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Key Actors' Perspectives on Agroforestry's Potential in North Eastern Germany

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Abstract: As a land use management system, agroforestry has environmental, economic and societal benefits over conventional agriculture or forestry. Important benefits of combining tree growth with agricultural crops and/or forage production systems include higher biodiversity through more diverse habitats, the control of runoff and soil erosion, the augmentation of soil water availability, the creation of microclimates, carbon sequestration and provision of a more diverse farm economy. As the climate changes, north eastern Germany is likely to be particularly prone to severe effects from droughts and wind erosion in the future. However, the area of land under agroforestry makes up less than 2% of the total agricultural area in Germany. Through qualitative interviews with key actors, this study analyzed the benefits of, potentials for and barriers to implementing agroforestry systems in the federal state of Brandenburg. Results showed that agroforestry systems have significant potential in relation to several benefits, particularly the mitigation of soil erosion and stabilization of microclimate regimes. Additionally, agroforestry has the potential to provide wood for energy production or material uses. Although a small but highly innovative and interlinked community exists, administrative barriers and high start-up costs currently hamper the transition from conventional agriculture to agroforestry systems.

Keywords: agroforestry; timber products; semi-structured interviews; barrier; opportunity

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1. Introduction

Agroforestry is an umbrella term for forms of land use that combine the cultivation of perennial woody plants with that of annual agricultural crops and/or animals in the same area in such a way that ecological and economic benefits are created through the interaction between the different components [1]. With longer rotation cycles and the generation of two or more yields, agroforestry systems are ecologically and economically more complex than monocultures [1]. Nair (1993) classified agroforestry systems according to their structures into the categories of silvoarable, silvopastoral and agrosilvopastoral systems. In many areas of the world, agroforestry systems are not a recent development. Rather, they are traditional and well-known cropping systems combining livestock and/or arable farming with trees and hedgerows. However, due to the demands of intensified agriculture, trees were removed from the agricultural fields in many places and the area of land under traditional agroforestry systems gradually decreased [2]. Historically, there have been various agroforestry systems in Europe such as wood pastures [3], which include

for example the Dehesas in Spain [4], or the Hauberg in the German Siegerland [5]. Besides wood pastures and more modern silvoarable and silvopastoral systems, the principal forms of agroforestry in Europe include the use of hedgerows, windbreaks, and riparian buffer strips on farmland; intercropped and grazed orchards; grazed forests; and forest farming [6]. Similar to the agroforestry systems in North America and Central Asia, the agroforestry systems in Europe are associated mostly to temperate agroforestry [7], in contrast to tropical agroforestry [8]. In the United States agroforestry has been practiced since the 1930s, but the "realization that agroforestry systems are well suited for diversifying farm income while providing environmental services and ecosystem benefits" is a more recent trend, which has led to an increased receptivity on the part of some landowners [9]. In this paper, our geographical focus lies on Central Europe and, more specifically, on north eastern Germany and the federal state of Brandenburg, which also is characterized as a large metropolitan area, with Germany's capital Berlin being located in the center of this federal state.

In addition to their productive function of providing food, fodder, fuelwood or other wood products, agroforestry systems also have protective and restorative functions [1]. Studies have shown that agroforestry: (i) Enhances biodiversity, for example by creating ecological corridors or by increasing diversity among pollinators [10–13]; (ii) Enhances soil fertility by increasing soil microorganisms and reducing nutrient loss and water runoff [10,13–15]; (iii) Slows down wind speeds and reduces wind erosion [16,17]; (iv) Can help control wildfires [11]; and (v) Mitigates climate change through high carbon sequestration potential in soil and tree biomass [10,18,19]. All in all, agroforestry systems can increase the resilience of both agricultural production and livelihoods. They bring both economic (e.g., diversified sources of income or new income possibilities) and social benefits (e.g., rural employment and cultural ecosystem services) [11,20–23]. These factors have positive impacts on rural economies. Additionally, agroforestry systems are often perceived as enhancing the aesthetic value of landscapes, thus offering cultural and recreational benefits. Therefore, agroforestry is a multifunctional and sustainable system that brings many long-term benefits to nature, farmers and society [24]. Despite all these benefits, agroforestry systems make up only 1.6% of the total agricultural area in Germany [25]. In contrast to northern and central Europe, the share is significantly higher in many southern European countries, such as Cyprus (40%), Portugal (32%) and Greece (31%). The European mean is currently 8.8% [25]. Currently, most agroforestry practice in Europe is wood pasture or livestock agroforestry, covering an area of approximately 15 million hectares. This represents 44% of the total area under agroforestry [6,25]. Still, modern agroforestry systems, which are adapted to modern production methods with machines, are slowly gaining popularity in Germany [26].

As seen on the map of agroforestry actors published by the German association for agroforestry, orchard meadows and alley cropping are two agroforestry systems that are already implemented by several landowners in north eastern Germany [27]. Orchard meadows are a traditional rural form of fruit cultivation, practiced particularly in Central Europe, which is often combined with sheep grazing in a silvopastoral system. Alley cropping is often designed as a silvoarable system. This technique involves the combination of parallel rows of trees or groves on arable land with the cultivation of arable crops (e.g., wheat, rye, maize and potatoes) on the field strips between the trees. Alley cropping may be dedicated to the production of high-quality logs. In Europe, this is achieved mostly with hybrid poplar (*Populus* spp.) and walnut (*Juglans regia* L.) trees, but also with wild-service tree (*Sorbus torminalis* Crantz) or Turkish hazel (*Corylus colurna* L.). The expansion of agroforestry systems with the use of high-value trees "will play an important role in reducing the current and continuously growing timber shortage in the market" and should, therefore, be investigated thoroughly [28]. Short rotation alley cropping systems are a variant of alley cropping. Trees with rapid juvenile growth, such as poplar, willows (*Salix* spp.), silver maple (*Acer saccharinum* L.) and black locust (*Robinia pseudoacacia* L.) [28], are harvested in short rotation cycles (e.g., 3 to 6 years) and the biomass is usually used in the form of wood chips to produce bioenergy. Thus, short rotation alley cropping systems "provide periodically high energy outputs and could help to answer environment and

energetic political objectives in Germany" [29]. In the federal state of Brandenburg, the low water-holding capacity of the mainly sandy and sandy loamy soils combined with low rainfall compared to the German average, limits rain-fed agriculture yields [30]. In this context, studies from north eastern Germany show that black locust might become interesting in the future because of its ability to fix nitrogen and its resistance to drought, both of which are crucial factors, especially on marginal arable lands or in post-mining landscapes [20,31].

