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Sheep in the Land of Fire and Ice- Socio-economic aspects of sheep grazing on highland rangelands in Iceland

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Sciences



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Yfirlýsing

Hér með lýsi ég því yfir að verkefni þetta er byggt á mínum eigin athugunum, er samið af mér og að það hefur hvorki að hluta né í heild verið lagt fram áður til hærri prófgráðu.

Anja Mager

Summary

The aim of this thesis is to examine socio- economic aspects of sheep grazing on highland rangelands in Iceland in relation to sustainable land use practices by means of a literature review. Socio-economic aspects refer to the economic environment of sheep husbandry in Iceland, agricultural policies, laws and regulations on the subject, historical aspects and efforts to mitigate the environmental impacts of sheep grazing. The main findings reveal that sheep farms operate in a difficult economic environment, being highly dependent on subsidy payments. Grazing highland commons is a very cost-effective practice for sheep farmers in the short run. The legislation, regulation and implementation of sheep grazing involves several actors and a set of laws and regulations. The system is considered to be imperfect and does not lead to sustainable land management. Sheep grazing has a long tradition in Iceland although it seems likely that sheep grazing on highland rangelands was more sustainable in past times. The most important historical aspects are the sheep production systems prevailing at different times, external factors and the overexploitation of Icelandic ecosystems. In recent years, efforts have been undertaken in order to mitigate the environmental impacts of sheep grazing. The work of the Soil Conservation Service of Iceland and the Quality Management of Sheep farming agreement comprise bottom- up and top- down approaches to land management and are important steps in the right direction. However, due to several reasons, the efforts are to some extent limited in their scope and are not effective to halt sheep grazing in unsuitable areas.

Key words: sheep grazing, highland commons, socio-economic aspects, sustainable land use

Ágrip

Tilgangur þessa heimildaverkefnis er að kanna samfélagslega og hagræna þætti varðandi sauðfjárbætur á afréttum Íslands í ljósi sjálfbærar landnýtingar. Með samfélagslegum og hagrænum þáttum er átt við rekstrarumhverfi sauðfjárbúa á Íslandi og beingreiðslukerfi sauðfjárræktarinnar, reglugerðum og lögum, sögulegum þáttum og verkefnum til að milda áhrif sauðfjárbætur á íslensk vistkerfi. Rekstrarumhverfi sauðfjárbúa er óhagstætt og eru þau mjög háð opinberum stuðningi. Nýting afréttanna er hagkvæmur landnýtingarkostur til skamms tíma. Mismunandi aðilar eiga hlut í lagalegu umhverfi sauðfjárbæturkerfisins. Þetta kerfi er álitid vera gallað og leiðir ekki af sér sjálfbæra landnýtingu á sumum svæðum. Löng hefð er fyrir sauðfjárbætur á Íslandi þó að líklega hafi sauðfjárbætur á afréttum verið mun sjálfbærari í gamla daga. Mestu áhrif á sauðfjárbætur í gegnum tíðina höfðu framleiðslukerfi, ytri áhrifaávaldar og ofnýting beitolanda. Undanfarna áratugi hafa mismunandi verkefni komið til sögunnar með það að markmiði að milda áhrif ofbætur á íslenskt vistkerfi. Vinna Landgræðslunnar í þeim málum og Gæðastýring sauðfjárbætur eru ofansækin og neðansækin verkefni og eru álitin míkilvæg skref í rétta átt. Þó eru þau takmörkuð vegna mismunandi ástæðna og hafa ekki komið í veg fyrir að sauðfjárbætur sé stundað á svæðum sem þola ekki bætur.

Lykilorð: sauðfjárbætur, afréttir, samfélagslegar og hagrænar þættir, sjálfbær landnýting

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I dedicate this work to my grandparents, Oma und Opa in Schmolde. Thank you for showing me the beautiful life in the country.

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1. Introduction

In Iceland, extensive sheep grazing on highland commons is an important land use practice just as in the whole Nordic region. This practice is the only way to use this type of land for agricultural production (Guðmundsson & Þórhallsdóttir, 1999; Ross et al., 2016). However, sheep grazing has been associated with extensive environmental degradation (Arnalds, 1987; Arnalds & Barkarson, 2003; Guðmundsson & Þórhallsdóttir, 1999; Marteinsdottir, Barrio & Jónsdottir, 2017a). Land degradation and soil erosion have been and still are serious environmental problems in Iceland (Arnalds, 1987; Greipsson, 2012), with approximately two-thirds of the country showing some degree of erosion (Arnalds et al., 2001; Arnalds, 2011).

During the last decades, the claim for sustainability and sustainable land management practices in Iceland has been rising (Arnalds et al., 2001; Dýrmundsson, 2002; Guðmundsson & Þórhallsdóttir, 1999; Ross et al., 2016). Sustainable land management practices are defined as “the adoption of land use systems that, through appropriate management practices, enables land users to maximise the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources” (Liniger, Mekdaschi Studer, Hauert & Gurtner, 2011, p. 19). Thus, sustainable land management not only includes ecological aspects such as ecosystem services, biodiversity, plant biomass or soil stability. Rather, sustainable land management also comprises social and economic aspects, since all three aspects are interconnected (Austrheim et al., 2008; Liniger et al., 2011; Ross et al., 2016). Since ecological aspects of sheep grazing on highland rangelands in Iceland have been reviewed recently (Barrio et al., 2018; Marteinsdottir et al., 2017a), the aim of this thesis is to examine socio-economic aspects of sheep grazing on highland commons in Iceland.

Socio-economic aspects refer to all social and economic activities that are undertaken by humans. But how does this apply to sheep grazing?

Socially, sustainable land management refers to laws and regulations implemented by official institutions as well as efforts to deal with the environmental impacts of sheep grazing (Austrheim et al., 2008).

Economically, sustainable land management aims at supporting rural livelihood and ensuring sustainable food production (Liniger et al., 2011). Costs and benefits play a central role in the context of sustainable land management (Liniger et al., 2011). Farmers have been found to be strongly influenced by their economic environment and economic incentives when it comes to

soil erosion and conservation (Boardman, Poesen & Evans, 2003). Land use policies have by far the strongest influence on farmers, either through constraints or, more commonly, through economic signals such as subsidies, guaranteed prices or protectionism. Emphasis should be put on taking a more holistic approach in understanding the underlying reasons to land degradation than only physical ones and deal with the question of why land managers act the way they do (Boardman et al., 2003). Thus, economic aspects of sheep grazing deal with the economic environment of sheep farming and economic incentives such as subsidies.

This thesis will deal with the economic environment of sheep farming, as well as land use patterns and policies in Iceland. First, the economic environment of sheep grazing will be considered by presenting the general business environment of sheep husbandry, its dependence on subsidy payments and the costs and incomes of land use in the Highlands. Secondly, sheep grazing patterns from past times until today will be described as well as the current sheep grazing system with the underlying laws and policies. Furthermore, efforts undertaken to deal with the environmental impacts of sheep grazing will be considered. Where possible, emphasis will be put on a holistic approach by taking into account opinions and different point of views of involved actors.

The thesis' aim is to answer the following research questions:

- What are the main socio- economic aspects driving the current grazing system of sheep farming in Iceland in the context of: a) economy and policies; b) laws and regulations; c) history?
- How do these main socio-economic aspects impact the practice of sheep grazing on common rangelands?

2. Methods

The research questions are addressed by means of a literature review and a review of other secondary information sources such as law and regulation codes and other information that is not accessible by searching in public and academic databases.

