UNDERSTANDING THE ACCEPTANCE OR REFUSAL OF AGROFORESTRY SYSTEMS BY FARMERS IN THE NORD –PAS-DE-CALAIS REGION (NORTHERN FRANCE)

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Introduction

Due to the unsustainable nature of the intensive agricultural systems, the new challenge of today's society is to conciliate high agricultural production with environmental awareness. Recently, modern agroforestry systems (AFs) have emerged and have been recognized worldwide as an integrated approach to use land in a sustainable manner. Beyond its agronomical and economic benefits, AFs may be a method of enhancing biodiversity, sequestering carbon, increasing soil organic matter, breaking dominant winds and reducing soil erosion and the potential leachable soil nitrate content (Andrianarisoa et al., 2015) in agroecosystems. In the Nord – Pas-de-Calais (NPDC) region (Northern France), there is an overall reluctance of the agricultural profession to reintroducing trees to agroecosystems. Farmers provided many reasons for their stance, but to date, no in-depth studies have been performed at the regional scale to understand this lack of enthusiasm. The aim of this study was to understand the acceptance or refusal of AFs by farmers in the socio-agro-environmental context of NDPC. The study was focused on hedges (H) and alley cropping (AC) systems.

Material and methods

The NPDC is an agricultural-dominated region with a total of 817,000 ha of utilized agricultural area (UAA) and 13,500 farmers in 2010 (DRAAF Nord - Pas-de-Calais, 2014). On the one hand, the NPDC region is the top producer of potato, peas, chicory and endive, the third-largest producer of sugar beet, the fourth-largest producer of bread wheat, and the fifth-largest producer of milk in France. The cereal and oleaginous crop yields are significantly higher than the national average as well as the prices of free and leased land and the tenant farming level. On the other hand, the NPDC region is the least-forested, the second-most artificialized, among the most affected by erosion risk in all seasons and classified as a vulnerable zone for nitrate in surface and ground waters. Surveys of 108 farmers were conducted from October 2013 to May 2014, within three sub-areas covering 95,151 ha of UAA, impacted by serious environmental issues in the region. A questionnaire combining closed and open-ended questions about the general characteristics of the farm, the farm functioning and practices, farmers' perception of agro-environmental issues in the territory, farmers' perception of innovation and farmers' perception of AFs, was established. The level of acceptance of AC and H was categorized as « favorable », « undecided » or « opposed ». Regarding farmers' openness to innovation, all practices that the farmer already applied or planned to implement in the next 10 years were noted. A score of 1 was assigned to each regulatory required practice recorded at the farm; a score of 2 was assigned to each noncompulsory but frequent practice observed in most farmers; and a score of 3 was assigned to each practice involving agro-ecological and technological innovation that the farmer willingly applied. If the farmer did not currently use the practice but planned to apply it, only half of the score was assigned. A variable called "Innovation index" was then created to represent the sum of the score obtained by a farmer. A chi-square test of independence and a generalized linear model were performed to test the relationship between the level of acceptance of AFs and all recorded variables.

Results

A summary of some parameters describing the surveyed farmers is presented in **Table 1**. Briefly, more than half were individual holding and two thirds was sustainable farms. The mixed farming type (various crops and livestock combined) was the most commonly encountered and the average utilized agricultural area was 101 ha. The percentage of UAA in tenant farming was 77%. Approximately 43% of farmers were involved in environmental programs. A strong majority of farmers (68%) already possessed hedgerows in their farm, which either existed before their farm ownership or were planted by the farmers themselves.

Table 1: Summary of descriptive, inferential and linear statistical analyses realized between the level of acceptance of hedges and alley cropping and a given variable. The symbol '.' indicates a p-value < 0.1; '*' for p < 0.05; '**' for p < 0.01 and ns means 'not significant'. MC: mixed cropping and GFC: general field cropping), sus: sustainable farm, conv: conventional farm and org: organic farm. LSU means livestock unit.

