Extensive sheep grazing in the North

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Introduction

Extensive grazing refers to the use of large areas of unimproved natural land - rangeland - for free roaming grazing livestock. Usually, that type of natural land can only be used for agricultural production through extensive grazing. The advantages of extensive grazing are that cost and labour can be kept at a minimum. The disadvantages are limited control and flexibility in management and high environmental, economic and social variability.

Extensive sheep grazing was the main grazing system in the north for centuries, though intensive sheep farming strategies may also have been practised in early ages (Ingimundarson 1995). Traditionally in most countries in the north, shepherds herded the sheep. In Scandinavia, shepherding was primarily to minimise losses due to predators, while in Iceland the ewes were used for milk production and had to be gathered together twice a day. Shepherding is still practised in a few places in northern Scandinavia. In Iceland herding the sheep was mostly abolished during the nineteenth century as the value of lamb neat rose above the value of the milk following the increased demand for meat in the fast-growing cities in Britain (Thorhallsdottir 1991). With more emphasis on meat production, the importance of extensive grazing on natural rangelands increased as, in practice, it gave the best carcasses. In later years in Iceland, criticism of overgrazing on some natural ranges has led to increased interest in lamb production under more intensive pasture grazing. In the other Nordic countries pasture grazing, most often utilising improved or cultivated land, has become more common, although in Norway, the far north of Sweden and Finland areas of common natural vegetation are still utilised for sheep grazing. In general, the trend was to intensify sheep production, as well as agriculture in general. More recently the trend has however been to extensify the grazing again in accordance with organic/ecological farming practices and the demands of the market (Gudmundsson 1997).

Grazing system

Winter grazing of sheep has now almost been abandoned in the Nordic countries. The sheep are housed during the winter and lambing is usually planned a few weeks prior to the optimal growth of the natural lowland pastures in the spring. After lambing, ewes and lambs commonly graze cultivated pastures until natural pastures are ready for grazing. Most farmers like to turn the sheep out on the natural pastures as soon as possible. Early spring growth is therefore very important. Often, however, late spring growth must be supplemented by feeding hay or concentrate on the pasture.

Some sheep are grazed on the lowlands throughout the summer, but others are grazed on extensive mountain or highland ranges. The variability of both the lowlands and the highlands is high, with various different plant communities intermixed. The wet areas such as mires are, in general, poorly utilised for grazing sheep (Palsson 1957, Gudmundsson 1988, Thorhallsdottir & Thorsteinsson 1993), whereas the dryer areas, especially in the mountains and highlands, usually support good lamb growth in Iceland (Gudmundsson & Dyrmundsson 1989).

In Iceland and the Faroe Islands, the main concern about sheep grazing has become sustainability of the land, as overgrazing is associated with land degradation and erosion. Land degradation and subsequent
erosion is a major environmental problem in Iceland, were about 60% of the original vegetation may have been lost (Arnalds et al. 1997). In most of Scandinavia, however, overgrazing is not the main problem but rather lack of grazing resulting in regrowth of shrub and woodland followed by changes in the cultural landscape and reduction in species diversity (Garmo et al.1993). In Scandinavia, livestock grazing is becoming a major tool to keep an open, cultural landscape and biological manifold.

In the lowland areas, both in Scandinavia and Iceland, horses and young cattle for meat and replacement purposes are often grazed with the sheep. The advantage of mixed grazing is, in general, most where the diversity of the vegetation, site and terrain are the highest (Valentine 1990). On natural pastures, mixed grazing has been shown to be beneficial in Iceland (Gudmundsson & Helgadottir 1980, Thórhallsdóttir & Olafsson 1999).

In Iceland, the tradition has been to slaughter finished lambs in the autumn, often directly off natural pastures, while poorer lambs are weaned and put on improved pastures for fattening. Most lamb and mutton has therefore been sold frozen throughout the year. More recently, the market has increasingly demanded fresh lamb and mutton, thus putting pressure on farmers to finish and slaughter lambs both earlier and later, from Easter to Christmas. To be able to supply the market with fresh lamb, many farmers have adjusted their lambing time as well as keeping lambs longer than before (Gudmundsson 1997, 1998).

