Identifying obstacles to the design and implementation of payment schemes for ecosystem services provided through farm trees

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Abstract
An important determinant of ecosystem services provision from European farmland is the amount and spatial arrangement of trees, shrubs, and woodlands that are integrated into the respective land use systems. Farm trees are considered ‘keystone structures’ of agroecosystems because of their disproportionally large ecological value (relative to their low abundance), but are threatened by agricultural intensification, land abandonment, and urbanization. While the preservation of farm trees is a component of several command-and-control approaches and while numerous payment schemes for ecosystem services (PES schemes) provided through agricultural practices do in general exist, there are few incentive-based policies that specifically target the conservation of farm trees. This paper uses an institutional economics framework for the analysis of PES schemes that enhance the establishment, protection, and management of farm trees. Using the German state of Saxony as a case, it elaborates on the reasons for the very reluctant participation of farmers in these schemes. The obstacles identified include high production and opportunity costs, contractual uncertainties, and land tenure implications. Further, since scheme adoption has been low compared with the total area covered by the respective farm tree types, the PES schemes alone cannot explain the substantial increase in number and size of some farm-tree types. Options to improve participation comprise regionalised premiums, result-oriented remuneration, and cooperative approaches. The example of PES schemes for farm trees highlights one of the major challenges for the protection and preservation of cultural landscapes: they are man-made and thus need to be preserved, managed, and maintained continuously.

Keywords: Payments for ecosystem services (PES), agroecosystems, trees outside forests, institutional economics, East Germany, Saxony

1. Introduction

With estimates for agricultural crops and pasturelands ranging between 24% and 38% of the global land area, the ecological services that agricultural systems provide are of utmost societal importance (Swinton *et al.* 2007). The agricultural sector is considered to be the most important “ecosystem services industry” by the Millennium Ecosystem Assessment (MA 2005). Depending on the specific agricultural system, provision of food, fibre, and fuel can be accompanied not only by a range of regulating and cultural ecosystem services, but also by dis-services to society, for example habitat loss, nutrient runoff, or pesticide poisoning of non-target species (Zhang *et al.* 2007). An important determinant of ecosystem services provision from European farmland is the amount and spatial arrangement of trees, shrubs, and woodlands that are integrated into the respective land use systems (Auclair *et al.* 2000). These landscape elements have been conceptualized as ‘farm trees’ (Arnold & Deewes 1997) or ‘trees outside forests’ (FAO 2001). The FAO (2000: 40) defines them as ‘all trees excluded from the definition of forest and other wooded lands’. Farm trees may be a spontaneously occurring resource or they may have been deliberately planted, domesticated, and cultivated (FAO 2001). Farm trees are considered ‘keystone structures’ of agroecosystems (Gibbons *et al.* 2008) because of their disproportionally large ecological value (relative to their low abundance). They provide important ecosystem services, such as buffering groundwater pollution (Ryszkowski & Kedziora 2007) or controlling surface runoff and soil erosion (Pattanayak & Mercer 1997). As a visual component of agricultural landscapes they offer important cultural services (McCollin 2000). Only recently has the contribution of farm trees towards the mitigation of (Nair *et al.* 2009) and adaptation to (Verchot *et al.* 2007) climate change been acknowledged. Farm trees also assist adaptive responses of organisms and, thus, can help to overcome the interacting negative effects of climate change and land use change on biodiversity (Manning *et al.* 2009).

Given all of these benefits, it is a cause of concern that a number of case studies from around the world report that farm trees are in serious decline in all their forms, that is, in natural, cultural, and recently modified landscapes. Among the most common threats are direct legal or illegal clearing, gradual regression through lack of tree regeneration, pathogens degrading tree health, shrub encroachment, abandonment of traditional grazing regimes, and agricultural intensification (Manning *et al.* 2006). For centuries, retaining trees in agricultural landscapes has been a common practice throughout Europe (Eichhorn *et al.* 2006). Since the 1950s, socioeconomic changes have caused a strong decline of these practices, along with the abandonment of many land use forms on marginal sites and the intensification, mechanisation, and structural simplification of land uses on fertile soils (Vos & Meekes 1999).

