AGFORWARD
Agroforestry for Europe

Lessons learnt: Agroforestry in the Spreewald flood plain, Germany

Project name	AGFORWARD (613520)
Work-package	2: High Nature and Cultural Value Agroforestry
Specific group	Agroforestry in the Spreewald flood plain, Germany
Deliverable	Contribution to Deliverable 2.5: Lessons learnt from innovations related to agroforestry of high nature and cultural value
Date of report	20 November 2017
Authors	Penka Tsonkova, Jaconette Mirck and Michael Kanzler
Contact	penka.tsonkova@b-tu.de
Approved	Gerardo Moreno

Contents

AGFORWARD (Grant Agreement N° 613520) is co-funded by the European Commission, Directorate General for Research & Innovation, within the 7th Framework Programme of RTD. 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.

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 in that it focuses on the field-testing of an innovation within the "agroforestry of high nature and cultural value" participative research and development network. This report contributes to Deliverable 2.5: Lessons learned from innovations in agroforestry systems of high nature and cultural value.

2 Background

The initial stakeholder report (Tsonkova and Mirck 2014), the research and development protocol (Tsonkova and Mirck 2015a), and the system description report (Tsonkova and Mirck 2015b) provide background data on agroforestry in the Spreewald Floodplain, Germany. The Spreewald Biosphere Reserve in Germany is protected by Natura 2000. The entire reserve is considered a Special Protected Area, and 27% is considered an important flora-fauna-habitat (FFH). The Filower area, investigated in this study is part of the FFH area.

Hedgerows are man-made structures that were widely established in the past and were valued for their benefits, such as protection from wind and supply of biomass. They were periodically harvested for firewood every 5-15 years, and these interventions helped to maintain the hedgerow structure (DVL 2006). In recent decades, trees in hedgerows have not been harvested due to a reduced need for firewood and the high harvest costs (Reif and Richert 1995; DVL 2006). Moreover, due to nature protection regulations and lack of ownership rights, farmers are not allowed to harvest hedgerow trees without a special permission.

In addition to the lack of management, hedgerow regeneration in the Filow area has been inhibited, as a consequence of recent extreme weather events (for example, the flood events in 2010 and 2013). The occurrence of flooding events has been exacerbated by a lack of maintenance of the small waterways developed in the past to improve drainage in the area. As a consequence, the occurrence of stagnant water impeded the vitality and resulted in an increased susceptibility to *Phytophthora alni* of black alder (*Alnus glutinosa*), the main tree species in the area (Riek and Strohbach 2004).

A rejuvenation strategy is necessary in order to maintain this historical agroforestry system and protect the provision of important ecosystem services. Rejuvenating these hedgerows demands a new approach which complies with the limitations of the regulations in the nature protection area, while taking into account the historical use of the hedgerows that was typical in the past.

3 Activities

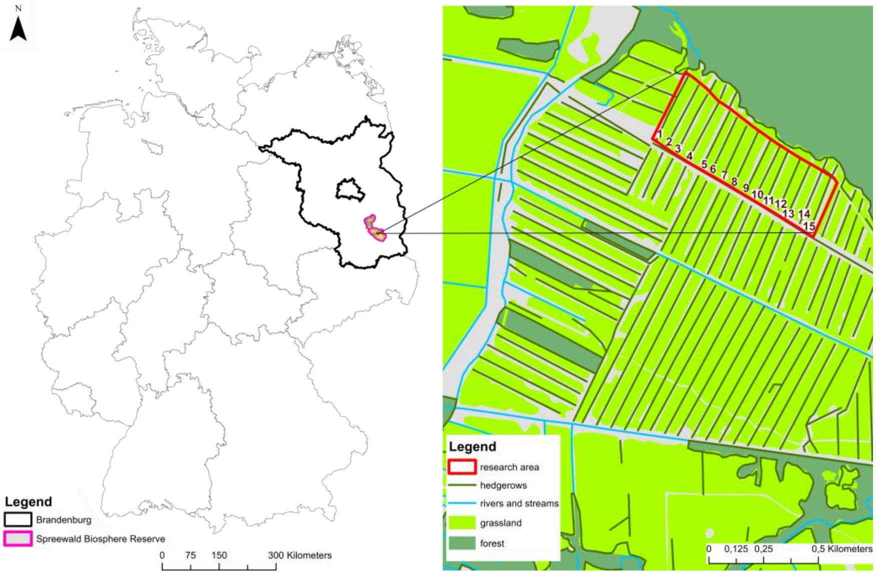
The activities included the following:

1. Vegetation assessment and development of a planting strategy for establishing new hedgerows
2. Assessment of biomass potential and the effects on additional benefits

4 Methodology

The research site, located in the Spreewald Biosphere Reserve, is characterized by a small scale mosaic of hedgerows with grassland in between. Table 1 provides a description of the specific case study system.

