Institutionalizing Agroforestry In Germany

Historical Development And Current Practices

Master's thesis for the Attainment of the Degree Master of Arts from the Munich Center for Technology in Society at the Technical University of Munich

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Abstract

In its broadest definition, agroforestry is the combination of trees and agricultural practices on the same area and the combinations are unlimited. These practices are often attributed to the tropics but they gain momentum in Europe and Germany, too. Agroforestry is interesting as an emerging topic and this is a special moment in time; the German government is about to attribute a legal status to agroforestry in Germany — and fix what counts as agroforestry.

This thesis maps the current agroforestry landscape in Germany and its institutionalization. In an inductive research, material speaks. And material is manifold: Scientific literature, written documents, internet presences, and expert interviews with scientists and practitioners. Depending on the context, the material provides factual information or material for analysis in the Grounded Theory methodology (Charmaz, 2006).

From a historical point of view, practices, lobby groups, politics and science are *co-produced* (Jasanoff, 2004a). Agroforestry in Germany was intended for biomass production and both politics and science focus on this area. Lobby groups emerged from scientific projects and try to reshape the political framework in order to ease agroforestry practices for the practitioners. However, the current political framework poses limitations on the lobby groups' work. The historical separation of agriculture and forestry cannot be overcome and agroforestry will be confined to agricultural areas.

In today's practices, practitioners experience different trajectories. The interviewees were *neo-practitioners*, i.e. they did not change from other practices to agroforestry but started with their undertaking right after their professional formation. These neo-practitioners conduct *real-world experiments* (Gross and Krohn, 2005) and advance agroforestry outside the laboratory. Their motivations revolve around ecology or economy but often the actors do not share the same motivations. In this context, agroforestry becomes a *boundary object* (Star and Griesemer, 1989) and is able to bridge different social worlds. The actors' definitions of agroforestry are individual as well, but they are heavily influenced by the picture politics or the lobby groups transmit. Some practitioners do not consider their own practices agroforestry although they indeed combine agricultural and forestal practices on the same area. From the interviewees' answers, I distilled five categories that classify agroforestry: The *type of practice*, *intentionality*, *complexity*, *intensity* and *products*. The concept of *classification* (Bowker and Star, 1999) projects that the future legal definition might not account for all the diverse practices and restrict diversity if it defines agroforestry by the tree density on agricultural areas. Current practices are more creative and diverse than what has been portrayed in important works like Gordon et al. (2018a). The next political steps will open a new chapter of agroforestry in Germany; most probably a less diverse one.

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- last but not least, my interviewees who answered all my questions, although they could not think of what I will do with it.

Declaration of Authorship

I hereby declare that the paper submitted is my own unaided work. All direct and indirect sources used are acknowledged as references. This paper has not previously been presented to another examination board or published.

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Furthermore, I consent to my paper being checked for plagiarism. This means that it may be transmitted to a plagiarism search service provider and checked for uniqueness and similarity with other sources. I also consent that my paper may be stored for future comparison purposes on electronic systems accessible only by the MCTS Academic Programs Office.

Side note

Minor changes have been made to the original before publication (correction of spelling mistakes, anonymization, gender-neutral citing of interviewees).

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1 Introduction: Land-Use Systems in the 21st Century

The most basic definition of agroforestry says it is "combining trees with crops and / or livestock on the same area". This could encompass many different practices all around the world — whether the practitioners call them agroforestry or not. On any account, agroforestry is a type of land-use, a type of primary production. And like all other types and manners of raw material production — I think of agriculture, horticulture, silviculture, pisciculture, precision farming, agroecology, industrial farming, organic farming, indoor farming, vertical farming, and so on and so forth — agroforestry is entangled in the questions of supply and sustainability. Primary production exists to satisfy the humans' basic needs like food and shelter. In light of a growing world population, primary production was confronted with the question of intensification from the 16th century onward. First it was Robert Malthus, who projected that the world population will grow faster than the increase in primary production can sustain (Malthus, 1798). He was proved wrong. World population grew and so did primary production. Agriculture today produces twice or trice the amount of potatoes and wheat than it did in the 1960s (acatech, 2019). However, like Prof. Dr. Eike Lüdeling claimed on the 8th Forum Agroforstry (E-01), world hunger is still a problem, but in the 21st century, it is rather a question of distribution than of production. Additionally, the modern, productive agriculture comes with considerable side effects: Nitrate contaminates groundwater, insect biomass is in decline, soil degrades, number of farms is in decline and productive land-use is a source of greenhouse gases. Therefore, Lüdeling claims, society poses the question differently; land-use systems encounter new expectations: Land-use systems should also provide ecosystem services, comply with the sustainable development goals and achieve (economic, ecologic and social) sustainability. Productive land-use systems have to change from "how can we produce more raw materials?" to "how can we sustainably produce enough raw materials?"

