Research and Development Protocol for Wood Pastures and Reindeer in Sweden

Project name	AGFORWARD (613520)
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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 (AGFORWARD 2014). 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 mainly contributes to the second objective. It contributes to the initial research and development protocol (Milestone 4; (3.3)) for the participative research and development network focused on the use of agroforestry in high value tree systems.

2 Background

Reindeer husbandry systems based on forest understorey resources in Finland, Norway and Sweden has been estimated to extend to 41.4 million ha (Jernsletten and Klokov, 2002). In Sweden, reindeer husbandry is managed alongside forestry and in the area of the Sami village of Njaarke since the late 19th century. The Sami villages have the legal right to use private and governmentally owned forest land in northern Sweden for grazing. The Sami settlement is older that the late 19th century, but the Sami's' relations to the land around their settlements have changed, due to the migration of other groups into the area. The coexistence between forestry and reindeer husbandry is currently regulated by Rennäringslagen (SFS, 1993) and the Swedish Forestry Act (Skogsstyrelsen, 2012). The former acknowledges the rights of the Sami village to the use of the land and the latter stresses that consultation with concerned residents from the Sami village is obligatory for owners of forest estates larger than 500 ha. In the areas where reindeer are allowed to be kept all year round, clear cuttings and road constructions should be planned in consultations with the local stakeholders. The Sami village is responsible for their management of the land.

The reindeer herd is kept in mountain areas when calving in spring and grazing during summer and autumn. In late autumn the herd are gathered before slaughter where after they walk or are transported to the forest land for winter grazing (Figure 1). During winter the grazing in the forest land are dependent of certain characteristics of the forest (Table 1). These are open mature stands that enable sight, protection from wind and snow and access to food, as both terrestrial lichens (e.g. *Cladonia* and *Cetraria* species) and arboreal lichens such as *Bryoria fuscescens* and *Alectoria sarmentosa*). Canopy coverage varies with the grazing site. The reindeers move between areas with different stem density depending on their need for protection, rest or food. 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 (Figure 2).

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. Several thinnings are made before the final cut. At final cutting standards are left on site to support natural regeneration.

Figure 1. Collection of reindeer before slaughter

Figure 2. Windmills in the far distance, power lines and dense *Pinus contorta* forests are constraints for the Sami village

3 Objective of trial

The objective of this study, decided in cooperation with stakeholders (Berg and Lind, 2014), is to evaluate sustainability indicators for forest operations and reindeer husbandry when using technical devices in order to track the movements of the herd. This will be done with or without adaptations of forest management to reindeer husbandry. Key questions include:

- What are the impacts on economic, social and environmental indicators of changes in forest operations and reindeer husbandry?
- Will anticipated profits in reindeer herding encourage further investments?
- Will allotted areas for winter grazing leave sufficient base for a winter herd with no complementary feeding?

Alongside these questions, a number of hypotheses can be evaluated:

- Safety for reindeer and Sami will be enhanced with GPS based devices for reindeer movements.
- The cost for winter feeding of reindeers will be reduced as well as the risk of fatal accidents.
- The average annual cut in forestry will be reduced as a result of adaptations of forest management to promote reindeer husbandry.

4 System description

The study is conducted in the area of Njaarke Same Village (Figure 3; Table 1). The reindeer herd consist of about 2000 animals during winter but the Sami village at Njaarke is legally allowed to have almost 3000 reindeer.