Table 1. Description of the specific case study system

Specific description of site	
Area	109 ha
Co-ordinates	51°52'N;14°4'E (51.87186654N, 14.07097541E)
Site contact	BTU contact: Jaconette Mirck and Penka Tsonkova
Site contact email	jmirck@gmail.com; penka.tsonkova@b-tu.de
Example photograph	
Map of system	 Map of Germany with location of the Spreewald Biosphere Reserve and the Filower area, where red line delineates the trial field with 15 hedgerows

Climate characteristics	
Mean temperature	9.4°C
Mean annual precipitation	570 mm
Details of weather station (and data)	Data from 01/01/1981-31/01/2010 (available here) for the Luebben-Blumenfelde weather station (id: 3083, 51°56'N, 13°53'E)
Soil type	
Soil type	Gleysol
Soil texture	Loamy sand
Groundwater	Groundwater depth between 10 and 80 cm
Tree characteristics	
Species and variety	Trees include black alder (*Alnus glutinosa* (L.) Gaertn.), black poplar (*Populus nigra* L.), bird cherry or hackberry (*Prunus padus* L.), English oak (*Quercus robur* L.), and willow (*Salix* spp.) Shrubs include glossy buckthorn (*Frangula alnus* Mill.), common buckthorn (*Rhamnus cathartica* L.), buckthorn (*Rhamnus alaternus* L.), wild rose (*Rosa canina* L.), blackberry (*Rubus sectio Rubus*), European cranberry bush (*Viburnum opulus* L.), and hops (*Humulus lupulus*)
Inter-row spacing	~50 m
Tree protection	None
Crop/understorey characteristics	
Species	Sedge (*Carex* spp), such as lesser pond-sedge(*Carex acutiformis*), meadow soft grass (*Holcus lanatus*), creeping buttercup (*Ranunculus repens*), rabbitfoot clover (*Trifolium arvense*), bitter dog *(Rumex obtusifolius*), and reed sweet-grass (*Glyceria maxima*)
Management	The grassland is extensively managed through mowing
Fertiliser, pesticide, machinery and labour management	
Fertiliser, Pesticides	None
Machinery	Mowing
Labour	Grassland: mowing by machinery
Livestock management	
Species and breed	Cattle which is currently not allowed on site

In 2015, 15 hedgerows in the trial area were characterised according to the proportion of tree and shrub species within the row and hedgerow density. Subsequently, a detailed vegetation assessment was conducted in hedgerows 13 and 15. Both hedgerows were divided into 6 plots each with a length of 20 m. The tree and shrub species within these plots were recorded. The findings of this assessment and tree and shrub species suitable for these site conditions according to the literature, were used to design a planting strategy for estalishing new hedgerows. The cost of establishing new hedgerows was determined by collecting non-binding offers from local companies. In addition, funding sources for these activities were investigated.

In order to assess the biomass potential of the historical use of this system for firewood, measurements of tree height and tree diameter at breast height (DBH) were carried out in seven hedgerows (1-4 and 13-15) in 2017. In addition, the species of trees and shrubs and their proportion were determined. The measurements in each hedgerow took place in five plots, each 20 m long, which were equally distributed throughout the total hedgerow length. Accordingly, the results were presented for a 100 m2 plot assuming that biomass utilisation takes place in 20 m x 5 m sections in order to preserve the habitat function of hedgerows. The merchantable tree volume (*V*) in solid cubic meters (scm) is the product of tree basal area (*g* ; units: m^2), tree height (*h*; units: m) and a form factor (*f*) that converts total tree volume to merchantable tree volume:

$$V_{scm} = g \times h \times f \qquad [1]$$

$$g = (DBH \div 2)^2 \times \pi \qquad [2]$$

The theoretical and technical biomass potentials were calculated. Theoretical potential refers to the maximal potential considering the total biomass. The technical potential includes the biomass that can be harvested due to the limitations of being in a nature protected area and for protecting landscape aesthetics. During harvest about 20% of the calculated biomass volume (V_{scm}) is lost with equal proportions lost by deducting for tree bark and losses during harvest (V_{hscm}). For the estimation of revenues V_{hscm} was converted to volume in stacked cubic metre (V_{stcm}).

In order to calculate the costs of biomass harvesting it was assumed that trees were cut manually into 1 m stems, by using a chainsaw. The labour required for harvesting was calculated based on standardized time necessary for harvesting trees based on their DBH (KTBL 2006). In addition removing the rootstocks of older trees is necessary, which can be conducted by a stump grinder, with labour time increasing proportionally to tree DBH (KTBL 2006). The removal of shrubs can be conducted by using a brush cutter (KTBL 2006). The hourly labour costs were used according to the current tariff register of Berlin and Brandenburg (ISAS 2017). It was also assumed that an additional proportion of tree biomass was collected by firewood collectors at their own expense.

Net revenues were estimated by subtracting the costs of tree harvesting from the revenues generated by selling biomass as firewood according to the scenarios in Table 2.