In contrast to many international research projects (e.g., [32–34]), studies that assess the attitudes of farmers towards agroforestry in Europe are relatively few, as reported by [21]. For example, Northern European farmers identified the general complexity of work and difficulties with mechanization as key negative attributes of agroforestry systems [35]. However, these farmers were not managing agroforestry systems. In Sweden, a study analyzed the willingness of farmers to adopt silvopastoral systems through reforesting treeless pasture [36]. Several studies used focus group discussions, questionnaire surveys and/or personal interviews with Czech farmers to evaluate "their knowledge of agroforestry systems, their willingness to participate in these systems, and their concerns and expectations therewith" [37] but also to analyze the perception of the offer of ecosystem services provided by agroforestry systems [38] or to determine the factors hampering the re-adoption of the once traditional land use system [39]. Another study by García de Jalón et al. asked 341 stakeholders from 11 different countries in the European Union how they perceive agroforestry in Europe by asking them to rank positive and negative aspects of implementing agroforestry [21]. In line with this study, our work assesses key actors' attitudes towards agroforestry systems, with the main objective to explore the potential to implement agroforestry systems in the federal state of Brandenburg. This is a region with one of the lowest population densities in Germany, poor soil quality, high threat of wind erosion and low precipitation.

The qualitative interview analysis focused on the individual opinions and perspectives of the key agroforestry actors in the federal state of Brandenburg. In this sense, the research did not aim for a conclusive mapping of all agroforestry stakeholders in Brandenburg, but rather sought to identify possible change agents with a discursively dominant role in implementing agroforestry systems in Brandenburg. That is why we choose the term 'key actors' instead of 'stakeholders'. In individual interviews, several questions were addressed in order to gain insight into: (i) The networking activities between the different actors and the importance of this networking; (ii) The most important functions of agroforestry systems; (iii) The potential of agroforestry systems to provide resources as construction materials; and (iv) The barriers and obstacles to further establish agroforestry systems in Brandenburg. This research was conducted within the scope of a project with BauhausErde and other cooperation partners—among others TU Berlin and Natural Building Lab—and focused on possibilities for and the application of local and renewable building materials in architecture and urban development.

2. Materials and Methods

2.1. Semi-Structured and Guided Interviews

The "problem-centered" or "semi-structured" interview was chosen from a variety of methodological interview forms to address the research question. As a social science research method, it allows for the elaboration of subjective perceptions of pre-identified actors regarding a specific set of issues, while at the same time following well-established methodological guidelines [40,41]. The interviews were structured using an interview guideline [40]. The guideline provided broad direction but was not understood as a fixed interview script in an effort to keep conversations open. The structure of the guideline followed the classical scheme [40–42]: 0. Conversation introduction; 1. General probing; 2. Specific probing; 3. Ad hoc questions; 4. Conversation exit.

2.2. Determination of the Key Actors

The study does not claim to have identified all agroforestry stakeholders in Brandenburg but rather focused on important key actors and possible change agents. To identify key actors, we used an inductive, two-step process. Firstly, existing contacts were used. The university has contact with individual actors in the region through its location in Brandenburg and its existing research and educational projects in the field of agroforestry [43]. A list of these actors was compiled, and the individuals were contacted using an interview request letter. This presented the project and inquired after actors' willingness to participate. Using the "snowball principle", a question was included in the interview guide through which the interviewees were asked to name the key agroforestry actors in Brandenburg. Named actors who had not been approached through the initial contact were then included in the field of actors and contacted. By asking this question in each interview, multiple responses were identified, and a qualitative and quantitative assessment of key actors became possible.

2.3. Data Collection and Data Protection

The interviews ran for 30–60 min and were conducted via the video-meeting software BigBlueButton, version 2.5.11 (BigBlueButton Inc., Ottawa, Canada). A visual and sound recording was made of each interview after the interviewees were provided with the data protection regulations of the University for Sustainable Development Eberswalde (HNEE) [44] and asked to consent to the recording. The interviewees were informed that the recordings would be stored according to the statutes and deleted after two years. In addition, a supporting protocol was written for all interviews during the conversation.

The interviews were transcribed using the transcription software Trint (Trint Limited, London, UK). The interviews were transcribed verbatim without additional commentary. Their spoken words were documented in their original form, including any deviations from written German in terms of sentence structure.

2.4. Evaluation of the Interviews

The interviews were evaluated using qualitative content analysis according to Mayring [45]. The evaluation technique used was content structuring, as this allows for a systematic evaluation of an interview according to certain criteria, which subsequently enables an interpretation of what was said (ibid.). The evaluation was based on the well-established procedure as developed by Mayring, which is divided into general and specific sections [45].

This involves the following methodological steps [45]:

1. Theory-guided determination of the main content categories, compilation of the category system and category definition. The following categories emerged on the basis of the research objectives and were derived inductively from the data during the material review (category and description, Table 1);
2. Run-through of the material and designation of the location of findings. The material was viewed and evaluated in accordance with the developed categorization, and the locations were marked;
3. Extraction of the findings. The findings were collected and merged category by category. The statements always remained assigned to the respective respondent. The extraction of the findings after the second material run-through resulted in the following frequencies of categorized text locations (frequency, Table 1);
4. Possible revision of the category system and second run-through of the material. The material was reviewed a second time, taking into account the developed categorization. The assignment to individual categories was refined and, if necessary, adapted to new perspectives;
5. Processing of the results, generalizing analysis of the interviews, transfer to detailed analysis and interpretation. Evaluation and preparation of the evaluated data.

Table 1. Inductively formed category system (left) and description (right).

Category	Description	Frequency
Statements on the agroforestry situation in Brandenburg	General statements describing the economic, ecological or social situation regarding agroforestry as a land use system in Brandenburg	23
Potentials of agroforestry systems (economic, ecological, social)	What potential does the interviewee generally see for agroforestry systems as a specific form of land use in economic, ecological and social terms?	21
Functions and tasks of agroforestry systems	Which functions does the respondent generally attribute to agroforestry systems as a specific form of land use in economic, ecological and social terms?	23
Own understanding of the 'ideal agroforestry system'	What would an 'ideal agroforestry system' in subjective terms look like? How should it be designed?	24
Potential of agroforestry systems for the construction industry in Brandenburg	What potential does the respondent see for agroforestry systems in Brandenburg to provide raw materials for the construction industry?	18
Needs and requirements for the implementation of agroforestry systems	From the respondent's point of view, what is necessary in structural and economic terms to sustainably implement and strengthen agroforestry systems as a specific form of land use in Brandenburg?	44
Problems and obstacles in the implementation of agroforestry systems	What structural and economic obstacles and problems does the respondent see as hindering the implementation of agroforestry systems in Brandenburg?	48
Actors and networking	Which actors does the respondent consider relevant for the agroforestry sector in Brandenburg? How do they judge the cooperation with the individual actors mentioned in each case?	40
Own positioning and role in the industry	How does the respondent define her/his own role and tasks in relation to agroforestry systems? What goals is she/he pursuing? With which institution, if any, is she/he affiliated?	20

The transcripts were screened and categorized using the analysis software MAXQDA 2022 (Verbi GmbH, Berlin, Germany). The results presented in the following section are based on the evaluation of the qualitative data as a whole. However, only selected concise quotes are included. The quotes are reproduced in their original wording. Only repetitions or filler words are marked with omissions ([. . .]).