Overall, primary production still navigates between productivity and sustainability. That is all the more true for agroforestry which promises to achieve both on the same area. The German lobby group for agroforestry, Deutscher Fachverband für Agroforstwirtschaft (DeFAF), advertises the economic, social and ecologic benefits of agroforestry: Agroforestry can increase yields, enrich landscapes and provide habitat for insects or birds (see figure 1). That means that agroforestry can integrate both production and conservation (or sustainability in the broader sense [1]).

[1] Sustainability and conservation can coincide or mean different things, depending on the context. In the context of primary production conservation means preserving habitats for wild animals. Sustainability can go further and mean providing clean air and water for humans or beautiful landscapes like mapped in the ecosystem service framework (MEA, 2005, p. v). However, in the end, an agriculture that can provide

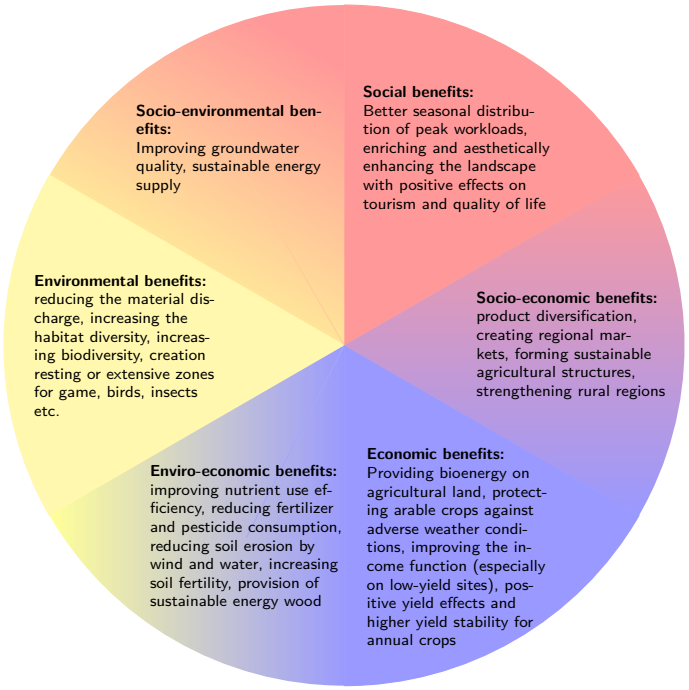

Figure 1: The circle segments show the different benefits of agroforestry as advertised by the DeFAF (2021b, own image)

Büscher and Fletcher, two sociologists who started out from political ecology, proposed similar ideas in their *Conservation Revolution* (2020). They postulate, in order to reduce biodiversity loss, production and conservation need to be integrated on the same areas. For that, they suggest so called *integrated conservation landscapes* which can produce raw materials while, at the same time, benefiting the environment — indeed the same idea that agroforestry projects. Can agroforestry work as a real-world example of an integrated conservation landscape? To answer this question, this thesis will map the landscape of agroforestry in Germany. It will investigate how agroforestry developed to the status quo, how it is (still) institutionalizing, how the areas politics, practice, lobby groups and science relate to each other and how interviewees from these areas frame agroforestry in Germany.

2 The Case of Agroforestry

Gordon et al. define (temperate) agroforestry in their compilation *Temperate Agroforestry Systems* (2018b) — which can be called the bible of temperate agroforestry — as

clean air and water for humans may also provide habitat for endangered species. Therefore, I might use sustainability and conservation interchangeably.

> an approach to land use that incorporates trees into farming systems and allows for the production of trees and crops and/or livestock from the same piece of land; [...]

When I speak about agroforestry, I will keep this general definition in mind. It might not be specific enough to serve as a legal definition, but it describes very well what agroforestry systems in Europe (and even around the globe) have in common. Trees, crops and/or livestock are combined on the same piece of land. To be more specific, agroforestry systems are often classified according to the combination of their components, i.e. the way how trees, crops and/or livestock are combined. The respective sub-systems are silvoarable (trees and crops), silvopastoral (trees and livestock) and agrosilvopastoral (trees, crops and livestock) systems. Generally, agroforestry systems can also be classified according to other criteria, e.g. according to their spread (tropics, temperate, highland, lowland etc.), their management (low input, high input, commercial, subsistence etc.), their function (production or protection) or their structure in space (dense, sparse) and time (coincident, concomitant, etc.). However, agroforestry systems in Central Europe are mostly differentiated into silvoarable, silvopastoral and agrosilvopastoral systems (DeFAF, 2021c; FAO, 2015; Nair, 1985).

As such, *agroforestry* is an umbrella term for many different practices which themselves are known under different local names: home gardens or shadow coffee in the tropics (figure 2), dehesa and montado as open systems in Spain and Portugal respectively (figure 3), wood pastures (figure 4) and meadow orchards (Ger. *Streuobstwiese*, figure 5) in Central Europe. They are all more traditional types and used to be cultivated by handwork with only little mechanization. Additionally, new types of agroforestry emerged, mostly in Central Europe: alley cropping, i.e. the linear arrangement of crops and trees (figure 6), or Short rotation coppices (SRCs)[2] combined with a chicken run (figure 7). These types of agroforestry employ more machinery and are scalable.