Variables	Categories or [min-max]	N	Percent (%)	Mean	SD	p-value	
						H	AC
Age (year)	[20 - 45]	45	42	-	-	ns	ns
	[46 - 55]	39	36	-	-		
	≥ 56	22	20	-	-		
Farming type	MF	45	42	-	-	ns	ns
	MC	40	37	-	-		
	GFC	23	21	-	-		
Utilized agricultural area (UAA; ha)	[2.5-310]	107	99	101	64	ns	ns
Agricultural work unit (AWU)	[0.5-12]	106	98	2.6	2	ns	ns
Plot size (ha)	[1-50]	108	100	7	6	ns	ns
Percentage of UAA in off-family tenant farming (%)	[0-100]	108	100	54	28	**	**
Turnover (k€)	< 200	40	37	-	-	ns	ns
	200-400	31	29	-	-		
	> 400	31	29	-	-		
Production type	Sus	72	67	-	-	ns	ns
	Conv	28	26	-	-		
	Org	7	6	-	-		
Livestock density index (LSU ha^{-1})	0	63	58	0	0	ns	ns
	< 2	11	10	1.5	0.3		
	≥ 2	28	26	6	7		
Participation to environmental program	NO	46	43	-	-	.	ns
	YES	46	43	-	-		
Belong to a water catchment feeding area	NO	52	48	-	-	ns	ns
	YES	49	45	-	-		
Knowledge of water quality deterioration	NO	26	24	-	-	ns	ns
	YES	59	55	-	-		
Aware of the role of farmers in water quality	NO	17	16	-	-	.	ns
	YES	70	65	-	-		
Innovation index	[11; 56]	103	95	33	10	**	*
Knowledge of AFs	NO	32	30	-	-	ns	ns
	YES	74	67	-	-		
Provided the correct definition of AFs	NO	55	50	-	-	*	ns
	YES	53	49	-	-		
Hedge length (m ha^{-1} UAA)	NO	35	32	0	0	**	*
	YES: [0.5-80]	73	68	13	15		

Regarding AC, except some small plots of ancient orchard-meadows recorded in 6 farms, only one farmer declared having planted 200 m² of trees within his poultry pasture. Seventy percent of farmers stated that they had knowledge of AFs, but only 49% of respondents provided the correct definition. Farmers were more favorable to the implementation of H than AC. Indeed, 58% of farmers were favorable to H compared to 25% for AC (**Table 2**).

Overall, more constraints were mentioned by farmers than advantages for AFs. They recognized the ability of AFs to limit soil erosion, break the dominant winds, restore or preserve the biodiversity in the agroecosystem and beautify the landscape (**Figure 1a**). However, they were cautious of the increased labor costs, the competition between trees and crops, the hindrance caused by tree rows for mechanized agricultural works, the loss of arable area, the incompatibity with small plot sizes and the land tenure (**Figure 1b**). Statistical analyses revealed that the level of acceptance of AC and H was negatively correlated with the percentage of UAA in off-family tenant farming and positively correlated with the length of hedges recorded in the farm and the innovation index (**Table 1**). There was no significant relationship between the level of H or AC acceptance and the farmer's age, farm juridical status, school education level, farming type, total UAA (ha), plot size, agricultural work unit (AWU), farms' turnover, type of production and livestock density index.

Table 2: Table of contingency crossing the level of acceptance of hedges and alley cropping by farmers.

