Chapter 4
Farmer Perceptions of Silvoarable Systems in Seven European Countries

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Abstract Between 2003 and 2004, 264 face-to-face interviews were undertaken to determine farmers' perceptions of silvoarable agroforestry across 14 sample areas in seven European countries. Across the 14 sample areas, 40% of respondents had heard the term "agroforestry" and 33% then defined it as an association of trees with crops or livestock. By contrast those farmers, who had not heard of the term, were almost as likely to define "agroforestry" as "silviculture" (24%) as an "association of trees and crops or trees and livestock" (25%). Farmers were then shown pictures of silvoarable agroforestry, where trees and arable crops were grown on the same land unit. Farmers in Mediterranean areas felt that the principal benefit of silvoarable systems would be increased farm profitability (37%), whereas farmers in Northern Europe placed greatest value on environmental benefits (28%). When asked to identify the greatest negative attribute, Mediterranean farmers tended to identify intercrop yield decline (31%), whereas farmers in Northern Europe tended to highlight the general complexity of work (21%) and difficulties with mechanisation (17%). When asked to design a silvoarable system for their farm, Mediterranean farmers tended to envisage systems with a higher tree density (100 trees per hectare) than those in Northern Europe (55 trees per hectare). Overall half of all farmers interviewed indicated that they would "attempt" silvoarable

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A. Rigueiro-Rodríguez et al. (eds.), *Agroforestry in Europe: Current Status and Future Prospects*.

agroforestry on their farm, ranging from 18% to 90% within the individual sample areas. These results suggest that with appropriate promotion and support, silvoarable agroforestry would become a more common feature of the European landscape.

Keywords Adoption, agroforestry, attitudes, crops, trees, social survey

Introduction

Silvoarable agroforestry can be defined as the integration of trees with arable crops on the same land unit. Such systems can increase productivity and profitability (Graves et al. 2007) and, relative to arable production, provide environment benefits such as control of soil erosion and leaching, increased carbon sequestration and increased landscape biodiversity (Palma et al. 2006, 2007). The European Commission (2004, 2005) states that such systems should be encouraged, because of their "high ecological and social value", and the European Union (EU)'s Rural Development Regulation (1698/2005) allows support to be provided for the establishment of agroforestry systems on agricultural land. However, relatively little is known about how European farmers regard such agroforestry systems. Most research regarding farmers' perceptions of agroforestry has been undertaken in tropical countries where it has sought to understand local practice (Barrance et al. 2003), opportunities for improvement (Dreschel and Rech 1998; Fischler and Wortmann 1999), and the reasons for success or failure (Franzel 1999; Graves et al. 2004).

From August 2001 to January 2005, the Institute National de la Recherche Agronomique (INRA) in France co-ordinated an EU-sponsored project called Silvoarable Agroforestry for Europe (SAFE) (Dupraz et al. 2005). The aim of the SAFE project was "to reduce uncertainties regarding the understanding, knowledge, and functioning of silvoarable systems in Europe". Its objectives included assessment of the production and value of silvoarable systems, the prediction of its potential as a new farming system, and the establishment of guidelines for agroforestry policy.

Overall the project comprised nine activity-based work-packages and one work-package related to project management. One of the work-packages was concerned with the collection of detailed measurements of on-going silvoarable experiments (Burgess et al. 2005, 2006; Moreno et al. 2005, 2007; Paris et al. 2005; Mulia and Dupraz 2006). Four of the work-packages were concerned with development of an appropriate modelling framework and the development, parameterising and testing of two biophysical models of forestry, agroforestry, and arable system called Hi-SAFE and Yield-SAFE (van der Werf et al. 2007). In another work-package, a modelling approach based on the Yield-SAFE model was used to undertake long-term economic simulations of the effects of different systems at a plot-scale (Plot-SAFE) and a landscape-scale (Farm-SAFE) (Graves et al. 2005, 2007). Another work-package used the Plot-SAFE and Farm-SAFE models to determine the effects of the different systems on the environment (Palma et al. 2004, 2007), and an eighth work-package elaborated guidelines for policy implementation of agroforestry in Europe (Lawson et al. 2005).

The remaining work-package was concerned with the collection and collation of information on traditional European silvoarable systems and the assessment of the attitudes of European farmers toward silvoarable agroforestry. The information collated on traditional European silvoarable systems was described by Eichhorn et al. (2006). This paper describes the results for a sample of farmers in 14 areas across seven countries in Europe. The objectives were to determine farmers' current awareness of silvoarable systems, to understand their perception of the potential benefits and constraints, to understand how they would design such a system, and to determine if they would consider implementing such a system.