The literature search was performed in January 2018 using national and international databases. National databases included public databases (leitir.is, timarit.is), specialized databases (landbunadur.is) and repositories of academic theses (skemman.is); international databases included Web of Science. Search terms included sheep, grazing, rangeland, Iceland, sauðfé, beit and úthagi and revealed a total of 365 documents (**Table 1**). The documents were then revised for relevance to socio-economic, ecological and historical aspects of sheep grazing on highland commons, and the documents dealing with these topics were labeled as potentially relevant. Other documents retrieved in the database were deemed not relevant due to different reasons:

- not within Icelandic context
- grazing of other livestock (horses, cattle)
- ewe or lamb performance and behavior, sheep diseases
- opinion pieces

Additional literature was obtained by searching within the original literature and experts' advice.

Table 1: Overview of literature search in different databases, using search terms in English and Icelandic. The total number of documents, including those potentially relevant and those deemed not relevant to the review topic are shown. Asterisks in the terms included in the search in Web of Science allow for terms with the same root to be included (e.g. Iceland and Icelandic)

Database	Search term	Total number of Papers	Potentially relevant	Not relevant
1. landbunadur.is	Sheep grazing rangeland	16	5	11
	sauðfé beit	134	32	102
	sheep grazing	57	15	42
2. Web of Science	Iceland* grazing sheep	17	8	9
3. leitir.is	Sauðfé beit	38	12	26
	sheep grazing	22	6	21
4. skemman.is	sheep grazing	8	4	4
5. timarit.is	sauðfé beit úthagi	73	5	68

3. The economic environment of the sheep grazing system in Iceland

Sheep farming has been through serious economic difficulties and this situation has been dominating for several decades (Bjarnadóttir, Sveinsson & Þorgeirsson, 2004). The economic relevance of sheep farming in Iceland has declined significantly in recent years (Ross et al., 2016), from being a vital part of subsistence agriculture to a subsidized agricultural system with limited importance on the national scale (Austrheim et al., 2008). Reasons are to be found in decreasing per capita consumption of sheep meat and the suspension of export compensation around 1990 (Bjarnadóttir et al., 2004). By the beginning of the 21th century, it was considered unlikely that markets for Icelandic sheep products would grow or the performance of sheep farms in Iceland improve (Maronsson, 2002).

Sheep meat consumption has traditionally been high in Iceland, but it has declined gradually over the past decades as poultry and pork became more important. Meat consumption per capita nowadays (2015) is half of what it used to be in the early 1980s (*Figure 1A*). At the same time, the total production of sheep meat has not declined at the same rate (*Figure 1B*). After 1985 with the implementation of a livestock quota system, sheep numbers dropped significantly and so did the production of mutton. However, meat production has been rising again since the beginning of the 21th century due to the effect of perverse subsidies (Crofts, 2011). Perverse subsidies refer to governmental payments that do not take into account impacts on the environment and therefore imply long term hidden costs to society in the form of environmental degradation (Boardman et al., 2003). Furthermore, the increase in sheep meat production has been facilitated by progress in breeding programmes that have increased fertility and carcass quality (Bragason, 2013a; Thorsteinsson, Olafsson & Vandyne, 1971; Thorsteinsson, 2002; Örnólfsson, Jónmundsson, Þorgeirsson & Eythórsdóttir, 2007). Simultaneously, sale rates at the domestic market have declined (*Figure 1B*), following the decrease in national sheep meat consumption. The production surplus has to some extent been exported but the prices in foreign markets are generally lower than in the domestic market, which led to a decline in the price of sheep meat in 2016 (Bjarnason & Jónsdóttir, 2019).

Although the general importance of sheep farming is declining, the importance at a local scale is still high (Austrheim et al., 2008). Sheep husbandry is important for the rural society especially in remote areas where fewer employment possibilities exist (Karlsson, Heiðarsson,

Jóhannesson & Þórsteinsdóttir, 2015). This leads to the question of how sheep farms perform economically.

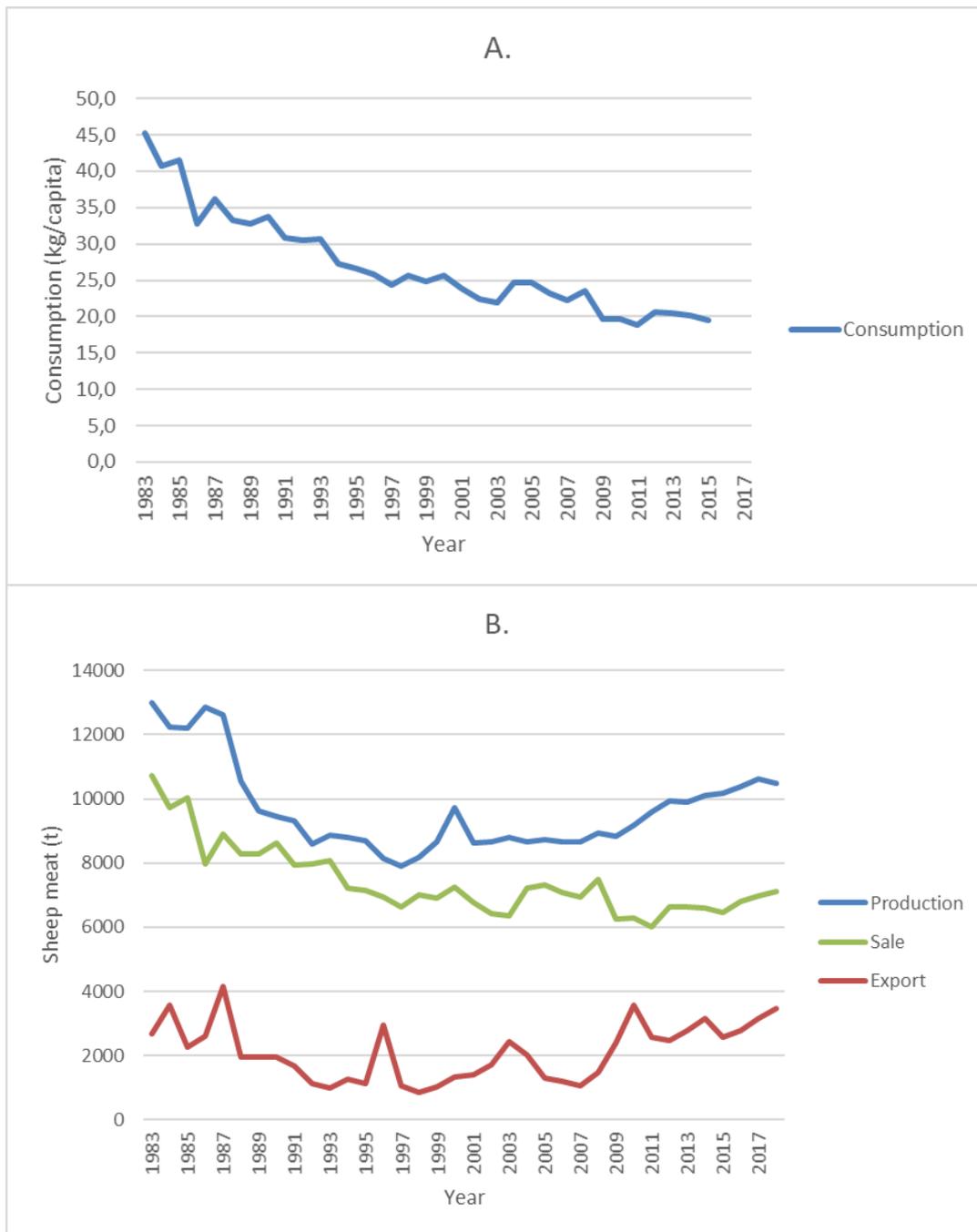


Figure 1: (A) Sheep meat consumption per capita in Iceland (Hagstofa, 2019a) and (B) sheep meat production (blue line), sale at the domestic market (green line) and export (red line) in Iceland, 1983- 2015 (Hagstofa, 2019b)

An overview of the performance of sheep farms in Iceland between 1994 and 1998 revealed that costs, debts and interest burden had increased over the four year period and the farms delivered less operation surplus (Maronsson, 2002). Between 2014-2017, the Icelandic Agricultural Advisory Center (RML) has collected information on sheep farm performance,

concentrating on large farms with more than 400 sheep. The data show clearly how the decline in lamb meat prices, about 35% for the four year period, affects the economic performance of sheep farms negatively (Bjarnason & Jónsdóttir, 2019).

