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A sociopsychological analysis of agroforestry adoption in Flanders: understanding the discrepancy between conceptual opportunities and actual implementation

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Abstract: Whereas the opportunities of modern agroforestry systems are increasingly recognized by policy makers, consultants, researchers and educators, the response of farmers to the recent subsidy program for alley cropping systems in Flanders is relatively low. Therefore in this study a mixed method technique including a survey (n=86), interviews (n=33), and a GIS analysis is used in order to better understand the reasons behind this implementation gap. The study showed that 55% of the Flemish farmers are not familiar with agroforestry and that the intention to engage in agroforestry is very low. As a result alley cropping in Flanders remains sparse with only around 30 farmers known to be consciously engaged in the practice. These pioneers installed in the last couple of years one or more agroforestry plots (average surface area of 2.3 ha) that often combine a variety of trees with grassland. Whereas negative perceptions of

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Flemish farmers are mainly related to compatibility and profitability of such a farming system, pioneers consider legal issues such as land tenure the most pertaining drawback. Therefore future research, and policy and extension efforts should target these aspects in order to enhance further diffusion.

Keywords: temperate agroforestry; alley cropping; attitude; policy; adoption

Introduction

From a historical point of view, various agroforestry systems existed in Flanders as in the rest of Europe. Agroforestry is considered here as a collective noun for all land use systems in which tree cultivation is combined with agricultural crop production and/or animal husbandry. Besides alley cropping systems, i.e. land use systems in which crops are grown in alleys formed by rows of trees or shrubs inside the field, also windbreaks or shelterbelts, standard fruit trees with grazing livestock and rows of pollard willows or poplar at the borders of agricultural parcels are considered here as agroforestry sensu lato (s.l.) (Herzog 1998). Despite the fact that these systems were previously very common, trees in the agricultural landscape have increasingly disappeared with intensification of agricultural production (Nerlich et al. 2012). In Flanders the former orchards with standard fruit trees and grazing livestock have been replaced by more intensive orchard systems with dwarf or half-standard fruit trees without livestock. Only some historic relics of traditional agroforestry systems can be found, while modern agroforestry in the form of alley cropping rarely exists.

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In recent years a renewed interest in agroforestry emerged because of its potential to deliver both food and non-food (mainly wood) products as well as environmental services and socio-economic benefits at the same time, therefore avoiding the trade-off between provisioning and several other ecosystem services that occur today in many modern intensive farming systems (Smith et al. 2012a). Because agroforestry systems are based on the ecological theory of niche differentiation, partially using different resources of the environment, their total system (biomass) productivity is often higher than in mono-cropping systems, where trees and crops are cultivated on different plots (Dupraz and Newman 1997). Economic studies have shown that this higher biomass yield in combination with increased output diversity can lead to financial benefits with higher long-term returns (Benjamin et al. 2000; Brownlow et al. 2005; Yates et al. 2006; Rigueiro-Rodríguez et al. 2009), although the economic performance of agroforestry is highly variable depending on the interaction of many factors influencing the output (Palma et al. 2007). Also the potential environmental benefits of agroforestry systems are manifold with the regulation and enhancement of nutrient cycles, air quality, carbon sequestration, water quality, erosion control and biodiversity as most important examples (Rigueiro-Rodríguez et al. 2009; Smith et al. 2012a). From a social perspective agroforestry systems could allow higher landscape amenities and a restoration of traditional landscapes. This could positively influence rural tourism leading to a broadening of farm activities and income, and a differentiation from other farm enterprises (Rigueiro-Rodríguez et al. 2009).

Since agroforestry is increasingly recognized as a sustainable agricultural innovation which could at least partially address current social, ecological and biodiversity problems in European agriculture, it is supported in Flanders through the regional implementation of both pillars of the

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new European Common Agricultural Policy (CAP 2020). In the first pillar 30% of the basic payment is 'greening payment' and depends on the implementation of agricultural practices beneficial for climate and the environment (Lamaison 2014). Besides permanent pastures and crop diversification also the establishment of Ecological Focus Areas (EFA) is listed as a greening requirement (Smith et al. 2012b; EC 2014). As such, conventional holdings with more than 15ha of arable land need to dedicate 5% to EFA from 2014 onwards and possibly 7% from 2017 onwards (EU 2013a). The inclusion of agroforestry as one of the types of areas qualified by the EU as potential EFA, is thus a strong support for agroforestry development in Flanders and the rest of Europe. The second pillar of the CAP is focused on rural development and is funded for 50% by the European Agricultural Fund for Rural Development. It includes agri-environment measures and management agreements, i.e. payments to farmers who subscribe on a voluntary basis to environmental commitments related to the preservation of the environment and maintaining the countryside (EU 2013b). They are implemented through regional Rural Development Programmes (RDP), translating the European into regional regulation. Examples of agro-environmental measures and management agreements concluded in the Flemish RDP for the period 2014-2020 are the cultivation of papilionaceous flowers, mechanical weed control, preservation of local cattle breeds, botanic management, erosion control, organic production, etc. (Van Liefferinge 2015). To further support agroforestry, the Flemish government included agroforestry in this list of agri-environment measures and management agreements eligible for subsidies. An initial subsidy program for the installation of agroforestry parcels was set up in 2011 and renewed in 2014. Though the original objective of the Flemish government was to establish 250 hectares of modern agroforestry through the new subsidy program by the end of

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2013, the initial response was low with 11, 5 and 7 accepted applications in 2011, 2012 and 2013 respectively, all together resulting in the establishment of merely 36 hectares of agroforestry. In 2014 and 2015 respectively 8 and 9 applications were accepted, good for an extra 60 ha of agroforestry. The objective of the new program period (2014-2020) is to establish 300 ha.

Agroforestry *sensu stricto* (*s.s.*), i.e. alley cropping, is thus a typical example of an agricultural innovation that is in Flanders according to Rogers' Diffusion of Innovation theory (1967) in its pioneer and early stage of diffusion. According to this theory, Flemish agroforestry adopters belong to the two first of five different innovation adopter categories (innovators, early adopters, early majority, late majority and laggards). Furthermore Rogers' theory says that people who adopt an innovation early in time have in general different characteristics than people who adopt an innovation later in time, although exceptions exist (Parra-Lopez, De-Haro-Giménez, and Calatrava-Requena 2007).

The limited success of agroforestry in Flanders as contrasted to the conceptual opportunities of such systems, reveals the need for more research about farmers' willingness to implement agroforestry. According to Montambault et al. (2005) and Pattanayak et al. (2003) agroforestry research expanded in the late 1990's from tropical into temperate regions, and with this expansion came also the need for more research on social, economic and adoption aspects of agroforestry. By reviewing 32 studies about agroforestry adoption in primarily tropical regions Pattanayak et al. (2003) found that most adoption behavior is significantly influenced by risk, biophysical and resource factors. Those factors are classified by Meijer et al. (2014) as extrinsic characteristics of adoption. Researches that focus on intrinsic characteristics, which are more

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emotional and dependent on individual perceptions, are less common although they are, according to Meijer et al. (2014), at the center of the decision making process. The largest research with respect to farmers' perceptions towards agroforestry in Europe was performed in 2003-2004, during which 264 farmers across seven European countries were interviewed about their views on the potential of agrosilvoculture systems (Graves et al. 2009). The study showed that many farmers in Europe are open to the possibility of integrating trees and crops, although large differences existed between regions with willingness to implement agroforestry ranging from 19 to as much as 90%.