While the preservation of farm trees is a component of several command-and-control approaches – for example, state conservation acts that prohibit the destruction of hedgerows, copses, and scattered fruit trees – and while numerous payment schemes for ecosystem services provided through agricultural practices do in general exist, there are few incentive-based policies in place that specifically target the conservation of farm trees. However, interest in establishing farm trees as alternative land use forms is rising. For example, the European Council Regulation on the European Agricultural Fund for Rural Development (EAFRD) states: "Agri-forestry systems have a high ecological and social value by combining extensive agriculture and forestry systems, aimed at the production of high-quality wood and other forest products. Their establishment should be supported" (European Union 2005: 5).

The present study focuses on PES schemes that enhance the retaining of trees in agricultural landscapes, using the German state of Saxony as a case. Our aim is to employ an institutional economics framework to understand why PES schemes for trees in agricultural landscapes are rarely found in central Europe, despite their mentioned benefits. Further, the reasons for the often very limited/reluctant participation of farmers and other land users in these schemes will be elaborated on. We analyze the obstacles to design and implementation of cost-effective PES schemes and seek to contribute towards the design of 'better' policies to promote the services provided by farm trees. We argue that, for farm-tree related PES schemes to become successful, specific resource characteristics – for example, rivalry, asset specificity, and joint production – need to be taken into consideration. The structure of the paper is as follows. First, we introduce an institutional economics-informed framework for the analysis of PES schemes related to farm trees. Second, we present a case study on farm trees and their role in the agricultural landscapes of Saxony, Germany. Third, an overview of existing incentive-based approaches to establish, preserve, and manage farm trees and their ecosystem services will be given. Fourth, obstacles to the implementation of these PES will be analysed. Fifth, suggestions for a more successful implementation of PES and insights concerning the wider debate on PES schemes in agroecosystems will be offered.

2. An institutional economics framework for analysing farm-tree related PES schemes

The performance of policy instruments can be evaluated against a number of criteria (see e.g., Bemelmans-Videc *et al.* 2007), the most common of which are effectiveness and cost-effectiveness (efficiency). In this section we first explore these two categories in some depth and then highlight some attributes of ecosystem services affecting effectiveness and cost-effectiveness of PES schemes in general and of those for farm trees, in particular. The (environmental) effectiveness and cost-effectiveness of PES schemes may differ substantially. While effectiveness refers to the accuracy and completeness with which the specified goals or policy objectives can be achieved, cost-effectiveness is determined by relating the resources expended (costs) to the accuracy and completeness of goals or policy objectives achieved. Considerations of cost-effectiveness refer to the economic costs that society incurs for carrying out a certain policy. Two main cost categories can be distinguished: *Production costs* refer to the costs of the actual activities that have to be undertaken by actors to provide ecosystem services. Cost differences may arise if an ecosystem service can be produced in different ways. Furthermore, the costs and benefits of certain individual measures to provide ecosystem services are subject to spatial and temporal variations; for example, the costs and benefits of hedgerows to reduce soil erosion due to water and wind differ depending on the slope and the soils of the adjacent land plots as well as on the frequency and the time of year when maintenance is carried out. Further, production costs also include profits foregone (i.e. opportunity costs) when carrying out the activities prescribed by the PES scheme, which might include lower yields. *Transaction costs* are not only incurred by the private sector, but also by the public sector at the administrative and political levels.

The effectiveness and cost-effectiveness of policy instruments in general, and PES schemes in particular are strongly influenced by the characteristics of the ecosystem, the ecosystem services, and the related transactions targeted (Hagedorn *et al.* 2002). Management and preservation of farm trees is connected with multiple transactions, ranging from the planting and maintenance of trees and shrubs through the production and selling of firewood and fruit to the 'production' of scenic landscape values for people living in or visiting the area. It is usually not possible to exclude people from benefiting from the aesthetic value of farm trees, in particular scattered fruit-tree meadows. While enjoying the aesthetic services of a landscape and its biodiversity are (as pure public goods) non-rival in consumption, the production of, for example, fruit or firewood covers a particular piece of land. Thus, there is rivalry with respect to alternative land uses, and the resource unit is both site-specific and immobile. Further, most ecosystem goods and services provided by farm trees are produced jointly and can, consequently, hardly be separately regulated. For example, planting and maintaining hedgerows for the reduction of soil erosion due to wind and water also produces habitats for a wide range of species and, thus, may increase biodiversity. Here, it is also important to consider that farm trees are part of semi-natural ecosystems that have been shaped by human uses. These are low-intensity systems that need to be maintained through extensive land management. Planting and maintenance of farm trees is knowledge intensive and specific, and there is also some moderate capital specificity involved. For example, special machineries or technologies for pruning trees or maintaining hedgerows often cannot be used for other purposes. Further, these management practices have to be carried out regularly, though usually only with a moderate frequency. Although the production process of farm trees depends to some extent on stochastic events, such as rainfall, the related natural cause–effect relationships are rather regular, continuous, and well-known in farm tree ecosystems. In addition to rivalry in production, non-excludability, and required asset-specific investments, we therefore consider the maintenance of farm trees as a non-heterogeneous, non-variable transaction of regular but moderate frequency. Its effects are reversible, yet reconversion from a different land use is only possible in the medium term.