Table 2. Description of scenarios used for estimating net revenues

Scenarios	Description
S1	Net revenue generated by 1 m stems, round, sold as firewood collected on site, at the price of 40 €/stcm according to the Forestry Association of Brandenburg (FAB).
S2	Net revenue generated by 1 m stems, round, sold as firewood collected on site at the price of 40 €/stcm (according to FAB). An additional 10% of wood is utilised by firewood collectors at the price of 15 €/stcm according to FAB.
S3	Net revenue generated by 1m stems, round, sold as firewood collected on site, at the price of 57 €/stcm (according to the highest price in eastern Germany for the period 2016/2017 from an information portal for heating with wood)
S4	Net revenue generated by 1 m stems, round, sold as firewood collected on site at the price of 57 €/stcm (according to the highest price in eastern Germany for the period 2016/2017 by the Information portal for heating with wood). An additional 10% of wood is utilised by firewood collectors at the price of 15 €/stcm (according to FAB).

In order to account for hedgerow diversity, evenness (E) was calculated based on the Shannon-Index (H') and the maximum of H' (H'_{max}):

$$E = \frac{H'}{H'_{max}} \qquad [3]$$

To assess the effect on soil, in 2016, soil samples were collected within hedgerow 7 (previously flooded) and hedgerow 13 (drier location) and the neighbouring grassland areas, at depths of 0-10, 10-30, and 30-60 cm.

5 Results

5.1. Initial vegetation assessment and development of planting strategy

The aim of this study was to establish a planting strategy including main species and their proportion, estimate costs of establishing new hedgerows includung material and labour costs, and identify a funding source for carrying out these activities.

5.1.1 Planting strategy

The results of the initial vegetation assessment can be found in Tsonkova and Mirck (2015b). The first rejuvenation activites in the research area were planned for five hedgerows in total, with 60% rejuvenation of three hedgerows and a complete rejuvenation of two hedgerows. The focus was set on the hedgerows in the middle of the research area which were most heavily degraded as a consequence of the flooding events. According to local regulations only native species are allowed to be used (MLUL 2013). The trees and shrub species selected for replanting as well as the planting design are shown in Figure 1. Every sixth tree is long-lived and will not be harvested, while fast-growing trees should be harvested in 10-15 years rotations.

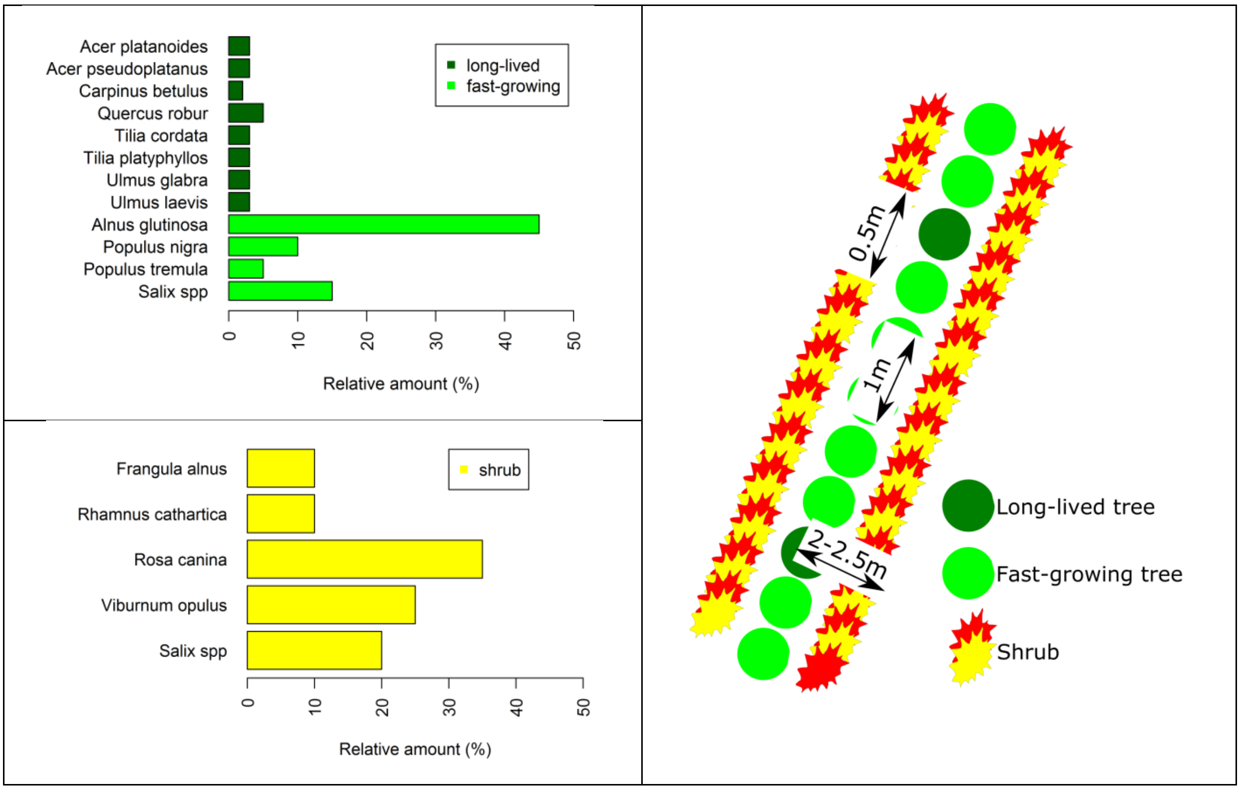


Figure 1. Relative proportion of tree and shrub species to be planted in selected hedgerows in the research area