The overall aim of this study is to shed light on and better understand the reasons behind the implementation gap between conceptual opportunities and actual implementation. By doing this, we want to offer perspectives for the future of agroforestry development, related to policies, governance, research, markets and extension. We achieve our overall aim by tackling three objectives, which are (1) to learn about the perceptions and attitudes of a small but representative sample of Flemish farmers towards this new innovation, (2) to give an overview of the current occurrence of land use systems in Flanders that combine trees with crops or husbandry (agroforestry *s.l.*) and (3) to learn about the experiences of a subgroup of farmers who already practice alley cropping and to give an overview of the characteristics of their alley cropping systems. To answer these different research questions a mixed method technique is used. As such it can be determined what is needed, in terms of knowledge, policy or logistics to tackle the current status quo.

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Materials and methods

2.1 Study area

The research took place in Flanders, the northern region of Belgium which is administratively divided into five provinces. Furthermore six different agricultural zones can be distinguished in the study area (Figure 1) which are determined in a historical perspective by soil conditions and topography and described in detail by Peeters (2010). These agricultural zones determine the local agricultural value, production type and system, and therefore also the relationship with and characteristics of 'trees on farms'.

In 2014 about 46% (616,301 ha) of the total land area in Flanders was under agricultural use, of which 56% served for the production of fodder crops, 35% for the production of arable crops (grains, potatoes and sugar beets) and the remaining 8% for horticulture (vegetables and fruits). The number of farm units in 2014 amounted to 24,252, which is a decrease of 32% in comparison with 2004. At the same time average farm size increased with 42% over the last ten years to 25.4 ha, which confirms the current scaling up practice in Flemish agriculture (Departement Landbouw en Visserij 2016; Platteau, Van Gijseghem, and Van Bogaert 2014). This scaling up practice is related to the land consolidation processes that were put in place from the 1950's onwards with the original goal to improve food productivity. This implied a clustering of the fragmented parcels into large units with an optimal rectangle shape and located adjacent to the farm, resulting in the disappearance of traditional hedges and 'bocage'-elements separating different parcels (Pauwels 2014). Furthermore Flemish farms are characterized by a strong

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specialization (84%) in either livestock, arable farming or horticulture and a strong majority (64%) of leased agricultural land (Platteau, Van Gijseghem, and Van Bogaert 2014; Departement Landbouw en Visserij 2016).

To promote agroforestry the Flemish government set up a subsidy program, which is supported by the second pillar of the CAP and of which 50% is financed by the European Agricultural Fund for Rural Development. This subsidy is entirely directed to the farmer and not to the landowner in case of leased land, although the tenancy law prescribes that the landowner always has to give permission to the renter to plant trees, which means that the landowner thus plays an important role. Since 2014 the subsidy covers up to 80% of the plantation costs, at least if some requirements are fulfilled: the surface area of the parcel is minimum 0.5 ha, conifers, short rotation coppice and some exotic woody species are excluded from the subsidy, tree density should be between 30 and 200 trees per hectare, the way in which the trees are spread over the parcel should enable a true interaction between tree and crop, the trees have to be maintained for at least 10 years and an agricultural crop production (or animal husbandry) has to be maintained on the parcel.

2.2 Theoretical framework

Figure 2 shows a holistic conceptual framework for the study of agroforestry adoption. It is slightly adapted from Meijer et al. (2014) with inclusion of the Theory of Planned Behavior as proposed by Ajzen (1991). According to Meijer et al. (2014) knowledge, perceptions and attitudes are at the center of the analytical framework, which are shaped by a large number of extrinsic variables. Those can be divided into three categories of which the first category is

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named ‘characteristics of the farmer’ (A) and includes personal characteristics (gender, age, marital status, etc.), socio-economic characteristics (income, assets, education, etc.), personality characteristics (self-confidence, independence, etc.), position in social networks (network size, connectedness, frequency of interaction, etc.), status characteristics (control over political power or economic resources) and familiarity with technology. The second category ‘characteristics of the external environment’ (B) includes geographical settings (ecology, topology, soil conditions, climate, demography, proximity to forests, etc.), societal culture (language, religion, ideologies, norms, values, etc.) and political conditions (land tenure and access rights, national and regional policies, the structure of the government, political freedom and laws, etc.). Finally the third category shaping knowledge, perceptions and attitudes of farmers (C) includes the benefits (contribution to household income, food security, soil fertility improvement, delivery of firewood and building materials, etc.) and the costs of the new practice (installation of agroforestry parcel, equipment, extra labor, etc.). This category corresponds largely with the attributes of innovations (relative advantage, compatibility, complexity, trialability and observability) as explained by Rogers (1967) in his diffusion of innovations’ theory. Meijer et al. (2014) furthermore emphasize the role of communication and extension services in the development of knowledge, perceptions and attitudes about agricultural innovations. With respect to communication and extension a deviation was made from the model of Meijer et al. (2014) by adding the RESET-model influencing extrinsic rather than intrinsic characteristics as proposed by Meijer et al. (2014). This model sums up possible strategies (regulation, education, social pressure, economic incentives and tools) to induce a desired behavioral change by acting upon farmers’ extrinsic characteristics.

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The core of the decision making process consists of knowledge, perceptions and opinions, which are in this study analyzed by means of the Theory of Planned Behavior (TPB). This socio-psychological theory dictates that intentions are guided by three considerations: (1) attitude, which is the degree to which execution of the behavior is evaluated positively or negatively, (2) subjective norm, which is the perceived social pressure from significant others (referents) to engage or not to engage in the behavior and (3) the behavioral control (the perceived own capability to successfully perform the behavior) (Ajzen 1991). Given sufficient actual behavioral control, which is the availability of prerequisites in terms of capital, knowledge, skills and opportunities, people will carry out their intentions (Fishbein and Ajzen 1975). Although the TPB has already been used multiple times to interpret environmentally friendly behavior, such as reducing energy use (Harland et al. 1999), recycling (Nigbur et al. 2010), sustainable farming techniques (Fielding et al. 2005) and agri-environmental measures (Home et al. 2014), the current applications of the TPB to agroforestry systems are, to our knowledge, limited to Switzerland and Pakistan (Sereke et al. 2015; Zubair and Garforth 2006; Hussain et al. 2012)

An important aspect of the TPB is that it goes beyond identifying the direct determinants of intention and behavior, but that it also theorizes about the underlying foundations of the psychological constructs (attitude, subjective norm and perceived behavioral control) and this according to the expectancy value theory. As such attitude is based on beliefs that the behavior will be associated with outcomes (behavioral beliefs), which are weighted by an evaluation of the outcomes (outcome evaluations). Subjective norms on the other hand are thought to be a function of how much a person perceives that other referents think he should perform the behavior (normative beliefs), weighted by our motivation to comply with the referents

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(motivation to comply). Finally perceptions of behavioral control are based on the beliefs about the factors that facilitate or act as barriers to perform the behavior (control beliefs) weighted by the expected impact that these factors would have if they were to be present (perceived power) (Fishbein and Ajzen 1975).

Although the TPB has a large support base, it is acknowledged that for some contexts and behaviors inclusion of other variables may increase the predictive utility of the model (Conner and Armitage 1998; Cook et al. 2002). Especially the inclusion of core concepts from social identity theory seems useful as the subjective norm is often the weakest predictor of intention of all variables in the TPB model (Fielding et al. 2008). For this reason, in this research 7 extra variables were added to the TPB model. Applied to this study these variables are (1) social identity, which refers to the extent to which a farmer feels a member of the agricultural community; (2) group norm which refers to the explicit or implicit prescriptions regarding a farmer's appropriate attitudes and behaviors as a member of the agricultural community; (3) intergroup perceptions, which are the farmer's perceptions about relations between famers and agricultural policy makers; (4) moral norm, which refers to the degree to which a farmer thinks he should apply a certain practice; (5) response efficacy, which is the degree to which a farmer believes that a recommended practice results in a certain positive effect; and finally (6) uncertainty about agriculture and (7) uncertainty about agroforestry.

2.3 Procedure and data collection

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The procedure applied in this research is a mixed method, which means that qualitative data collection and research techniques were combined with more traditional quantitative techniques, and this in different stages (Cameron 2009).