3. Farm trees in Saxony

The Eastern German state of Saxony is a highly illustrative and typical case of farm trees and related PES. It extends over an area of about 18,400 km^2, adjoining Poland in the East and the Czech Republic in the South. Saxony's topography is characterised by plain areas (dominated by heath land) in the Western and Northern parts, where open-cast lignite mining has impacted the landscapes. The South is covered by low mountain ranges, reaching up to 1,215 m in altitude. The land between is a gently undulated area, covered by fertile Loess soils (Mannsfeld & Syrbe 2008). Farm trees are characteristic elements of Saxony's agricultural landscapes, with common types including isolated trees, hedgerows, meadows with scattered fruit trees (*Streuobst*), woodlots, shrublands, and tree rows (see Fig. 1 for an example). Many farm trees have been lost in past decades, particularly in consequence of the intensification of agricultural production implemented under the former German Democratic Republic (GDR) of the 1960s and 1970s. Following the promotion of large-scale agro-commodity production, large-scale landscape interventions ('ameliorations') were carried out in order to allow heavy machinery to operate (Philipp 1997). Consequently, many 'disturbing' and 'inoperable' hedgerows, groups of trees, and alleys were eliminated. In the 1980s, there was a counter-trend in which – besides other measures – establishment of shelterbelts as a measure against soil erosion was promoted, but in most cases this has not been enough to reverse the large-scale landscape modifications that had been made. Since German reunification in 1990, nature protection, extensification of farming, and later the concept of ecosystem services provided by farm trees have become more prominent. At the same time, however, agricultural production has remained rather intensive, due to pressure from the EU CAP. The changes in number and area or (row) length of the various types of farm trees in this period (1992/93-2005), as assessed through state habitat and land use inventories, offer a mixed picture. While the number of and area covered by scattered fruit-tree meadows as well as isolated trees decreased drastically, other farm-tree types, in particular hedgerows, exhibit an opposite trend (see Table 1).

Figure 1 Exemplary spatial distribution of various types of farm trees inWeißenberg, Saxony

Source: ATKIS®-DOP, © Staatsbetrieb Geobasisinformation und Vermessung Sachsen 2010.

Table 1 Changes in number, area, and (row) length of farm trees in Saxony 1992/93 - 2005

	Number		Change	Area / Length		Change
	1992/93	2005		1992/93	2005	
Scattered fruit-tree meadows	20,528	11,733	-42.8%	10,724.6 ha	6,146.9 ha	-42.7%
Woodlots	39,274	47,891	+21.9%	9,704.2 ha	10,707.7 ha	+10.3%
Shrublands	2,549	4,671	+83.2%	847.3 ha	1,108.0 ha	+30.8%
Tree rows	93,245	140,774	+51.0%	8,283.5 km	16,481.4 km	+99.0%
Hedgerows	27,341	70,815	+159.0%	2,893.4 km	6,372.8 km	+120.3%
Isolated trees	47,716	29,090	-39.0%	-	-	-

Source: Own computation; land cover data provided by the Saxony State Office for the Environment, Agriculture and Geology, Dresden. Note: Data may also include trees outside agricultural areas, for example along roads or water bodies

Farm trees occupy parts of Saxony's agroecosystems that cover more than 50% (915,000 ha) of the state's total land area. The major share of the agricultural land is used as arable land (79%), and only 21% for grassland farming. The main crops grown on the arable land include wheat, barley, oats, rye, maize, potatoes, and sugar beets (SMUL 2010a). Average soil quality in Saxony is relatively poor – 46.4 for arable land and 41.8 for grassland, according to the German agronomic yield index – yet soil qualities differ substantially across the state. Almost 39% of the agricultural land is characterised as less favoured areas (SMUL 2009a: 47).