In 2004, there were more than 2200 sheep farms in Iceland, ranging from small farms with less than 100 winterfed ewes, where sheep farming is a secondary occupation to specialized large farms with more than 1000 winterfed ewes (Bjarnadóttir et al., 2004). Few sheep farmers receive full income from sheep farming, and most must work outside the farm. In fact, a minority of farmers solely receive their income from agriculture. Commonly it is the women who gain income outside the farm while men work to a larger extent on the farm (Júlíusdóttir, Karlsdóttir, Benediktsson, Vésteinsdóttir & Steingrímsson, 2009). In 2014, a study counted approximately 2000 sheep farms that culled lambs in registered slaughterhouses (Heiðarsson & Jóhannesson, 2015).

The trend thus goes towards larger but fewer farms (Bjarnadóttir et al., 2004) as sheep numbers have not decreased significantly (*Figure 3*).

3.1. Grazing highland commons: costs and earnings

To this day, the main part of sheep farm revenue derives from livestock grazing on common or private rangelands. Most of the farm income emerges from summer grazing in mountain or highland areas (Arnalds, 1986; Maronsson, 2002). Grazing highland pastures is a cost-effective practice in the short run because lambs gain weight quickly and sheep do not require attention during the summer months since they roam freely (Dýrmundsson, 1981; Arnalds, 1986).

Direct costs of highland grazing incur due to fences, night shelters and pathway construction for sheep gathering activities. As well, sheep farmers also have to finance the transport of the animals from their home to the commons and back again (Barkarson, 2003).

Other costs include a traditional fee, *fjallskil*, that is to be paid to district authorities either monetarily or by contribution of work. Article 42 of law nr. 6/1986 (*Table 2*) provides a major rule for this practice, claiming that the overall costs are to be divided between livestock owners according to the number of their animals (Barkarson, 2003). Nevertheless, in some cases the costs are divided according to land size or fringe benefits which raises legitimation questions since fewer and fewer landowners keep sheep- why pay for access to grazing land that you are not using? The payment of this traditional fee might also lead to self- termination of highland

commons usage because fewer farmers have to bear higher costs (Barkarson, 2003). For example, sheep gathering in autumn is an activity that requires considerable manpower and is crucially dependent on cooperation (Bragason, 2013b). As fewer and fewer farmers make a living on sheep husbandry, this lifestyle becomes as well less attractive for younger people who are in need of public services and access to education (Karlsson et al., 2015; Maronsson, 2002).

3.2. Subsidies

Subsidies are all direct payments from the government related to sheep farming. In addition to payments per animal this includes export subsidies, subsidies for wool and surplus storage payments (Arnalds & Barkarson, 2003).

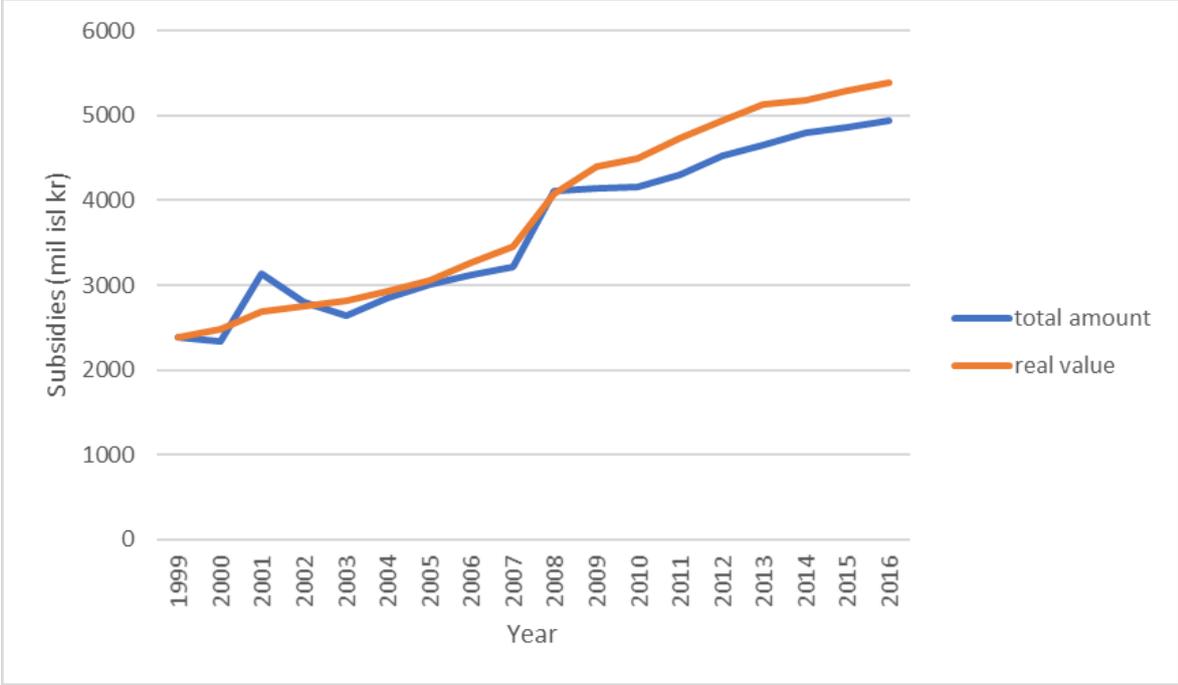
Sheep farming in Iceland is highly dependent on subsidy payments where subsidies represent about half the income of sheep production (Arnalds & Barkarson, 2003). Recent data from sheep farms with more than 400 ewes highlights that farms with fewer sheep and quota ratio perform substantially better than farms which have more sheep than quota (Bjarnason & Jónsdóttir, 2019).

In Iceland, government support for agricultural production has a relatively long history and whether and how the state should support agriculture has been repeatedly disputed (Bjarnadóttir & Sveinbjörnsson, 2002). The foundation for the current subsidy system can be traced to 1934, when the Act on Slaughtered Livestock was passed and to 1947, when farmers were ensured public support to maintain income at a rate comparable to similar occupations (*Table 2*) (Stefánsson, 2018). Initially, official support was entirely paid as production linked subsidies. This practice was criticized for leading to out of control overproduction.

If calculated as ISK per capita for each year, the subsidy payments show a rapid increase between 1955 and 1980 and a decrease since then. When sheep numbers were highest in the 1980s, production was maintained by export subsidies with average subsidies around 4127 mil ISK/year (Arnalds & Barkarson, 2003). In the nineties, a production quota system was implemented which had subsequently to be cut back because of overproduction (Bjarnadóttir & Sveinbjörnsson, 2002). In 2000, the overall amount of subsidies for sheep production was about 2340 mil ISK/year (Arnalds & Barkarson, 2003) and ranked at this point amongst the highest of the OECD countries. Since 1999, the total amount of subsidy payments has more than doubled (*Figure 2*). However, adjusted to price development, the real value of the total

amount is similar during the 17- year period. Although sheep farmers received higher payments, they could not buy more goods for the amount.

Figure 2: Sheep subsidy payments in Iceland 1999-2016. The blue line shows the total amount of monetary payments. The red line shows the real value adjusted to price development since 1999 (Ríkisreikningur, 2019; Hagstofa, 2019c).