In a first step a series of semi-structured interviews were executed in the summer of 2011, and this with eight Flemish agroforestry pioneers and early adopters and two timber buyers. The semi-structured interviews served as a basis for the development of a questionnaire and focused therefore on general, legal, economic and practical aspects of the installation and maintenance of agroforestry parcels in Flanders. The sample for this qualitative data-collection stage was obtained by purposive or judgment sampling, a form of non-probability sampling in which the researcher deliberately selects individuals from the population whom he or she expects to give the most information.

With the results of the semi-structured interviews a questionnaire was constructed which measured the socio-psychological constructs with respect to alley cropping. The constructs can be measured directly by questions about the construct itself, or indirectly by questions about the underlying foundations. In this research the focus was on the direct measurement of the constructs and this through items in the form of 7-point bipolar scaling questions. Every construct was measured through multiple items which are presented in Table 1. This increases the reliability but also identifies constructs that are multidimensional such as perceived behavioral control, which is an amalgamation of 'perceived control' and 'perceived difficulty' (Trafimow et al. 2002). All scale items were based on previous applications reported in the literature (e.g. Wauters et al. 2010, Fielding et al. 2008) and adapted to the context of

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agroforestry in Belgium. The questionnaire also included Likert-type questions with respect to the advantages, disadvantages and barriers to agroforestry. Furthermore the questionnaire contained questions about the farmer profile, the farm type and knowledge of the term and the concept agroforestry, and the agroforestry subsidy program. After testing the initial questionnaire and some minor adjustments, the final questionnaire was sent out in November 2011 by post to 507 randomly selected farmers in the study area. Those were selected through a two-stage geographical cluster sampling, to ensure an even distribution of the respondents in the study area. The questionnaire was accompanied by a cover letter, which explained the framework of the questionnaire, and an information letter about the concept of agroforestry and its subsidy program. Farmers who didn't respond within a certain amount of time were contacted by phone to increase the response rate.

The third part of the data collection was two-fold. First the surface area of agroforestry *s.l.* was calculated using the Single Application data of 2013 and the Biological Valuation Map (Biologische Waarderingskaart, BWK). The former is an administrative procedure through which farmers register their agricultural plots; it contains information about the destination of each of the agricultural parcels in Flanders in 2013. The latter is the result of an inventory of the biological environment and land use of the Flemish and Brussels region carried out between 2000 and 2010. Secondly, in order to enable a more in-depth evaluation of alley cropping (i.e. the specific type of agroforestry application which is particularly promoted by the subsidy program) a series of telephone and face-to-face interviews were conducted with current pioneers and early adopters, consisting both of farmers in Flanders who already made use of the agroforestry subsidy program and farmers that are actively and consciously engaged in similar

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agroforestry systems or consider the trees as part of their production system, even without using the subsidy mechanism. The list of farmers contacted in this way is certainly not a complete list of all farmers who combine trees with crops or grazing livestock on the same field, yet, these are the people with whom we had contact from 2011 up to today in the perspective of our agroforestry research and advisory service. To our knowledge, this list of farmers should include nearly all those applying alley cropping. A majority of these 31 semi-structured interviews were initially carried out in the summer of 2012. In autumn 2013, 2014 and 2015 newly started pioneers were similarly questioned about their agroforestry systems, during which also the data gathered in the summer of 2012 were updated. These pioneer and early adopter interviews included questions with respect to (1) the characteristics of the agroforestry parcels installed by the pioneers installed, (2) the problems encountered by the pioneers, and (3) the pioneers' thoughts about the role of the existing subsidy program.

2.4 Data analysis

The semi-structured interviews of the first stage were analyzed manually, and lists were made including the mentioned advantages, disadvantages, tree species, etc. This information was subsequently used in the construction of the questionnaire.

The results of the questionnaire data were analyzed using a sequence of steps. Validity was not tested here, because similar scales as in Table 1 already have been used numerous times to assess the constructs of the TPB and associated constructs such as social identity, group norm, intergroup perceptions, moral norm, response efficacy and uncertainty (Wauters, Haene, and Lauwers 2014; Lynne et al. 1995). First, the results of the questionnaire were analyzed through a

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reliability analysis, which tests to which extent a set of items accurately measures the concept of interest (Hair et al. 1998). A reliability analysis implies the calculation of reliability estimators such as Cronbach's alpha, which assesses the consistency of the complete scale, and item-to-total and item-to-item correlations which are calculated for every item. Rules of thumb suggest that the item-to-total correlations and inter-item correlations should exceed 0.4 and 0.3 respectively. The generally agreed upon lower limit for Cronbach's Alpha is 0.70, although 0.60 is also acceptable with regard to more exploratory research (Hair et al. 1998). Second, summated scales were calculated for all reliable variables and this happened as the average item score for that variable. With these results descriptive statistics were calculated, during which also skewness and kurtosis of the variables were examined. Third, a regression of the most important TPB variables (attitude, subjective norm, perceived control and perceived difficulty) on the variable intention was performed to test if the proposed TPB model was significant. Since the composite variables are not ordinal anymore and the distributions of the composite variables are often very skewed and not normally distributed, the most appropriate regression technique is a binomial logistic regression. Therefore the dependent scale variable intention was dichotomized. The 70.9% of the respondents that obtained a composite score of 1 for the variable intention (and thus chose 1 for the three items that measure the variable intention), formed one group, whereas all other respondents made up another group.

The data analysis of the last step includes both quantitative and qualitative techniques. First the interviews with the pioneers and early adopters were analyzed in a qualitative way. Then descriptive analysis was performed on variables such as acreage under agroforestry, tree species,

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tree density, and all mentioned observed obstacles and problems were listed. Finally the surface area of agroforestry in a broad sense was calculated by means of ArcGIS 10.2.2.

Results

3.1 Summary statistics

From the 507 questionnaires sent out, 94 (19%) were received back. Eight of them were excluded for further processing since more than 35% of the questions were not completed. As such 86 questionnaires were taken into consideration for further processing. The summary statistics of the final sample are shown in Table 2. The farmers in our sample are more or less evenly dispersed over the five provinces, are on average 51 years old, cultivate 42 ha of land of which they rent slightly more than half. A majority of the farmers focus on livestock production, a quarter on arable and horticulture farming and the rest of the farms are mixed (both livestock and arable or horticulture) farms. One third of the farmers in the sample apply agro-environmental measures and 8% of the farmers cultivate their land partially or completely according to the principles and rules of organic farming.

Table 3 displays the results of the reliability analysis, which measures the internal consistency of each scale. Cronbach's alpha, item-to-total and item-to-item correlations are very high for the scales attitude and intention. For the scales moral norm and uncertainty about agroforestry Cronbach's alpha is under the cut-off value of 0.600 (Hair et al. 1998) and for the scales group norm, intergroup perceptions, moral norm, social identity and subjective norms items-to-total

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and/or item-to-item correlations don't reach the stated cut-off value by Hair et al. (1998). Schmitt (1996) in contrast argues that there is no sacred level of acceptable Cronbach's alpha and that in some cases low levels of alpha may still be quite useful. Because the above mentioned Cronbach's alphas are close to the cut-off value proposed by Hair et al. (1998) the scales are considered acceptable for further processing, although adjustments of some scales are recommended with respect to future research. The only scale that is not acceptable is 'perceived behavioral control', which has a very low Cronbach's alpha (0.038) and low item-to-total and item-to-item correlations. This indicates that the two items that should measure the perceived behavioral control actually measure two different concepts, which are perceived difficulty and perceived control (Trafimow et al. 2002).

