

## 12 Role of supplementary feeding in reindeer husbandry

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### Introduction

Providing reindeer with supplementary feed (hereafter referred to as “feeding”) in winter is a strategy practised by reindeer herders when natural grazing resources are unavailable or the grazing conditions are challenging for various reasons. Causes and extent of this strategy have changed over time and differ across the reindeer herding area (Åhman et al. 2018). Winter feeding is practised across the whole of Fennoscandia and has increased during recent decades. A main reason is the combination of the impacts of climate change on the accessibility of natural grazing resources and the loss of land to other forms of land use (Chapters 4 and 5). Climate change has resulted in more frequent winters with deep and hard snow, and thaw-refreezing events creating ice crusts in the snow or ice layers on the ground. Such events can prevent reindeer from gaining access to forage resources on the ground, mainly terrestrial lichens. Loss of valuable land for grazing due to industrial land use (i.e., forestry, wind power parks or mining), and infrastructure for recreation and tourism, results in higher grazing pressure on the remaining pastures. Increased presence of predators (Chapter 6) also makes it difficult to use certain areas for reindeer grazing. These factors together increase the risk of there being situations when there is not enough available natural forage, and feeding is then the only solution to provide sufficient food for the reindeer. Feeding is also undertaken in other situations, not directly linked to lack of natural forage but, e.g., to facilitate handling or protect reindeer from predators.

Nowadays, it is less problematic than previously to feed large herds of reindeer due to the availability of factory-made feeds specifically formulated for reindeer, together with motorization, increased infrastructure and growing knowledge and practical experience among herders. However, feeding is both costly and laborious and may involve health risks for the animals (Chapter 13).

In this chapter, we describe how feeding of reindeer is practised in Finland, Sweden and Norway, and what the overall consequences are for reindeer husbandry. We summarize scientific results regarding positive and negative effects of feeding, review how feeding, as a recurring practice in reindeer husbandry, is perceived by herders, what concerns they raise in relation to feeding, discuss

benefits and drawbacks of feeding and how it may help or hinder reindeer husbandry in the future.

## **Feeding of reindeer in Fennoscandia**

Reindeer have probably been provided with supplementary feed by their owners since early domestication, in particular the animals that were kept for transportation and milking. Isotope studies of archaeological bone samples of reindeer dated to the 13th century suggest that feeding may have already been a part of the reindeer herders' practices at that time (Salmi et al. 2020). There is also documentary evidence of winter feeding practices by Forest Sámi in Finland, dating back to the period of intensive herding before the 18th century, when domestic reindeer were fed, e.g., bread, lichens and hay (Itkonen 1948; Kortessalmi 2007). Widespread practices during difficult winters were to provide emergency feed for reindeer by pulling arboreal lichens off trees, cutting down lichen-rich trees and breaking hard snow cover with shovels to make digging easier for the reindeer (Itkonen 1948; Helle and Jaakkola 2008; Berg 2011). Historical remains (tree stumps) from cutting trees rich in lichens, dating back to the early 1800s, can still be found within the Swedish reindeer herding area (Berg 2011). The majority of the remains date from the period 1844 to 1880, while the latest were from the 1930s. In Finland, lichen tree cutting was most common from the late 19th century until the Second World War (Itkonen 1948; Kortessalmi 2007).

There were large losses of reindeer due to mass starvation in the 1960s and 1970s, during a series of winters with difficult snow conditions affecting all three Fennoscandian countries (Helle & Sántti 1982; Vuojala-Magga et al. 2011; Berg et al. 2011; Riseth et al. 2016). This encouraged increased use of hay for winter feeding across large parts of the Finnish reindeer herding area (Helle & Saastamoinen 1979; Helle & Sántti 1982; Helle & Jaakkola 2008) and promoted the development of grain-based feeds formulated for reindeer in all three countries (numerous feeding experiments reviewed by Staaland & Sletten 1991). Composition and nutrient content of feeds for reindeer became an important topic for research (e.g., Skjenneberg & Slagsvold 1968). Loss of grazing areas due to modern forestry from the 1950s onwards (Finland and Sweden), together with other industrial activities and infrastructure development (Helle & Jaakkola 2008; Uboni et al. 2020; Riseth et al. 2016), gradually increased the need to feed reindeer in winter. Shrinking winter pastures increased reindeer densities in some locations and intensified grazing pressure on the remaining land, causing additional negative long-term effects on lichen pastures (Jaakkola et al. 2013; Kumpula et al. 2014).

