any scale especially in the uplands. It seems much more likely that, for the foreseeable future, developments in sheep production in the uplands will continue to depend on the more efficient use of grass and forage crops.

Although care has to be exercised in interpreting the data, because there is no way of knowing the extent to which the recorded farms are typical or otherwise of the whole population, Meat and Livestock Commission figures confirm other survey evidence that outputs of weaned lamb/ha are substantially lower than outputs obtained in the lowlands (eg 427 cf 636 kg/ha). Stocking rates are much lower in the uplands than in the lowlands (9.1 cf 11.4 ewes/ha) (MLC, 1976 b). Part of the reason for this is undoubtedly poorer levels of pasture production. Apart from the effect of higher altitudes and shorter and colder growing seasons, much upland pasture is renewed much less frequently, and drainage is often poor. Management also tends to be more difficult. Topography constrains the integration of conservation and grazing much more than in the lowlands. Weather conditions often interfere with the all-important timeliness of operations especially for sheep, where hay continues to offer advantages over silage.

Much upland pasture is however capable of improvement given present day techniques. It is noteworthy that the most profitable third of MLC's recorded upland flocks are stocked at an average of 10.4 ewes/ha as compared to the overall mean of 9.1 ewes/ha (MLC, 1976 b). The range of stocking rates observed in recorded flocks suggests that there is a great deal of scope for improvement in pasture production and management in the uplands.

Individual sheep performance in the uplands falls well short of the known potential of the various breeds and crosses commonly used. The number of lambs reared per 100 ewes is on average well below reasonable expectation. MLC data suggests rearing percentages in the region of 125% over a run of years. (MLC, 1977). Data from the same organisation reveals that over 20% of their recorded upland flocks rear fewer than 100 lambs per 100 ewes mated, and 130 lambs reared per 100 ewes mated is exceeded in only 20% of their recorded flocks (MLC, 1976 a). The number of lambs born per 100 ewes mated is the biggest single source of variation in reproductive performance. While recent work with upland Greyface ewes suggests that post-conception nutrition may be a much more important factor in lambing performance than had hitherto been thought (Gunn & Maxwell, personal communication), the application of current information on the effect of body condition on conception rates could considerably improve farm production figures.

Surveys tend to reveal high levels of lamb mortality in upland flocks. Some MLC data indicate that over 34% of their recorded upland flocks lose more than 15% of the live lambs born, and over 16% of them lose more than 20%. Whilst weather conditions in the uplands undoubtedly contribute to these losses, proper attention to nutrition and disease control could do a great deal to improve matters.

Data on lamb growth rates on upland farms are much less readily available. The importance of lamb growth rate varies with the system and marking objectives. It is less crucial to success where lambs are retained on the farm to be fattened on forage crop, as lambs or hoggets, but it is of great importance where lambs are sold off grass either fat or as stores. Lamb growth rate is probably the most satisfactory aspect of upland sheep performance but this is so partly because of the relatively low stocking rates found in practice.

The problem of maintaining high rates of lamb growth at high stocking rates is not yet completely resolved. Despite advances, prophylaxis parasites remain a problem in this context. The work of Rutter (1975) has demonstrated convincingly the value of systems in which sheep and cattle alternate on a year-to-year basis. Better lamb growth rates at higher stocking rates than under conventional management have been achieved and the practice seems likely to become more widely adopted.

Current work on the factors affecting the grazing intake of the sheep, lactation performance in grazing sheep and the relative importance of milk and pasture feed to lamb growth will all contribute to a better understanding of aspects of this major question. Other ongoing research at various centres will continue to provide better quantitative information on relations between nutrition and the other components of upland sheep performance. But, perhaps more importantly, current work at HFRO and elsewhere promises to provide greater insight into what is arguably the central problem of upland sheep production. The selection of a stocking rate for any given set of land resources which will optimise the balance between output per hectare and output per ewe remains a matter of not-too-enlightened guesswork and trial and error. The optimisation in the last analysis has to be judged on economic criteria, but its more objective attainment will only be possible when there is a much fuller understanding of the impact of stocking rate on the pattern of the relationship between feed requirement and feed provision from pasture. Choice of lambing date similarly affects the pattern of that relationship. This understanding is especially important in the short growing seasons of the uplands.

Only in the light of this understanding will it be possible more effectively to utilise the increasing body of information on the various aspects of upland sheep performance, pasture production, and utilisation, to develop improved management strategies aimed at superior, economically worthwhile output.

The multiplicity of breeds and crosses used and the range of upland environments encountered make it unlikely that the rate of genetic improvement in existing upland sheep will be very great in the foreseeable future. The difficulties which face genetic improvement in the hill breeds have already been referred to. The introduction of criteria related to the performance of hill sheep as parents of crossbred ewes for use in the uplands would only further complicate an already difficult matter. Genetic improvement in the ram breeds, eg the Border Leicester is more likely, but work is currently confined to pure-bred flocks.