Today, agricultural policies for subsidy payments in Iceland are set up as renewable multi-year agreements between state authorities and the Farmers Association of Iceland. These policies provide general support for farmers as well as production control by means of livestock quota. The latest agreement on sheep production was reached in 2016. It has been revised and amended due to severe economic problems in the sector.

Besides direct subsidy payments, sheep farmers receive market price support through border control measures like for example import duties (OECD, 2014). Moreover, farmers receive payments by participating in the Quality Management (section 6.2.).

4. Sheep grazing system and highland grazing patterns

4.1. Historical overview

Sheep grazing is a traditional and important agricultural practice in Iceland (Arnalds & Barkarson, 2003; Olafsdottir & Juliusson, 2000). The history of sheep grazing in Iceland is characterized by differing agricultural production systems, by which sheep products were the

most important at each time and by external factors such as sheep diseases and natural catastrophes.

The first settlers brought with them livestock and introduced them to the Icelandic ecosystems that had developed without the influence of large herbivores (Arnalds, 1987; Barrio et al., 2018). Thus, the vegetation lacked defense mechanisms for herbivory and was dominated by grazing-sensitive species (Þórhallsdóttir, Júlíusson & Ögmundardóttir, 2013). In addition, the settlement of the country was accompanied by extensive cutting of natural woodlands for building material, charcoal making, iron production and livestock grazing (Kristinsson, 1995; Crofts, 2011).

In the first centuries of Icelandic history, wool was the most important product of the sheep and wool cloth was the main currency in Icelandic foreign trade (Austrheim et al., 2008). During this period, the main aim for sheep husbandry was to maximize wool quantity and quality, calling for sheep to be kept outside of forests to prevent damage to wool (Austrheim et al., 2008). In the early 14th century, the importance of wool as an export product declined, leading to a change in farming practices in Iceland, with decreasing sheep numbers and declining grazing pressure (Austrheim et al., 2008). During the 14th to the 17th century, a period of severe economic decline, climate cooling and diseases, Icelandic farmers increasingly replaced cattle with sheep as milk suppliers since sheep imply lower maintenance costs (Þórhallsdóttir et al., 2013). Lactating ewes had to be kept under daily supervision for the milking period from the end of June to October. Thus only a small proportion of sheep, wethers and weaned lambs were roaming freely on common grazing lands (Austrheim et al., 2008). Up to this point, the agricultural production system can be defined as subsistence production (Þórláksdóttir, 2015).

A characteristic feature of this production system was the use of outdoor winter grazing since winter fodder production was very limited and usually only cattle got supplementary hay during winter times. Through harsh winters, this would lead to collapse of some flocks especially in the cold 18th century (Austrheim et al., 2008). It has therefore been argued that throughout the ages, winter grazing determined the grazing pressure of Icelandic rangelands (Þórhallsdóttir et al., 2013). Winter grazing has also been linked to severe environmental degradation close to farms because of its severe impacts on plant survival (Simpson, Guðmundsson, Thomson & Cluett, 2004).

The beginning of the 19th century brought about a change in farming practices: industrialization and a growing demand for food in emerging cities in Britain led to an increase in the export of live sheep, mainly wethers (Þórhallsdóttir et al., 2013). Subsequently, the importance of lamb meat production rose, and lambs were now roaming free with their mothers during the summertime, calling for good grazing lands. By 1920, hardly any farms kept sheep for milking but drove them to highland pastures (Austrheim et al., 2008). After the World War II, with technical progress, mechanization and improved knowledge, hay making became easier and more efficient (Karlsson et al., 2015). The practice of winter grazing was abandoned and sheep were kept indoors during the winter time (Þórhallsdóttir et al., 2013). Consequently, grazing pressure on highland pastures increased considerably (Barrio et al., 2018).

4.2. Historical highland grazing patterns

Livestock grazing has been regulated in Iceland throughout the ages. From the early days of settlement, the law codes Grágás from the mid- 13th century and Jónsbók from 1281 established regulations for access and usage of common rangelands in regard to which livestock was allowed to graze and when (Barkarson, 2003). Land ownership developed differently in Iceland: in northern Iceland, mountain and highland pastures remained private property belonging to individuals or later on, to the church (Simpson, Dugmore, Thomson & Vesteinsson, 2001). In the South, common grazing areas evolved known as *afréttir*. Communes (*hreppur*) were the basic administrative units and have been existing since at least 1097 (Eggertsson, 1992). The commune was an association of several farms and had amongst others the right to organize the common grazing resource. The risk of overexploitation was already addressed in the earliest law texts. To avoid overgrazing, access to common grazing lands was limited to members of the community and the maximum number of livestock roaming on the grazing lands had to be agreed on by the commune. The overall rule was that no more sheep were grazed on common land that adding more sheep would affect the average weight of the flock (Simpson et al., 2001). Each user of the common was given a quota for livestock grazing and the regulations prescribed heavy fines for farmers that did not comply (Eggertsson, 1992). The provision of the old law books were, with some changes, effective in Iceland until 1965, when the act on Land Reclamation was passed (see **Table 2**) (Þórhallsdóttir et al., 2013). Sheep grazing practices implemented by the old law texts are thought to be so persistent because it was the best practical solution for effective resource management (Eggertsson, 1992).

4.3. Sheep numbers

The fluctuations in sheep numbers can be used to delineate historical aspects of sheep grazing, at least since the early 17th century (**Figure 3**). In earlier times, there is no reliable data available but there are estimates that before 1400, sheep numbers were larger than in the 18th century and more comparable to numbers of the 19th century (Austrheim et al., 2008).

The number of ewes (red line in **Figure 3**), although incomplete due to lack of data, clearly shows the shift of production emphasis since the middle of the 19th century: Lactating ewes made only about 50% of sheep flocks, and wethers for wool production about 20%. In the 20th century, herd composition changed with ewes roaming freely in summer with their lambs being by far the largest part of all sheep flocks in Iceland (Þórhallsdóttir et al., 2013).