The present use of feeding differs between the Fennoscandian countries, and also between regions. Temporary feeding of reindeer, targeted at strategic events such as gathering and migration, has been a rather common practice in all countries for several decades (Staaland & Sletten 1991). Feeding in order to prevent acute starvation (“emergency feeding”) is also practised in all countries.

In particular, in the southern parts of the Finnish reindeer herding area, feeding during several winter months has become a regular part of the management system (Turunen & Vuojala-Magga 2014), while this has been more limited in Northern Finland and still rather sporadic in Sweden and Norway.

### ***Finland***

In Finland, regular winter feeding, either on pasture (Figure 12.1) or in enclosures (Figure 12.2), became a part of the herding system in the southern and central reindeer herding districts (RHDs) in the late 1980s and mid-1990s, mainly as a result of the detrimental impact of forestry on ground and arboreal lichen resources (Turunen et al. 2020). Since then the practice has also expanded towards the northern part of the Finnish reindeer herding area, although to a limited extent and mainly as a means to keep the herd in control or provide extra energy and nutrients for reindeer on winter pasture, especially when there are difficult snow conditions. In addition, seasonal migration and pasture rotation of reindeer generally occur over smaller areas in Finland compared to Sweden and Norway. In some RHDs this has led to increased grazing and trampling on lichen ranges during the snow-free season (Kumpula et al. 2011,



*Figure 12.1* Free-ranging reindeer fed hay in the field.

Photo: Jouko Kumpula.



*Figure 12.2* Reindeer eating from a feeding crib.

Photo: Jouko Kumpula.

2014), which might have contributed to the need to provide supplementary feed to reindeer.

Winter feeding of reindeer in Finland developed in combination with small-scale agriculture in the southern parts of the reindeer management area (Helle & Jaakkola 2008). The fact that herders in this area have been able to grow their own hay and had experience of feeding other animals has facilitated the development of feeding practices for reindeer (Turunen & Vuojala-Magga 2014). The gradual extension of winter feeding from south to north in Finland was influenced by increasing encroachment of forestry, and also by the Field Reservation Scheme, enacted in 1969. This scheme was established to cope with and reduce overproduction in the dairy sector. Thus, the state paid farmers to leave fields uncultivated. However, they were still allowed to use hay grown on these fields for feeding reindeer. Production of hay was further stimulated by subsidies when Finland joined the EU in 1995. As a result, most of the meadows and hay fields within the Finnish reindeer herding area are presently used almost entirely for production of hay for reindeer (Helle & Jaakkola 2008).

Reindeer in most parts of the Finnish reindeer herding area are thus regularly fed hay, grass silage, pellets or a combination of these during winter. The purpose is to keep reindeer in enough good condition and prevent starvation, as well as reduce loss to predators by keeping reindeer under control on pastures or gathered around feeding stations, and help to achieve or maintain pregnant

females at an adequate nutritional status over winter. Reindeer are fed both in enclosures, where all or most forage is provided by the herder, and on pasture, where they can get part of their forage from natural vegetation. The duration of feeding depends on the annual weather and snow conditions. In favourable winters, with thin snow and no ground icing, reindeer can be fed for two or three months, whereas in years with a deep snow cover, ground icing or both, the feeding period may last for four or five months (Turunen & Vuojala-Magga 2014). Providing supplementary feed on natural pasture (Figure 12.1), as it is generally practised in the northern part of the Finnish reindeer herding area, usually lasts for one to three months in late winter, but lasted up to five months in the exceptionally harsh winter of 2019/2020 (Kumpula et al. 2020). Feeding of pregnant females during calving, combined with marking of the newborn calves before the animals are released onto natural pasture for the summer, is common in some of the central and northern RHDs (Turunen & Vuojala-Magga 2014).