In 2009, there were 6,896 agricultural enterprises, including 634 corporate firms (joint stock companies, limited liability companies, and producer cooperatives) and 6,262 individual operations, of which 4,016 were managed by part-time farmers. While most agricultural firms (5,440) farmed less than 100 ha, there were also 467 enterprises farming 500 ha and more

(SMUL 2010a). After 1990, collectivised farmland was restituted to the former legal owners and a relatively fragmented land tenure structure arose. Most of the new/old landowners quickly leased their land to newly restructured and reorganised cooperatives and other agricultural enterprises. Although the share of leased agricultural land has been decreasing in Saxony, from 89% in 1993 to 79.7% in 2007, leasehold remains dominant (Winkler 2010: 4). While leasehold prices for arable land and grassland have been increasing steadily since 1991 – from about 71 € and 51 €/ha in 1991 to about 126 € and 72 €/ha in 2007, respectively – average sales prices for agricultural land went down from about 4,600 €/ha in 1999 to 3,800 €/ha in 2004, before increasing again to reach 4,400 €/ha in 2007 (ibid: 9).

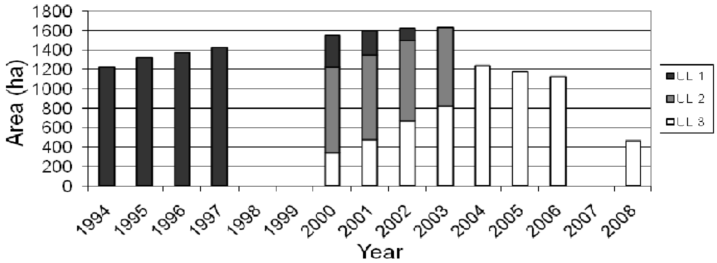
4 Incentive-based schemes for the plantation and management of farm trees in Saxony

Incentive-based schemes for ecosystem services in European agriculture are mainly rooted in agriculture and nature-conservation policies, expanding upon two command-and-control policies relevant for farm tree preservation that will be briefly introduced at this point. The Saxonian Law concerning Nature Protection and Landcare (*Sächsisches Naturschutzgesetz*), implemented in 1992, legally protects certain types of farm trees. Among other things, it is generally forbidden to remove or damage shrubs and scattered fruit-tree meadows; yet, state authorities for nature protection may allow exceptions. Additionally, concrete landscape elements, such as hedgerows, tree rows, and isolated trees may be designated for protection by the state authorities if the respective elements are characteristic of the surrounding landscape. Finally, some relevant landscape elements, such as isolated single trees, can be declared natural monuments with the effect that their removal or damage is strictly prohibited. However, while the legal protection of farm trees is rather effective, there is no related legal obligation to actively maintain the protected farm trees. This legal gap may be responsible for the great reduction since 1992 of isolated trees (often overaged and in need of regeneration) and meadows with scattered fruit trees (not viable without active management) (Table 1). The reform of the Common Agricultural Policy (CAP) of the EU in 2003 introduced the concept of *cross compliance*. Farmers will only receive (full) direct payments if they respect defined standards based on existing EU regulations and directives concerning environmental protection, food and fodder quality, and animal health and welfare, as well as on related national regulations (Dupraz *et al.* 2010). In this context, Germany has established specific standards for Good Farming Practices (GFP), such as maintenance of set-aside land, compulsory measures for preventing soil erosion, crop rotation, and preservation of landscape elements, such as farm trees. With respect to the latter, it is forbidden to fully or partly remove 1) hedgerows longer than 20 m, 2) tree rows of at least five trees and longer than 50 m, 3) woodlots from 100 m^2 to 2,000 m^2 in extent, and 4) isolated trees which are designated as natural monuments (Knickel *et al.* 2001). Yet, GFP do not include provisions to ensure maintenance of the above-mentioned farm trees. In general, the protection of abiotic resources, such as soil and water, is perceived predominantly as a basic component of GFP, whereas the active management of biotic and aesthetic natural resources, such as farm trees, is often regarded as exceeding this standard and thus would require compensation (Weins 2001).