3. Results

3.1. Key Actors

The study resulted in a "landscape" of agroforestry actors in Brandenburg, consisting of eleven interviewed key actors and structured as follows (the coding used in the analysis of results is in square brackets). On the production side, there are three farms of different sizes located in Brandenburg that have implemented agroforestry systems in their management concepts. These farms pursue different strategies: the medium-sized farms (370 and 360 ha, respectively) ([FaM1], [FaM2]) focused on the ecological melioration of the sites and the material use of the wood products. The managers of these farms particularly emphasized the social-ecological component of agroforestry, as well as the possibility of combined use (land efficiency). The representative of the small farm (4.5 ha) ([FaS4]) focused on fruit utilization and creation of regional marketing structures in his farm objectives. A large farm in Saxony-Anhalt was also included in the field of actors due to its spatial proximity, its significant focus on agroforestry systems and its networking activities with actors from Brandenburg ([FaL3].

The German Association for Agroforestry (Fachverband für Agroforstwirtschaft e.V., DeFAF) was identified as the central political actor ([ASS]). DeFAF is committed to the dissemination and promotion of agroforestry systems in Germany and brings together the interests and concerns of agricultural companies with the aim of developing agroforestry land use into an essential and recognized component of agriculture in Germany. Although

the association operates country wide, it is based in Brandenburg and is, thus, particularly well connected there.

The University for Sustainable Development Eberswalde (HNEE) accompanies agricultural and agroforestry projects, as well as experimental plots scientifically in research and teaching. It acts as an important contact for agricultural practitioners ([Uni]).

Two agricultural and forestry consulting firms bring together theoretical and empirical knowledge gained in Brandenburg. They also act as important knowledge brokers and networking actors between the individual farms ([CT1], [CT2]).

On the political side, three key actors were identified. Firstly, there is a representative of a political party in the federal state parliament of Brandenburg who is working on the content of legislative projects relating to the recognition and promotion of agroforestry systems ([POL]). Secondly, there is the Ministry of Agriculture, Environment and Climate Protection (MLUK) in Brandenburg, which is particularly important with regard to the development of funding guidelines given its implementation of EU directives for Brandenburg in cooperation with the federal and state governments ([MS]). Thirdly, both the (practical) agricultural projects and the political processes are accompanied by subject-specific expertise and sometimes critique (especially regarding the funding of projects) by a non-governmental nature conservation organization, which focuses on and emphasizes the ecological aspects of land use ([NC]). Figure 1 shows the location of the key actors interviewed, and Figure 2 shows the structure of the agroforestry "landscape" in Brandenburg.

3.2. Central Functions of Agroforestry Systems in North Eastern Germany

Despite their differing roles, the interviewees held common perceptions on the central functions of agroforestry systems. It became apparent that, in addition to the possibility of increased yields on agricultural land through greater land use efficiency and risk diversification, ecological aspects are considered to be the most important. Soil amelioration through wind refraction, increasing the degree of shading and reducing nutrient runoff were mentioned most frequently as functions of agroforestry systems (12×). The respondents also cited the positive effects of agroforestry systems on microclimates (lowering of soil temperature and evaporation; 9×). The positive influence of agroforestry on biodiversity through the increase of structural diversity and habitat offers was also mentioned (9×). In addition, interviewees spoke about climate protection aspects such as the more intensive land use in agroforestry increasing its function as a CO2 sink (6×).

3.3. The Importance of Networking between Key Actors to Further Promote Agroforestry Systems in Brandenburg

3.3.1. Strong Network and Pioneering Spirit

Particularly actors involved in the practical implementation of agroforestry (farmers and consultants) pointed out the necessity of intensive and constructive networking to further expand agroforestry systems in Brandenburg and to address concerns, especially among actors in conventional agriculture. At the same time, it was noticeable that all actors, regardless of their location in the field of actors, praised the mutual and trusting cooperation, which was considered a strength of and an important basis for the development of agroforestry systems. According to a recurring statement, this positive cooperation can be explained by the fact that it is a relatively small professional community in which the individual actors know each other well. This was observed particularly in the consulting sector: [CT1] the collaboration is "actually very, very nice. This is a "very, very young sector with very few actors" [CT1], "There is a lot of networking, people know each other" and they are in "very, very good contact" [CT2]. This is also acknowledged by the representative of the state parliament who said that the cooperation is very good and that the actors are very well networked.