Because of the sufficient internal consistency, descriptive statistics of the scales are calculated and presented in Figure 3 by means of a series of boxplots, except for perceived control and perceived difficulty, which are considered as separate scales. Overall, Flemish farmers have a very low intention (average of 1.42 on a score from 1 to 7) to implement agroforestry on their own farm. Also the attitude towards agroforestry scores is low (2.95), although its distribution of scores is less skewed in comparison to intention. Flemish farmers feel no or little obligation to install agroforestry parcels, neither by themselves (2.48) nor by the farmer community (2.42) nor by other important groups (2.42). Moreover they think to have a lot of control about the choice whether or not to install an agroforestry parcel (5.24). Whereas farmers are relatively sure about the impacts of agroforestry (4.28), they feel less sure about the extent to which these impacts are also effective (3.23). They also perceive the installation and maintenance of agroforestry parcels as quite difficult (2.24). The respondents feel themselves to a large extent part of the farmer

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community (4.85), whereas they think a certain gap exists between the farmer community and agricultural policy makers (2.90). This could explain the fact that farmers are quite unsure about the future of agriculture (3.48).

The results of the logistic regression analysis are presented in Table 4. The logistic regression model is statistically significant, explains 54.4% (Nagelkerke R^2) of the variance of intention (I=0 and I>1) and correctly classifies 84.2% of the cases. Of the four predictor variables only subjective norm and perceived control are statistically significant. The odds ratio which informs one of the changes of the dependent variable for each increase in one unit of the independent variable, is lower than 1 for perceived difficulty. This is very remarkable as perceived difficulty is expressed on a reversed scale (from 1, very difficult to 7, very easy), i.e. in general respondents with a higher intention to apply agroforestry in the next three years, think agroforestry is more difficult to implement than respondents with a low intention.

3.2 Knowledge, perceptions and opinions

The questionnaire showed that 55% of the farmers are not familiar with agroforestry, neither with the term 'agroforestry' nor with its principles, while only one third of the famers are familiar with both. Only three of the respondents (4%) indicate they are currently applying agroforestry *s.l.* on their farm. Farmers mainly learn about agroforestry through agricultural journals (63%), and in a lesser extent through other literature (9%) nature organizations (6%), internet (6%), and government agencies (6%).

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According to the respondents the main agroforestry systems that have potential in Flanders (Figure 4) are trees with grassland (average score of 3.68 on a scale from 1 to 7) and orchards with standard fruit trees (3.42), while they score the potential for trees with arable crops (1.84) and horticultural crops (1.96) very low. According to the respondents, the low potential of agroforestry systems in Flanders is mainly due to excessive shade (18% of respondents) which leads to a loss of yield (19%) and quality (8%), parcels that are too small (13%), a shortage of agricultural land (13%) which leads to a high pressure on (3%) and high prices (5%) for agricultural land, and the application of a too intensive and mechanized type of agriculture (7%) where there is no place and time for increased tillage difficulties (12%).

The respondents also indicated which trees they would recommend or discourage in an agroforestry system. It is striking that poplar, oak, beech and willow are recommended for use in an agroforestry system by a part of the respondents, while they are at the same time discouraged by other respondents (Figure 5). There is more unanimity about the advantages of short rotation coppice and trees that deliver fruit or nuts, and the disadvantages of conifers like pine and spruce. In the same way respondents had to indicate characteristics of trees they would recommend or discourage in agroforestry systems and here the same results apply: some characteristics, such as rapid growth, deep root growth and a high crown are recommended as well as discouraged by farmers. On the other hand respondents agree that trees in agroforestry systems should have a narrow crown and should not contaminate crops with easily falling branches and leaves.

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Figure 6 demonstrates how the respondents think about the extent to which some effects, positive and negative, will actually occur when agroforestry is applied. At first sight one can already determine from the positions of the boxes in Figure 6 that, in general, the respondents believe less in possible advantages than in possible disadvantages of agroforestry. On a scale from 1 to 7 the average values for the advantages lie, with exception of profitability, between 3.2 and 4.4. This means that the respondents are in general not that convinced about the benefits of agroforestry as listed in Figure 6. The respondents believe slightly more (average score > 4.0) in the achievement of some advantages of a social (landscape appreciation) and ecological nature (reduction of erosion, more nature and biodiversity), whereas they mutually agree that more profit is not a likely outcome of agroforestry. For the disadvantages average scores on a scale from 1 to 7 lie between 4.0 and 6.1. According to the respondents competition for light, reduced crop production and increased tillage difficulties are serious problems (average score > 6.0) to be expected. The only negative effects of agroforestry which respondents don't really recognize are a limited market for wood and more pests and diseases.

Finally respondents were also asked to score the subsidy measure on a scale from 1 to 7, which was at that time slightly different than nowadays (only 70% of the costs of the installaton was paid back, trees had to be maintained 15 years instead of 10 and there was no compensation for own labor). Figure 7 shows that the results are very nicely spread with almost as many farmers who think the subsidy makes little sense as farmers who are neutral and farmers who think the subsidy is interesting and decisive.

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3.3 Agroforestry in Flanders

Agroforestry is a broad concept which does not only cover alley cropping, but includes many other land-use systems in which woody perennials are integrated with crops and/or animals on the same land unit. Table 5 shows the surface area of the different land uses in Flanders that can be considered as agroforestry *s.l.*, and this according to the destinations indicated by the farmers in the Single Application in the year 2013. The total result of 1924 ha can be considered an underestimation of reality due to the fact that additional destinations only have to be registered by those farmers applying for specific subsidies. As such the information in parentheses in Table 5 only had to be delivered by farmers applying for the former subsidy for standard orchards. Furthermore the Single Application takes only farmland into account (which exception of 'garden with standard trees' referring to non-farmland for which the subsidy for standard orchards was applied). Almost half of the agroforestry *s.l.* is registered as 'grassland with standard trees' which refers to grassland with a tree density of minimum 50 trees/ha. Permanent or temporary grasslands which contain less than 50 trees/ha, but for which the subsidy for standard orchards was applied are second most important with 372 ha.

Additionally the BWK was used for calculating the surface area of all parcels with tree rows at one or more borders. This resulted in a total surface area of 150,690 ha. Whereas the Single Application is considered an underestimation, the BWK may represent an overestimation. This is confirmed by field investigations which showed that two trees bordering an agricultural parcel were considered as a tree row in the BWK.

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Table 6 shows the characteristics of the farms and agroforestry parcels of all those farmers interviewed in the framework of the third part of our data collection, i.e. those who are to our knowledge at this moment consciously busy with alley cropping. It includes, among others, all farmers which made use of the subsidy program from 2011 till 2015. Among these 31 current adopters motivations and their farm and agroforestry characteristics varied strongly. According to Table 6 the adopters have on average 1.8 agroforestry parcels of which the sum of the surfaces is on average 4.0 ha. The share of farmers with a mixed and/or organic farm is higher for the agroforestry adopters (respectively 46% and 26%) than for the participants in the questionnaire (respectively 10% and 8%). Regardless of ownership there are currently 55 known agroforestry parcels in Flanders, which have an average size of 2.3 ha. 78% of the parcels were installed with help of the agroforestry subsidy program that has existed from 2011 onwards. The on average 68 trees/ha are planted in rows which are on average 21m apart, whereas the main distance between trees in one row is 9m. Among adopters silvopastoral systems are most popular (51%) which is reflected in the most popular crop types, being grass (34%) and grass clover (32%). Furthermore some arable crop types such as corn (14%) and winter cereals (20%) are according to the adopters interesting in agroforestry systems, whereas walnut (51%), fruit trees (30%), oak (17%) and poplar (17%) are the trees preferred by the adopters. This demonstrates that adopters' motivations vary strongly and that they have often multifunctional objectives, such as production of wood, fruits and nuts.