### ***Sweden and Norway***

The situation regarding reindeer feeding in Sweden and Norway differs from Finland, although there is a large variation depending on region, RHD and individual herder (Landbruksdirektoratet 2017; Persson 2018). Although the reasons for feeding are similar to those cited for Finland, feeding is not as common and few herders regularly feed their reindeer during a large part of the winter. In Sweden, feeding during migration and gathering has been commonly practised for decades in many RHDs, while this practice seems to be less common in Norway. In both countries the need for so-called emergency feeding, to prevent starvation, has however increased during recent years, due to there being more winters with unfavourable weather and loss of land for grazing (Åhman et al. 2018; Horstkotte et al. 2020).

In cases when pastures are locked due to unfavourable snow conditions, reindeer herders usually try to move the animals to areas with better grazing conditions. Alternatively, they allow the reindeer to spread over larger areas in small herds, to search for suitable grazing conditions on their own. However, the presence of predators makes herders reluctant to use this strategy, and during periods with locked pastures they may, therefore, prefer to keep the reindeer in enclosures or in tight herds and provide supplementary feed.

Judging from the sale of commercial feeds for reindeer in Sweden (Uboni et al. 2020), the extent of feeding grew rapidly from the mid-1980s onwards. According to a survey of reindeer herders in Sweden, about half of the herders occasionally fed their reindeer during the late 1990s (Statistics Sweden 1999). Since then, the sale of feed for reindeer has increased, although it varies considerably between years.

The use of commercial reindeer feeds has previously been rather limited in Norway. Until recent years, a considerable part of factory-made reindeer feed was imported from Finland or Sweden. The increased need for feeding

has, however, promoted domestic production in Norway. So far, these feeds are mainly used in the northern parts of the Norwegian reindeer herding area (Nordland, Troms and Finnmark).

In certain areas in both Sweden and Norway, radioactive fallout from the Chernobyl nuclear power plant accident in 1986 resulted in contaminated pastures and high levels of radioactive caesium in reindeer. This forced herders to feed reindeer in order to reduce contamination of the meat before slaughter (Åhman 1999, Skuterud et al. 2016). The cost of this type of feeding is refunded by the respective state and is still happening in a few RHDs in both countries (Wiklund et al. 2018).

Unlike in Finland, it is unusual in both Sweden and Norway for reindeer herders to own agricultural land and produce their own forage. Thus, herders mostly have to buy all the feed that they use. High costs prevent most herders from feeding on a large scale, if not absolutely necessary in order to save reindeer from starvation. Herders also find that it is difficult to obtain the desirable quality of hay or silage (Persson 2018). Lack of knowledge about dietary requirements of reindeer among both herders and the farmers who produce forage is regarded as a problem, especially as reindeer have different requirements than, e.g., cattle and sheep (Åhman et al. 2018). Some herders are therefore reluctant to use hay or silage at all, and rely solely on factory-made grain-based pellets, even though this kind of feed is less like the natural food eaten by reindeer, and therefore generally associated with more digestive problems (see below and Chapter 13).

## **Feeds and feeding practices**

Commercial grain-based feeds for reindeer (hereafter referred to as “concentrates”, although they can be used as the only feed for reindeer) are commonly used in all three countries and offered by a number of feed producers. All concentrates are nowadays manufactured from milled ingredients in the form of pellets. The ingredients are similar to those used in concentrates for other ruminants, although the relative proportion of ingredients differs. Concentrates for reindeer thus contain various types of grain (including by-products), by-products from the sugar industry (beet pulp, molasses), some sources of extra fat (e.g., rapeseed) and protein (e.g., distillers draff) as well as added minerals and vitamins. The composition is based on the numerous feeding experiments that were undertaken mainly during the 1960s and 1970s, and practical experiences of reindeer feeding since then. The nutritional quality of all concentrates for reindeer is rather similar, though some feeds are adapted for feeding reindeer prior to slaughter and contain, e.g., more protein (up to 14%), compared to basic feeds that are formulated primarily to prevent starvation and keep the reindeer in adequate condition over winter (usually containing 10–12% protein). Some feeds contain additives that are aimed at preventing ruminal acidosis, which is a common problem in reindeer when they have to switch from natural pasture to a grain-based diet (Åhman et al. 2018; Chapter 13).

