



Lessons learnt: Reindeer husbandry in Sweden

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1 Context

The AGFORWARD research project (January 2014 - December 2017), funded by the European Commission, is promoting agroforestry practices in Europe that will advance sustainable rural development. The project has four objectives:

1. to understand the context and extent of agroforestry in Europe,
2. to identify, develop and field-test innovations (through participatory research) to improve the benefits and viability of agroforestry systems in Europe,
3. to evaluate innovative agroforestry designs and practices at a field-, farm- and landscape scale, and
4. to promote the wider adoption of appropriate agroforestry systems in Europe through policy development and dissemination.

This report contributes to Objective 2 and Deliverable 2.5 which describes the lessons learnt from innovations within agroforestry systems of high natural and cultural value. Within the project, there were ten stakeholder groups focused on such systems (e.g. grazed forests, semi-open pastures, wood pastures, and bocage). This report focuses on a stakeholder group which focussed on reindeer husbandry in Sweden.

2 Background

Reindeer husbandry is practiced in large areas in the boreal forest and sub-arctic tundra zone in northern Finland, Norway and Sweden (Jernsletten and Klokov 2002). In northern Fennoscandia the land area has been used by the Sami people for several centuries. In Sweden, the Sami people have statutory user rights to practise reindeer husbandry according to the Swedish Reindeer Husbandry Act (SFS 1993:36). These rights include permission for reindeer to graze freely on other landowners' land. Currently, reindeer husbandry faces competition with other industries such as forestry, hydro-energy, mining, tourism and automobile industry test facilities (Sandström 2011). Currently, land use competition is increasing and leads to changes in forests composition and affects important grazing areas. Clear cutting of forests and road construction has led to a greater need to improve the consultation between forest managers and Sami villages.

Competition for land and fragmentation has led to difficulties for reindeer to find suitable lichen rich areas for grazing (Kivinen et al. 2012). Furthermore, an increased standing volume in the forests as well as scarification of clear cut areas have led to decreased coverage of reindeer lichens (*Cladonia* spp.) in Scots pine forests, on sediment sites along the rivers and close to the Gulf of Bothnia coast. In these areas, reindeer are kept for grazing during winter (cf. Sandström et al. 2016). Modern forestry has reduced the area of old forests, which leads to smaller areas of arboreal lichens (*Bryoria fuscescens* L., *Alectoria sarmentosa* L.) which represents an important winter grazing resource. A study (Horstkotte et al. 2011) shows that arboreal lichens are most abundant in old forests. Another threat for reindeer husbandry is climate change (Moen 2008). A warmer climate increases forest growth and increased shading has negative effects on lichen growth.

In a previous study, Berg et al. (2016) evaluated the effect of new forms of forest management, as recommended by the Association of Swedish Sami (Svenska Samernas Riksförbund 2009). The recommendations included alternative scarification methods and road building routes, avoidance of non-native species (e.g. lodgepole pine; *Pinus contorta Douglas ex Loudon*), and an increase in

continuous cover forestry practices. These management practices were anticipated to benefit both reindeer husbandry and the growth of ground and arboreal lichens. Scenarios simulating these management approaches in the Malå study area showed a positive economic impact for the Sami village (Berg et al. 2016). One of the goals of the inhabitants of the Sami village is to have an economically and environmentally sustainable business. In order to achieve a sustainable reindeer husbandry business, forestry needs to be adjusted and pay attention to the needs of reindeer husbandry. This means that some specific adaptations in silvicultural management need to be taken in some areas, especially those areas which are of specific importance to the Sami village, for example areas used for the annual reindeer round-up (Figure 1), pastures for grazing and migration routes. For the forestry sector, these adjustments can however lead to a decrease in forest production as reported by Berg et al. (2016).



Figure 1. Several calves gathered before marking. Photo: Erik Valinger.