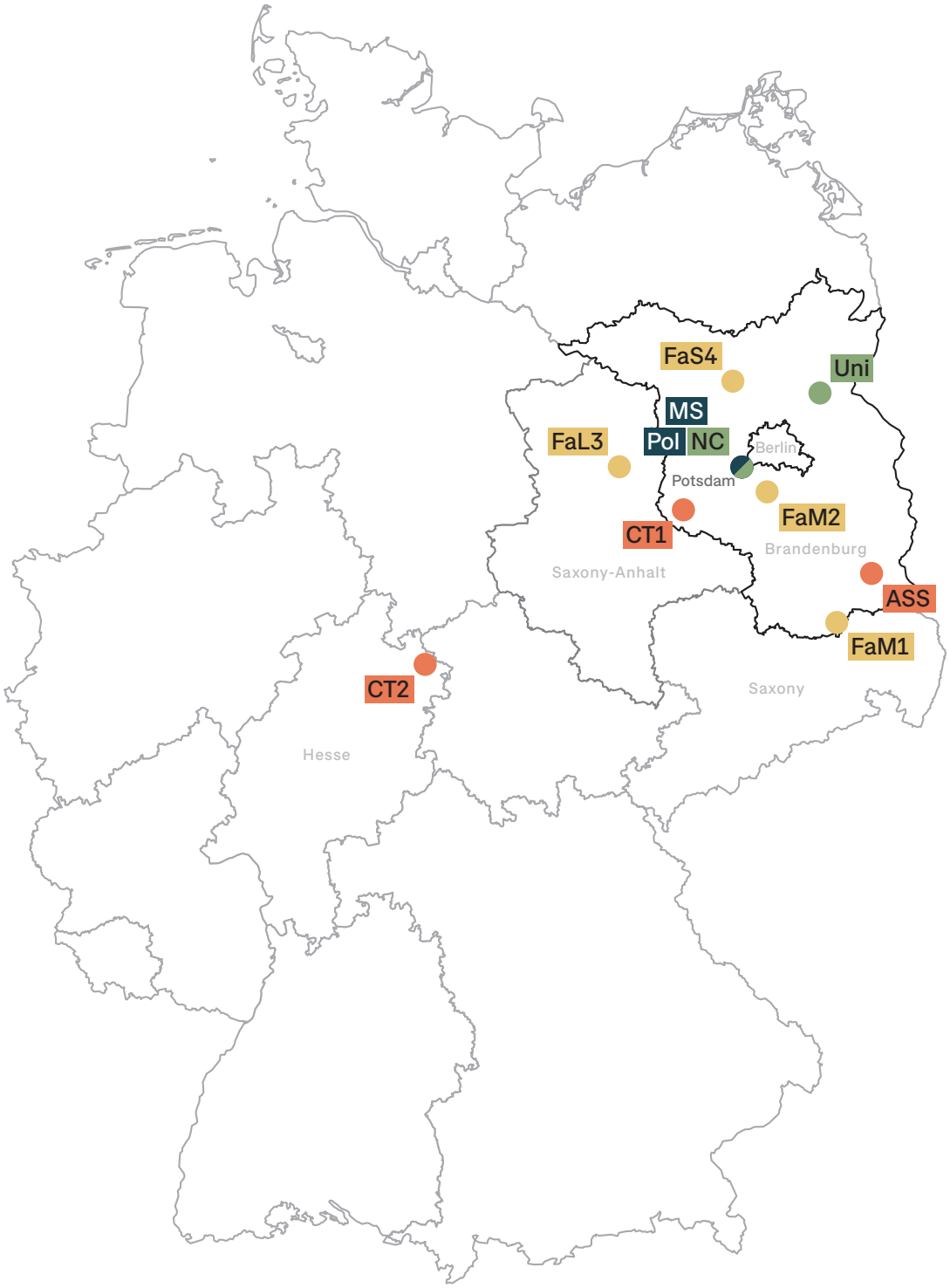

Figure 1. Location of the key actors interviewed on a map of Germany with Uni = Eberswalde University for Sustainable Development, FaS4 = small-sized farm, FaL3 = large-sized farm, FaM2 = medium-sized farm2, FaM1 = medium-sized farm1, Pol = politician, NC = nature conservation organization, MS = state ministry, CT2 = consultant2, CT1 = consultant1, ASS = German association for agroforestry.

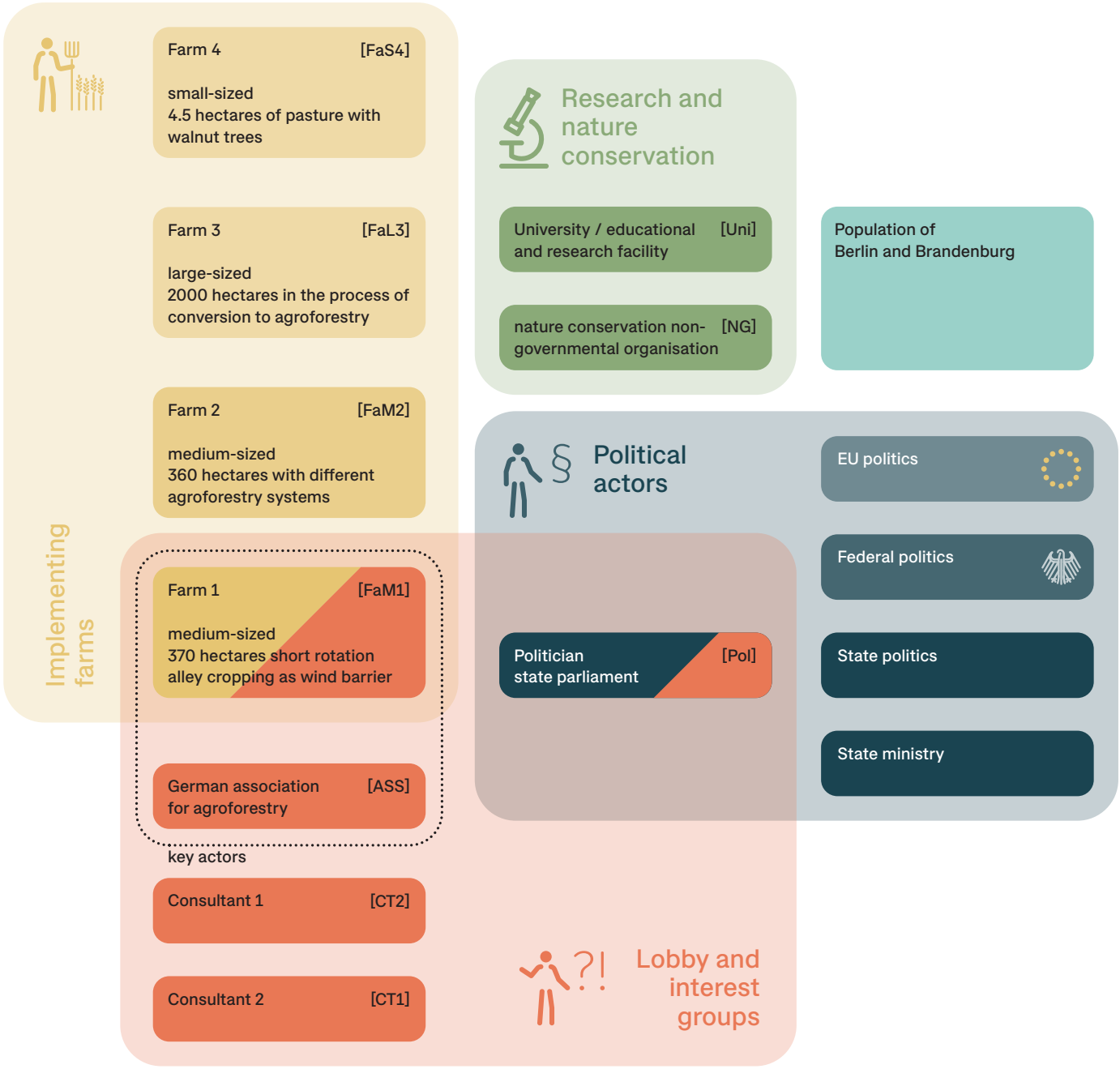

Figure 2. Networking and relationship map of the interviewed key actors.