According to Saarni and Nieminen (2011), the annual use of reindeer feed (including both hay/silage and pellets) in Finland is in the order of about 100–120 kg dry feed per live reindeer in the winter herd. However, the use of feed varies considerably between areas and years. In Sweden, two main producers of grain-based feeds for reindeer have been active on the market since the 1980s. The annual sales for these companies fluctuate between years, corresponding to 20–60 kg per reindeer in the winter herd (Uboni et al. 2020). This is combined with unknown amounts of silage and hay. In Norway, less than 1,000 tons of reindeer feed used to be produced annually (corresponding to an average of 4 kg per reindeer in the winter herd). There were, however, increasing imports from Sweden and Finland from the year 2000 onwards, which stimulated national production of concentrates for reindeer. In 2019, the production was about 10 kg per reindeer, and in the extreme winter of 2019/2020, with exceptionally deep snow, production reached 25 kg per reindeer (Landbruksdirektoratet 2020).

Grass silage and hay are commonly used to feed reindeer. Grass pellets are also sometimes used. Baled silage came into use during the 1980s and replaced much of the use of dry hay. Silage often contains less fibre (cellulose) than hay due to the harvesting and conservation process. This is important for reindeer as mixed feeders, since their digestive system cannot handle as much fibre as that of typical grazers such as cattle and sheep (Åhman et al. 2018).

Reindeer lichens, an important part of the natural winter diet of reindeer, are commonly used to complement concentrates and hay or silage, although in limited amounts. Reindeer greatly prefer lichens, and they are therefore used in order to accustom the reindeer to supplementary feeds and to being fed. Lichens can also be used in case of digestive problems linked to lack of adaptation to commercial feeds. Lichens are usually bought, or collected by the herders themselves, from areas outside the reindeer herding area. With a large herd or planned feeding for a longer period, lichens can only be a minor part of the feed given to the reindeer. In northern Norway, there is currently a shortage of lichens, due to the recent outbreak of Chronic Wasting Disease (CWD), that prevents herders from collecting (or buying) lichen from southern Norway, which was previously the tradition (see Norwegian Food Authority Regulation).

Feeding practices differ between herders (Figures 12.3 and 12.4). Some employ work-demanding systems, where the feed is spread manually on the snow for free-ranging reindeer, using no equipment other than a snowmobile, sled and shovel or pitchfork. Others have advanced systems, where reindeer are kept in enclosures and concentrates are provided in cribs, using various kinds of modern equipment and machinery which are common in agriculture (like silos for concentrates and bale cutters for silage). Sometimes the reindeer are kept in large enclosures with access to some natural pastures as well, while in other situations the animals have to rely entirely on the feed provided by the herder. Herders who feed free-ranging reindeer often need to transport concentrates (in cribs or sleighs behind their snowmobile) or bales of silage or hay over long



*Figure 12.3* Distributing feed for reindeer.

Photo: Minna Turunen.



*Figure 12.4* A reindeer eating grain-based feed (pellets) spread out on the snowmobile track.

Photo: Minna Turunen.

distances (several kilometres). Access to water is essential when reindeer are fed dry feed. Water can be provided in troughs (heated so that it does not freeze), or via a natural stream or river running through the feeding area. The availability of clean snow is often sufficient for reindeer fed on pasture.

Recommendations regarding feeding practices for reindeer are available in all three countries (e.g., Majjala et al. 2013; Rockström & Åhman 2017; Eilertsen & Winje 2017). Feeding of reindeer, and how to avoid or reduce the risks involved, is also a recurring topic at seminars and courses for reindeer herders. Nevertheless, there are many knowledge gaps, and herders are demanding more coproduction of knowledge and exchange of practical know-how between herders with various levels of experience (Horstkotte et al. 2020, Landbruksdirektoratet 2020).