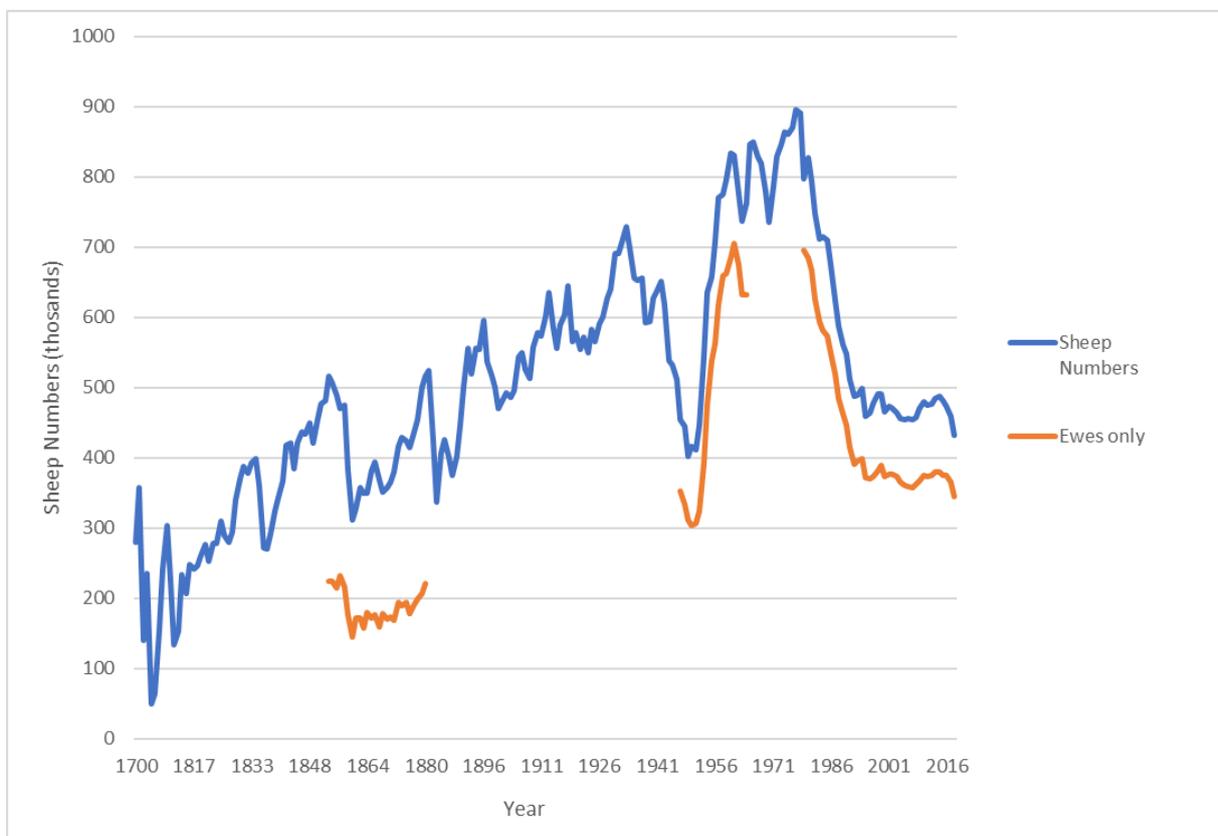


Figure 3: Sheep numbers in Iceland between 1700 and 2016, indicating total sheep numbers (blue line) and number of ewes (red line) (Hagstofa 2019d, Austrheim et al. 2008))

Sheep numbers steadily increased since the early 18th century (blue line, **Figure 3**). However, sheep numbers have dropped repeatedly and drastically at several points throughout history due to different reasons (Austrheim et al., 2008):

- In 1770 English sheep were introduced to Iceland for breeding purposes carrying with them sheep scab (*fjárkláðinn fyrri*). Death and systematic culling to prevent disease spreading reduced sheep numbers to 140.000 heads.

- After 1783, the eruption of Laki in South Iceland had catastrophic effects, reducing sheep numbers below 50.000. This is considered to be the historical minimum (*móðuharðindi*).
- 1855 the second sheep scab epidemic evolved after the import of English breeding rams (*fjárkláðinn síðari*). The 19th century was as well characterized by harsh climatic conditions.
- In 1933, German sheep were imported carrying with them diseases that the Icelandic sheep were highly susceptible to: maedi-visna virus, (*mæðiveiki*) and paratuberculosis, (*garnaveiki*). In an attempt to prevent further spreading of the diseases, the country was divided into sections by means of fences and natural borders which are still in use today.
- After 1950, sheep numbers grew again rapidly. A historical maximum was reached in 1977 with 896,000 sheep.
- In 1985, a livestock quota was introduced in response to overproduction (Austrheim et al., 2008, Crofts, 2011).

Since then, sheep numbers have declined significantly and have ranged between 480,000 and 430,000 sheep in the last few years (*Figure 3*).

4.4. Sheep numbers on highland pastures

Today, the grazing pressure on highland pastures is quite different from what it has been throughout the ages (Pórhallsdóttir et al., 2013). Nevertheless, the highest grazing pressure was reached only some decades ago from 1960 to 1980, when estimated 200.000 sheep and 3500 horses were grazed at highland commons (Barkarson, 2003). During those years, Icelandic highland rangelands suffered severe ecological damage (Barkarson, 2003; Pétursson, Guðleifsson & Valsdóttir, 2013).

In response to the livestock quota implementation in 1985, sheep numbers on highland ranges decreased (Maronsson, 2002), but these declines varied across different regions. In the years 1990- 2000, sheep numbers decreased about 16%, i.e. 24% in the Norðurland eystra district of North eastern Iceland but only 3% at the Norður- Þingeyjarsýsla district, while sheep numbers increased in the East of the country by about 16% (Maronsson, 2002).

In 2003, a study estimated that roughly 70 thousand sheep and 1300 horses were grazing 25 highland commons (Barkarson, 2003), calculating an average grazing pressure of 0.11 ewes/ ha. However, these numbers were probably underestimates because many farmers keep more

sheep than they have production quota entitlements for or even they have no quota at all. Still, by living in a certain district they have the right to graze commons (Eggertsson, 1992).

4.5. Current management and grazing systems

Since the abandoning of winter grazing, sheep have been kept indoors during winter time, being fed hay and other foodstuff (Guðmundsson, 2001). Lambs are usually born indoors during May and released with their mothers after a few days to cultivated pastures near the farms. In most years, these infield pastures have already started growing offering high-quality grazing. Nevertheless, supplementary food is usually offered at this time. When the uncultivated rangelands start growing, farmers with private land begin to release their sheep to their own rangelands. Farmers with access to highland common pastures, however, keep their sheep near the farms until late June, when sheep are rounded up and driven to the commons. The rangeland grazing season usually ends early to mid September when the sheep are rounded up (*réttir*). Lambs are chosen for culling or grazed on cultivated fields for fattening. Adult sheep are grazed on fields or lowland areas until the end of October when they are housed again (Austrheim et al., 2008; Ross et al., 2016).

5. Laws and regulations of sheep grazing in Iceland

From the establishment of Jónsbók, no significant changes to sheep grazing regulations were made until Icelanders partially regained independence from the Danish Crown in the late 19th century. The legal grounds for grazing management in Iceland are founded in the Act on Rangelands nr. 6/1986 and the Act on Livestock Handling nr. 38/2013. The issue is addressed in several other acts of law but usually not further specified (*Table 2*).

The legislation, regulation and implementation of sheep grazing in Iceland involves several actors (*Figure 4*). Laws and regulations on livestock grazing and land use issues are today in the hands of two ministries, the Ministry of the Environment and Natural Resources and the Ministry of Industries and Innovation (*Figure 4*). These ministries form the legislative level. In addition, municipal authorities regulate the land use of highland commons as described below. The administrative responsibility for implementing and surveilling laws and regulations is held by the Food and Veterinary Authority of Iceland. The Food and Veterinary Authority is responsible of subsidy payments to farmers. Issues related to land use are held by the Soil Conservation Service of Iceland (Þórláksdóttir, 2015). The Soil Conservation Service is

engaged in multiple tasks related to assessment, research, surveillance, advice and financing (section 6.1.).

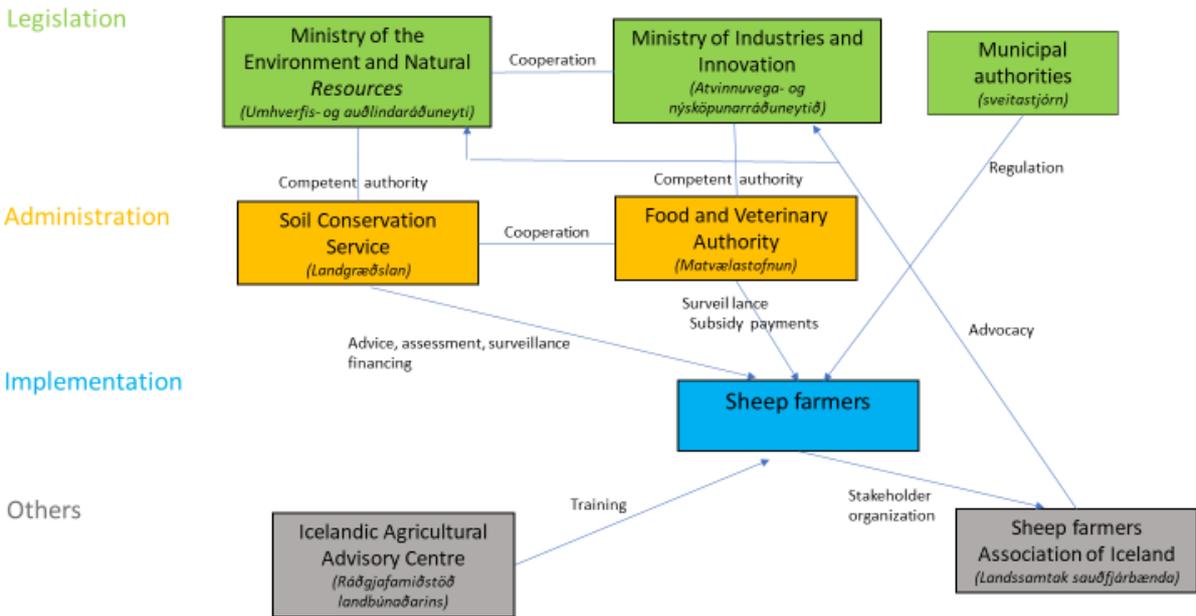


Figure 4: Map of actors involved in the Icelandic Sheep farming regime, adapted from Þórláksdóttir, 2015