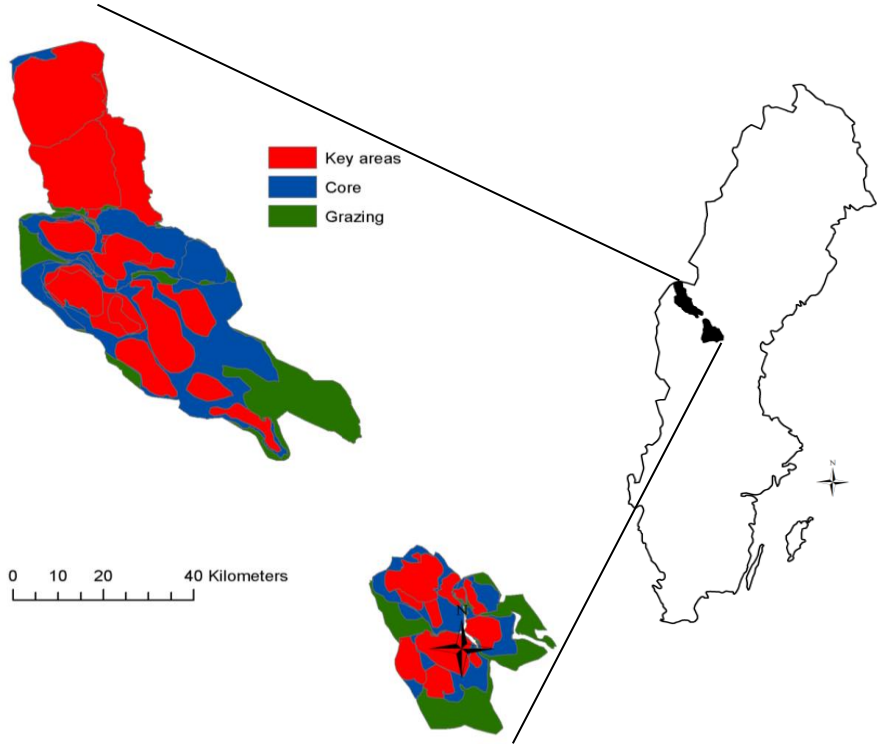

Figure 3. Classification of areas by reindeer husbandry plan and geographic location in Sweden (right). (The key areas, in red, are the most important areas for grazing, there are also core areas in blue, and the areas in green are less important). The grazing in winter is undertaken in the red areas in the south east, covering about 100,000 ha.

Table 1. Description of the site, with soil, tree, understorey, livestock, and climate characteristics

Site characteristics	
Area (ha):	504,500 ha in total including 281,000 ha of productive forest where annual production is greater than 1 m^3 ha^{-1}
Co-ordinates:	The Sami village is located at 63.5°N, 14.2°E
Site contact:	Torgny Lind, SLU
Site contact email address	Torgny.lind@slu.se

Soil characteristics (on productive forest land)	
Soil type (WRB classification)	Not available
Soil depth	Normally deep soils
Soil texture (sand%, silt%, clay%)	Sand 40 %, Silt 48 %, Clay 3 %

Tree characteristics (on productive forest land)	
System	Agroforestry system
Tree species (% of growing stock)	Norway spruce (50), Scots pine (33), Birch (12), Lodgepole pine (2), other broadleaves (2), Aspen (1)
Growing stock	142 m^3 ha^{-1}
Tree density[1]	2500 stems per ha on average in all forests age-classes, 1580 stems per ha forest older than 100 years.

Understorey characteristics (on productive forest land)	
System	Agroforestry system
Vegetation type (%)	Herbs (49), Bilberry (24), Lingonberry and Crowberry (13), Grass (12), Sedge and horsetail (1)
Coverage	Canopy coverage depending on site of grazing
Additional details	Low percentage of lichens < 1 %

Livestock characteristics		
System	Agroforestry system	Reference system*
Species	Reindeer	
Stocking density	2000 reindeer at winter (Grazing in the south-east area in winter, see Figure 3)	Higher number

Climate data**	
Mean monthly temperature	2.5°C (normal 1961-90)
Mean annual precipitation	543 mm (normal 1961-90)
Details of weather station (and data)	Frösön (63.1°N; 14.3°E)

* To which the agroforestry system is compared

** Swedish Meteorological and Hydrological Institute (SMHI)

[1] Number of stems with height > 1.3 m

5 Trial design and data collection

5.1 Description of design

The design involves one reference case and two scenarios (Table 2). The reference case is current forest management practice, and the two scenarios include management practices to promote reindeer husbandry.

Table 2. Description of the scenarios

Reference	Reindeer 1	Reindeer 2
Current forest management practices	Adaptations of forest management to promote better conditions for reindeer husbandry. Adaptations are for instance less soil scarification, no planting with Lodgepole Pine, more and harder pre-commercial thinning and thinning, and forests with longer rotation periods in some areas.	As Reindeer 1 but with inclusion of GPS tracking of reindeer

5.2 Data collection

Data on the forest stand, forest operations and reindeer husbandry will be collected for the scenarios suggested in Table 2. The forest land is owned by several owners such as the state, Sveaskog, private forest companies, and family owners.