During winter the grazing is dependent of certain characteristics of the forest. Important characteristics are open mature stands that allow the reindeer to have lines of sight in order to avoid predators, protection from wind and snow, and access to food, such as ground and arboreal lichens. During the transport and/or walking between areas it is important to be able to pass barriers and have areas of land with possibilities of grazing. When grazing areas are fragmented throughout the landscape the reindeer herders have great difficulty in keeping track of the herd and keeping it together. In order to keep track of the herd, some reindeer wear “cow bells”. However, cow bells not only help the herders to keep track of the herd, also predators have learned that the sound of the bell lead to possible prey (Jan Rannerud, Chairman of Malå Sami village, pers. comm. in 2010). Therefore a silent system to track the herd would most likely lead to a higher reindeer survival. A system for tracking reindeer with GPS collars on a number of the reindeer in connection to a mapping device is currently available on the market (Sandström et al. 2012) (Figure 2). The system

makes it possible for the reindeer herder to track the location of the reindeer herd in real time on an ordinary lap-top with a GIS program without the need for field checks. The system could reduce the amount of work in reindeer husbandry as the herd can be monitored and followed remotely (Andersson and Keskitalo 2017). The system could reduce the distance travelled by vehicle. Predator attacks, which are a serious threat to the economy of reindeer husbandry, can be detected at an early stage with the aid of a GPS tracking system (Creel et al. 2005).

The present study analyses the social, economic and environmental consequences of adapted silvicultural management and the use of GPS collars. One objective of this study was to evaluate the effects of changes in forest management on the utilization of the forests and on the grazing land for reindeer in a mountain Sami village. Another objective was to evaluate the effects of equipping part of the reindeer herd with GPS collars on the economy of a Sami village. Hopefully, the results of this study will further improve communication between different stakeholder groups in the area and show how IT tools could be used to inform decision making processes.



Figure 2. Female reindeer equipped with GPS collar. Photo: Erik Valinger.

3 Material and methods

3.1 Study area

The study was conducted in the area of Njaarke Same Village (Figure 3). The reindeer herd consist of about 2000 animals during winter but the Sami village at Njaarke is legally allowed to have almost 3000 reindeer (Berg et al. 2014).

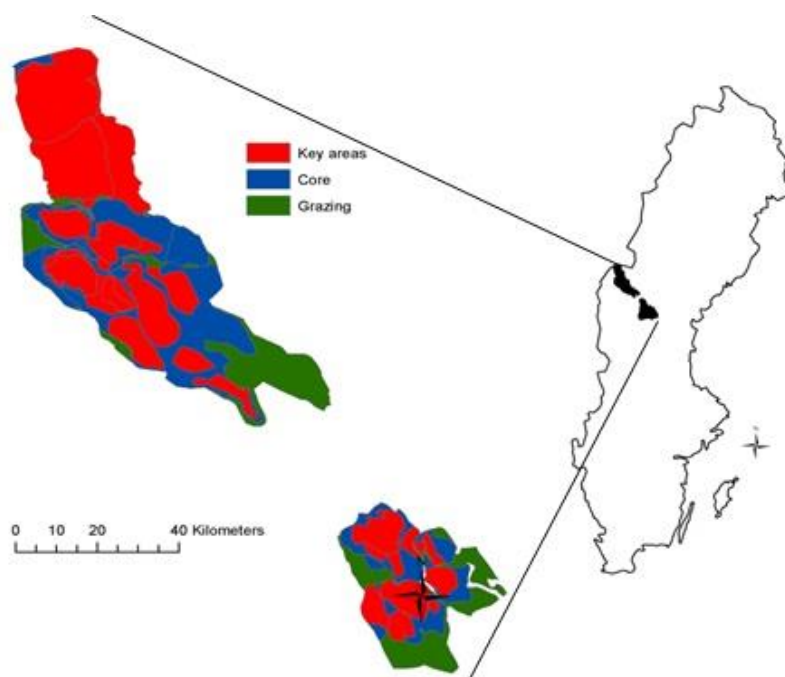


Figure 3. Map of case study area with classification of areas based on reindeer husbandry plan. Key areas – most used and valuable areas for grazing, Core – regularly used and valuable areas for grazing, and Grazing – available areas but normally not used for grazing.

The forest management in the area is dominated by a clear cutting system with a rotation period of 100-130 years. The forest management after clear cut is characterized by planting/seeding or natural regeneration with succeeding pre-commercial thinning. Normally, two thinning are made before the final cut. At final cutting stumps are left on site to support natural regeneration.