5.1.2 Costs of establishing new hedgerows

The costs of planting hedgerows with a total length of 570 m (60% rejuvenation of three hedgerows and a complete rejuvenation of two hedgerows) and fencing hedgerows with a total length of 750 m (five hedgerows) obtained from local companies are presented in Figure 2. The costs differed depending on the planned activities, such as maintenance of trees and replacement of trees that did not survive. Criteria for selecting the firm for planting included the willingness to comply with local regulations, experience with similar projects and knowledge of the area. Fencing is an indispensable measure in the area, due to risk of damage for the newly planted trees by domesticated and wild animals and should be applied in the first five years after planting. According to the non-binding offers received, the average cost of planting amouted to 24 €/m and the costs of fencing to 18 €/m (for both sides of the hedgerow).

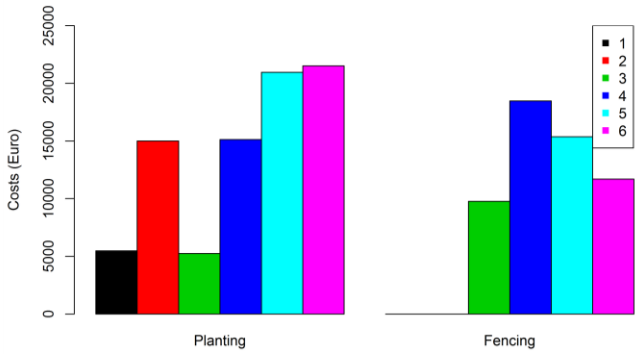


Figure 2. Costs of planting of hedgerows with total length of 570m and fencing of hedgerows with total length of 750 m, according to non-binding offers, submitted by local companies

In addition, it was considered that in order to improve drainage in the area, it was necessary to restore the small waterways, as it was practiced in the past. The excess sediment obtained after digging out the soil to create waterways should be used to develop small man-made soil walls along the waterways (lower than 50 cm). Planting alder trees on these elevated soil areas can improve their growth and survival, and decrease their susceptibility to *Phytophtora alni* (Riek and Strohbach 2004). In order to be effective, the created waterways should be connected to the main channel, located in the middle of the Filow area. As a pilot project, 12 hedgerows were considered for the establishment of waterways with a total length of 2400 m. According to a non-binding offer submitted by a local company, the costs of clearing the current waterways and restoring them within these hedgerows amounted to 18 €/m.

5.1.3 Funding source

Financial support for studies and investments associated with the maintenance, restoration and upgrading of the cultural and natural heritage of villages, rural landscapes and high nature value sites is provided under Article 20 of Regulation 1305/2013. Under this measure the Ministry of Rural Development, Environment and Agriculture of Brandenburg provides support for enhancing natural heritage and environmental awareness. It aims to promote and conserve natural heritage and focuses specifically on supporting the development of Natura 2000 sites. Within this program, a proposal for the renovation of the hedgerows in the Filow area was jointly prepared and submitted by the Biosphere Reserve Spreewald in 2016. A simplification of the legal procedure would improve the application process and potentially increase farmer's interest in these and other measures related to agroforestry.

More about farmer's perception of agroforestry and the administrative burden regarding agroforestry systems can be found in Tsonkova et al. (2016 and 2017).

5.2 Biomass assessment

The aim of this study was to determine potential biomass volume and the costs of biomass harvesting, to assess net revenues from harvested biomass, as well as the effects of hedgerows on additional benefits.

5.2.1 Biomass potential

The relative proportion of trees and the distribution of DBH in the investigated hedgerows are shown in Figures 3a and 3b, respectively. The estimated technical potential ranged between 1.3 and 4.2 *V*scm/100 m^2, amounting to 20-75% of the theoretical potential, which was between 3.1 and 7.0 Vscm/100 m^2 (Figure 3c). The majority of harvestable trees had DBH between 30 and 50 cm (Figure 3d).