Interestingly, agroforestry actors also network with other agricultural systems as "the topic [of agroforestry] is interlocked with the whole regenerative agriculture [...]. There is networking in the direction of nature conservation, where people are also interested in going out into the field and doing something new. So, it is a very good exchange" [CT2].

After a lengthy initial phase, the community is currently beginning to grow. This, in addition to the desired outreach and dissemination effect, also makes networking more difficult at times, as one of the interviewed consultants reports: "It's just starting to happen in such a way that we realize: okay, there are also people around who we don't yet know. That was not really the case over the years, instead people knew each other and knew who was doing what [...]" [CT1].

A shared pioneering spirit was repeatedly mentioned as a decisive aspect of this form of constructive cooperation. This spirit creates a feeling shared by all participants of

working together beyond classical agricultural strategies on an innovative and promising form of land use. [FaM1], for example, describes the goal as being "to bundle that and try to communicate that we can also spread agroforestry in Germany". This is confirmed by a consultant: "And here, the main thing is to support each other somehow and all act with the mindset: 'Hey, we want to advance this'" [CT1]. The respondents also went on to describe how this pioneering spirit also leads to constructive collaboration with strong community feelings.

Although agroforestry is well-researched from a theoretical point of view, management still has a highly explorative character. This is due, for example, to the high site-specificity, the dependency on local conditions and on a knowledge-base that, in many respects, is still uncertain. Accordingly, knowledge, experience, values and failures within the field of actors are largely communicated openly in order to avoid repeating the same experience. This is summarized particularly succinctly by [CT1], who states that there is "little competitive behavior", and that instead people "work together a lot and support each other and also have a very good exchange. [...] There are individual actors [...] who then hold back a bit with information because they say, 'Hey, that was so much effort to generate this wealth of experience somehow, we don't want to just share it and pass it on.' But that's actually really the exception" [CT1].

3.3.2. Farmer and DeFAF as Central Actors

With regard to the importance of single actors, the representative of a large agricultural enterprise [FaM1], as well as the interest group DeFAF [ASS] were mentioned by all interviewees as central pivots within the network. In the case of [FaM1], this relates above all to their role as a pioneer and trailblazer in the region regarding the implementation and management of agroforestry systems. In addition, the communication of their own project is seen as target-oriented and efficient. The farmer themselves sees their role not only as a land user, but above all as a political actor and communicator. [FaM1] is described by the other actors as "a farmer who brings the idea right to the fore" [MS], as a "pioneer" who would bring his experience into the community [CT1], as "active" [FaM2] and as a very good communicator, "who has simply communicated very well in the profession and thus has certainly done a lot for the whole agroforestry movement" [Uni].

The interviewees considered DeFAF to have an important function in terms of bundling interests, networking between actors, and commitment to an adequate funding landscape and professional advice through knowledge transfer.

Interviewees stated that DeFAF is "the most important player" [MS] and that "the networking is very, very good" [CT1]. Additionally, the actor from a non-governmental nature conservation organization confirmed that the association is "a large player, advising not only in Brandenburg, but also across Germany, joining up, developing as a professional association" [NC]. [FaM1] and [FaM2] noted that they used DeFAF "as a network [...] or at least for information". [CT1] and [Uni] attested that the association was very active and had "put the focus of the work and also the project work very much in Brandenburg" and had "certainly fueled this discussion and also done its homework."

On the other hand, the ministry [MS] that is responsible for agricultural funding and, thus, also for the institutional funding of agroforestry systems, was evaluated by the practitioners, on the one hand, as a relevant actor of the executive, and on the other hand as an obstacle to the implementation of practical goals and financial support. The ministry's complex and bureaucratic funding structures were criticized and actors involved in the practical implementation of agroforestry also considered it to be too tentative in anticipating the needs of the dynamically developing sector (see Section 3.5).

3.4. Potential of Agroforestry Systems in Brandenburg to Provide Materials for the Construction Industry

The key actors were also asked to assess the potential of agroforestry systems to provide materials for the construction industry. This question was used to find out whether

and to what extent the participants based in practice, science and administration see the possibility of using agroforestry systems to produce renewable and regenerative building materials regionally as part of a construction transition towards building with wood instead of concrete or steel.

Overall, the responses to this question were highly differentiated, as is shown in the following chapters. In summary, it was found that although the actors saw potential in principle, agroforestry systems were not yet considered high performers with regard to the production of building materials. The main reasons cited by actors who did not see high potential for the provision of raw materials were: agroforestry's lower woody biomass production compared to forestry in terms of total raw wood volume per hectare; resource conflicts that may arise from the competition between food and raw material production on agricultural land; and ecological aspects that specifically relate to the site situation in Brandenburg.

3.4.1. Potential of Wood-Based Products

It was noticeable that only the two consultants claimed that agroforestry systems have a greater potential to provide wood-based products than commercial forestry. [CT2] sees possible uses, especially for poplar (*Populus nigra* L.): "pulpwood, boards, pallets and so on, you can make everything from poplar, or even if you have veneer poplar, and thereby also peeled veneer, poplar multiplex boards that can be used for interior construction. [. . .] So there I think we could use huge, huge amounts of resources for the construction industry". [CT1] also thinks "it makes absolute sense [. . .]". He sees the distinct lower land consumption for log production in agroforestry compared to forest land combined with the positive deadweight effects for the agroecosystem (see Section 3.2) as a "huge opportunity". At the same time, the specific structure of agroforestry systems compared to the main tree species in commercial forests leads to greater diversity in the wood assortment: "There are completely different woods with completely different qualities. Qualities that are usually much better and more exciting" [CT1]. Additionally, according to [ASS], poplar wood can be used in construction without problems and can be used in outside areas after thermal treatment. The same can also be said for other kinds of wood.

In contrast, the other respondents were more restrained. They believed that building materials that can be obtained from agroforestry systems, would be primarily by-products or materials for utilization in agriculture, forestry and horticulture. As an example, [ASS] noted that: "Well, there are definitely uses for fence posts and so on. I don't know of any example where wood has actually been transferred to sawmills. At least not from Brandenburg, I'm not aware of that". The representative of the university states that the Brandenburg agroforestry systems are currently "just in the growth phase, they are actually not yet so far that they are in the phase where they are now used, particularly in the case of construction timber or valuable timber" [Uni]. The politician saw more potential in the energy transition than in the construction transition, alongside the production of insulation materials (see below), and stated that a strategic production of strong and/or valuable wood could be associated with logistical problems, as well as issues related to subsidy structures:

"But otherwise [. . .] the dimensions that are harvested are simply too small, [. . .]." [POL] It is true that wood piles can be obtained from agroforestry systems, "but otherwise, you don't harvest any beams or any things that you might use for roof battens or [. . .] for any beams. That's not going to happen. [. . .] Insofar, I think there is less usage in the construction industry" [POL].