The main products of agroforestry systems can vary, too. Agroforestry systems can be installed to produce fruits, nuts or wood (energy wood, high-grade wood or as raw material), to protect livestock or to produce any two or more products at the same time and with the same importance. The analysis will show that the core product both influences and depends on the actors' motivations, imaginaries and trajectories.

Agroforestry is a case of regenerative agriculture. Regenerative agriculture as an umbrella term contains many different practices, like plowless farming, holistic pasture management, agro-ecological practices etc., and focuses on restoring humus and binding atmospheric CO_2.

[2]Note that SRC alone would not exactly be an agroforestry systems since it indeed produces trees on agricultural land as a perennial crop but is not intentionally planted for the beneficial interaction with agricultural crops. Nevertheless, SRCs are often mentioned in connection with agroforestry systems

Figure 2: ©Brian Smith/American Bird Conservancy
Coffee in the tropics grown under trees: farmers plant the crops in a more story system with the intention that the plants use the sunlight most efficiently and benefit each other.

Figure 3: © Anne & Saturnino Miranda, Jörg Stendal, Juan Glez (clockwise)
Dehesa/Montado in Spain and Portugal: Loosely scattered cork oaks for cork production grazed by cattle, sheep or goats (agrosilvopastoral practice)

Figure 4: ©Reijo Telaranta.
Wood pasture: Goats, sheep or pig are grazing in the forest or are feeding acorns (silvopastoral practice)

Figure 5: © Michael Strobel
Meadow orchard (*Streuobstwiese*): Lined up fruit trees on grassland (silvoarable practice)

Figure 6: ©National Agroforestry Center (NAC)
Alley cropping: crops interspersed with lines of trees (silvoarable practice).

Figure 7: ©Lignovis GmbH
Energy wood and chicken run: Animals find shade under fast growing poplar trees (silvopastoral practice).

I will focus on agroforestry as my case because it a lobby group exists that strives for political legal definitions. It might be easier to define what counts as agroforestry than what counts as regenerative agriculture. However, both are entangled and cannot entirely be separated.

Additionally, agroforestry in Germany is worth receiving a closer look. Agroforestry in the tropics has already been researched comprehensively (Graves et al., 2009; Rois-Díaz et al., 2017; Santiago-Freijanes et al., 2018). Agroforestry in Europe (re)gains momentum right now and agriculture meets serious challenges here. The nation state is a good level for research because the legal framework is the same for practitioners but landscapes are different enough that practitioners in interviews will narrate different stories.

3 Literature on Agroforestry

3.1 Natural Science Literature

Research in (temperate) agroforestry narrows down on silvoarable systems and directly quantifiable results whereas other agroforestry types and qualitative studies have not been in the focus. Most studies in the European context (see summaries in Dupraz et al., 2018; Nerlich et al., 2013; Reeg et al., 2009) deal with data like yield, economics, productivity, erosion, nutrients, soil fertility, water resources, micro climate, tree species, tree growth, tree density, tree protection, etc. Dupraz et al. (2018) also treat crop protection and biodiversity but — measured by the number of cited publications — less studies have been conducted in this field. Studies about landscape aesthetics, income resilience, broader socio-economic impacts and effects on the practitioners' self perception were less frequent or absent.

For the newly emerging practices, literature focuses on SRCs [3] and alley cropping for energetic use or timber production (Dupraz et al., 2018; Eichhorn et al., 2006; Nerlich et al., 2013; Reeg et al., 2009), i. e. combinations of trees and crops (silvoarable systems) without animals. Eichhorn et al. (2006), for example, investigated the types and extension of silvoarable systems in Europe. The authors demarcate silvoarable and silvopastoral agroforestry but skip explaining why they focus on the first throughout their research. Silvopastoral and agrosilvopastoral systems have not been in the focus in central Europe or are often not conducted under the term agroforestry (e.g. Mosquera-Losada et al., 2005; Pannell, 1999; Sanderson et al., 2013).

Scientific research is oriented towards profitability and the success of agroforestry systems is assessed in economic terms. Reisner et al. (2007) focus on the potential and profitability

[3] Note that, strictly speaking, SRCs are not an agroforestry practice. SRCs are planted to produce wood on agricultural land, not for beneficial interaction between agricultural crops and trees —– which is one of the characteristics of agroforestry.

of silvoarable agroforestry and investigate which commercial trees can be productively grown in Central Europe. Smith et al. start from the point that "[i]ntegrating trees and agriculture through agroforestry has been attracting increasing interest as an agroecological approach to sustainable intensification" (2012a, p. 1), i.e. the primary goal of agroforestry for them is sustainable intensification. In many reviews, the feasibility of agroforestry is assessed by an economic indicator, the land equivalent ratio (LER). It was first proposed by Mead and Willey (1980) and revises if the agroforestry land-use system returns more ($\mathrm{LER} > 1$) or less yield ($\mathrm{LER} < 1$) than the monoculture:

$$\mathrm{LER} = \frac{Y_i}{Y_s}$$

with Y_i = yield per unit area of mixed crop and Y_s = yield per unit area of monoculture.