Growth
The relationship between grazing pressure and animal performance has been recognised for centuries. Icelandic law, over a thousand years old, states “that… no more grazing animals should be allowed on the range than in the case that if one was removed the remaining animals should not get fatter…” (Grágás, early 12th century). Most old Icelandic laws (Commonwealth period 930-1264) have their basis in or are analogous to Norwegian laws from the same time.

An extensive research project, studying both intensive and extensive sheep grazing was undertaken in Iceland from 1975-1989 (Gudmundsson & Arnalds, 1976 – 1980). Stocking rate experiments were conducted in 10 different locations and vegetative communities. Four locations will be used in this paper to demonstrate the relationship between stocking rate and sheep performance on natural rangelands. The first location was on dry lowland grassland and another on partly drained lowland mire, both in south Iceland at approximately 20 – 50 m above sea level (a.s.l.). The third location was on a dry shrubland in the highlands of north central Iceland at approximately 500 m a.s.l. and the fourth in the north-east, on a mixture of dry and wet land at approximately 600 m a.s.l.

The main results from these experiments were that the effect of stocking rate on sheep performance varies considerably with location and vegetation communities. For example, the effect of stocking rate was much greater on the dry pastures than the mire, independent of altitude. Similarly, the effect on the live weight of the ewes was greatest on the dry highland and least on the lowland mire, with the dry lowland and mountain areas being similar (Gudmundsson & Thorgeirsson 1989). The great stocking rate effect on sheep performance on the dry land also reflects vulnerability of the land to overgrazing and subsequent land degradation and erosion. In Iceland, the dryland therefore requires much more decisive management than the wetlands.

In general, lambs grew better on the highlands and mountains than on the lowlands. This was especially noticeable during the peak-growing season. In late summer and autumn the average daily gain decreased very fast in the highlands, whereas it was a more gradual decrease throughout the summer on the lowlands. In late August, the growth of the lambs on the highland and mountain ranges was no better than on the lowlands, with further decreases in early September (Gudmundsson & Dyrmundsson 1989).
The ewes were on the average heavier in the autumn on the lowland mire and semi-wet mountain areas than on the dry lowland or highland areas. This could possibly indicate higher milk production by the ewes on the dryland compared to the mires and semi-wet areas. This is supported by the fact that the lambs on the dry highland had significantly heavier carcass weights than lambs on the semi-wet mountain range. In addition the lambs on the semi-wet mountain range produced heavier carcasses than the lambs on the mire and dry lowland (Gudmundsson & Thorgeirsson 1989).

In the experiments, it was only on the mountains and highlands that twin lambs attained acceptable carcass weight so as to be marketable directly from the pasture in the autumn. Although the highland and mountain ranges produce more lamb meat per ewe than the lowlands, the opposite is true for production per unit of land (Gudmundsson & Bement 1986).

As mentioned earlier, the benefit of grazing sheep with other animal species is relatively well established (Wright & Connolly 1995). In Icelandic experiments, lambs suckling ewes have also been shown to benefit from grazing, both with cattle and horses, (Gudmundsson & Helgadottir 1980, Thorhallsdottir & Olafsson 1999) on lowland mires. The benefit increases as the number of sheep in the mixture decreases (Gudmundsson & Helgadottir 1980). However, the growth rate of the lambs in mixed grazing does not reach the growth rate in the highlands. The horses also benefit from grazing with sheep (Gudmundsson 1985, Gudmundsson & Dyrmundsson 1994), but there is negligible benefit for growing cattle. These results are more or less in agreement with results from other countries and is most likely due to differences in plant preference and therefore diet selection of the different animal species, but could also be associated with other factors, such as reduced gastro-intestinal parasite burden (Valentine 1990).

In Iceland, it is a common practice to wean and finish the lighter lambs for slaughter in the autumn on improved pastures such as re-fertilised hayfield aftermath or spring-sown crops such as kale (Gudmundsson & Dyrmundsson 1989). Lupine, such as Lupinus angustifolius, may also be used (Gudmundsson & Runolfsson 1988) depending on its growth potential under harsh weather conditions. In general, it has been found that lambs do not gain as fast on hayfield aftermath as on green annual forage crops (Palsson & Gunnarsson 1961). This improved autumn grazing increases the carcass weight considerably but does not reduce the quality of the meat as the lambs accumulate protein and fat in similar proportions (Gudmundsson & Dyrmundsson 1989).