Another aspect of the potential for providing building materials that was viewed with skepticism related to the overarching issue of land use and resource distribution. Two respondents expressed concern that competitive situations may arise between food and agricultural production. A call was made for a prudent approach in this context, at the very least.

"I have the feeling that an incredible competition for land has emerged. It started with biogas plants and is now massive with photovoltaics on the field. And now we're coming up with raw materials from the field. We have to remember that we still need arable land. In principle, we cultivate almost all arable soils worldwide. We can't just make way, and we have to continue to feed people and, if necessary, produce animal feed. We may not overestimate, so to speak, what we can get from the field. [...] Not, 'Hooray, now we're getting everything from the field'" [FaL3]. Similarly, [CT1] sees a "construction-versus-plate discussion" (instead of the well-known "tank-versus-plate discussion"), which criticizes the use of agricultural land for the production of biofuels instead of food. In his view, a compromise in land use that would both support a construction transition and take food production into account would be meaningful: "Okay, the wood comes for the construction sector and the rest around it, however, continues to be food without a huge loss of land" [CT1]. This again was taken as an argument in support of the combined land use in agroforestry systems.

The landscape attributes of Brandenburg and the local conditions mean that high-value timber production would be difficult to implement over a wide area. The representative of the ministry made the following comments with regard to the site requirements of various species, especially hardwood species: "In Brandenburg, we have very few areas that are fertile. And on these areas, which are less fertile, it is probably difficult to implement woody plant production that will ultimately be used for construction timber". Instead, the interviewee sees great potential for raw material production in the extensive moorland areas of Brandenburg: "The cultivation of paludicultures [...], where then reeds can be used among other things as insulation material for buildings or as thatch. That's exactly where the potential would lie".

3.4.2. Non-Wood Products

The interviewees saw increasing potential in the innovative use of non-wood products or agriculturally produced materials. For example, [FaS4] said that it would be interesting for the company "to experiment with the peels [of the fruits] and to see where they can be put to further use". In addition to the small amount of wood production, the interviewee "cannot imagine [...] which fibers, i.e., which materials, could still be used, unless you combine it with hemp or something, where something can then be made out of it again" [FaS4]. The representative of the state parliament sees, at most, limited innovation potential in the production of insulation material: "Better than Styrofoam, because it is a natural building material. And if you could use the woodchips or whatever then as a by-product of agroforestry then the [potential] would be somewhat higher. [...] And in this sense, it is then something for the screw conveyor of a heating system at the very most" [POL].

3.5. Obstacles, Barriers and Proposed Solutions with Regard to a Forced Implementation of Agroforestry Systems in Brandenburg

The respondents were cautiously optimistic about agroforestry systems being able to deliver materials for the construction industry. At the same time, they highlighted the great ecological and economic potential of this form of land use (3.2). This raised the question of what obstacles and barriers hinder an expansion of the area used for agroforestry.

Two clear points of consensus were identified among the key actors: firstly, the funding guidelines in the Brandenburg's Agricultural Promotion Law ('Landwirtschaftsförderungsgesetz'), and secondly, the associated bureaucratic hurdles that would prevent many farms from implementing agroforestry systems. The farmers are, therefore, left with high investment costs and an equally high entrepreneurial risk. It was shown that this gave rise to high levels of frustration, particularly for the farmers running agroforestry systems. Furthermore, some key actors saw a discrepancy between annual agricultural cycles and medium-term management concepts in agroforestry systems as well as specific, lease-related ownership structures in Brandenburg. In addition to a streamlined yet more precise

support structure, a strengthening of the market demand was identified as a potential solution, which would provide security and incentives for producers.

3.5.1. Funding Structure, Bureaucracy, and Economic Risk

The interviewee representing nature conservation [NC] summarizes the situation as follows: the obstacles ranged "from funding, from support via the state and also via the federal government which, after all, did not exist before and is now only supposed to provide low levels of support under the new agricultural reform". [FaL3] sees an enormously high workload on the part of the farmers as a consequence, which would likely deter many farms: "There is an enormous amount of preparatory work involved until you can put a system like this into practice". According to the DeFAF representative, this leads to a situation where "not everyone is shouting 'hurray' now when it comes to agroforestry" [ASS]. These perspectives were echoed by the other farm representatives. [FaM2] criticized the fact that Brandenburg's subsidy system does not categorize agroforestry systems as independent land use systems, but wrongly classifies them as short rotation coppices. [FaM1] summarizes: "And you see how much bureaucracy it is before you get the first cutting in the ground. That's when you lose interest. It's so simple: [...] It's all way too complicated and that's why people won't do it". The politician criticized specific rules for the conception of agroforestry systems without "any technical and scientific bases" [POL]. These and similar bureaucratic requirements are problematic in two respects: on the one hand, because they dampen interest in the agricultural industry to establish agroforestry systems from the outset, and on the other hand, because they limit the economic benefit that can be obtained from such systems.

In addition to bureaucratic hurdles, interviewees also mentioned that the proposed subsidies would not cover the real management costs of agroforestry systems. The planned subsidy amount of 60EUR per hectare of tree area from 2023 was described as "a joke, plain and simple" [FaL3] and "a drop in the ocean" [LWg 2]. Given the costs of establishing and maintaining agroforestry systems, it was noted that the subsidy amount was clearly not enough for farmers to consider the cultivation of agroforestry systems to be possible or economically beneficial. The politician also shared this view and criticized the fundamental adjustment of agriculture to subsidies, stating that "60 EUR per hectare is way too low, even if [the farmer] has woodchips at a later stage. So, it simply is not affordable for the farmer. [...] 60 EUR per hectare, that is simply too little, then nobody is going to do it" [POL]. Thus, it was observed that there was a lack of financial incentives for farmers, meaning that a crucial component for the establishment of agroforestry systems is missing: "If I can't make it economically just from the product alone, then at least the cultivation has to be subsidized" [FaM1]. It is, therefore, "not as if one would really classify it as an attractive offer right now, so to speak, especially if one sees the high investment costs behind it" [FaS4]. In addition to these, the operating and maintenance costs for an agroforestry system are often overlooked ("Value-feeding, for example, or tree selection at a certain point. The implementation, the protection of the trees from browsing, even fencing if necessary, irrigation" [Uni]). However, without these investments, the successful implementation of agroforestry systems is inconceivable, which is why, in combination with the funding situation outlined, a business risk arises that many farms would shy away from: "It's a big risk that farmers take when they now set up such systems for the first time, first of all they don't immediately get a real return of investment. This means that you can only assess whether it has all been worth it, whether the return on investment is right years later, when all these commodity revenues are due, so to speak" [NC].