3.2 Data used for the analysis

At the time of the start of the study the Sami village consisted of four families with a total of 20 members. For the financial analysis, it was assumed that one hour of work beneficial to the whole village represent a cost of 13.88 €, and that the hourly cost of external personnel was 28.91 € (Per Nilsson, pers. comm. April 2016 and May 2016). Annual working time was assumed to be 1600 hours per year full time employment.

At the start of the study in 2013, the Sami village had 40 collars in use. The purchase cost per GPS collars for tracking the reindeer varied between 200 € (Tellespor) and 1400 € (Vectronics). The mean value 700 € was used in the calculations and the collars depreciated with 20% annually. Annual cost for maintenance of the GPS system and the collars were 220 € per collar.

At slaughter, the slaughter weights of the reindeer were assumed to be 33.20 kg for females, 21.28 kg for calves, and 43.00 kg for males (Sametinget 2016). The payment for the meat including government payment (within parenthesis) was 7.12 (1.68) € per kg for calves and 6.55 (1.04) € per kg for adults (Sametinget 2016). Predators are serious threat to the herd. Hunting of predators is allowed with the permission of the competent authorities and is part of the adapted wildlife management in the area. The Njaarke Sami village annually receives about 86736 € as compensation for maintaining bear, lynx and wolverine populations. Wolf is not supported in the reindeer husbandry area.

The Sami village had the reindeer herd divided in two parts, the north and the south, where the south had 65% of the reindeer and reindeer were transported to and from winter grazing land by truck. The smaller northern herd was moved to and from winter grazing land by walking (pers. comm. Pär Nilsson, April and May 2016). The cost for transportation by truck for 200 reindeer was 46.25 € per hour.

The economic activities of the Njaarke Sami village also include recreational activities such as hunting, cabin rental and access to fishing in the surrounding lakes and streams.

3.3 Comparison of three alternative management options

In this study, three management alternatives were analysed; no adaption of forest management i.e. business as usual with or without the use of GPS collars (BAU + GPS or BAU – GPS) and adapted forest management with GPS collars (AFM + GPS). Adaptations included less scarification, no planting of *Pinus contorta* or *Larix* spp, stronger and earlier pre-commercial thinning and thinning to keep the forest less dense. Longer rotation periods were assumed to maintain old and multi-aged forests at both stand and landscape level, and to preserve forests with tree-lichens. These adaptations were mainly located in the most important grazing areas (Figure 1). In the AFM scenario it was assumed that better conditions for reindeer husbandry would lead to the production and slaughter of an additional 200 reindeer calves per year.

3.4 Economic, social and environmental impact assessment

For analysing the sustainability impacts of the three proposed management alternatives, we used the ToSIA tool (Tools for Sustainability Impact Assessment) which was constructed for analyses of social, economic, and environmental indicators in production value chains (Lindner et al. 2010; Lindner et al. 2012; Berg et al. 2016). The production processes related to reindeer husbandry included activities during a typical reindeer year such as calving and grazing after calving (Table 1). The cost and energy value of petrol and diesel consumption are included in the analysis. By simulating the material flow (the reindeer herd) through the processes of the value chain, the sustainability impacts of the activities in each of the three management alternatives were compared by indicators (Table 2).

Table 1. The timing of the activities related to three value chains of reindeer husbandry, moose hunting, renting of cabins and fishing.

Season (month)	Activities per value chain		
	Reindeer husbandry	Hunting of moose	Cabin rent and fishing
Spring (April-May)	Calving		Sales of fishing licences and renting of cabins
Early summer (June)	Grazing after calving		
	Round-up and marking of calves		
Summer (June-July)	Grazing after marking		
Late summer and autumn (August-October)	Late summer and autumn grazing	Hunting and slaughtering	
Early winter (November-December)	Grazing	Hunting and slaughtering	
	Round-up, sorting and slaughter		
	Transport to winter grazing area		
Winter (December-March)	Winter grazing		
Late winter (March-April)	Transport to calving area		

Table 2. Indicators, indicator units and process units used in the analyses

Category	Indicator	Indicator unit	Process unit
Economic	Gross value added	€	kg meat or nr. of guest nights
	Production costs	€	kg meat or nr. of guest nights
Social	Full time employment	Number	Number of full time employed person eq.
Environmental	Fuel consumption	MJ	Litres of fuel
	Greenhouse gas emissions	kg CO ₂ eq.	kg of carbon

Data on resource use and economic performance of reindeer husbandry were collected from the Njaarke Sami village (Per Nilsson and Daana Fjällberg, Chairman of Njaarke Sami Village, pers. comm. 2014) and from Per Sandström who is a researcher at the Department of Forest Resource Management at SLU (2015). General economic and social information were acquired from published statistics (Statistics Sweden 1999, Statistik från Sametinget 2010). Although reindeer husbandry performance varies from year to year, for this study we used data from 2013.