Economic studies have shown, however, that fertiliser application to improve production during the summer, independent of the grazing system used, is not profitable (Stefansson 1984, Arnalds 1985, Arnalds & Rittenhouse 1986). Different plants have also been studied for summer pasture production, for example Nootka lupine (Lupinus nootkatensis) (Gudmundsson & Thorsson 1994) originating in Alaska. Nootka lupine is hardy and high yielding (Magnusson et. al. 1995), but it contains bitter alkaloids and is as such unfit for grazing or feed production (Gudmundsson et al. 1994). Therefore it has been suggested that the lupine be sweetened by breeding to make it available for grazing and feed production.

**Diet selection, intake and quality**

The relationship between stocking rate and the performance of grazing sheep is well known. The relationship between quality, consistency and gastro-intestinal parasites is, however, not as clear. It is well established that the nutritive value, as well as the availability of the herbage, can often become the limiting factor. In the autumn, it is most often the quality rather than the quantity of herbage that is limiting, as the nutritive value decreases with time. In the spring, the protein and energy content of the plants are highest (Thorsteinsson & Olafsson 1969, Fernlund 1994) and coincide with the highest milk production of the ewes and the fastest growth of the lambs. As to minerals, phosphorus and potassium content are highest early in the summer while the opposite is true for calcium and magnesium (Thorsteinsson. & Olafsson 1969, Fernlund 1994). By late August, the nutritive value of the range...
plants has reached quite low levels and a corresponding decline in lamb weight gain is usually observed at this time, with a positive interaction with the stocking rate (Gudmundsson & Bement 1986). In the autumn the milk production of the ewes has declined to very low levels or terminated. Later in the autumn and early winter the dry ewes often have a tendency to lose weight. Feeding a small amount of protein supplement, such as fishmeal (Jonsson 1955), at this time is important for the future fertility and production of the ewe.

Although artificial fertilisers are not commonly used on natural pastures and rangelands in Iceland, they can be applied as a management tool to reduce grazing pressure on poor grazing lands and areas vulnerable to erosion and to improve the distribution of grazing animals (Gudmundsson 1989, Gudmundsson & Dyrmundsson 1989). Fertiliser application can also be valuable to supply enough nutritious herbage when sheep are turned out after lambing and again in the autumn for finishing lambs for slaughter, as well as for ewes and replacement lambs.

The explanation of better lamb gain per head in the mountains could be related to the nutrition of the animal or the nutritive value of the herbage. However, measured digestibility is in general similar or higher in the herbage consumed on the lowland mire than on the dry highland (Gudmundsson 1993), while the forage intake is higher on the highland (Gudmundsson 1998, Gudmundsson et al. 1998). This could be due to a higher content of soluble carbohydrate and lignin and lower cellulose and hemicellulose on the highland pastures (Gudmundsson 1993). The composition of the herbage consumed on the dry highland is therefore closer in composition to legumes than grasses, which can explain the higher intake on the highlands and the difference in growth between the highlands and the lowlands.

Studies on diet selection of sheep in Iceland have shown that the main grazing species are the same on lowland and highland pastures. Fewer than ten species are the main foraging plants, i.e. Festuca sp, Poa sp, Agrostis sp, Calamagrostis neglecta, Carex sp, Salix sp, Polygonum viviparum, Galium sp, and Equisetum sp. (Thorsteinsson 1980, Thorhallsdottir 1981, Thorhallsdottir & Thorsteinsson 1993). The proportion of these in the diet, however, has been shown to vary according to the amount available, the time of day and time of year (Thorhallsdottir 1981). Thus, free roaming sheep in Iceland have been shown to select mires during the daytime and dryer areas at night (Thorhallsdottir & Thorsteinsson 1993) and to prefer and select some species like Equisetum sp and Salix sp early in the growing season but not later on (Thorhallsdottir 1981, Thorhallsdottir & Thorsteinsson 1993). Diet selection studies from Norway and Denmark (Garmo et al. 1990, Fisker 1991) indicate a similar pattern by sheep in these countries. In a study by Thorhallsdottir (1981), plant preference was estimated by comparing demand and supply. Results from early July and late August showed high preferences for certain plant species on a mountain range in early July. In August, overall preference was down, indicating less selective grazing. Redhead & Tyler (1988) concluded that animals foraging in bad, stable environments should stay longer at each patch, i.e. be less selective. On a mountain range in Iceland in late August, after the first frost, all plants are senescent and their nutritional value is down. For grazing sheep, therefore, selective grazing is not as much of a gain as in early July when the differences between good and bad bites are much larger.