With regard to encountered obstacles legal issues were mentioned most frequently and these encompass two specific problems. The first problem has to do with the fact that the majority (64%) of farmland in Flanders is leased, whereas farmers only tend to plant trees on farmland

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they own. As such Table 6 shows that only 15% of the Flemish agroforestry plots are owned by another person than the farmer. According to the tenancy law in Flanders, farmers who want to plant trees on their leased farmland, always need to ask permission to the landowner. Therefore one condition of the agroforestry subsidy is that the interested farmer-renter has to submit a written permission of the landowner. According to Arbuckle et al. (2008), who measured non-operator landowner interests in agroforestry practices, closer ties to farming, stronger financial motivations for landownership and higher proportion of land planted to row crops were negatively associated with interest in agroforestry, whereas environmental or recreational motivations for landownership and contacts with natural resource professionals were positively associated with interest in agroforestry. Although landowners' interest in agroforestry thus seems to depend on personal values and preferences, in Flanders there is one more important reason for landowners not to give permission, which is the uncertainty about the possibility to harvest the trees. This is considered the second legal obstacle, and it applies equally to farmers with respect to the decision to implement agroforestry. Because of their value for biodiversity, nature and society, trees in the landscape in Flanders are protected through different laws, and whereas agroforestry meanwhile is explicitly excluded from the Flemish Forestry decree and the 'Veldwetboek' (rules neighborhood issues in rural areas, equivalent to the English Countryside Code), there are still a lot of other potentially conflicting rules and decrees that apply to agroforestry systems. As such, in some cases, two different felling permits might be required (under the Nature decree and under the Codex Spatial Planning) and on top of that also the Tenancy law and the Landscape decree have their own rules with respect to trees in the agricultural landscape. Landowners and also farmers fear that, if at the end of the rotation they

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don't manage to get a felling permit without a replanting or financial compensation obligation, they can never legally go back to the original situation. Also Shrestha (2004) found this kind of legal uncertainty to be the most critical threat towards the adoption of silvopastoral systems in Florida. Furthermore there is a general mistrust in government, which according to farmers does not implement a steady policy, and in their attempts to protect nature on farms only creates more thresholds. Besides the legal obstacles, agroforestry pioneers also had a lot of questions and uncertainties about possible markets and corresponding prices for obtained products, such as wood, fruits and nuts.

Discussion

The results show that only 55% of the Flemish farmers are familiar with agroforestry and that the intention to engage in agroforestry is very low. Comparison of these results with the results of Graves et al. (2009), who questioned in 2004 264 farmers in seven different European countries about their willingness to integrate trees in their agricultural parcels, shows that the knowledge of Flemish farmers corresponds most with the knowledge of farmers from north-western Europe. Here roughly half of the farmers had never heard of the term or the concept of agroforestry before. In the Mediterranean area farmers were in general more familiar with agroforestry, with only 20% of the farmers that never heard of the term or concept before (Graves et al. 2009). Also the ideas of Flemish farmers about agroforestry are broadly in line with the ideas of farmers in Northern Europe, who found the principal advantage of silvopastoral systems to be environmental benefits and the largest constraints the complexity of the work and the mechanization difficulties. Also in the south-eastern United States, aesthetic, environmental and

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conservation benefits were considered most important by farmers, rather than profitability (Workman et al. 2003). The situation in the Mediterranean area was different: here farmers felt that the principal benefit of systems with agrosilvocultural potential was farm profitability (Graves et al. 2009), an advantage in which Flemish farmers currently absolutely don't believe. These differences reflect the local agricultural practices and the extent to which tree products are seen as relevant to local economic opportunities (Graves et al. 2009). As such numerous traditional agroforestry systems are found in Southern Europe, such as olive associations in Italy (Rühl et al. 2011), and oak associations in Spain (i.e. 'dehesas') (Plieninger and Wilbrand 2001) and Greece (Vrahnakis et al. 2014).

The concerns with respect to economic and technical aspects of agroforestry might partially be linked with the lack of experience in Flanders, making the true potential of agroforestry systems in Flanders currently insufficiently acknowledged. In order to make a better judgment on the potential and compatibility of agroforestry in Flanders more research on temperate agroforestry systems is needed. In contrast to tropical agroforestry which has been investigated since the 1970s, little study results on technical and biophysical aspects of temperate agroforestry systems are currently available (Smith et al. 2012b). This study shows that also socio-economic research on agroforestry is important. This is confirmed by Nair (1998) and Mercer and Miller (1998), who found that the percentage of socioeconomic articles was maintained at a low 10% and 22% respectively of the overall number of articles on agroforestry published from the beginning of the 1980's till the end of the 1990's. With respect to farmers, future research should target farmers' negative perceptions related to profitability and compatibility. As such local studies covering field trials, market assessments and product sales such as performed by Josiah et al. (2004) are

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still non-existent. Furthermore, in order to maximally incorporate practical questions and experiences, research should be performed with farmers as equal research partners. In this way it is possible to gain a broad insight into the economic opportunities of agroforestry systems relevant to the Flemish agricultural context and an increased knowledge of the ecological interactions, ecosystems services and technical impact.

Since farmers are different, as well with respect to intrinsic as extrinsic characteristics, a combination of actions and communication strategies is necessary to induce a behavioral change. Some effective intervention strategies are given by the RESET-model, adapted from Van Woerkum et al. (1999) and Leeuwis (2004). A first strategy given by the RESET-model is regulation, which forces people by law to act in a preferred way. It works thus via coercion by authorities leading to a compulsory behavioral change. While regulation in terms of obligations or coercion would not be the preferred strategy, there are other policy measures that could enhance the current agroforestry adoption rate in Flanders. As such there is some work still needed to find an appropriate place for modern agroforestry in the legal landscape. Although some of these stumbling blocks already have been solved, there are still some conflicting regulations within the nature, forestry, agricultural and spatial planning policy domains. In order to solve these problems, there are currently meetings on a regular basis in Flanders between policy makers, farmer organizations and researchers. Also at the European level much has been improved during the last years: whereas Smith et al. (2012b) called the lack of European policy support one of the main barriers to wider adoption of agroforestry, Europe now supports this cultivation system in numerous ways (through among others Pillar 1 and Pillar 2 of the Common Agricultural Policy).

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A second strategy to induce a behavioral change in farmers is education. This study demonstrated that 55% of the farmers are currently not familiar with agroforestry, which suggests that extension efforts should focus on dissemination of knowledge and sensitization. This is supported by previous studies which proved that knowledge, information and contact with extension agents are significant factors positively influencing the interest and uptake of agroforestry practices (Workman et al. 2003; Hall et al. 2006; Valdivia and Poulos 2009; Raedeke et al. 2009; Thangata and Alavalapati 2003). For those farmers interested in, planning to start with or already engaged in agroforestry, some frequently asked technical or logistical questions need to be addressed. Although it is important that this kind of information is provided in an organized way and made accessible for all interested farmers through a central contact point, it is equally meaningful to give interested farmers the possibility to interact with each other and exchange information and experiences. This strategy is not limited to the provision of information and advice to farmers only; it wants to target all people who deal with agriculture in one or another way. Therefore agroforestry and more generally agroecology should be given a clear and appropriate place within agricultural education.

The third letter of RESET stands for social pressure, which influences farmers' norms and values. Currently farmers feel little or no obligation to practice agroforestry, which is expressed by the low scores for the variables subjective norm, group norm and moral norm. The logistic regression however demonstrated the importance of social pressure by assigning the largest odds ratio, 2.48, to the variable subjective norm. This means that for every unit increase of subjective norm, the probability to belong to the second group (with a score for intention larger than 1) is 2.48 times larger. Research institutions, agricultural consultants and advisers are thus important

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for increasing social stimuli by setting up a network and sending the same message with respect to agroforestry. By influencing national and regional dialogues in policy and extension environments, agroforestry can gradually be built into the social norms and identities of the farming profession, thereby making it one of the default options.