Occurrence (*percentage*)		Level of acceptance of alley cropping			Total
		Favorable	Undecided	Opposed	
Level of accept-ance of hedges	Favorable	24 (22%)	17 (16%)	22 (20%)	63 (58%)
	Undecided	3 (3%)	7 (6%)	8 (7%)	18 (17%)
	Opposed	0 (0%)	3 (3%)	24 (22%)	27 (25%)
Total		27 (25%)	27 (25%)	54 (50%)	108

Discussion

Studies from surveys in different regions of France and in some European countries also reported the same values of AFs acceptability and cited the same advantages and constraints (Liagre et al., 2005). As hedges were frequently observed in surveyed farmers, it is not surprising that they were more accepted by farmers than AC. Many authors suggested that the most important factor in increasing the adoption of conservation practices is the trialability, observability, complexity, risk and uncertainty and perception of long-term profit (Cary and Wilkinson, 1997; Fuglie and Kascak, 2001). Practices that can be implemented on a small scale prior to full implementation are more likely to be adopted. Hence, the low acceptance of AC in our finding may be partially attributed to the lack of local references of the system and to the opinion that the inclusion of trees in plots is complex to manage and requires specific skills. In terms of economic profitability, farmers feared the decrease in crop production in the short term by the loss of arable area due to uncropped tree rows and in the long term by the increase of tree-crop competition for water, light and nutrients. With the high crop yields and price of land recorded in the NPDC region, a majority of farmers noted that the development of AFs in the region is counterproductive. In addition, there is tension regarding land property due to the increase of urban pressure. To provide responses to these concerns, an agronomic and economic evaluation of AFs in the pedoclimatical context of the NPDC region should be conducted, based on an experimental and modeling approach.

Following statistical analyses, farmers who were favorable to AFs were:

1. Those with low land areas in off-family tenant farming. Pattanayak et al. (2003) also showed that landowners are more likely than tenants to adopt agroforestry. These results from statistical analysis are consistent with the perception of AFs by farmers described in figure 1 and showed that this variable was a determinant factor that should be addressed for the development of AFs in the NPDC region. During surveys, one farmer declared that it is not possible for him to address his 75 landowners, and another declared that he cannot plant trees for the grandchildren of his landowners. Considering these problems of land property, some farmers were ready to accept arrangements in the lease contract with their land owner, for instance, a lower rent or a guarantee to have a long-term lease.

2. Those with an important scoring for technical and agro-ecological innovative practices and those were already familiarized with AFs. Patanayak et al. (2003) also confirmed the positive correlation between the adoption of AFs and the experience of the farmer in tree planting. They specified that the familiarity with the system decreases the uncertainty associated with unpredictable returns. Hence, awareness efforts should be realized through, for instance, meetings and farmers' groups, or by extension officers.

Surprisingly, farmers who were involved in special environmental programs and belong to zones with environmental challenges were not particularly amenable to the implementation of AC. In contrast, they felt that they were often accused as being solely responsible for the water quality pollution by nitrates and soil erosion, whereas in their opinion, urbanization, shopping areas, highways and diverse infrastructure also strongly contribute to water quality deterioration. Farmers stated that they have already taken sufficient action to satisfy compulsory measures to mitigate environmental issues and were not prepared to adopt new practices (such as AFs) or other regulatory constraints.

Conclusions

Our results showed that farmers were largely favorable to the implementation of H than AC. Overall, they perceive AC to be a sustainable farming system providing numerous environmental advantages, but they were still skeptical of its profitability and adaptation in the

local context. Among variables related to farms' characteristics and functioning, land tenure was a serious obstacle, and the familiarization with trees and innovative practices was a driving force in the development of AFs in the region. The diverse perceptions of agroforestry by farmers demonstrate the possibility of implementing several strategies for further AFs development projects. The three main strategies are as follows: (i) increase awareness of the different advantages of AFs, particularly in terms of economic and technical aspects, (ii) initiate a farmer group dynamic to provide a better exchange on AFs and (iii) implement serials of AF demonstration-experimentation plots to provide local references. A significant communication effort should be conducted because there was a clear lack of knowledge about AFs and their functioning in the field.