Method

The survey took place in 14 areas across seven countries in Europe (Table 4.1, Fig. 4.1). Six areas occurred within the Mediterranean environmental zone described by Metzger et al. (2005). The eight remaining areas in Northern Europe

Table 4.1 Brief description of the 14 sample areas

Country	Area	Description of landscape and agricultural practice
UK	Bedfordshire	Relatively flat; intensive arable production; some woodland
Netherlands	Northern Friesland	Flat, open landscape; principally dairy farming and some arable farms with potato, sugar beet or vegetable; few trees and bushes
Netherlands	The Achterhoek	Relatively flat; small and mainly mixed farms; landscape features include hedges, tree lined plots, solitary trees and copse wood bushes; many trees some forests
Germany	Schleswig-Holstein	Flat; large-scale arable farming and large deciduous forests
Germany	Brandenburg	Flat; large-scale arable farming and large coniferous forests
France	Poitou-Charentes	Primarily arable farming focussed on wheat; substantial area of hedges
France	Centre	Research focused on intensive arable area
France	Franche-Comté	Substantial forest cover (43%), agriculture focussed on livestock and pasture
Spain	Castilla y León	Relatively flat; large-scale cereal and sunflower farming; small irrigated plots with alfalfa and beetroot; treeless landscape
Spain	Castilla-La Mancha	Relatively flat; large-scale cereal farming, olive plantations and vineyards; occasionally combination of olive trees with vineyards
Spain	Extremadura	Flat landscape dominated by irrigated cropland with tomatoes, tobacco, corn, and vegetables. Dehesas (silvopastoral system with scattered oak trees) and cereal farms dominate non-irrigated lands
Italy	Northern Italy	Intensive mechanised agriculture
Italy	Central Italy	Extensive agriculture including traditional agroforestry systems
Greece	West Macedonia	Diversified agriculture, presence of scattered trees

Fig. 4.1 Map showing the approximate location of the study areas together with a line indicating the approximate border of the Mediterranean zone

occurred within the Atlantic or continental environmental zones. The areas were selected on the basis of having a significant arable production for that country whilst minimising the distance from the organisations undertaking the research. One exception to this was Franche Comté in France which is well-forested and the principal agricultural system is livestock production (Table 4.1).

In 2003, in each of the areas, a sampling frame (Schofield 1996) of commercially-active farmers was developed. Various avenues were taken for this. In the UK, the sampling frame was developed from a listing of farmers in a local telephone directory; whilst in The Netherlands, a fee was paid to a consulting company to provide the names of potential farmers. In Germany, addresses of farmers were given by regional farmers' union ("Kreisbauernverband") and agricultural schools. In France, the surveyed farmers were identified through the ROSACE database (Réseau d'observation des systèmes d'explotation). In Spain, the farmers were randomly sampled from the list of addresses given by farmer associations (at province

level) and the agriculture extension services (at county level). In Italy the interviewed farmers were identified through both institutional contacts with farmer associations, consortia or cooperatives and personal contacts. In West Macedonia, all of the farmers were within the Askio Municipality and each had at least one plot of land contained or bordered by trees. The number of farmers interviewed in each area ranged from 14 to 30 (Table 4.2). The exceptions to this were in Germany where budget constraints meant that between six and ten farmers were interviewed.

In each of the 14 areas, individual face-to-face interviews were undertaken with farmers and farm managers using an interview schedule based on a standardised questionnaire (Neuman 2000; Liagre et al. 2005). The questionnaire comprised

Table 4.2 Number of interviews, mean age of the interviewee, the proportion able to identify a successor, mean farm area, proportion of the farm that was owned by the occupier, the area per worker, and the number of arable crops being grown per farm, for each of 14 sample areas

Area	Number of interviews	Mean age (years)	Proportion identifying a successor (%)	Mean farmed area (ha)	Proportion of area owned (%)	Workers per farm	Area per worker (ha)	Number of arable crops
Bedfordshire, UK	15	45	53	306	64	3.4	106	3.3
Northern Friesland, NL	15	50	20	52	65	1.4	39	3.4
The Achterhoek, NL	14	48	29	61	54	1.5	46	2.6
Schleswig-Holstein, D	6	40	17	392	28	3.4	163	6.2
Brandenburg, D	10	42	20	1,450	60	11.8	65	6.9
Poitou-Charentes, F	22	48	18	115	43	1.4	99	4.0
Centre, France, F	22	39	14	135	27	1.4	104	4.0
Franche-Comté, F	15	44	13	130	41	1.3	99	4.4
Mean		**45**	**23**	**331**	**48**	**3.2**	**90**	**4.4**
Castilla y León, ES	25	50	12	134	66	1.7	83	3.6
Castilla-La Mancha, ES	30	50	50	120	69	3.2	51	2.8
Extremadura, ES	30	45	23	302	81	10.9	80	2.5
Northern Italy, I	20	49	65	35	83	2.1	23	2.6
Central Italy, I	20	50	45	120	76	2.4	44	2.8
West Macedonia, GR	20	52	55	4	90	1.5	1	1.3
Mean		**49**	**42**	**119**	**77**	**3.6**	**47**	**2.6**
Overall mean (n = 14)		**47**	**31**	**240**	**60**	**3.4**	**72**	**3.6**
Total	**264**							

both open and closed format questions and, apart from a change in language, the same questionnaire was used in each country. Each interview comprised four main phases and generally lasted between 30 and 90 minutes according to the interest and availability of the farmer. The quantitative and qualitative data collected during the interviews were entered onto a laptop computer.