Economic incentives make up the fourth strategy in the RESET-model. In Flanders the subsidy program was established as an economic incentive to promote agroforestry. The questionnaire showed that the respondents' opinions are very evenly distributed, with as many farmers finding the subsidy uninteresting and indecisive, as farmers finding the subsidy interesting and decisive. Although the subsidy program is meanwhile already partially adjusted and optimized, it is criticized by farmers that it still does not solve the most pressing obstacles of planting trees on agricultural land. Especially the fact that there is still no compensation for maintenance of trees, is by farmers considered as a substantial drawback. More scientific field data should therefore lead to a more effective subsidy program, based on a more in-depth cost-benefit analysis taking into account the uncertainty, long term investment, crop production losses and maintenance costs related to agroforestry. Economic incentives that are currently not yet addressed in Flanders are alternative contract- and financing options, such as Payments for Environmental Services (PES), crowdfunding, interesting loan conditions, etc. An example of an alternative financing system that was proposed by some farmers is a system in which wood processing companies remain the tree-owners and are responsible for the planting and harvesting of trees, while farmers get an annual compensation for the partial use of the field and for the maintenance of trees. Whereas it is currently unknown if such systems, in which the uncertainty is shared between different actors

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in the value chain, could be effective in Flanders, it is worthwhile to research in more detail the possible advantages and disadvantages.

The last letter of RESET stands for tools, i.e. means and methods which make agroforestry much easier and attractive to perform. An example of such a tool is a Financial Decision Support Tool, such as the web-based application for agroforestry planning and tree selection developed by Ellis et al. (2005) for the Southeast of the United States. These tools combine growth and yield prediction models with financial decision models. They can instantly show the impact of establishment, management, and harvesting and marketing decisions on the financial performance of the agroforestry system. Such a web-based application could assist interested farmers and extension agents in Flanders to evaluate potential sites and suitable trees species and crops for use in agroforestry systems. However, the development of a tool requires the availability of detailed, long-term datasets of yields (e.g. timber and crop yields within alley cropping systems over time, etc.) and benefits or drawbacks (animal health in silvopastoral systems, labor, etc.), which are often not available for local conditions. Luckily for Flanders they are now being collected in the context of a large research project about agroforestry development in Flanders. Furthermore tools could address the negative perceptions of Flemish farmers towards mechanization and tillage efficiency. As such machines that are adapted for use in agroforestry systems could be considered as a tool to promote agroforestry. These can be tailor-made for agroforestry systems and made available to the farmer through contractors and manufacturers. However, this requires a large investment of the farmer, which adds to the drawbacks making interested farmers reluctant to adopt. Therefore the possibilities have to be explored to use and modify existing equipment for use in agroforestry systems instead of

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investing in new machinery. The availability of adapted or tailor-made machinery acts upon the extrinsic characteristics of the innovation itself, more specifically the complexity of the innovation, and could as such prevent that agroforestry is regarded as a system in which the current mechanization efficiency in agriculture has to be abandoned.

Conclusion

This research shows that the adoption of agroforestry in Flanders remains rare with only 31 farmers currently known to be involved in alley cropping. They often installed in the last couple of years one or more agroforestry plots that combine a variety of trees with grassland. The low adoption rate of agroforestry in Flanders results logically from a low intention of the general farmer community to engage in agroforestry. Although Flemish farmers believe in certain socio-ecological advantages of agroforestry, they have a lot of concerns with respect to the economic (yield and quality loss, profitability, marketing of wood products) and technical (mechanization difficulties, compatibility) aspects of agroforestry. For the pioneers and those farmers considering implementation of agroforestry in the near future, especially legislative issues continue to cause uncertainty, although the last few years already some effort has been done to tackle this problem. To further increase the agroforestry adoption rate, a combination of different actions and communication strategies are necessary. Besides more scientific research on both the ecological and socio-economic aspects of temperate agroforestry, some effective strategies are given by the RESET-model. As such more and better education and extension services, the set-up of a local agroforestry network consisting of both researchers and agricultural advisors, the inclusion of a compensation for maintenance into the subsidy program and the set-up of

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alternative contract- and financing options are effective means to improve the current low adoption rate of agroforestry in Flanders.

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Figures

Figure 1. Provinces and agricultural regions in Flanders

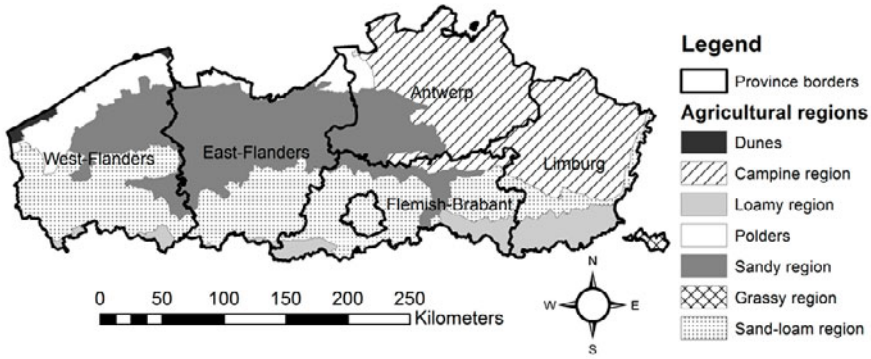

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Figure 2.Conceptual framework showing the linkages between extrinsic variables (A,B,C) and intrinsic variables (TPB) and the influence of communication and extension services (D) in the decision-making process of adoption of agricultural innovations. Adapted from Meijer et al. (2014), with inclusion of the TPB model (Ajzen 1991) and the RESET model (Van Woerkum et al. 1999; Leeuwis and Van den Ban 2004)

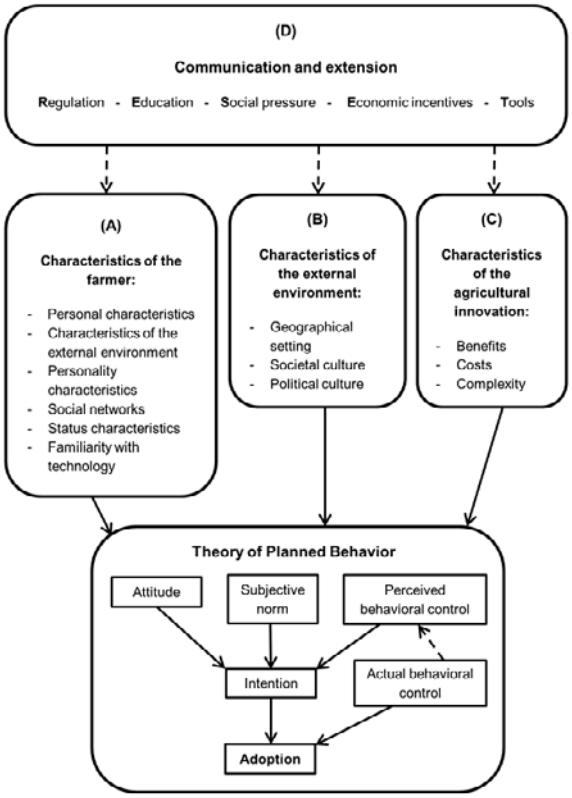

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Figure 3. Boxplots of TPB variables on a scale from 1 to 7 (with little circles and stars representing outliers, respectively smaller and larger than 1.5 times the interquartile range)