Since the early 1990s, various successive regulations have been instituted by the European Commission to foster rural development in the Member States. Unlike price supports and later direct payments, these Rural Development Regulations have been intended to promote, among other things, environmentally friendly farming practices, extensive forms of arable- and grass-land farming, and the long-term set-aside of farm land. However, apart from the environmental objectives, the regulations have also been explicitly intended to stabilise farmers' incomes and to reduce overproduction. These regulations have provided the main policy framework for the introduction of agri-environmental schemes (or PES schemes) in the EU. In Germany, the respective Rural Development Plans (RDP) (schemes and measures) vary widely in terms of number, design, targeted environmental problem(s), and content between the federal states. As one obligatory component, each RDP has to include a PES scheme, with the EU financing up to 75% of the costs and the states contributing the rest. Farmers can participate voluntarily in the respective schemes and have to commit to them for five years. To get financial support, farmer's activities need to exceed mere compliance with the principles of GFP. Only an individual farmer's income losses – opportunity costs for introducing/continuing) a certain farming practice – are to be compensated, plus a maximum incentive component of 20% of the opportunity costs (see e.g. Bruckmeier & Schubert 1996).

In Saxony, all RDPs – here coined 'Environmentally Friendly Agriculture' (*Umweltgerechte Landwirtschaft, UL 1-3*) – that were implemented between 1994 und 2008 included only one measure explicitly targeting farm trees, concerning specifically the maintenance of scattered fruit-tree meadows. Here, premiums paid amounted to 205 €/ha of scattered fruit-tree meadow plus 3 €/tree, up to a total maximum of 450 €/ha (Bruckmeier & Schubert 1996). Figure 2 sketches the supported land area from 1994 to 2008. The supported area never exceeded 1,700 ha and was during the whole period well below 15% – mostly even below 10% – of the total area covered by scattered fruit-tree meadows (see Table 1).

Figure 2 Area supported by EU co-financed PES schemes for the maintenance of scattered fruit-tree meadows between 1994 and 2008.



Sources: Own figure, based on Bruckmeier & Schubert 1996: 75; Deimer *et al.* 2007: 86, 94, 96; SMELF 1998: 47-51; SMUL 2009b: 45; Note: Contracting periods for the different schemes may overlap, though no 'double funding' by the same measure for the same plot was allowed. No data available for 1998, 1999, and 2007.

In some German states, schemes or measures within the RDPs are co-financed by national state funds and/or by state funds. All German states provide some form of separate Contractual Nature Conservation Schemes (*Vertragsnaturschutz*) which are targeted at specific habitat and species conservation, but also include activities to maintain cultural landscapes. These schemes are voluntary and introduced with variable but limited contract duration. Environmental authorities at the district level conclude contracts with individual or groups of farmers, or so-called Landcare Associations (LCA, *Landschaftspflegeverbände*), and monitor and enforce them. Although there are detailed guidelines for measure design and related premiums provided for by the state, there is some flexibility in tailoring actual contracts, thus allowing for specific local and natural conditions. Yet, agreements are mainly adopted in high-priority conservation areas, meaning existing nature reserves, where they are often provided to meet legal compensation needs. In Saxony, several nature-protection programs for agriculture, fish ponds, and forestry were established in the 1990s. With respect to farm trees, among others, the plantation and renewal of scattered fruit trees, hedgerows, shrubs, and riparian woods have been financed. These project-oriented payments could also be used to finance project-related preparation and management costs, machineries, and costs for the acquisition of land. However, the impact of these programs has been rather low. For example, between 2000 and 2006, only 49 ha of hedgerows were planted, a further 120 ha of hedgerows regenerated and supplemented, and 2,700 scattered fruit trees planted on 21 ha (Deimer *et al.* 2007). A total of 14 LCA in Saxony, which operate at the district level, have played an important role for the plantation and maintenance of farm trees. Like all of the 140

LCA in Germany that have been established since 1986, they are voluntary collaborations between nature-protection associations, farmers, land owners, and municipalities mainly to protect the native fauna and flora as well as the biological resources in cultural landscapes and to support environmentally friendly land use systems and regional economic development (Bluemlein 2009). Their activities are financed from various sources, among others EU and (national) state co-financed PES schemes, compensation and land consolidation funds, and money provided by private individuals and businesses. In Saxony they have been, among other activities, planting and maintaining hedgerows and riparian woods. For example, in 1997, 98 measures were carried out by LCA to plant 37 km of hedgerows and other protective woodlands (SMLEF 1998: 114f., 126).