### **Effects on reproduction and herd productivity**

Body condition, i.e., body reserves of fat and protein, is a key factor for survival and reproduction in reindeer, as in other animals (Åhman & White 2018). When natural forage resources are limited, feeding is therefore generally expected to have positive effects on survival, reproduction and population growth, and thus on the productivity of the reindeer herd.

It is well documented that female body mass (BM) in autumn is positively correlated to the chance of the female getting pregnant and calving the following spring (e.g., Cameron et al. 1993; Rönnegård et al. 2003). Poor winter grazing conditions may nevertheless have negative effects on calving success (Vuojala-Magga et al. 2011), which can be counteracted by feeding (Ballesteros et al. 2013). Rognum et al. (1983) demonstrated positive effects of enhanced energy and protein intake on foetal growth rate and early survival, and Eloranta & Nieminen (1986) showed that female BM prior to calving correlated with calf birth weight and early survival. Female BM in spring is also positively correlated to milk production (Jacobsen et al. 1981), which in turn strongly correlates to the early growth rate of the calf (White & Luick 1984). Consequently, the calves of reindeer that have been offered supplementary feed are often heavier than those of reindeer that have had to rely on natural pastures only (Säkkinen et al. 1999; Majjala & Nieminen 2001), which may positively affect their future performance.

According to earlier studies in Finland, one main benefit of introducing regular winter feeding has been increased and stabilized meat production (Kojola & Helle 1991, Helle & Kojola 1993, 1994; Kumpula et al. 1998). However, expanded and intensified feeding is currently a major financial burden for herders. The comparatively regular and extensive feeding practices in Finland seem nonetheless necessary to keep up the present productivity level in the face of the declining and unpredictable environment for winter grazing (Kumpula et al. 2002; Pekkarinen et al. 2015).

In Sweden, the use of feeding in the reindeer management system partly explains why population size has remained relatively stable, despite a considerable

loss or reduced quality of winter pastures, and increasing occurrences of difficult winter weather and snow conditions (Uboni et al. 2020). The productivity (meat production relative to herd size) is nevertheless low compared to Finland, and probably less affected by feeding (Chapter 10).

### **Negative consequences and risks associated with feeding**

Feeding is obviously associated with high financial costs, not only for the feed itself but also for facilities, equipment, machinery and fuel. It is also associated with a change of workload (other, and often heavier, work). Expenses for feeding may be one of the major costs in some RHDs (Rantamäki-Lahtinen 2008). However, feeding sometimes is the only profitable option for herders. The economic gain from feeding varies considerably depending on, e.g., pasture quality, meat prices and the subsidy system (see Chapter 11). It is thus difficult to assess the potential final economic gain of planned feeding and often hard for a herder to decide whether to feed or not based solely on economic grounds.

There are several health risks for reindeer associated with feeding (Åhman et al. 2018; Tryland et al. 2019). Many of the health problems are linked to poor adaptation of the digestive system to a novel diet. Others are related to keeping animals within restricted areas, particularly when they are fed in enclosures, and the associated increased risk of spreading infectious diseases. Stress in relation to handling also increases the risk of impaired health. Health problems related to feeding are further discussed in Chapter 13.

Feeding on pasture may result in increased grazing and trampling pressure on vegetation and soil due to high animal densities around feeding stations. Furthermore, left-over silage or hay has the potential to affect the natural vegetation. A two-year experiment in Finland (Turunen et al. 2013) showed that frequent feeding may cause changes in the soil and in vegetation composition. In the longer run, this can lead to a gradual shift from a nutrient-poor forest (sub-xeric heath forest type) towards a more nutrient-rich type of forest (mesic heath forest type). No invasive plant species were, however, introduced by spreading grass silage and hay, but the cover and height of the naturally occurring wavy hair grass (*Deschampsia flexuosa*) increased, while the cover of some mosses, lichens and shrubs declined.

In addition to the direct effects of feeding, there are potential long-term effects on reindeer grazing behaviour and on the reindeer management system as a whole, which are further discussed below in relation to herders' perspectives on feeding.