A more likely development is the use of ram breeds other than the traditional ones, such as the Texel and the Animal Breeding Research Organisation's Dam line as sires of crossbred ewes, and current work on slaughter lamb sire breeds, including the Texel, is likely to lead to a more objective selection of appropriate sire breeds in the future.

An important development in recent years has been the accumulation of data by MLC from recorded flocks in the uplands. The value of the contribution of this body of information to improved management can be expected to increase.

CONCLUSIONS

The existence of technical opportunities does not by any means guarantee that they will be taken up at any speed, or even at all. The time lag in the uptake of research is at best in the region of a decade, and there are many factors in the hills and uplands which combine to suggest that the rate of application of technical advances will be slow.

More extensive agricultures tend to be more conservative and to change more slowly than more intensive systems of farming. Traditional lore and experience play a much larger part in extensive systems, and resistance to change where, historically, change has been limited in extent and slow, is to be expected.

Smaller units tend to be less well-endowed with the know-how and capital on which innovation depends so much. The family nature of hill and upland farming may also tend to slow the pace of change, partly because insufficient capital from family resources is often allied to a very cautious approach to borrowing. It is in the hills where these factors might be thought to operate with greatest force that technical advance requires a deliberate and conscious decision to invest capital in what is to many hill farmers a substantial departure from traditional practice.

Raeburn (1972) points out that the supply prices of family owned capital are comparatively low, and low rates of return tend to be accepted if they are regarded as properly related to the farming system and the family's way of life. But the capital requirements of hill sheep system development are considerable at £5-£15/ewe net cost to the farmer. The wide range of costs depends on the nature of the land to be improved, the means by which it is improved and the degree and extent of the improvement. Although such investment can be shown to be profitable at present costs and prices the longer term nature of the investment requires a judgment by the farmer about the future. Here it must be said that recent changes in capital taxation, the collapse of the cattle market in 1973 and 1974, the problems of the CAP and general economic uncertainty all detract from the confidence so necessary to longer term investment.

The nature of the upland sheep problem is different from that of the hills in a variety of respects. The various factors operating against change probably do so with less force in the uplands. But the major difference lies in the fact that technical advance in the uplands can and does take place in an evolutionary fashion. There is much less of a 'once and for all' major decision to be made, and we can look forward to a steady improvement in the quality of the land resources used, and in the efficiency with which these and other resources are employed in upland sheep production.

Finally, mention must be made of one or two other constraints placed on agricultural development in the hills.

Hill sheep farming's major competitor in the land use sense has been, and will continue to be, forestry. For many years land transfers to forestry did not lead to a reduction in hill sheep stocks, but since 1968 hill sheep numbers in Scotland have declined significantly. This trend is most marked in those counties where afforestation has been most evident.

It has been argued recently (Cunningham *et al*, 1977) that the continuation of afforestation along present lines will be increasingly at the expense of meat ouput, and that the problem of conflict between the future development of hill farming and forestry is more urgent than is generally appreciated. There is both an urgent need, and a new opportunity arising out of the technical advances which have been made in hill farming, to reassess the whole question of agriculture/forestry integration in the hills.

A substantial proportion of the common land in the country is rough grazings. In Scotland the common land is largely in crofting tenure and the special problems of crofting agriculture lie outwith the scope of this paper. In England and Wales the traditional arrangements for the management and regulation of use of common land have in many cases broken down. Registration is proceeding under the Commons Registration Act, 1965, but its pace is slow and because of this and the difficulty of identifying ownership in many cases and the legal complexities surrounding the whole matter, it seems likely that the constraints on agricultural advance on much of the common land will remain for the foreseeable future.

Many of the operations essential to agricultural development in the hills, eg scrub clearance, fencing, etc. affect the texture and the character of the landscape, create systems of production more sensitive to interference and generally heighten the potential conflict between more intensive land use on the one hand, and recreational opportunities and, to some eyes, visual amenity on the other. The issue is more sharply focussed in the National Parks and Regional Parks than elsewhere. In the future much will depend on the view which Government takes of the proposals of the National Parks Policies Review Committee (1974) with respect to constraints on agricultural development.

It seems possible that what is decided for the National Parks will set the scene for future pressures to constrain hill land development generally. It is to be hoped that adequate regard will be paid to the prospects for meat referred to in the Introduction, and the likely future value of systems of production whose output of food per unit of energy 'subsidy' is low relative to that of meat from intensive systems. If the real long-term contribution that the hills can make to the vital matter of home-produced food is to be realised, the industry must have a framework within which advantage can be taken of economically worthwhile technical advance. It cannot prosper and develop if it is to be constrained within the bounds of an outworn technology.

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