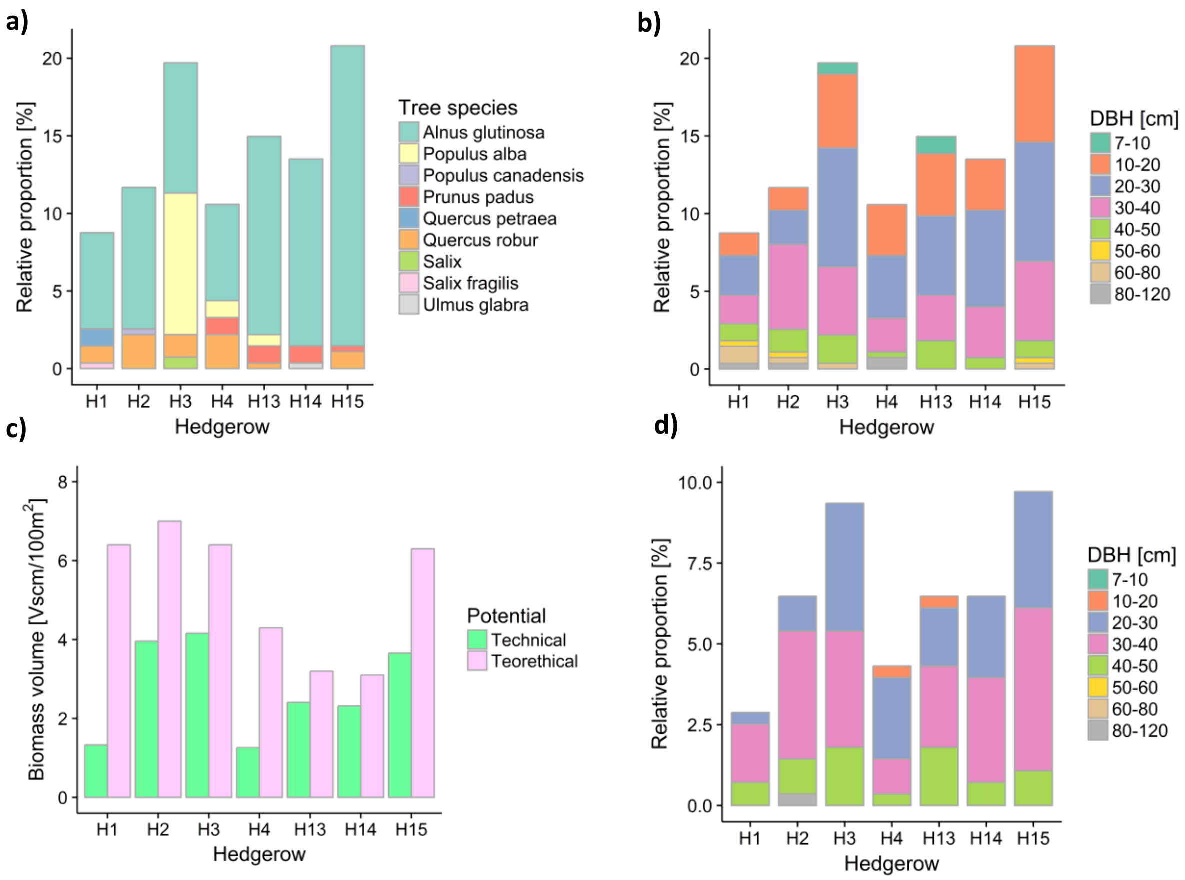


Figure 3. a) Relative proportion [%] of tree species; b) Relative proportion [%] of diameter at breast height (DBH); c) Biomass volume [Vscm/100m^2] for technical and theoretical biomass potential; and d) Relative proportion [%] of trees which were suitable for harvesting in the seven hedgerows

Most of the harvestable trees were black alder. Trees with DBH > 50 cm which were mostly represented by *Quercus* spp. and a single *Ulmus* spp. and *Salix fragilis*, would not be harvested, but rather kept for retaining the nature conservation value and the cultural appearance of the system. In H2, a *Populus canadensis* was found, that was not native to the area and despite its old age was considered suitable for removal. Younger trees with DBH < 20 cm were assumed to be left unharvested in order to replenish future biomass reserves. It is noteworthy, that very few young trees with DBH < 10 cm were found in the investigated area, indicating a lack of natural rejuvenation.

As the research area is located in the buffer zone of the Spreewald reserve, forestry activities are subordinated to nature conservation. In the forestry area located within this buffer zone up to 10 Vhscm/ha per year can be harvested MLUL (2012). The amount of wood that was actually harvested in the district of Oberspreewald between 2000 and 2010 MLUL amounted to 3.3 Vhscm/ha per year (2012). To estimate the potential amount of biomass feedstock in the research area, 10 hedgerows (Hedgerows 1-4 and 10-15), representing three main hedgerow types, according to the coverage of tree and shrub layers in Tsonkova and Mirck (2015b), were studied (Figure 4). For these three hedgerow types the average biomass potential of harvested biomass was estimated (Figure 4). These 10 hedgerows covered a total area of 1 ha. As mentioned, the biomass harvested per year should not exceed 10 Vhscm/ha, which suggests that depending on the type four to five 100 m^2 (20 m x 5 m) plots can be harvested per year (Figure 4).