Forest data

Biophysical data for the scenarios concerning forest conditions as stem diameter, growth and age distribution can be generated from sample plot data from the Swedish National Forest Inventory (NFI) (Fridman et al., 2014), and with the aid of Heureka (Wikström et al., 2011). The type and areas of adapted forest management will be determined from the Njaarke reindeer husbandry plan combined and forest data.

Forest operations data

The data will be obtained from landowners and open source data. This will include data about processes of the chain, the harvests and logistics (Figure 4). Several indicator values will be calculated with the aid of partial models, based algorithms of resources, costs, and performance of processes.

Reindeer husbandry data

Njaarke Sami village and Sametinget (2015) can provide specific and generic data for reindeer husbandry including hunting and other commercial activities provided by the Njaarke Sami village. This will include data about processes of the reindeer production chain, the composition of the herd during the seasons and its movements, animals to be slaughtered and losses (Figure 5).

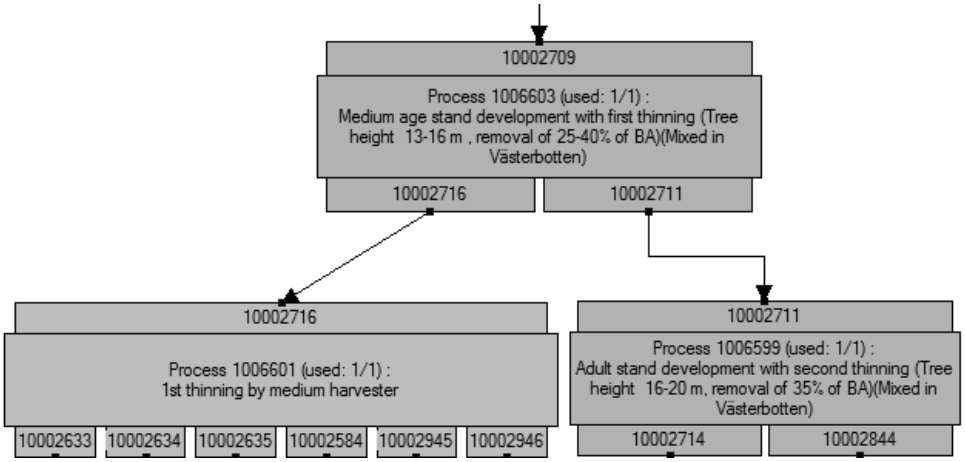

Figure 4. Example of processes and products related to forest operations. The delineated area above and under each process with numbers are representing incoming and outgoing products.

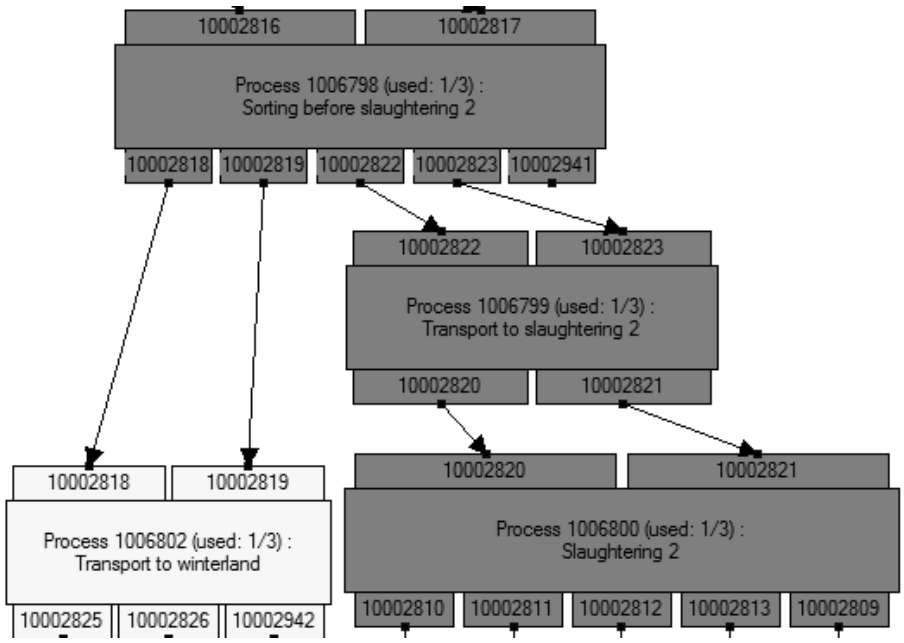

Figure 5. Example of processes and products related to reindeer husbandry. The delineated area above and under each process with numbers are representing incoming and outgoing products.