The first section of the interview was used to determine (i) background information on the farmer and farm business, and (ii) the farmer's understanding of agroforestry systems. The second section included a demonstration of silvoarable systems using images on the computer so that farmers were aware of the types of silvoarable agroforestry being considered in the SAFE project (Fig. 4.2). The third section aimed to determine the perceived positive and negative aspects of the silvoarable systems shown. The final section aimed to determine how farmers would design a silvoarable system and to determine if, after the interview, they would be interested in establishing a silvoarable agroforestry system.

The data collected during the interviews were analysed using a variety of parametric and non-parametric tests (Liagre et al. 2005). Qualitative data were disaggregated and coded according to thematic content (Strauss and Corbin 1998). They

Traditional system with walnut trees and intercropped sunflower at Drôme, France

Traditional systems of olives and vines at Hérault in France

Modern system of 24-year-old walnut trees with triticale in Charente-Maritime, France

Experimental system of nine-year-old poplar with wheat on Leeds University farm, Yorkshire, UK

Fig. 4.2 Examples of the types of silvoarable systems shown to the farmers during the second phase of the interview

were then used to substantiate responses to closed format questions, i.e. triangulation of method (Neuman 2000), introduce new themes and explanations in the analysis.

Results

Sample of Farmers

Across the 14 sample areas, those interviewed included farmers and farm business managers. The mean age of the interviewees was 47 years (Table 4.2); however the mean age per area ranged from 39–40 years in Centre France and Schleswig-Holstein to 52 years in West Macedonia. Across the 14 sample areas, 31% of the farmers were able to identify a successor to the farm, a third indicated there was no successor and a third were unable to specify if there was a successor or not. Whereas over 50% of those interviewed were able to identify a successor in Bedfordshire, Northern Italy, and West Macedonia, less than 20% were able to identify a definite successor in Castilla y León and the three sample areas in France (Table 4.2).

The mean cropped area per farm across the 14 areas was 240 ha. However this area ranged from only 4 ha in West Macedonia in Greece to 1,450 ha in Brandenburg (Table 4.2). Although the mean farm size in Brandenburg was 1,450 ha, the distribution of farm size was bimodal with seven farms each covering less than 700 ha and three farms each covering between 3,000 and 7,000 ha. Across the 14 sample areas, farmers owned a mean level of 60% of the farmed area; the rest was rented. The lowest level of ownership (<45%) was in the three French areas and the highest level was in West Macedonia (90%). The mean number of people employed on each farm was generally between 1 and 4, except in Extremadura and Bradenburg, where the mean number of people employed was between 10 and 12. The area per worker ranged from 164 ha per person in Schleswig-Holstein to about 1 ha per person in West Macedonia.

Trees, Arable Crops and Knowledge of Agroforestry

Across the 14 sample areas, 45% of farmers reported no trees on the cropped area of their farm (Fig. 4.3). The proportion of farms without trees on cropped fields was greatest in Bedfordshire, Northern Friesland, the Achterhoek, France Comté, and Castilla y León. In part this appeared to be a result of farmers wishing to maximise the area for crop production, however even in the UK and Germany, some farmers had kept isolated trees for environmental or landscape value. The frequency of farms with more than 20 trees per hectare was greatest in West Macedonia, Castilla-La Mancha and Extremadura.

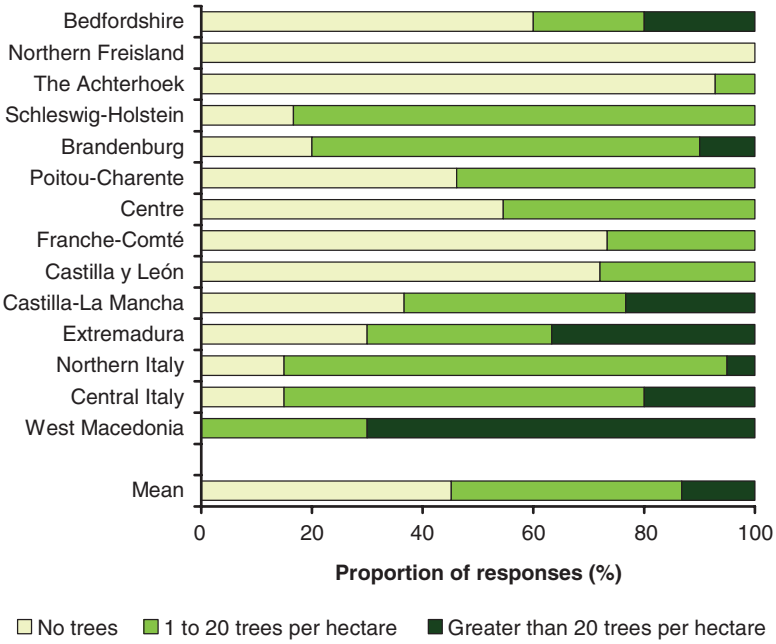

Fig. 4.3 Proportion of interviewees in each of 14 sample areas reporting no trees, 1–20 trees per hectare or over 20 trees per hectare on the cropped area of their farm

Although it was intended that the sample farms should be specialised arable farms, this condition was difficult to achieve. For example, in the Netherlands, it was difficult to find farmers producing crops who did not also have livestock enterprises. In Spain, Italy, and Greece, many of the farms included fruit production. The mean number of arable crops found on the sampled farms ranged from more than six in Germany to less than two in Greece (Table 4.2). Typical arable crops in Northern Europe included wheat, barley, oilseed rape and field beans, whilst those in the Mediterranean included maize and alfalfa.