### **Economic support**

As mentioned previously, reindeer herders in Finland can get EU subsidies for using fields to produce hay for reindeer, in accordance with the size of their fields. The Finnish "Act on compensation for damage caused to reindeer

husbandry” (987/2011 and 655/2016) has not been used earlier to cover extra costs associated with feeding due to exceptionally difficult weather. Now, this is happening in relation to the exceptionally hard winter of 2019/2020 (Kumpula et al. 2020).

Reindeer herders in Sweden can apply for government support for feeding through the Sámi Parliament (so-called katastrofskadeskydd/disaster relief), when snow conditions make it impossible for the reindeer to dig for forage on the ground (STFS 2019:1). Compensation can then be paid to the RHD for up to 50% of the verified costs for buying feed for the reindeer. It has also become increasingly common that compensation is paid for encroachments on grazing areas caused by other forms of land use, like mines or wind parks, to cover feeding costs (Lawrence & Larsen 2017). Payment for feeding as a means to protect reindeer from predators has hitherto been uncommon. However, during the winter of 2019/2020, several RHDs were paid for feeding reindeer when they had to be fenced in order to protect them from wolves (<https://sverigesradio.se/artikel/7383770>).

The Norwegian government provides financial support for feeding under certain circumstances (Landbruksdirektoratet 2017). One is to cover feeding expenses for RHDs that are unable to utilize parts of their traditional winter pastures in Sweden due to the termination in 2005 of the former Reindeer Grazing Convention between Norway and Sweden. Herders can also apply for financial support to prevent losses to predators through the funding scheme “Prevention and conflict reducing measures” (Forebyggende og konfliktreducerende tiltak – FKT) administered by the regional governments. The money can be used for feeding in order to aid the tending of the herd. In Norway, RHDs are building “disaster funds” (“katastrofefond”) which can be used for buying feed when winter pastures are unavailable. Up to 2 NOK per reindeer per day can be used for this purpose (Landbruksdirektoratet 2020). During the catastrophic winter of 2019/2020, all money in the funds was used up early in the winter, but after negotiations with the government, an extra 30 million NOK was added to the funds.

## **Herders’ perceptions of feeding**

Discussions between reindeer herders from Finland, Sweden and Norway at a workshop in 2018 (Horstkotte et al. 2020) revealed several short- and long-term concerns related to the feeding of reindeer. The health and welfare of the animals is obviously a worry for the herders, and more facts on this topic were requested. Many herders pointed out the value of exchanging knowledge and experiences with other herders in order to learn how to avoid health problems related to feeding. In line with this, reindeer herders in Finland interviewed by Turunen and Vuojala-Magga (2014) emphasized the importance of knowledge and experience, and the value of learning through the transfer of knowledge between herders to achieve good results when feeding reindeer.

High costs and increased workload, and the difficulty of making trade-offs between costs and benefits of feeding, were also highlighted by the herders at the workshop (Horstkotte et al. 2020). However, herders focused in particular on the long-term effects that the growing need to feed the reindeer could have on the reindeer management system as a whole. Herders place a strong emphasis on the fact that reindeer herding needs to be based on the use of natural pastures in order to be ecologically, economically and culturally sustainable (Chapter 5).

Herders see a potential risk of losing access to pastureland if government bodies, developers or society at large, without knowledge about reindeer husbandry, regard feeding in fenced areas as a solution and a substitute for natural pastures. However, in reality, supplementary feeding is only treating symptoms of absent or inaccessible forage resources (Horstkotte et al. 2020). Herders are also concerned about the risk of losing traditional experience-based knowledge about reindeer's use of winter pastures. Knowledge about reindeer, nature and landscape is learned through experience and participation in herding activities. Consequently, if herders need to spend more time at the feeding troughs than in the landscape with their herd, there is a risk that such knowledge is not transferred to future generations (a concern also reported by Risvoll & Hovelsrud 2016).

Another risk mentioned by herders (Horstkotte et al. 2020) is that meat and other products from reindeer will no longer be regarded as purely "nature-based" and "traditional". In spite of the fact that reindeer are generally slaughtered in autumn, after several months solely on natural pasture, and that the majority of the slaughtered reindeer are calves, this might have negative effects on the market.