A further institution involved is the Icelandic Agricultural Advisory Centre that runs an introductory course for farmers applying for participation in the Quality Management program. Sheep farmers form the implementation level. Their stakeholder organization, the Sheep Farmers Association, is involved in the development of new laws and regulations.

The Act on Rangelands (nr. 6/1986) regulates the use of common grazing lands stating that grazing rights belong exclusively to livestock owners. Decisions on the grazing period and stocking density are in the hands of municipal authorities and district councils (Barkarson, 2003). Thus, this regime allows for self-organization on the local scale, meaning that political actors can adjust the legal frame according to the local conditions (Stefánsson, 2018). Furthermore, the Act on Rangelands states that there are no limits on stocking density of grazing commons unless complaints or formal comments from the Soil Conservation Service have been made. Recently, a new law on Land Reclamation, nr. 155/2018 extends the Soil Conservation Service’s rights to intervene in cases of unsustainable land use. Land owners and the district authorities are then obliged to work out restoration plans that might as well imply a ban of livestock grazing. Furthermore, the Soil Conservation Service is now able to impose fines on land owners for not complying its decisions.

The Act on Livestock Handling nr. 38/2013 states that commonly, free range grazing of smaller livestock is allowed outside urban areas. District authorities though have the right to apply a grazing quota (*ítala*) for either specific areas or the whole municipality. Further, livestock owners are not responsible if their livestock trespasses other people's property.

Table 2. A summary of legal acts and their amendments concerning sheep grazing in Iceland. Adapted from Aradottir, Petursdottir, Halldorsson, Svavarsdottir & Arnalds, 2013; Stefánsson, 2018 and Þórláksdóttir, 2015.

A summary of legal acts			
Nr/Year	Title/Description	Icelandic Title	Effects
1914	Act on Land Reclamation	<i>Lög um landgræðslu</i>	Legal right to fence off erosion areas in order to protect them from grazing
1923	Sand Reclamation Act	<i>Lög um sandgræðslu</i>	Land with active erosion could be expropriated if owners could or would not share costs of land reclamation
1934	Act on Slaughtered Livestock	<i>Afurðasöluölög</i>	Basis of current subsidy payment system
94/1947	Act on Production Council in Agriculture	<i>Lög um framleiðsluráð landbúnaðarins, verðskráningu, verðmiðlun og sölu á landbúnaðarvörum o.fl.</i>	Farmers are ensured comparable wages to similar professions through public funding and production increase
17/1965	Act on Land Reclamation	<i>Lög um landgræðslu</i>	Emphasis on sustainable land use, protection of soils and vegetation.
1974	Resolution by Parliament regarding land reclamation and land conservation		Substantial increase in funds for vegetation restoration, and soil conservation leading i.a. to more research and growing number of professionals in the field
46/1985	Act on Agricultural Production, Pricing and Sale	<i>Lög um framleiðslu, verðlagningu og sölu á búvörum</i>	Delegated responsibility to Minister of Agriculture, implementation of Agricultural Products Contracts (<i>búvörusamningar</i>)
6/1986	Act on Rangelands	<i>Lög um afréttamálefni, fjallskil o.fl.</i>	Decision on common grazing in the hands of district authorities
99/1993	Act on Agricultural Products	<i>Búvörulög</i>	Restrictions of herd size in cases of land degradation due to grazing
70/1998	Farming Act	<i>Búnaðarlög</i>	Land improvement should promote sustainable land use and take into account international commitments regarding conservation of biodiversity
57/1999	Act on Agricultural Education	<i>Lög um búnaðarfræðslu</i>	Agricultural schools play an important role in providing education in protection and restoration
2000	Changes of Act on Agricultural Production		Quality Management: Enables subsidies for sheep products, based on rangeland condition. Revegetation plans can be part of cross-compliance for achieving governmental support
80-81/2004	Acts on the Rights and Obligations of Landowners and Landusers	<i>Ábúðarlög og Jarðalög</i>	Agricultural activities should not have negative effects on land conditions
38/2013	Act on Livestock Handling	<i>Lög um búfjárhald</i>	Free range grazing and grazing quotas
155/2018	Act on Land Reclamation	<i>Lög um landgræðslu</i>	Extended rights for the SCSI to restrict land degradation and implement restoration efforts

The existing laws and regulations in regard to sheep grazing on common rangelands are considered to be imperfect and do not always lead to sustainable land management (Barkarson, 2003; Stefánsson, 2018). Furthermore, the knowledge on the Icelandic grazing resource seems insufficient (Marteinsdottir et al., 2017a). A case study in North East Iceland suggested that the

underlying communication problem between different interest groups is inherent in the system (Þórláksdóttir, 2015). The problem is based on different perceptions and definitions of aspects related to sheep grazing.

There is severe dissatisfaction amongst actors in the governance system related to sheep grazing regarding the legal framework, which spills over to the discussion on the Quality Management (section 6.2.3). The regime is considered to be highly deficient and is in need of a holistic revision (Stefánsson, 2018), especially with regard to sustainable land management (Pétursson et al., 2013).

6. Mitigating the impacts of sheep grazing

In the Icelandic context, it is acknowledged that sheep grazing on ecologically damaged ecosystems can have severe negative impact on vegetation succession and accelerate further ecosystem degradation (Thorsteinsson et al., 1971; Arnalds et al., 2001). The following section provides an overview of the activities of the Soil Conservation Service, that is involved in many of the sheep-related regulations (see *Figure 4*). Furthermore, the Quality Management of sheep production and related initiatives will be discussed.

6.1. The Soil Conservation Service of Iceland

Icelandic ecosystems had become severely degraded at the end of the 19th century with a high rate of desertification and vast areas becoming denuded (Arnalds, 1987; Arnalds et al., 2001). Erosion and sand dunes severely threatened rural communities and many farms were abandoned. Soil erosion became a national concern. As well, the extent of native birch woodland reached its historical minimum of 1% at this time (Arnalds, 2005). In response to this challenge, a legislation was passed in 1907, the Act on Forestry and Mitigation of Soil Erosion. This law laid the foundation for two public institutions: the Soil Conservation Service of Iceland (formerly the Sand Reclamation Service) and the Icelandic Forestry Service.

During its first decades, efforts were devoted to the urgent task of halting sand encroachment and other forms of desertification (Arnalds, 2005). This was mainly done by fencing off eroded areas to exclude grazing and by sowing agronomic or native grass species such as *Elymus arenarius*, *Festuca rubra* and *Poa pratensis* (Runolfsson, 1987). Forestry efforts focused on preserving the remaining birch woodland. The emphasis shifted around 1930 when planting of exotic conifers started and was encouraged until the 1980s (Runolfsson, 1987, Crofts, 2011).