Across the 14 sample sites, only 40% of farmers claimed to have heard of the term "agroforestry" and were willing to suggest a definition of the term (Table 4.3). In total 33% identified agroforestry as an association of trees with crops or livestock. The four areas – where a higher proportion of farmers related agroforestry to an association between trees and livestock, rather than trees and crops – were Northern Friesland, Castilla y León, Castilla-La Mancha, and Northern Italy (data not shown). Of the remaining 7% who had heard of agroforestry, 4% considered that it was silviculture and 3% considered that it was tree planting on arable land. Of the 54% of farmers, who had not heard of the term "agroforestry" but were willing to suggest a definition, 25% considered that it was silviculture, 24% considered it was an association of trees with livestock or crops, and 5% related it to tree planting on arable land. Overall 6% of farmers did not offer a definition (Table 4.3).

Table 4.3 Proportion of farmers who had heard or had not heard of the term "agroforestry", and the respective proportions who then defined it as "an association between trees and crops or livestock", "silviculture" or "tree planting on arable land" for each of 14 sample areas

		Proportion (%) who had or had not heard of "agroforestry" and their definition						
		Had heard of "agroforestry"			Had not heard of "agroforestry"			Other
Area	n	Association between trees and crops or livestock	Silviculture	Trees planting on arable land	Association between trees and crops or livestock	Silviculture	Tree planting on arable land	Responses including "don't know"
Bedfordshire	15	20	0	27	0	0	0	53
Northern Friesland	15	27	7	0	0	66	0	0
The Achterhoek	14	7	7	7	0	79	0	0
Schleswig Holstein	6	66	17	0	17	0	0	0
Brandenburg	10	50	0	0	30	20	0	0
Poitou-Charentes	22	18	5	0	27	36	9	5
Centre, France	22	14	0	0	9	41	27	9
Franche-Comté	15	20	0	0	40	7	27	6
Mean		**28**	**4**	**4**	**15**	**31**	**8**	**9**
Castilla y León	25	20	0	0	68	12	0	0
Castilla-La Mancha	30	17	7	0	33	40	0	3
Extremadura	30	33	4	0	54	6	3	0
Northern Italy	20	70	0	0	20	10	0	0
Central Italy	20	60	10	5	5	15	0	5
West Macedonia	20	35	0	0	40	25	0	0
Mean		**39**	**3**	**1**	**37**	**18**	**1**	**1**
Overall mean (n = 14)		**33**	**4**	**3**	**24**	**25**	**5**	**6**

Positive Perceptions of Silvoarable Systems

After the farmers had been shown computerised photographs of a range of silvoarable agroforestry (e.g. Fig. 4.2), they were asked to identify possible benefits and constraints of the system. When the positive attributes were ranked across the

Table 4.4 Proportion (%) of respondents in each of 14 sample areas identifying selected characteristics as the most important positive benefit of silvoarable systems

		Positive benefit							
Area	n	Profitability	Environment	None	Diversification	conservation	Patrimony	Subsidy	Other
Bedfordshire	15	27	20	13	7	13	0	7	13
The Achterhoek	14	21	36	0	14	0	7	21	0
Northern Friesland	15	7	20	47	7	0	7	13	0
Schleswig-Holstein	6	17	33	0	0	50	0	0	0
Brandenburg	10	30	30	0	10	0	30	0	0
Poitou Charentes	22	18	32	14	14	5	0	0	18
Centre	22	27	23	5	14	14	9	0	9
Franche Comté	15	13	27	0	20	20	13	0	7
Northern mean		**20**	**28**	**10**	**11**	**13**	**8**	**5**	**6**
Castilla y León	25	52	12	20	0	0	4	0	12
Castilla-La Mancha	30	33	20	17	23	0	0	0	7
Extremadura	30	43	10	3	30	0	3	0	10
Northern Italy	20	35	15	30	15	0	0	0	5
Central Italy	20	30	15	35	15	0	0	0	5
West Macedonia	20	30	10	25	30	0	0	5	0
Mediterranean mean		**37**	**14**	**22**	**19**	**0**	**1**	**1**	**6**
Overall mean (n = 14)		**27**	**22**	**15**	**14**	**7**	**5**	**3**	**6**

14 sites, the most highly ranked positive aspect was increased profitability (27%), followed by environmental benefits (22%) (Table 4.4). Across the 14 sites, 15% of respondents were unable to identify any positive benefit, 14% identified diversification benefits, followed by soil and water conservation (7%), patrimony (5%) and the possibility of obtaining subsidies (3%). The perceived benefits of establishing silvoarable systems varied from Northern to Mediterranean Europe. In Northern Europe only 20% farmers perceived increased profitability to be the principal benefit compared to 37% of farmers in Southern Europe. By contrast 28% of farmers in North Europe considered that the principal benefit would be environmental (including landscape and biodiversity) compared to 14% of farmers at the Mediterranean sample sites (Table 4.4).