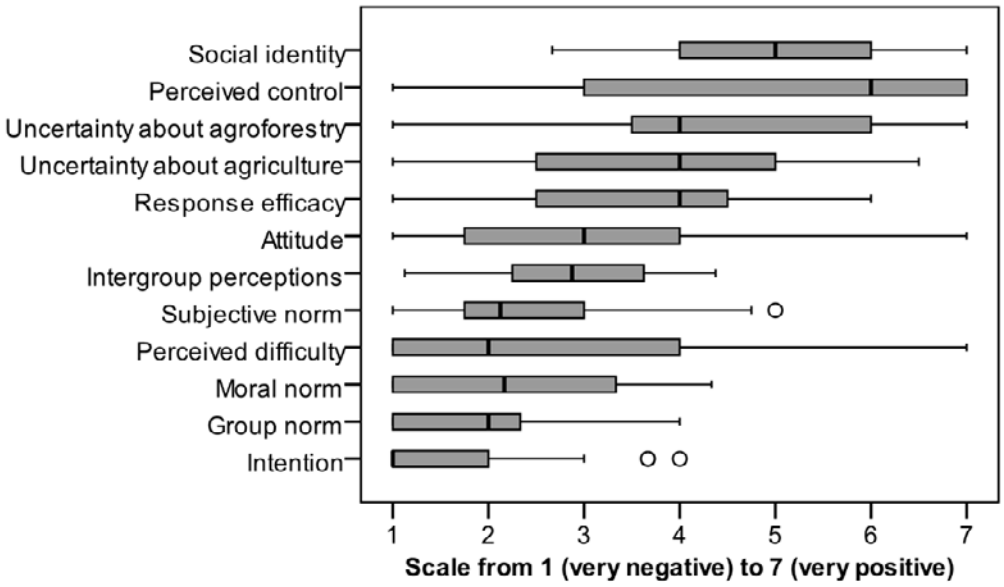

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Figure 4. Boxplots of the potential of different agroforestry systems in Flanders according to the respondents (with little circles and stars representing outliers, respectively smaller and larger than 1.5 times the interquartile range)

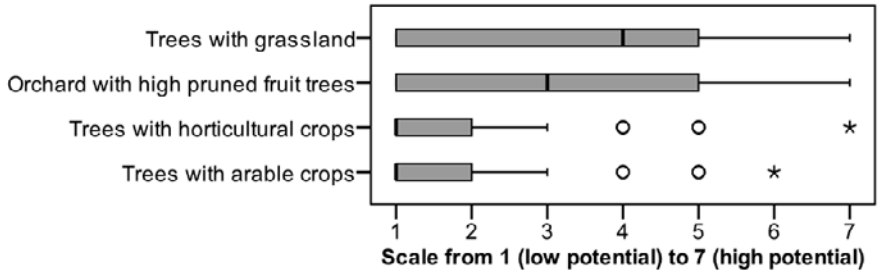

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Figure 5. Percentage of the number of times a tree species (or type of management practice) is recommended/discouraged by the respondents for the application in agroforestry systems in Flanders

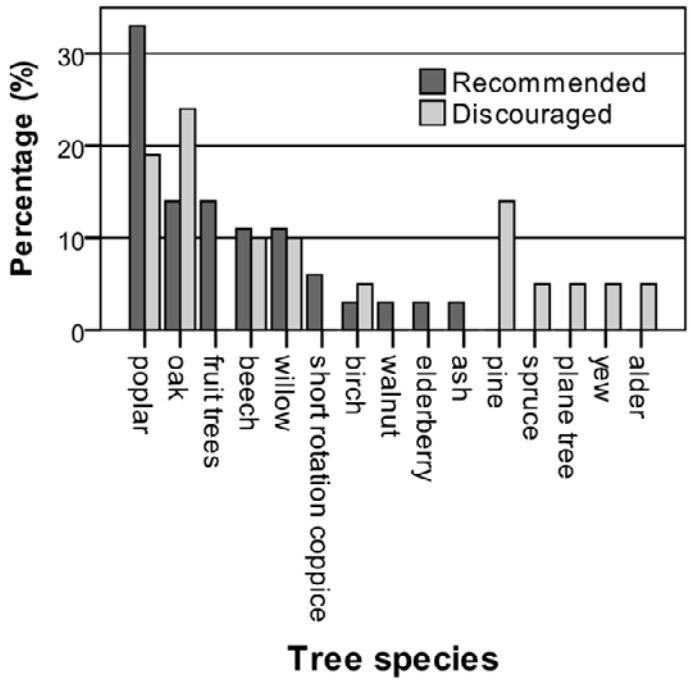

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Figure 6. Boxplots of the extent to which (a) advantages and (b) disadvantages of agroforestry will occur according to the respondents (with little circles and stars representing outliers, respectively smaller and larger than 1.5 times the interquartile range)

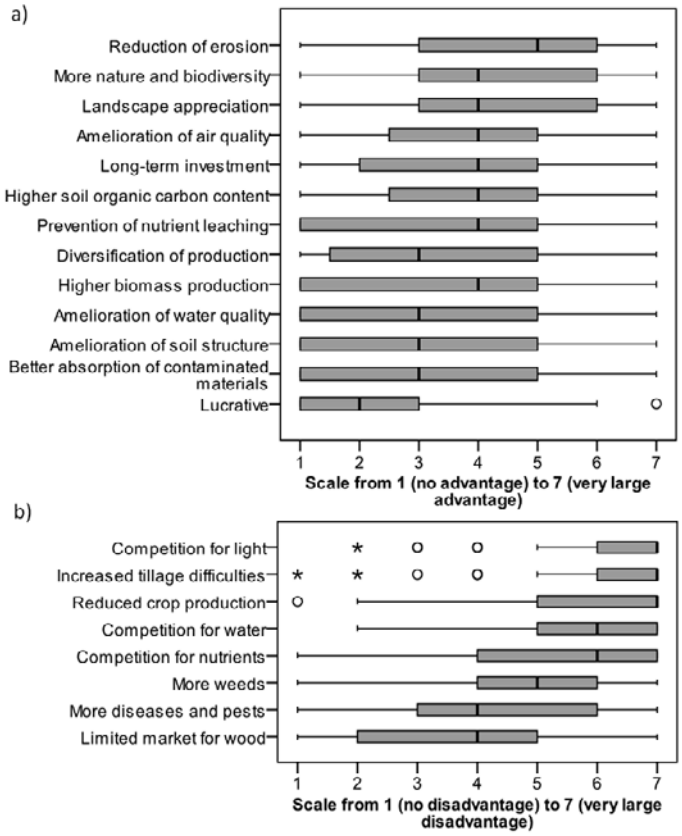

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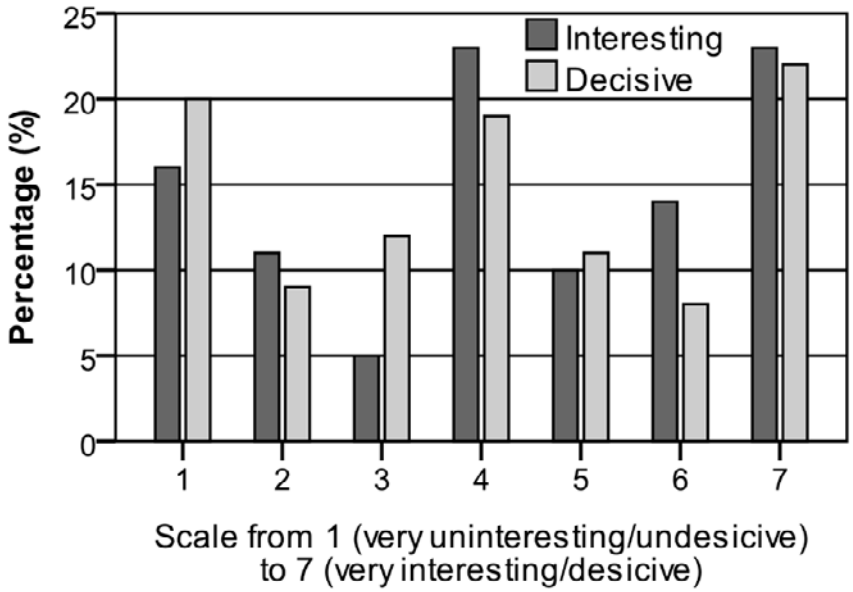
Figure 7. Scores of the respondents for the subsidy program (2011-2013) on a scale from 1 (very uninteresting and indecisive) to 7 (very interesting and decisive)



- **Tables**

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Table 1. Latent constructs and hypothesized item structure. TPB variables are based on the hypothesized item structure and calculated as the average item score per construct.