According to Dupraz et al. (2018, p. 115), "[t]he use of land equivalent ratios (LERs) is one way to conveniently assess the advantage of growing crop mixtures". However, agroforestry systems could also have advantages which would not condense in the LER, e.g. if positive interactions reduce pest infestations and thus the need for pesticides. Although this would also be an economic advantage, it would especially influence farmers' health and biodiversity which cannot be measured with yield increase. If the assessment of agroforestry systems focuses on the LER, the aim is to produce as much biomass on one acre as possible. This will in turn bias further research to focus on silvoarable agroforestry and productivity.

In contrast to productivity, sustainability is seen as a (possible but not necessary) side effect (Chalmin and Möndel, 2009; Eichhorn et al., 2006; Gordon et al., 2018a; Hurtig, 2020; Konold and Reeg, 2009; Nerlich et al., 2013) which means that sustainability and biodiversity have not been in the focus of most studies. As Eichhorn et al. (2006) argue for example, agroforestry is today intrinsically linked to sustainability and conservation and thus confronted with high expectations. It almost equates the solution to climate change on a large scale (genetic diversity, product diversity, provision of ecological and economic important environmental goods and services). The authors articulate these high expectations: "Mixed systems of agriculture present an opportunity for future European rural development and have the potential to contribute towards the increased sustainability of agriculture and enhancement of biodiversity, whilst preserving landscapes that are both culturally important and aesthetically pleasing" (Eichhorn et al., 2006, p. 1). In the same publication, they also reduce the expectations towards sustainability due to a trade-off with cheap labor cost:

> It is necessary to be cautious in claiming environmental benefits for silvoarable systems in general, especially in the context of the increased sustainability of agriculture. Considerable experience accumulated in the tropics has shown that

> management of intercropped systems is often intensive. The high cost of manual labour in Europe is likely to lead to a greater reliance on agro-chemical input, especially when unfavourable combinations of trees and crops are employed. The combined peach and vegetable systems of southern France, which require intensive fertilisation and irrigation, provide an appropriate example. (Eichhorn et al., 2006, p. 46)

Nerlich et al. (2013) add that commodities interact differently according to their composition and with that differs also the overall ecological benefits such as soil conservation, water and air quality improvement, biodiversity conservation and scenic beauty. They request to remember that the results depend on the practices, especially if many different things can be understood under one umbrella term like agroforestry. This means that environmental benefits are directed by and subject to the economic outline. Scientific publications treat both economic and sustainability issues but the focus and aim is on the former ones. Ecological issues are analyzed but research is not designed to optimize outcomes in this area.

3.2 Sociological Literature

Sociological studies about income stability, rural structures and development, working environments, farmers' perceptions or trajectories etc. have rarely been mentioned. The few existing often do not demarcate agroforestry, silvoarable systems and alley-cropping consequently so that systems and study scopes become blurred and it is difficult to generalize and compare the findings. Furthermore, they do not differentiate answer given by *adopters*, farmers who embraced agroforestry practices on their farm, and *non-adopters*, i.e. farmers who did not embrace any agroforestry practices on their farm, although they might have different attitudes, understandings and needs on their respective farms.

Pannell (1999) was one of the first sociological study on complex farming systems and often cited by subsequent studies. In *Social and economic challenges in the development of complex farming systems*, the author summarizes what is needed that farmers establish complex farming systems. According to his definition, in complex farming systems "there are more elements than in a simple system, there is more to learn before the system can be competently managed, and therefore there is more chance of problems occurring" (Pannell (1999, p. 393)). As they can be of various formats, agroforestry would also fall under this term. The author focused on farmers who change from "regular" agriculture to complex farming systems and assigns to them the qualities of skepticism, uncertainty, ignorance, prejudice and preconceptions which means that farmers have to be *convinced* to change. The author proposes four conditions which are necessary for an individual farmer to adopt

an innovative farming-system: Awareness of the innovation, a successful smaller trial of the innovation, the perception that the innovation is worth trialing on a larger scale, and perception that the innovation promotes the farmer's objectives. He concludes that the challenges for any new system are (a) making the system profitable, (b) determining whether it is profitable, (c) heterogenity of farm situations, (d) the timing of benefits and costs, (e) social or institutional issues. The study is a review of other research and does not include any empirical data. Although the study titles *social and economic challenges*, the content focuses mostly on economic issues and presents economical profitability as the most important point for farmers. The imagined farmer is (a) one who changes from other practices to complex farming systems and (b) one who needs to be convinced.