Negative Perceptions of Silvoarable Systems

Across the 14 locations, the principal negative perceptions related to silvoarable systems were the negative effect of the trees on intercrop yield (18%), the complexity of the work (17%) and problems with mechanisation (15%) (Table 4.5). Some

Table 4.5 The proportion (%) of respondents in each of 14 sample areas identifying selected characteristics as the most important negative aspect of silvoarable systems

		Negative attribute									
Area	n	Intercrop yield	Work complexity	Mechanization	Project feasibility	Labour required	Status and subsidy	Risk	Environment	None	Other
Bedfordshire	15	20	13	20	20	7	7	13	0	0	0
Northern Friesland	15	13	0	47	0	0	13	7	20	0	0
The Achterhoek	14	14	0	21	36	7	7	7	0	7	0
Schleswig-Holstein	6	0	33	0	0	17	17	0	33	0	0
Brandenburg	10	0	40	20	10	10	0	20	0	0	0
Poitou Charentes	22	5	18	0	9	23	27	14	0	0	5
Centre	22	0	18	0	14	14	23	14	0	0	18
Franche Comté	15	13	47	27	0	0	13	0	0	0	0
Mean		**8**	**21**	**17**	**11**	**10**	**13**	**9**	**7**	**1**	**3**
Castilla y León	25	4	24	16	24	0	16	8	0	8	0
Castilla-La Mancha	30	17	10	10	10	13	10	10	7	7	7
Extremadura	30	30	7	17	10	3	0	23	0	0	10
North Italy	20	35	5	20	0	30	0	5	0	0	5
Central Italy	20	40	5	10	0	10	0	10	0	25	0
West Macedonia	20	60	20	0	15	0	0	0	0	5	0
Mean		**31**	**12**	**12**	**10**	**9**	**4**	**9**	**1**	**7**	**4**
Mean (n = 14)		**18**	**17**	**15**	**11**	**10**	**10**	**9**	**4**	**4**	**3**

farmers citing lower yields mentioned their experience of reduced growth of maize and decreased tuber volume of potatoes in areas next to woodland, which they attributed to competition for light and/or water. The problems with mechanisation were primarily linked to a perception that machine operators would reduce the speed of machine operations to minimise collisions with trees. Some farmers said they had already experienced these kinds of difficulties during machine operations near isolated trees or woodlands. Some indicated that these concerns could lead to contractors charging extra for machine operations or refusing to undertake the work. Farmers also mentioned the need for adequate headlands around such systems which would make silvoarable systems unsuitable for small fields or particular field shapes.

Farmers' perceptions of constraints appeared to vary with region. For example the proportion of farmers in the Mediterranean area of Europe (31%) listing intercrop yield decline as the principal constraint was greater than that in Northern Europe (8%). In those areas, the principal concerns were the complexity of work (21%) and mechanisation (17%). Across the 14 samples, 9% of farmers cited market risk as the principal constraint in such a long-term system. There was a

perception that a range of circumstances could unexpectedly lead to a reduction in the value of the trees and some form of insurance or subsidy would be required. There was also concern about the long-term eligibility of the land to EU subsidies and agri-environment support measures, and some saw possible constraints as they rented some or all of their land from a landowner. Across the 14 samples, 4% of farmers considered agroforestry had a negative environmental impact. For example, 20% of farmers in Northern Friesland felt that this was the principal constraint of the system. Some felt the open landscape in that area was part of the cultural heritage and that this would be undermined by the presence of trees. Also in Northern Friesland, others mentioned that trees could have a negative impact on wild birds such as geese which used the open fields and others believed that the lack of shelter reduced the incidence of livestock pests.

Design of a Silvoarable System

In the last part of the survey, farmers were asked to imagine what tree and crop species they might include in a silvoarable system and how such a system might look on their farm. The suggested tree species included walnut (*Juglans* spp.) (26% of responses), poplar (*Populus* spp.) (17%), fruit trees (12%), oak (*Quercus* spp.) (10%), and wild cherry (*Prunus avium* L.) (6%) (Table 4.6). The choice was generally governed by existing practice in the area. For example, because of large local reforestation projects at Castilla y León in Spain, 90% of farmers stated they would want a tree species such as walnut which can produce valuable timber. Where there were few existing trees, such as in Centre in France or in Northern Friesland, farmers found it more difficult to identify a suitable species; in total 18% indicated that they did not know. Generally farmers suggesting walnuts, poplar or wild cherry trees said their choice was governed by wanting a profitable timber product and rapid tree growth. The primary reason that farmers gave for selecting slow-growing trees such as oak was to contribute to the local landscape.