By the late 1950s, the movement and spread of the worst sand drifts had been halted and accordingly, attention shifted to other conservation tasks like halting extensive soil erosion and restoring degraded vegetation (Runolfsson, 1987). The conservation work was reinforced by greater availability of fertilizers and improved technical equipment. In the following decades, the main thrust of reclamation was the seeding of grasses and fertilizing sites with the help of small airplanes. Another approach, which had obvious impacts on wide areas, was the seeding of non-native species, most notably the Alaska lupine, *Lupinus nootkatensis* (Runolfsson, 1987). Today, the Alaska lupine is considered an invasive species (Magnússon, 2010).

A further shift in emphasis took place in the late 1960s and early 1970s when it became clear that most the conservation programs were not as effective in attaining their goals as they were supposed to be (Aradottir, Petursdottir, Halldorsson, Svavarsdottir & Arnalds, 2013; Arnalds, 2005). Project planning and implementation was solely undertaken by Soil Conservation staff; a typical top- down approach in land care. This led landowners and land users to consider ecosystem improvements as a public problem rather than their own. However, the task of improving ecosystem condition needed more active participation of locals (Aradottir et al., 2013; Baldvinsdóttir & Jónsdóttir, 2000). On a larger scale, the public became more aware of nature conservation issues. Moral values such as “*repaying the debt to the land*” emerged and led to more awareness of and interest in restoration activities (Aradottir et al., 2013). In 1974, a resolution was passed by Parliament commemorating 1100 years of settlement in Iceland which substantially increased funding for vegetation reclamation and soil conservation (**Table 2**). Subsequently, restoration programs evolved which focused more on local stakeholders’ participation.

6.1.1. Farmers Heal the Land

In 1990, the Farmers Heal the Land program was launched. It is a state funded and cost- shared voluntary program between the Soil Conservation Service and sheep farmers that applies participatory bottom- up approaches with the aim of restoring damaged grazing lands in the lowlands. About one quarter of all sheep farmers participate in the program (Baldvinsdóttir & Jónsdóttir, 2000; Berglund, Hallgren & Aradottir, 2013). The Soil Conservation Service offers advice, evaluates outcomes and supports the farmer’s expenses for fertilizers and seeds. The farmers carry out the restoration work by purchasing and dispersing artificial fertilizer, contributing machinery and knowledge. Although the Farmers Heal the Land program does not

include highland commons, it was seen as a tool to reduce usage of the commons with increasing usage of private land in the lowlands (Baldvinsdóttir & Jónsdóttir, 2000). The main objectives of the program were (Berglund et al., 2013):

- to enhance trust and cooperation between different stakeholders
- to encourage restoration of degraded lowland areas
- to raise awareness of the importance of proper grazing management
- to implement behavioral changes towards sustainable land use practices.

Recent evaluations of Farmers Heal the Land have shown that the program has fulfilled these objectives only to some extent. The program has increased awareness and facilitated restoration activities on extensive areas and has also strengthened communication and trust between stakeholders (Berglund et al., 2013; Petursdottir, Aradottir, Baker, Halldorsson & Sonneveld, 2017). However, it became clear that attitudinal and behavioral changes only reached a limited scope. Farmers participate in the program due to agronomic rather than ecological reasons, meaning that they participate in land restoration with the aim of improving their own grazing resources and thereby economic gains (Petursdottir et al., 2017).

6.1.2. GróLind

More recently, further efforts are being implemented to increase knowledge on the grazing resource and sustainable land use practices. The GróLind project was initiated in 2017 by initiation of the Sheep Farmers Association and the Soil Conservation service (SCSI, 2019). The program is financed by the agreement on sheep production between the government and the Sheep Farmers Association. The purpose of GróLind is to assess vegetation and soil resources and to develop systematic indicators of sustainable land use (Marteinsdóttir et al., 2017b). By integrating different methodologies, from detailed on-site measurement to the use of drone and satellite images GróLind aims at providing both large- scale and on- site ecosystem analysis. An ongoing project within GróLind is the assessment of sheep's grazing behavior throughout summer by using GPS tracking devices on different sites in Iceland (SCSI, 2019). By connecting the results of land resource assessment by GróLind with e-government monitoring strategies of the Food and Veterinary authority, hopes are raised that this will lead to increased effectiveness and efficiency of the Quality Management monitoring process (Stefánsson, 2018).

6.2. The Quality Management of sheep farming

In 2000, a new agreement on sheep production was signed by Icelandic state authorities and the Sheep Farmers Association (section 3.4.). The Quality Management of Sheep Farming treaty was regarded as a milestone for sustainable land use since it outlined for the first time that the main paradigms for land use are to be nature conservation and sustainable land use patterns (Arnalds & Barkarson, 2003). The main goals of this new agreement were (Arnalds & Barkarson, 2003):

- To improve the quality of sheep production
- To improve the image of sheep farming as eco- friendly
- To increase cooperation between different stakeholders, see *Figure 4*.

The Quality Management agreement is a cross- compliance regime linking financial support to a set of requirements (Stefánsson, 2018) and was initially signed for seven years but continues today (Karlsson et al., 2015). The Quality Management is based on voluntary participation and farmers have to apply for membership. Farmers' participation levels have been high since the implementation: in 2013, about 90% of Icelandic sheep production was within the Quality Management, carried out by approximately 70% of sheep famers (Þórláksdóttir, 2015; Karlsson et al., 2015).

The Quality Management promised gradual increase up to 22,5% in support for farmers who fulfill certain quality criteria (Arnalds & Barkarson, 2003). These criteria encompass a comprehensive set of rules to secure good and sustainable farming practices: accurate documentation of farming practices and animal treatment, controlled use of chemicals and medicine, participation in the national breeding program and sustainable land use (Arnalds & Barkarson, 2003). Within the Quality Management agreement, three main principles were formulated, defining which criteria sheep farmers would have to meet in order to label their land use as sustainable (Arnalds & Barkarson, 2003):

- For each farm an upper limit was set to the total number of hectares in poor condition classes C (half vegetated) and D (denuded land), see below.
- Farms that were not within these limits automatically missed the criteria for quality management.
- A ban was set for grazing severely degraded or desertified commons.

Farms which failed to meet the criteria were obliged to enter a land improvement program thus gaining a temporary certification with an adjustment period of about ten years. Still, this allowed for grazing on land in poor condition (Arnalds & Barkarson, 2003). Until today, sheep grazing continues in areas that are not suitable for grazing, especially in the volcanic active zone (Crofts, 2011; Pétursson et al., 2013; Marteinsdottir et al., 2017a).

The Quality Management regulations were implemented by developing land restoration and land use plans which aim at preserving and improving grazing areas that do not meet the criteria for sustainable land use. For example, one such plan was done in 2004 for the common of Álftaversafrétt in Skaftárhreppur, Southeast of Iceland (Valsdóttir, Ásbjörnsson & Barkarson, 2006). This plan was set up for a period of seven years and supposed to be revised each year (Valsdóttir et al., 2006). In 2012, the land restoration plan for Álftaversafrétt was prolonged (Ásbjörnsson & Stefánsson, 2012) and is still valid.

In the context of the land use part of the Quality Management, it was necessary to formulate rules for sustainable land use. As well there was a need to assess Iceland's different land types and land use forms since there was no comprehensive knowledge available on the status quo (Arnalds & Barkarson, 2003). Consequently, two programs were initiated:

6.2.1. The Icelandic Farmland Database

The initiative The Icelandic Farmland Database (*Nytjaland*) was launched, aiming at establishing an easily accessible database which categorizes different states of private farmland and highland commons regarding land size, vegetation, farmland boundaries and landscapes. It was supposed to be a tool for information, organization and instruction for land use and official structure plans. Landsat 7 satellite images were used to divide the land according to ten different classes and four different categories, A, B, C and D (Gísladóttir, Grétarsson, Metúsalemsson & Arnalds, 2002; Arnalds & Barkarson, 2003). This information, in combination with soil erosion criteria has since then been used as a basis for land use evaluation within the Quality Management. The work on the Icelandic Farmland Database was terminated in 2008 (Gísladóttir, Brink & Arnalds, 2014).