Two sociological studies (Graves et al., 2009; Rois-Díaz et al., 2017) were conducted in course of two agroforestry projects in Europe, SAFE and AGFORWARD respectively. SAFE (2000–2005) and AGFORWARD (2014–2017) were the most extensive and influential projects on (silvoarable) agroforestry in Europe (see section 7.6 Research Projects). When non-adopters, were asked, they emphasized the importance of economic profitability when adopting a new system. For pioneer practitioners, i.e. farmers who already embraced a new system like agroforestry when the movement was still small, profitability however was never a reason to adopt agroforestry. This hints at a complex relation between prospected advantages/disadvantages, reasons and barriers, differences between adopters and non-adopters, as well as a complex relation between ecologic, social and economic impacts. Both studies did not ask for these specific relations.

In detail, the study *Farmer Perceptions of Silvoarable Systems in Seven European Countries* was part of the SAFE project. Graves et al. (2009) conducted empirical research and interviewed about 264 farmers between 2003 and 2004 to determine their perceptions of silvoarable agroforestry systems across 14 sample areas in seven European countries. The sample farms were specialized on arable farming and reported no trees (Northern Friesland) or many trees (West Macedonia) on their area, depending on their location. Before, little was known about farmers' perceptions, especially in Europe. The study investigated (a) if the farmers are aware of agroforestry, (b) how they perceive the benefits and constraints of silvoarable systems, (c) how they would design and (d) if they would consider implementing such a system. The *SAFE* project (see table 7 in the appendix A Tables), which the study was part of, investigated silvoarable systems in Europe. Interestingly, the farmers were asked to define *agroforestry* in the first step. Afterwards, the questionnaire continued with *silvoarable systems* only. The authors acknowledged that several scientific publications equate agroforestry with silvoarable practices and the same happened in this study. Therefore, it is notable that the farmers nevertheless defined the term agroforestry more broadly than sil-

voarable practices. The second important point is that the perceived benefits of silvoarable systems are not distributed equally in Europe. Whereas the Southern European farmers identified profitability as the most important benefit of such systems, Northern European farmers considered ecological benefits (environment and conservation) as the most important ones. The study did not explain these apparent differences. Overall, the farmers feared negative effects on the intercrop yield, complexity of work and problems with mechanization. Lastly, farmers were also asked about impediments. They indicated that they would need role models, that substantial commitment of land, labor and capital makes a trial risky, and that current European legislation penalizes such mixed cropping systems. Unfortunately, the authors did not explicate the relations between benefits, constraints and impediments. This means it is still unclear if maximizing profitability would outweigh other impediments or if farmers start agroforestry for environmental reasons as long as the income is secured on the same level[4]. The authors built upon Pannell's (1999) image of skeptic and risk-averse farmers but the outcomes do actually neither confirm nor reject Pannell's argument that the most important point for farmers is profitability.

The study *Farmers' reasoning behind the uptake of agroforestry practices: Evidence from multiple case-studies across Europe* was part of the AGFORWARD project (see table 7 in the appendix A Tables). Rois-Díaz et al. (2017) investigated why farmers adopted agroforestry practices or not. The authors interviewed 183 farmer interviews in 14 case study systems in eight European countries. The cases were from a broad range of agroforestry systems (not only silvoarable systems) and the farmers themselves defined agroforestry broadly. In difference to the studies above, this study interviewed both non-adopters and adopters. The reasons for farmers not to adopt agroforestry were lack of knowledge, they considered it not a viable option, considered it to be labor intensive and projected management difficulties. Farmers who had adopted agroforestry practices indicated tradition, diversification of product range and learning from others as the main reasons. They identified problems with farm management, regulation problems and lack of knowledge as the key barriers. This study shows that indeed the conditions for the non-adopters are not the same as the reasons for the adopters.

With *Farmer perception of benefits, constraints and opportunities for silvoarable systems*, Graves et al. (2017) conducted a similar study like the ones mentioned above. The authors

[4]Example: a farmer can adopt a new practice because of the ecological benefits and just needs to have ensured that s/he has still enough income. Her neighbor can have the same vantage point, but s/he rented the land and the landlord does not allow trees to be planted. Then one key barrier outweighs the initial (strong) reasons. A third farmer could strive for increasing profitability (reason) and sees this as a possible advantage of agroforestry system, but s/he does not receive a loan from his bank and therefore, cannot afford planting trees. Then, profitability would be the reason but, again, another impediment overthrows the plans. There are many different possibilities how these things can relate.