6 Modelling of the wood-pasture reindeer system

The two key value chains involved in forest and reindeer management can be modelled (Lindner et al. 2012), using data from the Njaarke Sami village, forest companies in the area, and government statistics.

6.1 Biophysical modelling

A set of assumptions regarding forest management practices and adaptation will be developed for the scenarios. Adaptations of forest management to endorse better grazing conditions will be based on a proposed forest policy made by the National Association of Swedish Sami (Samiid Riikkasearvi 2010) and input from Njaarke Sami Village. To compare the outcomes of different scenarios the software Heureka RegWise will be used. RegWise is a forestry decision support system developed by the Swedish Agricultural University SLU (http://www.slu.se/sha) which simulates the forest development and output of goods and services in periods of 5 years (Figure 6).

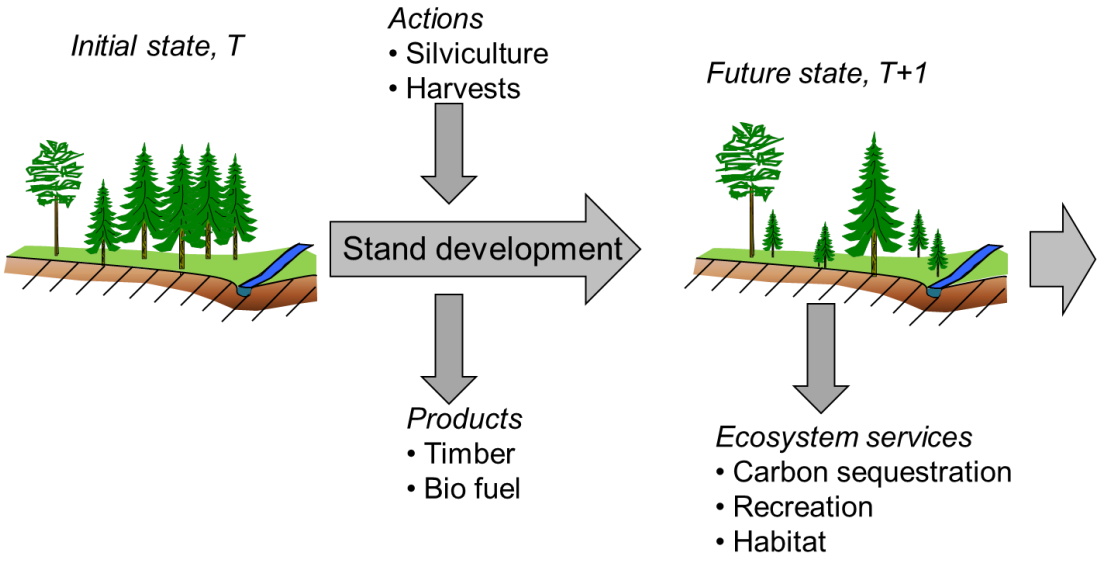

Figure 6. Schematic view of simulations of forest development with RegWise

Results of the simulations for each scenario will include the area of regeneration, development of growing stock, stand densities, and harvesting volumes distributed according to tree species for the period 2015 to 2035. The results for each scenario will be an input to the Tool for Sustainability Impact Assessment (ToSIA) (Lindner et al. 2012). Calculations are made in order to initialise the material flows in the forest operations chain.

6.2 Operational data

The prioritized sustainability indicators are presented in Table 3. These indicator data will used as inputs to ToSIA calculations for the different components of the system (Appendix A). The method for indicator calculations include partial modelling based on generic or specific data from studied organisations or generic data providers.