Constructs and associated items
Attitude (A)
Applying practice X is very bad - very good
Applying practice X is very unpleasant - very pleasant
Applying practice X is very useless - very useful
Applying practice X is very negative - very positive
Subjective Norm (SN)
Very few - a lot of people whose opinions I value think I should apply practice X
Very few - a lot of people that I find important think I should apply practice X
It is to a very small - very large extent expected of me that I apply practice X
I think most people outside agriculture think it is very positive - very negative to apply practice X

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Perceived behavioral control (PBC)

I think applying practice X is very difficult - very easy

I have very little - very much control over the decision to apply practice X

Social Identity (SI)

I feel myself very little - very much connected to other farmers

I feel myself to a very small - to very large extent farmer

I identify myself very little - very much with the agricultural community

Group norm (GN)

Most farmers would very little - very much approve the fact that I would start applying practice X

Very few - a lot of farmers already apply practice X

Most farmers think it is a very good - very bad idea to apply practice X

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Intergroup perceptions (IGP)

Very often - very seldom outsiders decide how agricultural policy is evolving

People who make decisions about agricultural policy know very little - very much about practical considerations in agriculture

I agree to a very small - very large extent with the current agricultural policy

I think that people that influence agricultural policy know very little - very much about agriculture

There is a very large - very small gap between people inside and outside of agriculture

Agricultural policy makers take opinions of farmer to a very small - very large extent into account

I think there is very little - very much understanding from outsiders for people in agriculture

I belief that farmers and agricultural organizations have very little - very much influence on agricultural policy

Moral norm (MN)

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I would regret very much - very little the decision to apply practice X

I think it is very good - very wrong not to start applying practice X

I feel personally very little - very much obligated to apply practice X

Response efficacy (RE)

I think practice X is a very good - very wrong way to ensure that agriculture has a more positive impact on the environment

I think that I would very little - very much contribute to a more ecological agriculture by applying practice X

Uncertainty about agriculture (UAg)

I am very unsure - very sure about my future as a farmer

I am very unsure - very sure about the future of agriculture in general

Uncertainty about agroforestry (UAf)

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I am very sure - very unsure about the effects of applying practice X on my agribusiness

I am very sure - very unsure about the possible positive or negative effects of practice X

Intention (I)

I intend to a very small - very large extent to start applying practice X in the next 3 years

I am planning very little - very much on starting practice X within the next 3 years

I am very little - very much resolved to apply practice X within the next 3 years

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Table 2. Summary statistics of the questionnaire sample (based on 86 respondents)

Characteristic	**Statistic**
Geographical distribution (% farms)	
Antwerp	24.40
Limburg	18.60
East-Flanders	22.10
Flemish-Brabant	16.30
West-Flanders	18.60
Farm and farmer characteristics	
Sex (% men)	96.50
Age (years)	50.92 (11.13)
Farm size (ha)	42.11 (43.30)

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Percentage leased land	53.02 (34.28)
Assured farm succession (% farms)	26.70
Farm type (% farms)	
Arable and horticultural farming	26.80
Livestock farming	63.40
Mixed farming	9.80
Sustainable farming techniques (% farms)	
Organic farming	8.10
Agro-environmental measures	30.2

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Table 3. Results of the reliability analysis (Cronbach's alpha, range of item-to-item and item-to-total correlations) of the scales

	Cronbach's Alpha	**Item-to-total correlations**	**Item-to-item correlations**
Attitude	0.979	0.926-0.958	0.883-0.956
Group norm	0.620	0.272-0.557	0.224-0.566
Intention	0.847	0.652-0.759	0.595-0.737
Intergroup perceptions	0.772	0.257-0.640	-0.090-0.570
Moral norm	0.524	0.288-0.469	0.188-0.398
Perceived behavioral control	0.041	0.021	0.021
Response efficacy	0.753	0.607	0.607
Social Identity	0.601	0.349-0.486	0.233-0.414
Subjective norm	0.664	0.310-0.574	0.217-0.583

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Uncertainty about agriculture	0.680	0.516	0.516
Uncertainty about agroforestry	0.591	0.421	0.421

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Table 4. Results of the logistic regression predicting the likelihood of Intention being equal or larger than 1, and this based on the predictor variables attitude, subjective norm, perceived control and perceived difficulty

	Odds ratio	95% Confidence Interval		χ^2	p
		Lower	Upper		
Model				36.45	0.000***
Attitude	1.05	0.67	1.64		0.826
Subjective norm	2.48	1.23	5.00		0.011**
Perceived control	2.47	1.36	4.46		0.003***
Perceived difficulty	0.77	0.55	1.09		0.138

**** Significant at the 0.05 level; *** Significant at the 0.01 level**

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Table 5. Surface area of agroforestry s.l. in Flanders according to the Single Application of 2013

Destination	Total surface area (ha)	Number	Average surface area (ha)
Hedges and hedgerows	186	2468	0.08
Garden with standard trees	121	398	0.3
Grassland with standard trees	987	1593	0.62
Walnut plantations	25	26	0.95
Hazelnut plantations	4	6	0.68
Standard cherry trees	51	81	0.63
Apple trees (standard)	52	65	0.81
Pear trees (standard)	2	3	0.81
Plum trees (standard)	2	5	0.49

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Other perennial fruit crops (standard trees)	35	54	0.64
Permanent grassland (with standard trees)	372	273	1.36
Temporary grassland (with standard trees)	67	62	1.08
Other destinations (with standard trees)	20	13	1.53
Total	**1924**	**5047**	**0.38**

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Table 6. Characteristics of the farms and agroforestry parcels of the known agroforestry pioneers and early adopters in Flanders (situation 2015-2016).

Farm characteristics	Statistic	**Crop types and tree species**	Statistic
General		Crop type (% parcels, list only includes subsidized parcels from 2011-2015)	
Number of farms	31		
Surface area of AF/farm (ha)	4.0 (4.7)	grass	34
Number of AF parcels/farm	1.8 (1.5)	grass-clover	32
Farm type (% farms)		corn	14
Arable and horticultural farming	37	winter cereals	13
Livestock farming	17	potatoes	3
Mixed farming	46	clover	1
Sustainable farming techniques (% farms)		vegetables	1

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Organic farming	26	soft fruit	1
Agroforestry parcel characteristics		Tree species (% parcels, list excludes those species occurring only on one parcel)	
General			
Number of AF parcels	55	walnut (*Juglans* spp.)	51
Size (ha)	2.3 (2.2)	apple (*Malus domestica* Borkh.)	26
Use of subsidy program (% parcels)	78	plum (*Prunus domestica* L.)	25
Leased farmland (% parcels)	15	pear (*Pyrus communis* L.)	23
Plantation year (% parcels)		sour cherry (*Prunus cerasus* L.)	19
< 2000	8	oak (*Quercus* spp.)	17
2000-2010	8	poplar (*Populus* spp.)	17
> 2010	83	alder (*Alnus glutinosa* (L.) Gaertn.)	13

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Agroforestry types (% parcels)	
Silvopastoral	51
Silvicultural	41
Agrosilvopastoral	8
Plantation design	
Density (trees/ha)	68.3 (52.4)
Distance between rows (m)	21.1 (11.0)
Distance between trees in row (m)	9.1 (2.4)

wild cherry (*Prunus avium* L.)	13
rowan (*Sorbus aucuparia* L.)	9
chestnut (*Castanea* spp.)	9
willow (*Salix* spp.)	9
common hazel (*Corylus avellana* L.)	8
lime tree (*Tilia* spp.)	6
ash (*Fraxinus excelsior* L.)	4
beech (*Fagus sylvatica* L.)	4

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