When farmers were asked to suggest the crop species that would form the most appropriate inter-crop, 27% said they would stop cropping altogether and 20% suggested shifting to fodder crops or pasture. Of the 53% who suggest a crop, most said they would continue using their existing crops. The most cited crops included autumn-planted cereals, which were considered suitable because leaf growth during the autumn and winter would minimise light competition with the trees. Similarly, farmers growing spring-planted crops such as sunflower or vegetables said they might change their existing rotation to minimise light competition. Other farmers focussed on the importance of machinery operations. Many felt that farm machinery for cereal and pasture production could be adapted for use in silvoarable systems, whereas some focussed on crops such as maize and alfalfa which required less frequent use of machinery. Some farmers suggested that selecting nitrogen-fixing crops such as alfalfa could provide a nitrogen benefit to the trees. Crops identified by farmers as unsuitable for silvoarable

agroforestry included potatoes, sugar beet, tomatoes and pepper. The basis for this included intolerance to shading, susceptibility to weed or pest competition, and difficult and frequent machine operations.

Farmers in Northern Europe tended to envisage systems with wider alleys (mean = 27 m) than in Mediterranean areas (mean = 18 m) (Table 4.6). However the within-row distance between trees was similar for both Northern European and Mediterranean sites (means = 6–7 m). Overall, these dimensions suggested that

Table 4.6 Tree and crop species proposed by farmers and mean dimensions of suggested silvoarable plots in each of the 14 sample areas

Area	n	Tree species cited by more than 20% of farmers	Most cited crop species	Tree row distance (m)	Within row tree distance (m)	Tree density (ha^{-1})	First year crop width (m)
Bedfordshire	15	Poplar and oak	Cereal	28	7	53	24
Northern Friesland	15	–	Pasture	25	7	57	22
The Achterhoek	14	Walnut	Cereal	27	6	59	25
Schleswig-Holstein	6	–	Cereal	29	6	55	27
Brandenburg	10	Wild cherry	Cereal	na	na	na	na
Poitou-Charentes	22	Walnut and poplar	Cereal	23	9	50	20
Centre	22	Walnut	Cereal	27	6	61	24
Franche-Comté	15	Walnut and poplar	Cereal	27	8	50	23
Mean				**27**	**7**	**55**	**24**
Castilla y León	25	Poplar	Cereal	21	5	90	20
Castilla-La Mancha	30	Walnut and fruit tree	Cereal and alfalfa	14	7	105	14
Extremadura	30	Walnut and poplar	Pasture	19	5	103	17
Northern Italy	20	Cherry	Cereal and legumes	18	6	96	15
Central Italy	20	Walnut and fruit tree	Cereal and legumes	24	7	60	21
West Macedonia	20	Walnut, fruit tree, poplar	Beans and vegetables	13	5	146	6
Mean				**18**	**6**	**100**	**16**
Overall mean (n = 14)				**23**	**6**	**76**	**20**

na = no response available

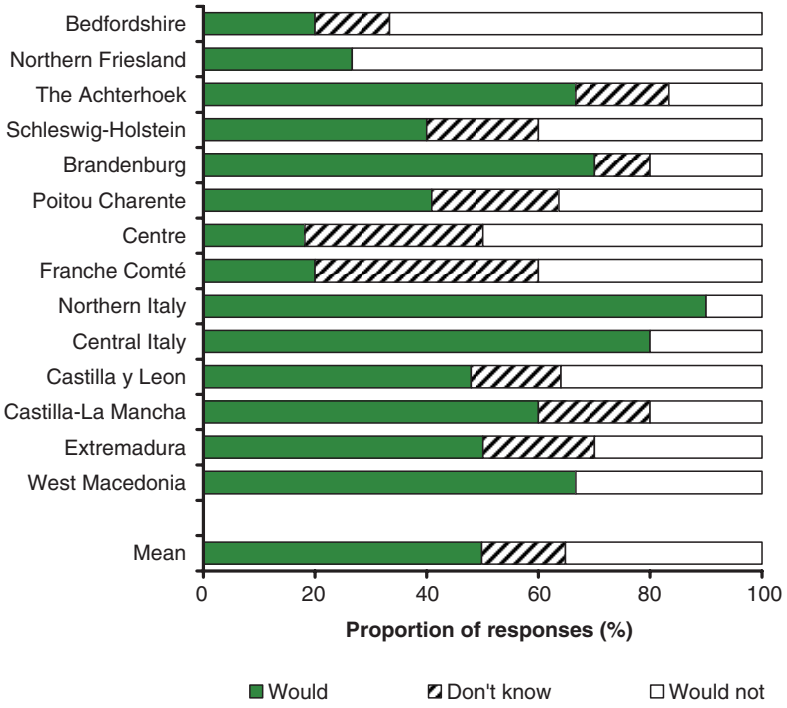

Fig. 4.4 Proportion of interviewees in each of 14 sample sites reporting if they would or would not attempt a silvoarable project

mean tree density for the Northern European sites (55 trees per hectare) was less than that in Mediterranean areas (100 trees per hectare).