Type	Shrub layer (%)	Tree layer (%)	V_{scm}/100m^2 mean (s.e.)	V_{hscm}/100m^2 mean (s.e.)
1 (n=3)	0-33	66-100	3.15 (±0.91)	2.52 (±0.89)
2 (n=3)	0-33	33-66	2.41 (±0.69)	1.93 (±0.68)
3 (n=1)	33-66	66-100	2.41 (NA)	1.93 (NA)

V_{scm} technical biomass potential; V_{hscm} technical biomass potential after deducting for harvesting losses

Figure 4. Average biomass potential according to hedgerow types, determined by the proportion of tree and shrub layers

5.2.2 Costs of biomass removal

The costs of tree harvesting by using a chainsaw, shrubs removal by using a brush cutter and roots removal by using a stump grinder for seven hedgerows are presented in Figure 5. Tree harvesting constituted the main costs which varied between 85 and 245 € per 100 m^2 (Figure 5). The highest costs were incurred in H15, where also the highest number of trees was considered suitable for harvesting, due to its monotonous structure, consisting almost exclusively of black alder. The majority of these trees were however young with DBH < 40 cm and were expected to regrow after cutting, hence no roots removal was necessary. The ability of trees to regrow after cutting is species and age dependent and for alder trees it is reduced after the age of 20-30 years (LUBW 2007). The total cost of rootstocks removal for trees with DBH > 40 cm and shrubs removal ranged between 19 and 40 € per 100 m^2 (Figure 5). Additional costs are incurred by the fact that the trees suitable for harvesting have to be marked, which is usually conducted by the responsible district forester. The cost of this activity would amount to additional 200 € per hectare, assuming a work load of 4 h/ha and an hourly cost of a forester of 50 €/h (Romer et al. 2016).

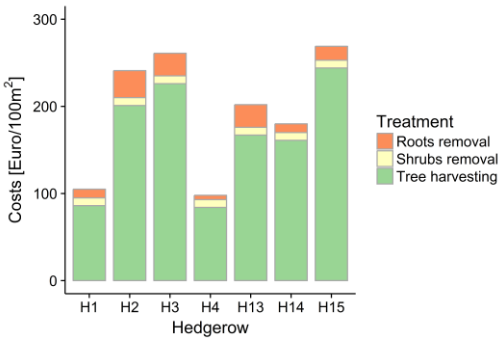


Figure 5. Costs [Euro/100 m^2] of tree harvesting by using a chainsaw, shrubs removal by using a brush cutter and roots removal by using a stump grinder for seven hedgerows

5.2.3 Revenues

The net revenues obtained by subtracting the costs of biomass harvesting from the revenues generated by selling biomass as firewood, calculated according to the scenarios in Table 2, are presented in Figure 6. At lower prices for firewood in Scenarios 1 and 2, the revenues were not sufficient to compensate for the harvesting costs, which resulted in a financial loss. At higher prices for firewood the revenues were higher. In scenario 4, the profit margin was positive in 5 out of 7 hedgerows and varied between -3 and 69 €/100 m^2. In three hedgerows (H1, H4, and H15) the positive revenue was due to the fact that a higher proportion of the wood than its merchantable volume was utilised by firewood collectors. After subtracting the costs of root and shrub removal only H2 and H3 remained positive with 12 and 4 €/100 m^2 in S3 and 28 and 22 €/100 m^2 in S4, respectively. These hedgerows were characterised by a dominant proportion of tree and fewer shrubs (Figure 4). This hedgerow structure was proposed as the most economically viable option as it demonstrated the highest biomass potential.

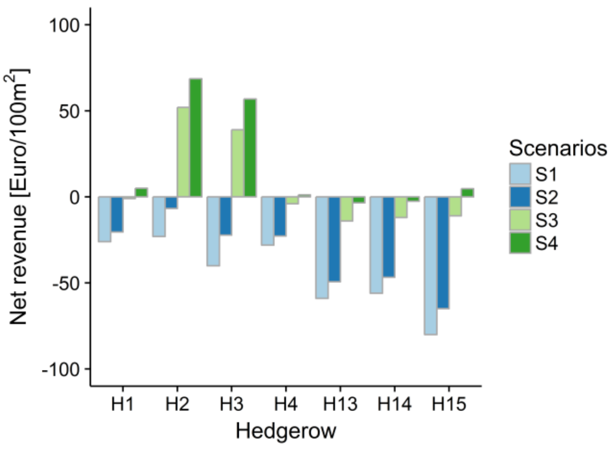


Figure 6. Net revenues [Euro/100 m^2] calculated for seven hedgerows, according to scenarios S1-S4 in Table 2.

Harvesting trees with larger DBH such as *Quercus* spp. and *Ulmus* spp. would improve the net revenues. The value of these trees as well as their calorific value is greater than for black alder. More importantly, it should be further considered that maintaining tree hedgerows would provide additional environmental benefits which currently do not have a financial benefit.

5.2.4 Additional benefits

Additional benefits provided by trees include system diversity, protecting soil and regulating the natural water balance, as well as improvement in landscape aesthetics.