researched farmers' perceptions of benefits, constraints and opportunities for silvoarable systems in Bedfordshire, England. They interviewed 15 arable farmers and concluded that farmers mostly do not consider silvoarable systems to be profitable, that the benefit of such systems would be environmental or social in nature and that arable farmers need especially the economic advantage to consider implementing these new systems. The outcome seems to support Pannell's (1999) statements that, for farmers, the most important point is a system's profitability. Yet again, the study does neither explicate the relation between reasons, benefits, constraints and impediments nor between ecological, economic and social benefits. But what is more, the sample again consists of arable farmers who do not practice (silvoarable) agroforestry yet. To promote a practice, it is important to know the needs of prospective practitioners but it is equally important to ask actual practitioners how they consider these questions. Maybe they display different answers, especially in the early period of a movement. In addition, the farmers did not give a commitment to change to agroforestry. Even if all requirements were fulfilled, it would not necessarily mean that farmers indeed changed their practices.

Finally, Borremans et al. (2016) reiterate similar points: The term agroforestry is demarcated imprecisely and adopters and non-adopters hold different positions. In *A sociopsychological analysis of agroforestry adoption in Flanders: Understanding the discrepancy between conceptual opportunities and actual implementation*, the authors investigated why the farmers' response to a subsidy program for alley-cropping systems in Flanders (Belgium) is relatively low. In their study, they defined agroforestry as "a collective noun for all land use systems in which tree cultivation is combined with agricultural crop production and / or animal husbandry" (Borremans et al., 2016, p. 2) — implying a wider scope than alley-cropping at which the subsidy program was addressed. Here again we find terms imprecisely demarcated. The authors concluded that conventional farmers suspected negative impacts on compatibility and profitability whereas pioneer farmers saw legal issues as the most important drawback. This shows that prospective practitioners and pioneer practitioners can indeed have different points of view.

This shows that there is only a small number of original works sociological topics, i.e. this area has received only little attention in the last years in temperate agroforestry. Furthermore, the demarcation of agroforestry, alley-cropping or silvoarable farming is not clear. Finally, the studies have not been sensitive enough to the motives of farmers who recently started an agroforestry practice.

3.3 The Relation of (Sustainable) Intensification and Nature Conservation

Hurtig (2020) investigates the long history of polyculture and argues that precision farming and the like are actually in line with the paradigms of intensification and monoculture and will not help to live and produce sustainably. Merchant (1980) argues in the same direction and traces the current problems of extractivism back to a paradigm shift at the time of the scientific revolution when the natural space was turned from Mother Nature into an object ripe for investigation. Both would argue that sustainability — in the basic sense that people can still inhabit planet earth in the next generations time — is irreconcilable with intensification — in the sense of producing more every year.

My first interest was to know if agroforestry could create such *integrated conservation landscapes* as Büscher and Fletcher (2020) envisioned (see section 1 Introduction: Land-Use Systems in the 21st Century). As they integrate production and conservation, these landscapes would fall under the *land sharing* approach. I assigned agroforestry completely to this idea of land sharing because it can incorporate biodiversity elements like hedges and trees into the productive area. Overall, Büscher and Fletcher reject land sparing approaches like the Half Earth Theory (Wilson, 2020) as unrealistic because it stays unclear who would set the boundaries and how and according to which criteria. Furthermore, they argue, the separation would in turn increase the pressure on the other half of the earth with the need to further intensify productivity. Franks (2014), on the other hand, argues that sustainable intensification could refer to both land sparing and land sharing ideas and labels sustainable intensification subsequently a boundary object. In this case, agroforestry can not only be perceived as a way to integrate nature conservation into production but also as a way of sustainable intensification. Interestingly, Smith et al. handled both ideas, agroforestry as sustainable intensification and agroforestry as reconciling productivity and protection of the environment in two publications (Smith et al., 2012a, 2012b), in the same year without resolving the apparent contradictions. in Smith et al. (2012b), the authors put productivity and ecology on the same level:

> A central hypothesis in agroforestry is that productivity is higher in agroforestry systems compared to monocropping systems due to complementarity in resource-capture, i.e., trees acquire resources that the crops alone would not. In addition to increased productivity, agroforestry systems are believed to provide a number of other ecosystem services and environmental benefits, including biodiversity conservation, regulation of soil, air and water quality and carbon sequestration. (Smith et al., 2012b, p. 80)

Subsequently, they classify the benefits of agroforestry according to the categories of the

ecosystem services framework (provisioning services [5], regulating services [6], cultural services [7], and supporting services [8]). They conclude by saying:

> This review demonstrates that temperate agroforestry can provide an alternative approach to land management that, through the re-integration of trees and agriculture, can balance productivity with protection of the environment. (Smith et al., 2012b, p. 88)

In Smith et al. (2012a), however, the main goal is to increase productivity and intensification under the premise that it is sustainable. Brand and Jax, 2007 noted how vague the concept of sustainability became in recent years. I for myself set out with the idea that maximizing intensification and maximizing conservation is mutually exclusive — whereas uncoerced production and conservation can go hand in hand.