In turn, interviewees [FaM1], [FaM2], [NC] and [Uni] took state, federal and EU policy to task for developing leaner and more practical funding structures, and focused primarily on the ministry [MT] at the state level. The following statement exemplifies this:

"And then you have to come down a bit from your control mania. And the documentation must also become much simpler than what is now required, this bureaucratic madness is taking its course and cannot be stopped. And politicians are definitely called

upon to create new and better framework conditions. But please, together with us and with us, I mean DeFAF and the farmers who have to and want to work with these systems in the end" [FaM1].

3.5.2. Agricultural Management Cycles and Ownership Structure

With regard to the ownership structure in Brandenburg, it was repeatedly emphasized that the duration of lease agreements is often less than a potential rotation period in agroforestry systems. This means that farmers would have to take a big risk, "because you don't know whether the landlord might say in three years' time, 'Well, now I'm not going to lease it anymore, I'm going to take the land for myself now.' Or there will be a lease change or whatever" [ASS]. Consequently, there is a lack of the necessary commitment required for farmers to change their land use.

According to some interviewees, this is reinforced by the fact that it is inherent in agricultural work to think and plan in one-year cycles. The rethinking process is, thus, also challenging from a 'cultural' point of view. The DeFAF representative summarized this as follows: "Farms usually think in terms of annual cycles. When I plant this tree, I first have to be able to think in terms of decades. That is first a very big thinking task [. . .]" [ASS]. From the farmers' point of view, this initially leads to a loss of actual cultivation area with an annual return on investment. The university representative sees a need for further education here: "And that's the exciting thing about agroforestry systems, because we have to really bring it together, bring long-term management and long-term thinking into agriculture" [Uni].

3.5.3. Prospects: Generating Market Demand

In addition to the aspects that stand in the way of widespread implementation of agroforestry systems, the interviewees were also asked about possible solutions. In addition to the above-mentioned call on the ministry to simplify and reform the funding structures in the long term, the interviewees shared a desire for a generated market demand. In particular, the interviewees from agricultural practice and the consulting sector expressed this wish based on their experience in marketing agricultural products.

[FaM1] emphasized that the decisive factor in exploiting potential would be a downstream value chain on site, in this specific case, the processing industry, which would give farmers a purchase guarantee: "Well, if there is a demand, then we can definitely meet it. Especially with fast-growing woody plants, you don't need that much time to respond" [FaM1]. [FaL3] assumes that it would be possible to "get a lot more out of it" for the construction sector, but that there would then have to be "a rethinking of how valuable wood is. That not everything that has a deviation of five centimeters on five meters is no longer usable for construction. A lot more can be used in construction than is currently being used" [FaL3]. [ASS] criticizes that wood processing "always has to be done very cost-effectively and that there is not really the use for many wood assortments". He also concludes: "That means there is actually currently a lack of purchasers for agroforestry products" [ASS].

The consultants take a similar view. [CT1] describes the demand for renewable raw materials in the construction sector as "huge. We see this everywhere, in all the statistics and figures, and it will continue to increase". Especially "from an architectural point of view [. . .] on the subject of lightweight construction", he wishes that there would be increasing utilization of products from agroforestry systems because—as already described—these systems can offer other assortments and woods due to the short rotation, which increases flexibility compared to classical forestry. The focus on the value chain is "incredibly important in this regard". However, given remaining uncertainties and unanswered questions, the expansion of agroforestry systems requires "a buying hand that manages to generate an appropriate added value on the market". To communicate the agricultural goals and potentials, [CT1] recommends participatory methods, e.g., "on the basis of round

tables, stakeholder workshops" to create "more awareness and more direct contact from purchaser to producer".

[CT2] takes a similar line of argumentation, but also calls on agriculture to adopt a new way of thinking. He sees the predominantly intensive agriculture in Brandenburg confronted with an urban health-oriented buyer milieu, which has differing demands on products and production: "There are demands for nuts, tree fruits, mulberries, for example, but who grows them in Brandenburg? In the organic food stores, you can find dried berries from Eastern Europe, Hungary or elsewhere. But in Brandenburg there are just a few of us small enthusiasts, so small businesses that were founded perhaps also from lateral entrants. And the big ones simply have a completely different mindset". This mindset is exclusively concerned with economic and rational aspects, i.e., "that the numbers add up somewhere in the end and that a large capital income comes out of it". The urban customer milieu, which has high purchasing power, cannot be served satisfactorily in this way, which in turn forces a "deserted landscape". Changed, more diverse farm structures would then bring not only improved marketing opportunities for regional products, but also ecological and social diversity [CT2].

Overall, it can be concluded that the respondents see great potential on the one hand, but on the other hand point to outdated structures, bureaucratic hurdles and a demand for products and materials that still needs to be generated. The results can be summarized as follows: "There is a lot of potential to positively change landscapes and agriculture in the long term. But it will take an effort by society as a whole. Farms can't do it alone" [FaL3].

4. Discussion

4.1. Functions of Agroforestry Systems

Agroforestry can play an important role when it comes to addressing current environmental and social threats, such as food security, biodiversity loss and adaptation to and mitigation of climate change. Nevertheless, it is still difficult to implement agroforestry in Germany because of the lack of knowledge, as well as the skepticism within the agricultural sector, broader society and representatives from administration and politics [46]. It is clear that arguments around the ecological benefits of agroforestry are not sufficient if the systems are not profitable or if payments for environmental services are not an option. However, as they provide the opportunity to produce woody biomass for energetic utilization on the same land as crops for food supply, agroforestry systems will become more important in the future [2]. As a very flexible but low-input system, they can deliver sustainable biomass resources while providing ecological benefits. These systems contribute to the improvement of microclimatic conditions on farmland and can, consequently, increase crop yield stability and overall resilience in environmentally fragile regions of Central Europe. A more efficient use of water resources and better nutrient utilization can support this positive effect. Our study confirmed that the opinions of key actors are in line with the scientific literature regarding the economic and ecological benefits of agroforestry systems. In addition to economic benefits through risk diversification, the positive ecological effects of agroforestry systems that were frequently cited included soil melioration, increased biodiversity and an increased CO_2 sink function.