The individual differences between animals must be stressed, however. In plant selection studies in east Iceland, six sheep from the same flock with oesophageal fistulas were grazed together in five different vegetation communities (Thorhallsdottir & Thorsteinsson 1993). Although the same plant species were grazed by all the individuals, large individual differences were found in the relative amount of each plant species selected. On occasion, certain forbs, i.e. Rubus saxatilis, dominated in the diet of a single individual and were not found with others. Research has shown that diet selection is, to a large extent, a learned process with sheep (Thorhallsdottir et al. 1987, Thorhallsdottir et al. 1990abc) as well as with other animals (Garcia 1989, Provenza and Balph 1988), where the mother plays a major role (Thorhallsdottir et al. 1987, 1990a).
**Growth preventors**
Defoliation in the early spring is more detrimental than defoliation later in the season because the plants have not produced enough root and tiller biomass for good production. Early spring grazing decreases the overall production of the pasture as well as reducing the number of desirable forage species, as undesirable plants gain a competitive advantage (Archer & Arnalds 1982). A pasture should always be allowed to grow well in the spring before being grazed to secure good production throughout the season.

During the spring, grazing is generally intensive, which can cause problems such as coccidiosis. It is therefore recommended that the same pastures not be used for spring grazing for two years in a row. During extensive mountain or highland grazing, gastro-intestinal parasites in sheep are rarely a problem. The same is true for the natural lowland ranges, if they are properly managed and not overstocked. Helminthic burdens can be prevented by the use of anthelminthics but, in general, they are not used for sheep during extensive grazing. It is, however, common to treat the ewes and rams during housing in the winter. Coccidiosis can, in addition to spring grazing, cause problems during intensive summer and autumn grazing (Gudmundsson et al. 1983), but not during more extensive grazing, such as during the summer in the highlands and mountains. It can be prevented on the lowland by carefully planning the grazing during the summer, frequently moving the sheep to clean pastures.

There is experimental evidence that one of the factors contributing to the reduced growth of lambs on lowland pastures in Iceland could be a soil fungus *Paecilomyces carneus* present in the lowland mire but not found in the upland pastures (Eyjolfsdottir et al. 1988). The active substance in this fungus, Penicillin N, can considerably reduce the *in vitro* digestibility of the pasture (Eiriksson et al. 1989). Further research is needed on this subject.

**Future prospects**
In recent years, organic and ecological farming practices are gaining more interest, as the market demands healthier and more ecological sound products. Products from extensively grazed animals are therefore gaining more interest, especially as more questions are being raised about the healthiness of intensively produced products (i.e., dioxin). For extensively grazed sheep products to be classified as organic, the grazing must be sustainable, i.e., no land degradation or erosion and no input in the form of anthelminthics or artificial fertilisers. The challenge of the near future is to produce sheep products from extensively grazed animals as sustainable as possible. To accomplish this task, good knowledge about the system is required, not only the land, the plants and the animal, but also the interactions between these factors.

The most limiting factor in the process of new research on grazing is the lack of new and/or improved research methodology and techniques in the field. The old methods used have been shown not to be reliable enough; for example, *in vitro* digestibility methods based on hayfield feedingstuffs have not seemed to be reliable on natural rangelands (Jonsdottir 1994, Gudmundsson & Thorsson 1998). Similarly experimental results on natural pastures in Iceland have shown that sheep, both on dry highland and lowland mire, consume more herbage on the heavily grazed pastures and ranges than on the more lightly grazed areas (Gudmundsson & Thorsson 1998). However, the gain of the lambs is higher during light than heavy grazing, with the ewes often losing weight during heavy grazing. These contradictory results between intake and gain are difficult to explain and could be due to error in the methodology used, but could also to some extent reflect the utilisation of the herbage by the animals and the milk production of the ewes. To answer these and many other questions a more accurate comparative methodology must be developed.
References


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