4 Literature on Concepts

Science and Technology Studies (STS) concepts work as a lens. By looking through them at the case, the conceptual tools guide the analytical work. I decided to use four analytical concepts: *Co-production* by Sheila Jasanoff, *real-world experiments* by Matthias Gross and Wolfgang Krohn, *boundary objects* by Susan Leigh Star and James R. Griesemer and *classification* by Susan Leigh Star and Geoffry C. Bowker.

4.1 Co-Production by Sheila Jasanoff

In the introductory chapter to her book *States of Knowledge: The co-production of science and social order*, Jasanoff defines co-production as:

> Co-production is shorthand for the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it. (Jasanoff, 2004a, p. 2)

She materializes this philosophical definition in that co-production helps to analyze power, culture and social change. When scholars look at the natural and the social orders as being

[5] Interactions between trees, crops and livestock; measuring productivity; economics

[6] Air quality regulation, climate regulation, C sequestration, carbon substitution, greenhouse gas abatement, water quality and regulation, erosion regulation, pest and disease regulation, biodiversity regulation, natural hazards and extreme events

[7] Cultural heritage values, societal benefits, recreation and ecotourism, aesthetic values

[8] Soil formation and nutrient cycling

produced together, they can explain human activities more accurately. Jasanoff emphasizes that co-production is not a theory but rather an idiom, "a way of interpreting and accounting for complex phenomena so as to avoid the strategic deletions and omissions of most other approaches in the social sciences" (Jasanoff, 2004a, p. 3). Co-production is a non-deterministic account of the world. It analyzes how the world has been constructed by looking both at how entities are socially organized as well as at how social formations manifest epistemically and materially. This is in line with the methodology I will use, Grounded Theory (see section 6), that lately also received a constructivist turn by Kathy Charmaz and Adele Clarke. Co-production also critiques the realist ideology that tries to separate nature, facts, objectivity, reason, policy from culture, values, subjectivity, emotion, politics. As the case of agroforestry underscores, the analysis is enriched exactly by bringing these to realms together.

Jasanoff focuses in co-production on knowledge, especially scientific knowledge, and technology, which she considers to be embedded in social practices, identities, norms, conventions, discourses, instruments and institutions etc., i.e. the social world. She wants to make clear that "[s]cientific knowledge, in particular, is not a transcendent mirror of reality" (Jasanoff, 2004a, p. 2), i.e. scientific knowledge does not (only) report what is in the world, it likewise modifies the world. In the case of agroforestry, I do not focus on scientific knowledge and technology. Rather, I look symmetrically into the realms of practices, lobby groups, politics and science.

Actually, no matter at which scale co-production is studied, "the findings help to clarify how power originates, where it gets lodged, who wields it, by what means, and with what effect within the complex networks of contemporary societies" (Jasanoff, 2004a, p. 5). On the micro-scale, one could look at a single farm. On the macro-scale, one could look at agroforestry around the world. I opt for a meso-scale and analyze agroforestry in Germany.

Jasanoff summarizes that

> work in the co-productionist idiom stresses the constant intertwining of the cognitive, the material, the social and the normative. Co-production is not about ideas alone; it is equally about concrete, physical things. It is not only about how people organize or express themselves, but also about what they value and how they assume responsibility for their inventions. Equally to the point, co-production occurs neither at random nor contingently, but along certain well documented pathways. (Jasanoff, 2004a, p. 6)

Iles et al. (2017) look at agriculture and food from a STS perspective. They follow Mazoyer and Roudart (2006) in that the agricultural systems underwent dramatic changes after the 1700s and were subsequently integrated into industrial production networks and

markets which imposed a productivist form of agriculture. Iles et al. then argue that the dominance of productivsm needs to be understood as co-production of agricultural knowledge, technology, organization, landscapes, politics, markets, consumers, eaters and species. The task for STS is be to investigate *how* these facets have been co-produced and how these transformations have made productivist agriculture powerful. These agri-food and social studies of agriculture have already been conducted since the late 1970s and in the last decade, diversified studies of agriculture are emerging. In the second part of their chapter, the authors present current work that brings counter-currents to productivism into focus, e.g. organic agriculture, agroecology, agrobiodiversity etc. Here, "[c]o-production helps scholars and practitioners understand the ways in which productivist agriculture systems transform sustainability into technological solutions. Co-production also suggests that developing alternative forms of science, policy, and practice could eventually change the epistemic underpinnings of agriculture with the outcome of marginalizing productivism" (Iles et al., 2017, p. 956). In what follows, the authors recapitulate studies on indigenous agriculture, agroecology, organic farming, sustainable intensification and bioindustrialization.

Agroforestry has not yet been investigated by STS. Some findings from agroecology could be transferred, but they mostly investigated indigenous knowledge in the Global South. The case of agroforestry in Germany is special because of its history and entanglement with law.