4.2. Stakeholder's Perceptions and Needs across Europe

The results of a survey from 2018 confirmed the struggles mentioned above: they highlighted the huge amount and complexity of work, management costs, and administrative burden as key barriers to implementing agroforestry systems in Europe [21]. Similarly, the severe concerns of Czech farmers were excessive bureaucratization, high cost of establishment and uncertain profitability [39]. Subsequently, Tsonkova et al. acknowledged that it is essential to facilitate the implementation of agroforestry by simplifying the regulatory framework. This includes better recognition of modern agroforestry through existing policies and payments for environmentally friendly agriculture. It is essential to strive for an integrated approach that combines environmental benefits and production goals, which

is based on compensating farmers for providing ecosystem services and increasing public involvement in sustainable practices of land utilization in the future. In order to enable diverse forms of agroforestry in Germany, the agricultural sector needs improved and more flexible framework conditions at the EU level [47]. Moreover, it is essential that landowners and farmers can be confident that the benefits of agroforestry systems outweigh the extra costs in the long run, especially in terms of implementation and maintenance. Therefore, more efforts in research are needed. García de Jalón et al. [21] defined four key methods for promoting agroforestry:

- National demonstration sites and education programs;
- Improved regulation;
- Providing a market for the positive externalities with agroforestry;
- Increasing the opportunities for new profitable businesses.

The importance of demonstration sites was also emphasized in another study; Graves et al. found that approximately 50% of the interviewed farmers across 14 sample sites in Europe were interested in setting up a silvoarable system on their own farm. In Brandenburg, the result was 7 out of 10 farmers. However, "this willingness was often conditional on visiting an existing system or profitability" [35]. This is also in line with the results of this study, as the importance of existing systems for promoting agroforestry but also as a space for exchange between agroforestry farmers was highlighted by several key actors. Moreover, the integration of agroforestry in academic agricultural and forest science study programs should be intensified, for example, through real-world laboratories and other innovative forms of innovative teaching and learning [43]. This could generate more multipliers and change agents who are able to advise farmers and other practitioners on setting up economically viable agroforestry systems [48]. Another study pointed out similar key issues and challenges that emerged during workshops and interviews with Italian stakeholders [49]. Beside improving management skills (optimization of biological synergies and increasing productivity) and enhancing economic value (identifying viable products and implementing valuable chains for these products), the stakeholders highlighted the need to share knowledge on agroforestry by creating communication tools or through the organization of educational trainings [49]. Special attention should be paid to Mediterranean agroforestry, where high natural and cultural value agroforestry systems were evaluated as the agroforestry practices with the greatest benefits [50]. High natural and cultural value agroforestry system stakeholders identified challenges for management and socio-economic categories, but also challenges concerning production and environment, which should be addressed with case-specific solutions [51].

4.3. Case Study Approach

One of the medium-sized farms ([FaM1]) and DeFAF were identified as the central actors. The main objective of DeFAF is to promote agroforestry systems in Germany through, for example, networking activities, lobbying, publishing technical literature, or participation in research projects. To attract new farmers into agroforestry systems, it is important that active members of this association share their experience and act as demonstration farms. The association currently has 12 members with a farm under agroforestry systems in Brandenburg. In this study, we did not contact all of them as the objective was to interview the key actors who were mostly identified by the actors themselves. There was one more farm, which was mentioned several times by the interviewees, from which we were unable to elicit a response from. Even if the sample size is small, we believe that this qualitative interview analysis considered most of the key agroforestry actors of Brandenburg. Because of the case study approach, attempts can be made to generalize our findings and transferred them to comparable regions with comparable frame conditions. Moreover, it was seen as crucial to involve the farmers' association in further research, which is a huge interest group with a strong lobbying force.

Compared to other areas in Germany, agricultural practice in north eastern Germany is dominated by large farms. With a high degree of mechanization and a small labor force

per hectare, the majority of farms are oriented towards profit maximization, for example, through large-scale operations [30]. Thus, modern agroforestry concepts that still allow for conventional mechanized agricultural management should be demonstrated and promoted. A shift towards a more site-adapted design of agroforestry systems that takes into account the micro-site-specific conditions and uses patches instead of rows (as demonstrated here: https://agrarsysteme-der-zukunft.de/en/consortia/dakis, accessed on 9 February 2023) seems possible only in the future, as this would require a complete transformation of farmers' technical equipment. However, the slow expansion of areas under agroforestry in north eastern Germany is not only due to the lack of demonstration sites. The complex and rigid funding structure was identified as a major obstacle by the actors, with the farmers and representatives of the consulting sector placing particular emphasis on this issue. A more rapid approach and a clearer commitment to agroforestry as a modern land use system was called for, both from the federal ministry in charge of agricultural funding and from the representative of state politics. Agroforestry practitioners perceive state policy and administration as an impediment.

4.4. European Common Agricultural Policy (CAP)

Within the framework of the first pillar of the new European Common Agricultural Policy (CAP), farmers may apply for funding of 60EUR per hectare of woody strips when all requirements regarding agroforestry systems contained in the CAP 2023–2027 are fulfilled [52]. The actors appreciated that agroforestry was officially incorporated into the new CAP. However, DeFAF also criticized the CAP in terms of: (i) The low subsidy amount, which does not consider the high investment costs for tree planting and maintenance; (ii) The requirements on tree spacing, which are not compatible with practice and hamper scope of design; (iii) The possibility to combine areas under agroforestry and areas with conventional agriculture; and (iv) The list of accepted tree species [53]. Regarding the latter, several interviewees could not comprehend the prohibition of black locust, particularly given that this species is frequently used for the establishment of multi-row tree strips and in certain circumstances, such as on post-mining landscapes in north eastern Germany, may produce more biomass than poplar and willow clones [20,31]. Despite it being a non-native and potentially invasive tree species, the planting of black locust in agroforestry systems could be authorized with more stringent regulations.

5. Conclusions

Agroforestry actors in Brandenburg define themselves as being a very well-connected and active sector. Moreover, interview partners stated that a dynamic growth in the sector is noticeable, which is also characterized by the implementation of innovations such as new agroforestry systems. It was obvious, due to similar statements from most of the key actors, that there is a great need for policy revision and support for agroforestry, related changes in funding structure support, revision of expectations in the wood-use and related sectors, education and training regarding agroforestry. This leads to both further research needs and practical, key-actor-based perspectives. Thus, future research in collaboration with the key actors is very promising. Potential future research could be, for example, to explore the value chain of agroforestry products. Key actors clearly indicated in the interviews that generating market demand could increase the area under agroforestry and mitigate the economic risk that currently still deters many farmers. In further projects, the market structures should, therefore, be analyzed. For this reason, a broader view on stakeholders in Brandenburg, extending beyond the 'key actor' focus of this study, would be beneficial. In addition, as suggested in some of the interviews, bringing together the key actors with other relevant stakeholders could help to drive market flows, roundtables or transdisciplinary stakeholder workshops bringing together representatives of the wood-processing industry, architecture and the construction sector, in addition to practitioners and political actors, which could expand the network structures shown here.

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