Apart from incentive-based schemes financed by public bodies, there are also other incentive-based approaches and initiatives for farm trees in Saxony in place that derive their financial means from private sources, more precisely, from project developers and consumers. According to the impact regulations of German nature conservation law, any economic activity, such as road construction or the construction of industrial parks, that negatively affects ecosystem functions and the appearance of landscapes has to be avoided, minimised, or in the last resort compensated for (Rundcrantz & Skärbäck 2003). In 2008, the concept of 'habitat banking' (*Ökokonten*) was implemented in Saxony as an approach to pool financial obligations for compensation from different individual developers to implement larger and more comprehensive compensation measures, including planting of scattered fruit trees and hedges. Coordinated by a state-owned 'habitat banking agency' (*Sächsische Landsiedlung GmbH*), farmers, LCA, and other land users offer specific measures that create new or enhance the quality of existing habitats that they have already carried out on a voluntary basis. Developers who are required to carry out compensation measures now have the option to (fully or partially) re-finance their costs. Importantly, once the respective compensation has been re-financed via the eco-accounts, those who contributed the measures are legally obliged to ensure adequate and permanent preservation of the established habitat (SMUL 2010b). In 2008, the project 'Regional Scattered Fruit Cycles' (*Regionale Streuobstkreisläufe*) was initiated by the German Association for Landcare to provide financial and practical incentives for harvesting the fruit of scattered fruit trees. In three pilot regions in Saxony – Central Saxony, Northern Saxony, and Lusatia – comprehensive extension services for owners and land users of scattered fruit-tree meadows have been offered measures including advice on support programs, maintenance of trees and meadows, options for processing of fruits, etc. Further, collaborations between *Streuobst* producers with local associations, wine pressing houses (including, mobile fruit pressing facilities), distilleries, and tree nurseries have been organised. Finally, a marketing campaign on 'Forgotten Diversity – *Streuobst* from Saxony' was begun in 2009, developing some specific *Streuobst* products, such as apple juice, apple wine, apple liquor, pear wine, and jams (DVL 2010).

5. Obstacles for participation in PES schemes for farm trees

In this section, we elaborate on some potential obstacles for the participation of farmers in PES schemes for farm trees. These refer to production costs, opportunity costs, contractual uncertainties, land tenure implications, consumers' willingness to pay and the risk of 'crowding out'. Some aspects may to some extent also be true for PES schemes in general, though most are rather specific for farm trees. The *first aspect* refers to the production costs connected with the provision of farm trees. Relatively high initial investments needed for the plantation of farm trees and the continuous efforts necessary to maintain them contribute substantially to the reluctance of farmers and other land users to engage in PES schemes for farm trees (see e.g., Brodt *et al.* 2009). For example, Nottmeyer-Linden *et al.* (2000: 107) calculate about 26 €/tree for the plantation of scattered fruit trees and 2 €/tree/year (cutting every 10 years) for their maintenance. They recommend paying about 1.1 times the usual compensation payments needed for 'normal' extensive grassland use when scattered fruit tree meadows are concerned. For the plantation of hedgerows and shrubs, they state 4.60 €/m^2 for plantation and 511 €/ha per year (every 10 years) for maintenance. The premiums offered in such PES schemes are often perceived as not being sufficient to compensate for the costs incurred. Further, many PES schemes only allow for homogenous yearly premiums, not covering the initial investment costs. Investments in farm trees are also very asset specific. That is, these investments made by farmers cannot easily be transferred across time and space, once they have taken place. For example, a hedgerow planted by a farmer to reduce wind erosion or to increase biodiversity cannot simply be moved to another spot. Further, planting and maintaining of farm trees is very knowledge intensive (Brodt *et al.* 2009) and may demand the use of special machinery.