According to the results for evenness H1-H4 demonstrated the highest diversity (Figure 7a). On the other hand, H13-H15 were largely dominated by black alder. Conversely in these hedgerows, shrubs were more equally distributed than these in H1-H3 with predominant tree layer (Figure 7b). New planting should consider maintaining high diversity of trees and shrubs as it was suggested by the planting strategy in this study. A portion of dead wood should be kept on the site for its ecological value.

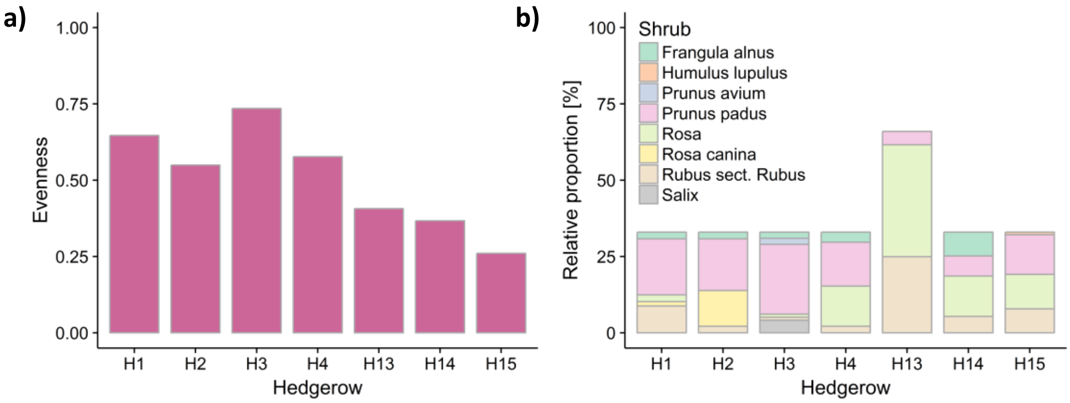


Figure 7. a) Evenness and b) relative proportion [%] of shrubs coverage within the seven hedgerows

One of the main threats for gleysols is the loss of soil carbon (C) due to lowering of the groundwater table. Soil C for the upper layer (0-10 cm) was higher for the tree hedgerow than under grassland (Figure 8). In the previously flooded location, where hedgerows have degraded this difference was not statistically significant ($p > 0.05$, Tukey's HSD test). At the drier location, the difference between hedgerow and grassland was statistically significant for 0-10 cm and 10-30 cm ($p < 0.05$, Tukey's HSD test). In addition, in H7 and G7, the highest C values were measured for soil depth of 30-60 cm, while in H13 and G13, C values decreased with depth. The mineralisation and release of C in the Spreewald soils is strongly influenced by the wetland hydrology (Riek and Strohbach 2004). In order to protect these soils, the preservation of the natural water balance is essential. This is possible through the existence of proper drainage works. In order to improve the drainage of water after flooding events, the restoration of the historical waterways in the Filow area and replanting of hedgerows on elevated soil walls lower than 50 cm was suggested as a reasonable strategy. These measures were expected to improve the soil and water quality in the field as well as the growth conditions for alder trees.

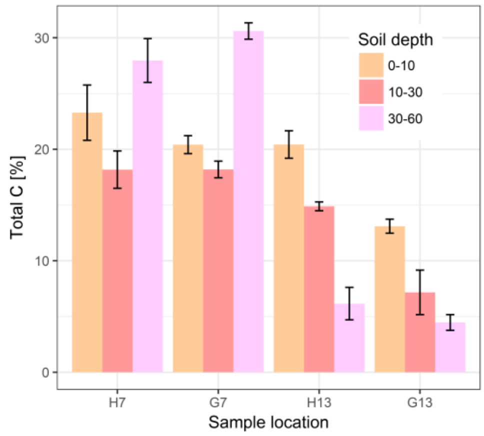


Figure 8. Mean total carbon (C) ±SE [%] measured within hedgerow (H) and the neighboring grassland (G) at a previously flooded location (H7 and G7) and at a drier location (H13 and G13) (n=4).

According to Marks et al. (1992) the value of the landscape for recreational purposes increases with the proportion of the edge of tree areas (hedgerows or forests). With its small-scale hedgerow mosaic, the Filow area represents a region with a unique character. The planned small scale activities would not cause a severe landscape disturbance and would allow for hedgerow structure improvement resulting in enhanced landscape aesthetics.