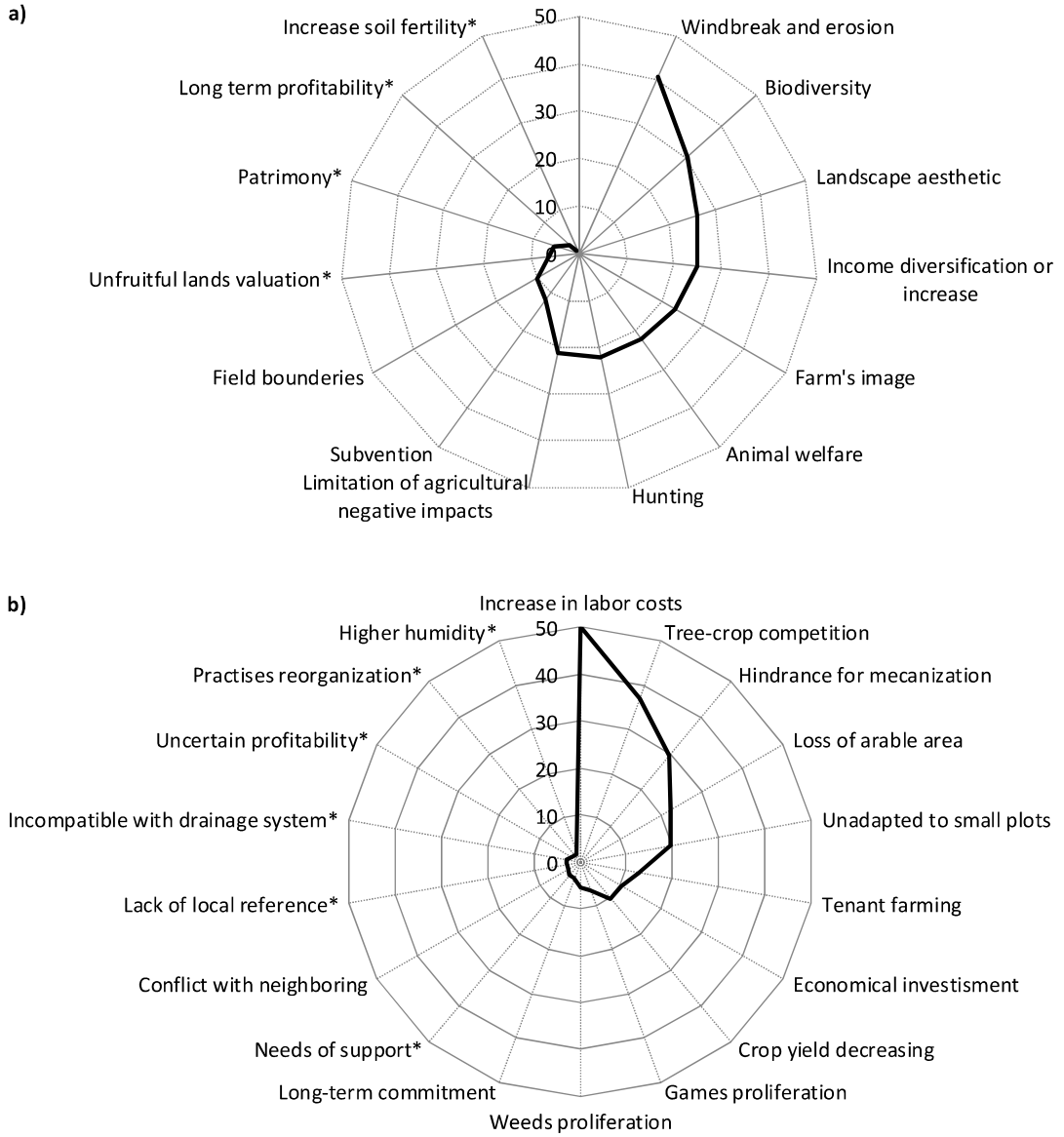

Figure 10: Advantages (a) and disadvantages (b) of agroforestry systems cited by farmers. The * symbol indicates the advantages or disadvantages exclusively noted for alley cropping system.

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