Tourism, fishing and hunting are also economic activities in the Sami village (Table 4). We estimated incomes from these activities using information on the website of Njaarke Sami village (2017) and from the village's representatives Per Nilsson and Daana Fjällberg (pers. comm. 2014-2016). Other economic information was collected from the authorities from the County of Jämtland. The Njaarke Sami village had hunting rights to hunt 44 moose, which corresponds to about 4000 kg meat (carcass

weight of 250 kg per moose). As previously stated, it was assumed that the AFM scenario yielded 200 additional reindeer for slaughtering and required no supplementary feeding during winter compared to BAU and the other scenarios due to the assumed larger areas being suitable for grazing. This assumption was based on interviews with the representatives from the Sami village.

4 Results

The use of GPS collars reduced the number of person years working in reindeer husbandry from 8.3 to 6.9, which means a reduction in work load of 1.4 person years (Table 3). Without GPS collars the costs for labour and energy were higher. The GPS collars and GIS maps were helpful in locating reindeer and made it easier for the herders to find the most appropriate grazing sites. This made the work safer and faster. Although the labour costs were reduced, the cost reduction was less than the cost of the GPS system itself. The seasonal distribution of costs shows that the highest costs are made at the start of the reindeer year (Figure 4). Other major costs occurred at round-up and marking of the new-born calves in early summer (June) and collection and transporting to slaughter in late summer (September). Without GPS, energy use was higher as about 70000 MJ more were used, which corresponds to an increase in greenhouse gas emissions of about 4550 kg CO₂ equivalents. In this case study, adapted forest management resulted in an assumed higher number of reindeer slaughtered. In the adapted forest management scenario (with GPS), the gross value added increased to 105 197 €, which was 35 488 € higher than the business as usual scenario with GPS.

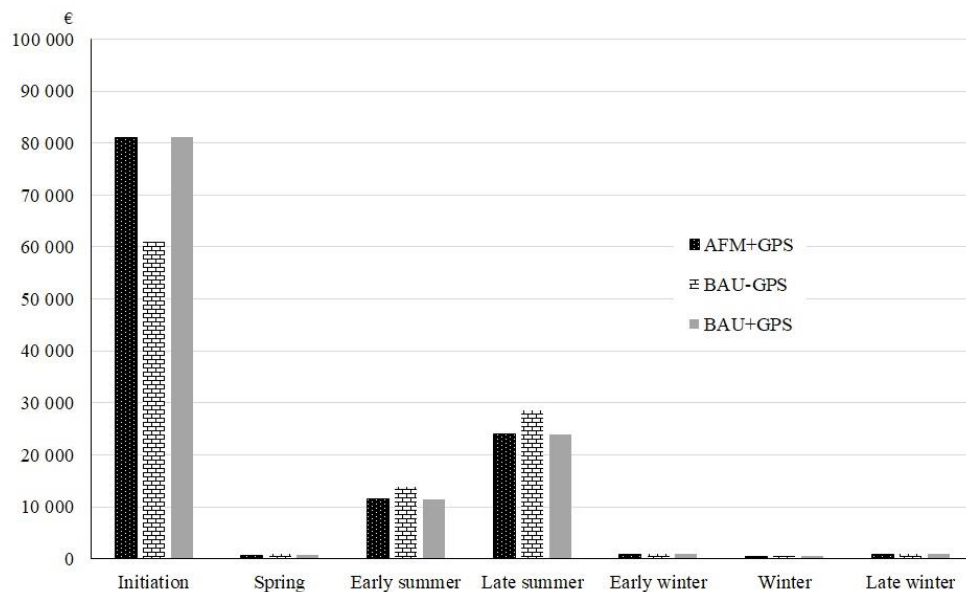


Figure 4. Seasonal distribution of the production costs (€) in three reindeer husbandry management alternatives: 1) Business as usual without GPS (BAU - GPS), 2) BAU with GPS (BAU + GPS), and 3) adapted forest management with GPS (AFM + GPS).