Table 3. List of sustainability indicators

Type of indicator	Indicator (type)	Indicator Unit	Process unit
Economic	Gross Value Added	€	m^3ub or kg meat
	Production costs	€	m^3ub or kg meat
Social	Full time employment	Number of full time working persons	1000 m^3ub or kg meat
	Fatal accidents	Number of accidents	1000 m^3ub or kg meat
Environmental	Greenhouse gas	kg CO_2eq	m^3ub or kg meat

7 Acknowledgements

The AGFORWARD project (Grant Agreement N° 613520) is co-funded by the European Commission, Directorate General for Research & Innovation, within the 7th Framework Programme of RTD, Theme 2 - Biotechnologies, Agriculture & Food. The views and opinions expressed in this report are purely those of the writers and may not in any circumstances be regarded as stating an official position of the European Commission. We also acknowledge the support from Njaarke Sami Village, the forest owner association Norrskog, Swedish Association of Swedish Sami, SCA, and the European Forest Institute.

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Appendix A. Example recording interface for the ToSIA data Client

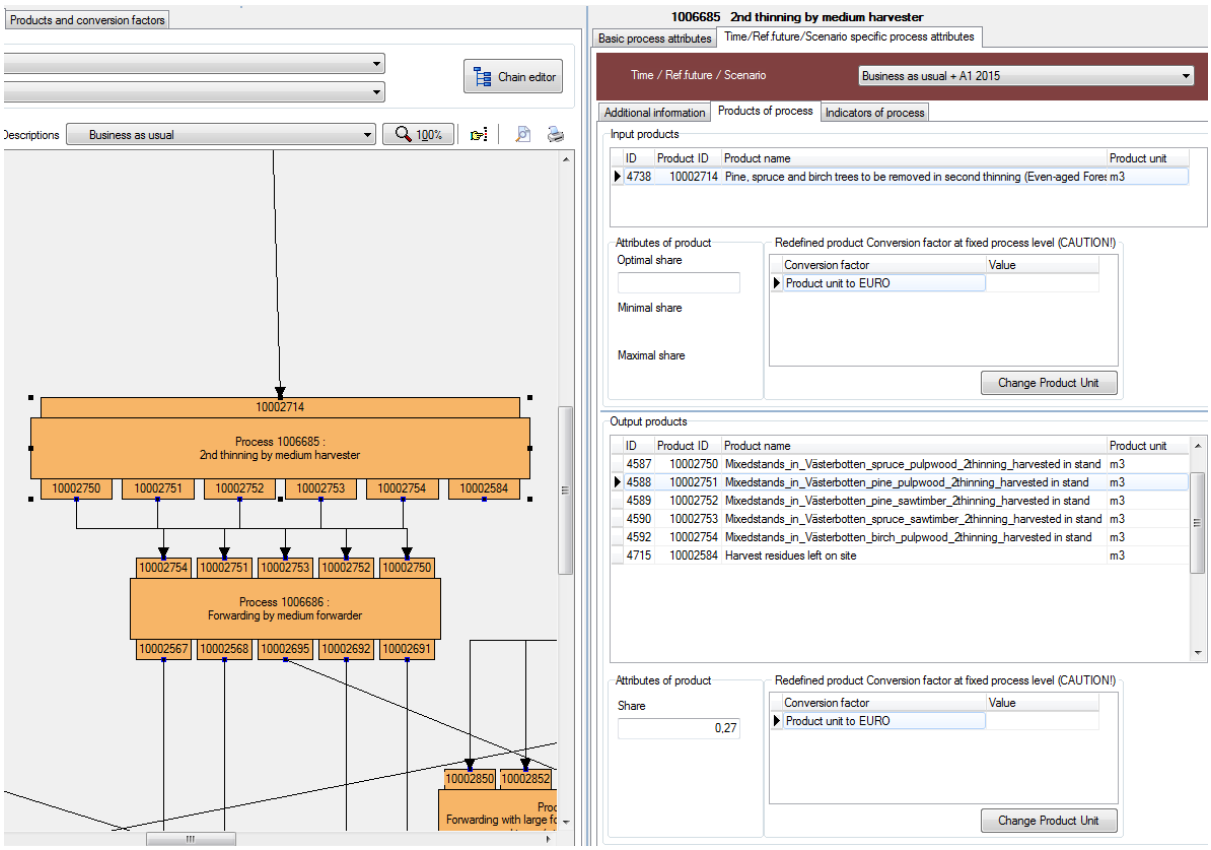

Figure A.1. The ToSIA data client provides an interface for input of indicator values for the chains and their processes and products. The figure shows the process 2nd thinning by medium harvester.