Second, other analyses have shown that farmers are very reluctant to implement measures for farm trees on arable land, meaning cases where farmers face comparatively higher opportunity costs for land use, as opposed to grassland areas. Other agricultural policies may even increase the opportunity costs for planting farm trees, for example by providing payments for growing energy crops. However, it is precisely here where many of the ecosystem services provided by farm trees are in short supply and where demand would be high, in particular, for preventing soil erosion due to wind and water, but also for maintaining biodiversity (Reeg 2008). Examining the correlation between local natural conditions and demand for PES schemes in general Osterburg (2000) finds that the demand for PES schemes is significantly higher in regions with relatively poor natural conditions due to poor soil quality or being mountainous regions, as well as in regions with low average yields, low stocking rates, and low land use intensity. Further, the demand for PES schemes decreases if the related compulsory requirements are increasing. This would be relevant for farm trees that rely on long-term maintenance activities. Moreover, if the density of farm trees on a particular plot exceeds a particular point, the entire plot would not be regarded as an 'agricultural area'. Currently, this is a grey area in German law and is currently decided on a case-to-case basis by the responsible agricultural authorities. This constitutes, however, a clear disincentive for land users depending on these – often fairly substantial – payments. It may even prove to be a sufficient incentive for the removal of tree rows and (parts) of hedgerows adjacent to plots in order to increase subsidised farm size and, thus, income.

Third, PES schemes in the context of EU Rural Development Regulations as well as many state-financed schemes usually require the participation of farmers for at least five years. The continuation of such contracts after the contract period, however, is not guaranteed by the state. In cases that require investments, this may negatively affect the willingness of farmers to commit themselves to such contracts and, consequently, the introduction of long-term contracts has been suggested (Hampicke 2001). Such long-term contracts may also avoid the problem that – in cases where a conservation benefit has been created which cannot be easily reproduced elsewhere – the farmer is in the position to bargain for higher payments by threatening not to renew the contract (Wätzold & Schwerdtner 2005). However, Stern (2003) argues that long-term contracts would impose risks on both contracting partners: a) political and administrative authorities at state level would not have the option to end the contract prematurely free of charge, for example in response to budgetary problems and b) farmers, in turn, would lose the option to react flexibly to changing market prices.

Fourth, in most PES schemes for farm trees, farmers are conceptually treated as landowners, an assumption that is not supported by the reality of many European agricultural regions in general, and in Saxony in particular. In order to participate in PES schemes fostering the planting of farm trees, farmers need the formal and official agreement of landowners. However, apart from contractual nature-protection schemes, PES schemes do not allow for compensation of negotiation costs or the acquisition of land. This problem of negotiation costs is even more pronounced in regions with fragmented land ownership, as is the case in Saxony. Yet, there is also a risk involved on the part of landowners that, if they agree to the planting of farm trees on their land, future potential lease holders may not want to lease land covered by farm trees or may want to bargain for lower land rents because of this. Further, a lock-in effect may be observed, since investments in farm trees only break even after the end of a current lease contract. Here, a land owner may opt for increasing land rent. In turn, if the current landlord dies and an heir raises rent, the investment may be endangered if the farmer does not want to or cannot pay the elevated rent.

Sixth, consumer and/or societal willingness to pay does not necessarily go along with environmental scarcity as assessed, for example, by environmentalists and other experts. It is a well-known fact that some symbolic 'charismatic' species (Tisdell & Swarna Nantha 2007) or landscape features may attract much more public attention than others. In consumers' perceptions, aesthetic aspects may also play a more important role than detailed, materialistic ecosystem services accounts, which are favoured by natural scientists. Willingness to pay seems high for some types of farm trees, especially for scattered fruit-tree meadows (see e.g., Zander & Waibel 2005). In other cases, however, the necessary financial means cannot be raised from society. *Finally*, as with other PES schemes as well, there is the danger of 'crowding out environmental virtues', meaning that farmers will only provide farm trees if they are paid for it, whereas they used to provide this societal benefit voluntarily, prior to the introduction of PES schemes (Vatn 2010).