Table 3. Gross value added, total revenue, energy use, greenhouse gas emissions, and labour needs for hunting, fishing and renting of cabins, and of three reindeer husbandry scenarios: 1) Business as usual without GPS (BAU - GPS), 2) BAU with GPS (BAU + GPS), and 3) adapted forest management with GPS (AFM + GPS).

Indicator	Hunting	Fishing /cabins	Reindeer husbandry scenario		
			BAU - GPS	BAU + GPS	AFM + GPS
Gross value added, €	27 453	20 767	85 092	69 709	105 197
Total revenue, €	29 988	22 545	148 816	148 816	184 304
Revenue from meat, €	0	0	62 105	62 105	97 593
Other revenue, €	29 988	22 545	86 711	86 711	86 711
Production cost, €	2 536	1 778	107 010	119 618	119 618
Labour costs, €	0	0	43 286	40 511	40 511
Capital cost, €	925	0	17 573	24 048	24 048
Other costs, €	994	1 734	39 041	49 215	49 215
Energy costs, €	616	44	7 110	5 844	5 844
Energy use, MJ	19 542	2 873	478 511	407 464	407 464
GHG emissions, kg CO ₂ eq.	1 432	211	34 417	29 867	29 867
Labour, FTE	0.8	0.2	8.3	6.9	6.9

5 Wider considerations

The use of GPS tracking allows the Sami people to monitor the location and activity of their reindeer (Andersson and Keskitalo 2017). It also reduces the risk of accidents and incidents in the field and on roads for both reindeer and people. Knowledge about migration routes as recorded from the tracking devices provides information for better management and this could also serve as background information for consultation with forest owners in order to better take into account reindeer husbandry when planning new forest operations. In addition, the system can give the herders an early warning in case of predator harassment. GPS tracking can also be used for tracking the predators themselves, for instance lynx and wolverine (e.g. Mattisson 2011).

Another benefit is that the members of the Sami village become skilled in using information technology and this may provide additional communication benefits in sparsely populated areas. A drawback was that received incomes failed to cover costs for the GPS collars. Nevertheless, even though the financial benefits of the GPS collars are not very convincing, there are important benefits of using GPS collars related to work safety, land use planning, herd management and IT skills. Information on grazing areas will be absolutely necessary for future communications with other land users. When taking all benefits into account, the use of reindeer GPS collars is definitely worth considering as a sound and feasible management option.

The study also included a comparison of adapted forest management with the business as usual approach. Adapting forest management (AFM) increased the suitability of the area for reindeer husbandry. However it is anticipated that this will reduce the profitability of future timber harvest and the Gross Value Added of the forest value chain. The cost for adapting forest management taking into account reindeer husbandry will probably reduce the amounts of wood what can be harvested in the future and the gross value added of the forest value chain. However, the total gross value added of reindeer husbandry and forestry combined will probably increase.

6 Conclusions

The work in the Njaarke Sami village demonstrates that:

- 1) The use of GPS tracking enables a better monitoring of the reindeer herd
- 2) The use of GPS at current prices did not pay off financially
- 3) The benefits of using GPS are easier working conditions and better control of the herd, knowledge on migration routes and real-time tracking of predators.
- 4) Adapted forest management, paying proper consideration to important grazing areas, was estimated to increase the profitability of reindeer husbandry

7 Lessons learnt

The research on reindeer husbandry in Sweden primarily focused on i) the use of GPS tracking of reindeer to ease reindeer husbandry and ii) adapted forest management paying more consideration to the needs of reindeer husbandry. The key lessons learnt are outlined below.

- The GPS tracking enables a better monitoring and less risk of accident of reindeer and people in the field and with the traffic.
- Information about migration routes recorded by the tracking devices provides the basis for better management practice, including consultation with forest owners which is important for taking properly into account the needs of reindeer husbandry when planning new forest management operations.
- An additional benefit is that the Sami village will become skilled in using new technique.

8 Acknowledgements

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