5 Main lessons

Preliminary results from the investigations in the Filow area can be summarized as follows:

1. In order to reduce flooding events, the restoration of the small historical waterways was suggested. Restoration of these waterways and establishment of new hedgerows requires a significant financial investment and is possible only with an external funding source. Fencing is costly but indispensable in the first five years after planting, due to the risk of damage by wild animals.
2. A simplification of the application process for funding could increase farmer's interest in the proposed measures. In addition to increased access to subsidies, improved regulation of harvesting rights is necessary. In addition, land tenure is a challenge as well; due to the fact that the land was rented and it was divided in numerous small parcels, obtaining permission from land owners was a very time consuming process [Moreover, one landowner did not give his consent for hedgerow intervention].
3. Utilisation of the biomass by firewood collectors can improve the economic profitability of the hedgerow system. The advantage is that firewood collectors can make use of a higher volume proportion than the merchantable biomass volume. Moreover, small scale harvesting can be practiced gradually in compliance with the sustainable rates of biomass harvesting, which resembles the historical biomass use of this system.
4. Hedgerows with a predominating tree proportion were the most economically viable option as it demonstrated the highest biomass potential. Maintaining trees would result in the provision of additional benefits, which are currently not taken into account financially.

6 Acknowledgements

The AGFORWARD project (Grant Agreement No. 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.

7 References

Deutscher Verband für Landschaftspflege (DVL) e.V. (2006). Landschaftselemente in der Agrarstruktur - Entstehung, Neuanlage und Erhalt. DVL-Schriftenreihe "Landschaft als Lebensraum", Heft 9, 122 S.

Forestry Association of Brandenburg – Brandenburg die Forstwirtschaftliche Vereinigung Brandenburg w.V. (FVB w.V.), Available online: http://www.fvb-wv.de/startseite.html

Information portal for heating with wood–Infoportal zum Thema Heizen mit Holz. Preisindex für den Handel mit Brennstoffen auf Holzbasis (Kaminholz, Holzbriketts, Holzpellets und Holzhackschnitzel) für die Heizsaison 2016 / 2017, Available online: http://www.kaminholz-wissen.de/

KTBL – Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. (2006). KTBL Datensammlung Landschaftspflege (2005). Autoren: Ackermann I, Baals C, Hundsdorfer M, Kraut D, Rothenburger W, Sauer N. Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. p. 100

LUBW - Landesanstalt für Umwelt, Messungen und Naturschutz Baden-Württemberg (2007). Gehölze an Fließgewässern, SchwaGeDruck, Rheinstetten, p. 112

Marks R, Müller MJ, Leser H, Klink HJ (1992). Anleitung zur Bewertung des Leistungsvermögens des Landschaftshaushaltes. Forsch. zur Deutschen Landeskunde, vol. 229. Trier (2nd ed.; 1st ed. 1989).

MLUL (2012). Ministerium für Ländliche Entwicklung, Umwelt und Landwirtschaft des Landes Brandenburg. Bericht zur Überprüfung des UNESCO BR Spreewald. Last accessed 26.04.2016 at: http://www.mlul.brandenburg.de/media_fast/4055/br_evaluierung.pdf

MLUL (2013). Amtsblatt für Brandenburg. Nr. 44 vom Oktober 2013. Sicherung gebietsheimischer Herkünfte bei der Pflanzung von Gehölzen in der freien Natur. http://www.mlul.brandenburg.de/media_fast/4055/ErlassGG2013.pdf

Riek W, Strohbach B (2004). Einfluss der Forstwirtschaft auf Böden und Wasserhaushalt im Spreewald. Beitr. Forstwirtsch. u. Landsch.ökol. 38(1): 19–23.

Romer T, Kaufman T, Kammermeier M (2016). Ökonomische Wertigkeit von Flurgehölzen und Kurzumtriebsplantagen in der Agrarlandschaft. Bachelorprojekt an der Studienfakultät Forstwissenschaft und Ressourcenmanagement der Technischen Universität München, p. 47

SIAS – Senatsverwaltung für Integration, Arbeit und Soziales (2017). Gemeinsames Tarifregister Berlin und Brandenburg. Kurzübersichten über tarifliche Arbeitsbedingungen in verschiedenen Branchen in den Ländern Berlin und Brandenburg. Stand: Juni 2017. p. 65

Tsonkova P, Mirck J (2014). Initial Stakeholder Meeting Report: Agroforestry in the Spreewald flood plain, Germany. 20 October 2014. 8 p. Available online: https://agforward.eu/index.php/en/agroforestry-in-the-spreewald-flood-plain-germany.html

Tsonkova P, Mirck J (2015a). Research and Development Protocol: Agroforestry in the Spreewald flood plain, Germany. 31 March 2015. 11 p. Available online: http://agforward.eu/index.php/de/agroforestry-in-the-spreewald-flood-plain-germany.html

Tsonkova P, Mirck J (2015b). System Report: Agroforestry in the Spreewald flood plain, Germany. 10 November 2015. 20 p. Available online: http://agforward.eu/index.php/de/agroforestry-in-the-spreewald-flood-plain-germany.html

Tsonkova P, Mirck J, Böhm C, Fütz B, Freese D (2016) The lack of a clear definition of agroforestry hinders its acceptance in Germany 3rd European Agroforestry Conference – Montpellier, 23-25 May 2016 Farmers' testimonies across Europe. pp 259–262

Tsonkova P, Mirck J, Böhm C, Fütz B (2017). Addressing farmer-perceptions and legal constraints to promote agroforestry in Germany, Agroforestry Systems, submitted