6. Conclusions

In this paper, we have shown that there has only been a rather restricted portfolio of measures within PES schemes available to foster the development of farm trees in Saxony. This finding is in line with the results of an evaluation of agri-environmental schemes in the EU, where it has been strongly recommend that a landscape approach should be followed that ensures the inclusion of farm trees, such as hedgerows and willow plantations, in EU funding programs (European Commission 1998: 140f.). Most PES schemes in Saxony have been focused on the maintenance of scattered fruit-tree meadows, though some project-related funding for planting of scattered fruit trees and – to a lesser extent – for hedgerows was also identified. Moreover, the participation of farmers and other relevant actors in these schemes has been relatively low compared with the total area covered by the respective farm tree types. Obviously, in Saxony the existing PES schemes as well as the other policy approaches have not been at all sufficient to stop the drastic decline of scattered fruit-tree meadows and isolated trees there. Yet, it remains to be investigated whether they have in fact been dampening the decline to some extent. Further, the portfolio of measures and the participation in PES schemes can only partly explain the increase of other farm tree types, such as woodlots, hedgerows, shrublands, and tree rows. Possible explanations for this development include that these farm trees have expanded in size due to natural growth that has not been actively restrained by land users; perhaps these areas have been treated as set-aside. It may also be the case that some farmers or other land users have planted hedgerows even without financial assistance. Perhaps idealistic rationales have been at work here, or they did not participate in PES schemes because of the restrictions that would have been involved with formal contracting. In this case, they may have valued the option to reverse their decision (to grow farm trees) without possibly high exit costs. Alternatively, very small farmers (below 2 ha) may not have been able to participate in EU co-financed PES schemes, because they are not eligible. Here, the only recently developed and implemented alternatives in Saxony (Habitat banking, 'Regional Scattered Fruit Cycles') may foster the planting and maintenance of farm trees in the future, particularly for such small farmers.

We turn now to the question of what can be done to increase the participation of farmers in PES schemes for farm trees. Based on our investigation, we developed these suggestions:

1) Regionalised premiums for PES schemes that better account for variances, such as in soil quality, that sometimes result in high opportunity costs for farmers, may increase participation. However, implementing such a differentiated approach would entail higher transaction costs for administration and planning. Still, contractual nature-protection schemes for farm trees that are project-oriented, that is where premiums and conditions are negotiated individually based on calculations in project plans, seem to show promising levels of cost-effectiveness particularly for complex measures related to farm trees.

2) Since the planting and maintaining of farm trees is often very labour, time, and knowledge intensive, co-operative approaches may be helpful to reduce related costs, for example, for special machinery. Coordination between farmers is also required because the specific spatial configuration of farm trees across landscapes is critical to the provision of many ecosystem services, for example water purification services (Goldman *et al.* 2007). Successful examples of such environmental co-operatives can be found in the Netherlands (Slangen & Polman 2002). Alternatively, demonstration projects could induce farmer-to-farmer discussions about options for support, plantation, maintenance, and regional marketing (Brodt *et al.* 2009). Here, Landcare Associations could play a greater role.

3) Agricultural economists regularly stress that the effectiveness as well as cost-effectiveness of PES would increase, if outcome-oriented rather than measure-oriented payments were to be applied (see e.g. Wätzold & Schwerdtner 2005) Furthermore, result-oriented remuneration would increase the innovation potential, reduce information asymmetries, and promote self-interest, co-operation, continuity, and farmers' intrinsic motivations and interests regarding environmental problems (Gerowitt *et al.* 2003). However, the high complexity, heterogeneity, and variability of ecological systems, such as farm trees, make it difficult to apply result-oriented remuneration. Planting activities, for instance, may result in rather stochastic, uncertain, and very much delayed (environmental) effects, such as the recurrence of certain rare plants or birds nesting in a particular hedgerow or woodlot. Thus, a farmer's 'investment' would be confronted by a highly uncertain premium level or even no premium at all (Hampicke 2001).

Finally, we point to some lessons that can be learnt for the wider debate on PES schemes in agroecosystems. As stressed before, many obstacles we identified for the participation of farmers in PES schemes for farm trees are also relevant for other agroecosystems and have indeed already been identified. The specific features of farm trees, however, bring particular aspects related to land tenure, the temporal (long-term investment) perspective, and high opportunity costs to the forefront. Solutions that may be developed to overcome these problems for PES schemes for farm trees are likely to improve other PES schemes dealing with similar resource characteristics. The example of PES schemes for farm trees also highlights one of the major challenges for the protection and preservation of cultural landscapes: they are man-made, unlike primeval forests, and thus need to be preserved, managed, and maintained continuously. This, however, demands constant efforts – not only financially, but for improving the design of PES schemes and other policy approaches as well.

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