6.2.2. Better Farms

It was obvious from the beginning that some sheep farmers would fail to meet the criteria defined in the Quality Management regulations and would have to take active steps in grazing

management and sustainable land use (Maronsson, 2002). One step towards sustainable land use was the implementation of the Better Farms (“Betri Bú”) initiative, a program under the supervision of the Soil Conservation Service in cooperation with a wide variety of institutions like the Farmers’ Association, the Agricultural University, local agricultural associations and others (Schmidt, 2003). One of the main goals of the Better Farms initiative was to enable farmers to be more ecologically literate on land condition, assess the state of the land, apply sustainable land management practices and implement land restoration efforts where needed. This was done by setting up land use plans (Arnalds, 2005). Yet here, an emphasis was put on the evaluating and adjusting aims and methods (Grímsdóttir, Örnólfsson & Valsdóttir, 2003).

6.2.3. Reception and evaluation of the Quality Management

Initially, the Quality Management agreement was criticized by sheep farmers because it required considerable bookkeeping and because of the potential issues of some of the highland commons not meeting sustainability criteria (Arnalds & Barkarson, 2003). It was precisely the land use regulation which was considered to be the most difficult part of implementation with regard to stocking rates, traditional land use and the different opinions on the problem (Dýrmundsson, 2000).

The Quality Management regulations have been reviewed and evaluated at different stages of implementation. One aspect that has gotten some attention is how the Quality Management influences and changes farmers’ perspectives on land use and restoration (Þórláksdóttir, 2015). Generally, results are quite ambivalent. A qualitative study in the North-East region of Iceland revealed that the program is an important step in the right direction towards improving the highland and communal areas and was long overdue (Þórláksdóttir, 2015). It thus led to a change of opinion towards sustainable environmental behavior. Furthermore, it seems as if the Quality Management has improved the governance of sheep farming and the sheep grazing regime as a whole (Stefánsson, 2018).

Nevertheless, the Quality Management has some structural deficiencies which limit its scope. For example, farmers still have differing views on land restoration and sustainable grazing practices. The Quality Management lacked from the very beginning a proper introduction of the land use part as well as appropriate tools to control grazing management effectively (Stefánsson, 2018). The Quality Management does not offer the possibility of concluding formal agreements between livestock owners concerning land use on private lands. The

enforcement and surveillance mechanisms are not functioning properly, to some extent because the supervision bodies do not have enough resources to thoroughly monitor the different parts of the Quality Management (Stefánsson, 2018). This results in further dissent between farmers. As well, this demonstrates the importance of developing common definitions and a shared understanding of land use and management practices (Þórláksdóttir, 2015).

Additionally, a communication problem seems inherent in the Quality Management regulation (Stefánsson, 2018). Farmers perceive that their knowledge of local conditions, their former restoration activities as well as their ideas and incentives for land improvement are not appreciated equally to the views of other actors, especially of the Soil Conservation Service. This negatively affects their attitude towards the program (Stefánsson, 2018). A perceived lack of transparency and clarity in the program's structure underlines this problem which causes dissatisfaction amongst participants within the program (Stefánsson, 2018).

With regard to dissatisfaction on behalf of the Icelandic sheep grazing regime (section 3.4.), one of the major errors in the regime is that the Quality Management is a centralized program whereas local authorities regulate sheep grazing (Stefánsson, 2018). This results in less interest in the sustainability of sheep grazing affairs on behalf of municipal stakeholders (Stefánsson, 2018).

7. Conclusion

This thesis focuses on socio-economic aspects of sheep grazing in Iceland. Throughout the thesis, it becomes obvious that sheep grazing of highland commons in Iceland does not always fulfill the criteria of being a sustainable land use practice when considering the socio-economic issues alone.

With regard to the economic environment, sheep farms are currently operating within difficult circumstances resulting in a thinning of rural areas. Many farmers struggle to make a living on sheep farming and have to seek employment outside the farm. The current financial support system has contradicting effects: on the one hand, perverse subsidies, paid per head of sheep, encourage production and thus more grazing pressure. On the other hand, the Quality Management part of the subsidy payments requires sustainable land use practices and thus less grazing pressure in some areas. High participation rates in the Quality Management underline however the importance of economic incentives to change action.

Regarding the legal framework of sheep grazing in Iceland, rules and regulations do not lead to sustainable grazing practices. The regulations neither mitigate the economic difficulties in sheep farming. The system is considered to be fallible. Structural deficiencies of the current system lie for example in differing responsibilities: the Quality Management is a centralized program but the regulation of grazing common highlands lies within the jurisdiction of municipal authorities. Furthermore, the system leads to communication problems between involved actors. Here, the question arises of how a legal framework is supposed to be in order to ensure sustainable grazing practices and maintain rural livelihoods.

From the historical point of view, sheep grazing has a long tradition in Iceland and had extensive impact on Icelandic ecosystems. Sheep grazing on common grazing lands was regulated strictly already in the first law books of Grágás and Jónsbók. Sheep grazing in common Highlands was likely a more sustainable land use practice in the past, although winter grazing near farms was not sustainable and had devastating ecological impacts.

From the historical and the economic perspective, the question arises whether sheep grazing in Iceland needs to be still production oriented. With the declining importance of sheep farming and the thinning of rural areas, other grazing systems might gain more importance. Sheep grazing might for example become an important tool in the conservation of cultural landscapes (Þorsteinsson, Karlsdóttir & Þórhallsdóttir, 2002).

Grazing on highland commons is a very cost- effective practice which explains to some extent why grazing in unsuitable areas still continues. Here, the question arises whether other forms of grazing would fulfill criteria of sustainable land use rather than grazing highland commons. Research has shown that lowland grazing and active grazing management actions could be an alternative way (Bjarnadóttir, Sveinbjörnsson & Eyþórsdóttir, 2006), as lowland areas are less sensitive to disturbance due to milder environmental conditions that prevail in these areas. However, these alternative grazing practices would require some investments, due to the costs arising from fences, fertilization, active management practices and others. Sheep farms today do not have the financial scope to implement these actions.

Efforts to deal with the impacts of sheep grazing in Iceland include different approaches from various sides with the aim of improving land use towards sustainable practices. On the one hand, bottom-up programs have been developed which imply the participation of local actors

such as the Farmers Heal the Land program. On the other hand, the main initiative from governmental authorities, the Quality Management, is a classical top-down approach. The approaches from different sides do have an impact on participants regarding their attitude towards sustainable land use practices. However, their scope is limited due to different reasons. Although the approaches are a step in the right direction, they have not been effective in hindering overgrazing and stop land degradation in areas suffering from erosion especially in the volcanic active zone.

The different approaches discussed here demonstrate the importance of truly participatory initiatives. All stakeholders have to be involved equally for positive outcomes and active engagement. GróLind is a further step in this direction- being designed according to the concept of adaptive management and referring to systematic evaluation, revision and adjustment of the ongoing program.

Finally, sheep farmers and other actors involved in sheep grazing in Iceland still do not seem to have a common understanding of sustainability and sustainable land use practices. The concept of sustainability is broad and unclear, and differing understandings lead to differing aims and actions. In order to strengthen sustainable grazing practices, all actors involved need to act in concert on the basis of communication and education, adapting their actions to increasing knowledge in the field.

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