Implementation of Silvoarable Agroforestry

In the last part of the survey, the farmers were asked if they were interested in setting up a silvoarable system on their own farm. Across the 14 samples, 50% of farmers indicated that they would consider using such a system (Fig. 4.4). The proportion of farmers giving a positive response ranged from 18–20% in Bedfordshire, Centre and Franche Comté to 90% in Northern Italy. However, this willingness was often conditional on visiting an exiting system or profitability.

Discussion

The results are discussed in terms of knowledge of agroforestry, the benefits and constraints of silvoarable agroforestry, system design and factors constraining the adoption of such systems. The research reported here on silvoarable system is novel

in that previous research on farmers' perceptions of agroforestry in temperate areas has tended to focus on riparian strips (Ducros and Watson 2002), hedgerows (Morris et al. 2002), windbreaks (Matthews et al. 1993) or silvopastoral systems (McAdam et al. 1997).

Knowledge of Agroforestry

In the scientific literature, agroforestry is often taken to mean practices where trees are intimately associated with agricultural components at a field scale (Sinclair 1999). However there are papers, e.g. Carvalho et al. (2002), where "agroforestry" seems to refer to the planting of woodland on agricultural land. Across the 14 sites, 33% of the farmers sampled had heard of agroforestry and gave a definition similar to that provided by Sinclair (1999). In fact, most farmers who had heard of the term were able to distinguish "agroforestry" from silviculture and tree planting on arable land. The proportion of farmers – who had both heard of agroforestry and defined it as an association of trees with crops or livestock – was particularly high in Italy (60–70%). This may be a result of the sampled farmers being identified through established contacts rather than random sampling, and the presence of established agroforestry systems (Eichhorn et al. 2006). Pannel (1999) reports that the first condition necessary for adoption of new systems is that farmers must be aware of the system. The results presented here would suggest that the term "agroforestry" remains unfamiliar to a high proportion of European farmers. Moreover of those farmers who had not heard of the term "agroforestry", a similar proportion guessed that it referred to silviculture (25%) rather than an association between trees and crops and trees and livestock (24%). This finding is significant in that an understanding of agroforestry as an association of trees with crops or livestock does not seem to flow naturally from the term itself. In fact the use of the term "agroforestry", without an accompanying definition, could potentially lead to greater misunderstanding than the use of more traditional terms such as "grazed woodlands", "dehesa", or "parklands".

Benefits and Constraints of Silvoarable Agroforestry

Across the 14 sample areas, after the farmers had been shown examples of silvoarable agroforestry, they identified that the principal benefit of such a system was likely to be an increase in farm profitability (27%) or environmental benefit (22%). Overall 15% saw no benefit and 14% considered that the greatest benefit was related to diversification. A similar range of motivations was observed by Lawrence and Hardesty (1992) who used a postal questionnaire in Washington State in the USA, to survey employees of the Soil Conservation Service, an extension service, and a group comprising academics, land managers, and owners of natural resource businesses. Overall, Lawrence and Hardesty (1992) report that the principal

perceived benefits were land use diversity (25%), enhanced productivity (18%), aesthetics (13%), and income diversity (13%). The focus on environmental benefits, particularly in Northern Europe, also matches the responses of landowners in Florida (USA) as observed by Workman et al. (2003) who found that the four greatest suggested benefits of combining trees with crops and animals related to aesthetics, provision of shade, creation of wildlife habitats, and soil conservation.

Across the 14 locations, the principal constraints identified for silvoarable agroforestry were the negative effects of the trees on intercrop yield (18%), the complexity of the work (17%), and problems with mechanisation (15%). This matches the results of Workman et al. (2003) amongst landowners in Florida (USA) who identified component competition and the expense of management as two of the top four obstacles. The other two major obstacles observed by Workman et al. (2003) were lack of information and a lack of markets. A lack of information and a lack of technical assistance were also identified as key obstacles by respondents in Lawrence and Hardesty's (1992) study in Washington State. The procedure used in the European interviews of describing the silvoarable system within the interview is probably one reason why the proportion of farmers indicating a lack of information or technical assistance was smaller in this study than in the American studies.

Design of System

The farmers sampled in Northern Europe suggested lower tree densities than those in Southern Europe. This is probably a result of the respective width of and type of agricultural machinery in these regions. For example in France and the UK, the width of spray booms was cited as the main criteria for determining the tree row distance. By contrast in some areas of Spain, the width of the tree rows was determined by the width of the combine harvester, as there was minimal use of spray treatments. In addition farmers in Northern locations tended to cite a larger number of crops within the crop rotation and this may also lead to an increased tree row width. For example, it would be important that the tree-row distance is both a multiple of the sprayer and a combine harvester. The choice of the tree row width is critical, because once planted it is fixed unless, for example, a farmer removes alternate lines of trees. Hence some farmers in France specified particularly wide tree row spacing in anticipation of increased spray boom widths within the length of the tree rotation.