Changes in the reindeer's behaviour and tameness were other concerns emphasized (Horstkotte et al. 2020). These issues were also raised in earlier surveys and interviews with reindeer herders (e.g., Helle & Jaakkola 2008; Vuojala-Magga et al. 2011; Turunen & Vuojala-Magga 2014; Persson 2018). Increased interactions between humans and reindeer during feeding make reindeer more tame and thus often easier to handle. Reindeer that are used to feeding can be attracted by forage and get other reindeer to follow, which helps to get the herd into round-up fences. On the other hand, reindeer that become too habituated to humans may lose their fear of vehicles and people, and therefore become more difficult to gather and move. Herders are also concerned about reduced vigilance making reindeer more susceptible to traffic accidents and predators (Turunen & Vuojala-Magga 2014).

Moreover, herders see a risk of effects on the reindeer's normal grazing and migration behaviour. For example, there is a concern that reindeer that get used to feeding will lose their willingness or ability to search for forage on their own (including the skill of digging through snow). If so, this will compromise their capability to live and survive on natural pastures (Turunen et al. 2016; Persson 2018; Horstkotte et al. 2020). Another concern is that reindeer feeding may make reindeer unnecessarily fat during a season when they are normally rather

lean. This is especially important in pregnant females and can lead to problems at calving.

### **Future role of feeding**

Feeding has evidently become an integral part of the reindeer management system in many areas of Fennoscandia. Feeding for short periods (a few days), and in specific situations, seldom creates any major problems and seems to be generally accepted by herders. The use of supplementary feed in acute situations when there is the risk of starvation and during winters with long periods of extreme weather conditions are strategies that have helped to stabilize reindeer numbers and maintain productivity (Helle & Kojola 2006; Uboni et al. 2020). The financial costs, however, are high, and there are obvious health risks associated with the change of diet, especially if the reindeer are already weakened. Access to land and flexibility to move to better areas are key factors for reducing the need for feeding. However, if encroachments on land and altered grazing conditions due to climate change continue to increase, reindeer herding will most certainly become even more sensitive to unfavourable weather.

The system with several months of feeding every winter is a management practice that is much disputed by herders but regarded as the only solution for survival by many herders in the regions where it is commonly applied. There are evidently many economic arguments against a reindeer herding system that depends strongly on feeding, but bio-economic model analyses show that it may sometimes be the only economically profitable solution for the herder (Pekkarinen et al. 2015). However, key arguments against feeding are that the right to grazing resources for reindeer may be questioned as a result, that knowledge and skills related to the utilization of land and how to herd reindeer will be lost, and that the reindeer will lose their ability to survive on natural forage in winter. If these things happen, it would be hard to return to a herding system based on the use of natural pastures all year round.

It has been repeatedly pointed out that the increased use of feeding is not a choice preferred by herders but rather forced on them by external factors related to encroachments by others on the land (including predator policy) and climate change (e.g., Risvoll et al 2016; Turunen et al. 2016; Horstkotte et al. 2020). There is a risk that frequent use of feeding will create an undesirable transition in the reindeer management system that will be difficult to escape from (Landauer et al. 2021; Chapter 14).

The future role of feeding is very much dependent on state policy related to the right to land and the relationship between reindeer husbandry and the surrounding society. Particularly in Sweden and Finland, restoration of degraded pastures through alternative forms of forest management, compared to the current practices, could improve the long-term availability of natural forage (Chapter 4). In Finland, a reorganization of seasonal grazing patterns, to protect lichen pastures from trampling and grazing during the snow-free season, could also promote forage availability.

Escaping or preventing the trap of systemic feeding is a complex task that requires action beyond the agency of reindeer herders themselves. Instead, the wider impact of different actors within the reindeer herding area, including state legislation, needs to be considered to avoid pushing reindeer herders in the direction of feeding. However, climate challenges will persist, and feeding will therefore continue to be a necessary response as crisis relief.

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