It is sometimes proposed that farmers may decrease the width of the alley during the tree rotation. However the farmers surveyed generally indicated that they would use a consistent cropped-alley width for the duration of cropping within the silvoarable system, which was generally perceived to be the same as the rotation for the tree crop. Some farmers were concerned about the possibility of losing agricultural subsidies if they reduced the intercrop area, and one third of farmers said they would continue cropping even if it was unprofitable. Some of those who said they would consider reducing the intercrop area, as the trees grew, mentioned

that they could block specific lines within a seed drill. Others said they would establish a fodder or pasture crop, whilst a small proportion said they would maintain bare soil.

Opportunities for Adoption

The proportion of farmers indicating that they would seriously consider adopting silvoarable agroforestry systems ranged from 18–20% in Bedfordshire, Centre and Franche Comté to 90% in Northern Italy. The high value obtained in Northern Italy may in part be a result of the existing practice of such systems in areas such as the Po Valley. These overall results suggest that many farmers are open to the possibility of integrating trees with crops. However, it should be noted that these values do not relate to a firm commitment to plant silvoarable systems, but only that the possibility would be seriously considered. It is also possible that the positive results could have been inflated by the temporary "euphoria" of the interview.

Clearly a decision to consider silvoarable agroforestry is the first step in possible implementation. However before farmers decide to implement such systems they will usually seek further evidence to allow them to make a well-informed decision. Several farmers stated that they would need to see further experimental results in order to understand better how crops grow between trees. Many indicated that they would like to see real sites. Subsequent to the EU project, the French government has agreed to support a number of agroforestry demonstration sites across various French departments to demonstrate the range of systems.

Pannel (1999) indicates that once farmers are aware of a new system, the next three conditions are that than farmers must consider that (1) it can be trialled, (2) that it is worth trialling, and (3) that it meets important objectives such as profit. Farmers are often considered to be "risk-averse" (Antle 1987; Myers 1989) especially if a technology causes fundamental changes in farm management and resource-use and they therefore prefer to trial new technologies before adopting them. The long-term requirements of silvoarable agroforestry mean that it is difficult for an individual farmer to consider trialling the system because of the substantial commitment in terms of land, labour and capital. Across the 14 samples, those farmers interested in considering agroforestry further were keen to understand the economic implications of establishing such systems, for example, investment levels, cash flow evolution and timber prices. Bio-economic models such as Plot-SAFE and Farm-SAFE (Graves et al. 2007) are one possible tool to help demonstrate the potential effect of different market prices on the likely outcomes of different scenarios.

A third point that was often raised by the farmers was the extent to which current EU agriculture and environment regulations penalised mixed cropping systems. Many farmers for example stated that the tree area would need to be eligible for single farm payments. At present it is unclear that this will always be the case as the interpretation of the land management criteria for continued single farm payments can vary with country. In addition some farmers asked that, since there are

grants for conventional woodland establishment, was it possible to obtain corresponding grants for agroforestry systems? Although the recent European Regional Development Regulation does allow each EU country to create grants for agroforestry establishment and management, this option may not be taken up in some countries. Pilot-schemes, such as those being trialled in Scotland, can be a useful initial step to see what is possible.

Conclusions

The results from the survey suggest that many farmers are open to the possibility of integrating trees with crops. They also showed that the perceptions of farmers varied with area and according to the environmental and socio-economic contexts. Farmers in Mediterranean areas felt that the principal benefit of silvoarable systems was to improve farm profitability, whereas farmers in Northern Europe highlighted environmental benefits. In terms of negative attributes, farmers in Mediterranean Europe prioritised intercrop yield decline whereas farmers in Northern Europe felt that complexity of work and mechanisation were the most important constraints. Compared to Mediterranean farmers, farmers in Northern Europe envisaged systems with wider alleys and lower tree densities. This difference was associated with the use of larger machinery.

Farmers in Mediterranean areas appeared to be the most likely to establish silvoarable systems on their farms. To some extent these results reflect local agricultural practices or the extent to which trees and tree products are seen as relevant to local economic opportunities. The Southern areas of Europe are where most of the extant silvoarable systems are found, for example, olive associations in Italy or oak associations in Spain and Greece. Olives, fodder and firewood are all valuable products within Southern farming systems. Even so, even in intensive arable production areas in Northern Europe, at least one fifth of the farmers sampled were willing to consider the possibility of a system on their own land. Clearly there is more that is needed from policy, research, demonstration sites, and extension services, if silvoarable agroforestry is to become a significant feature of the European landscape.

Acknowledgements We thank the 264 farmers who agreed to be interviewed in this survey. The research was carried out as part of the SAFE (Silvoarable Agroforestry for Europe) collaborative research project. SAFE is funded by the EU under its Quality of Life programme, contract number QLK5-CT-2001-00560, and the support is gratefully acknowledged.

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