Therefore, I will add to the discussion around productivism and its alternatives by investigating agroforestry in Germany with the help of co-production. "Much of the power of industrial food is due to its technological momentum and deeply entrenched structures and processes that reinforce one another, therby locking human societies into productivist methods. [...] As STS scholars are helping to reveal, agricultural systems worldwide still harbor substantial diversity — often in the form of agrobiodiversity, heterogeneous landscapes, farmer and food-maker knowledge, customary laws, and inherited foodways." (Iles et al., 2017, p. 965) With the help of co-production, I will situate agroforestry inbetween these two poles, productivism and its alternatives.

4.2 Real-World Experiments by Matthias Gross and Wolfgang Krohn

Gross, Krohn and Hoffmann-Riem (2003, 2005) argue that experiments can also exist outside the laboratory and the societal impact of technologies or policies can only be analyzed in *real-world experiments*. Generally, experiments are perceived as a scientific method testing a hypothesis in the confined and controlled setting of a laboratory without affecting the society outside the laboratory. Since the 17th century, experiments were the constitutive element of modern science and distinguished this form of knowledge from prior forms of

knowledge. Gross and Krohn elaborate on a notion of experiment that is not based on the laboratory ideal. Rather, they argue to see society as a self-experimental community. For that, they build upon the Chicago School of Sociology which understood the "development of modern society itself [...] as an experimental performance, with the sociological scientist partaking in the experiment as an observing participant" (Gross and Krohn, 2005, p. 65). The experimental setting is arranged *for* the scientists and the scientists are rather observing participants (or participant observers) than controllers of the settings. Additionally, both knowledge producers (the society) and researchers operate in an non-scientific environment which, nevertheless, generates new knowledge and reveals further knowledge gaps. "A knowledge society, then, would mean a society that builds its existence on certain kinds of experiments, practised outside the special domain of science. [...] [T]he experimental character of social action and societal development, which — taken full strength — takes the form of an open-ended experiment. A knowledge society thus would be a society of self-experimentation [...]" (Gross and Krohn, 2005, p. 77). In real-world experiments, the application of knowledge affects society beyond the boundaries of a laboratory. Some practices like nuclear energy or waste management can only partially be modeled or simulated. When they are applied on the large scale, society itself becomes a space of experimentation and societal actors become a central ingredient to the experiment. Society learns recursively by experimenting and re-including the learnings into further experimentation. Thus, the boundaries between knowledge application and knowledge production become blurred.

The concept of real-world experiments has been applied to large-scale implementations of new technologies, but we can also gain valuable insights when conceiving agroforestry practices as on-site experiments. Matthias Gross is an environmental sociologist, Wolfgang Krohn a sociologist of technology. Therefore, the concept of real-world experiments evolved from and has been applied to cases such as the development of waste management technologies, the introduction of genetically modified plants in agriculture, strategies of modern warfare or the meltdown of the Chernobyl power plant in 1986 (see Gross and Hoffmann-Riem, 2005). For their large-scale implementations, these technologies were tested outside the laboratory, as institutional practices in society, where knowledge production continued. "Here the borders between technology development and detached scientific knowledge production on the one side and the application of knowledge and technologies in the wider society on the other side tend to become blurred." (Gross and Hoffmann-Riem, 2005, p. 269) In Gross and Hoffmann-Riem (2005), the authors apply the concept to the restoration of Montrose Point, a peninsula in Chicago that gradually developed from a dump. The authors argue that restoring nature "has become a 'public experiment' where the gaining of new insights and the application of new knowledge can go hand in hand" (Gross and Hoffmann-Riem,

2005, p. 272). Also in this case, the real-world experiments tend to be singular cases; cases that cannot be reproduced elsewhere. Although there can be many potential real-world trial sites for agroforestry practices, each site on its own is a real-world experiment because each practitioner only deals with one specific and unique site. When we see agroforestry practices as a real-world experiment, more is required than quantifiable results from a research site and asking non-practitioners what they would need to change their practices.

> People here are not passive subjects but active agents in the scientific process. In ecological field practice, contestation of restoration knowledge via the involvement of the human community has produced a transformed and enlarged definition of "scientific research" and has fostered public involvement in science. Learning here thus can be understood as an ongoing and perhaps never ending process, performed as a real-world experiment based on recursive loops. In real-world experiments the relative lack of control over boundary conditions is absorbed and compensated by the recursive design of the research process and the institutional steps in the design cycle, here for instance: frequent public participation or the openness to surprises by the actors involved. The recursive process of learning allows both positive as well as negative experiences to be fed back into the next cycle of the design process.
>
> (Gross and Hoffmann-Riem, 2005, p. 280)

4.3 Boundary Objects by Susan Leigh Star and James R. Griesemer

> Boundary objects are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. They may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is key in developing and maintaining coherence across intersecting social worlds. (Star and Griesemer, 1989, p. 393)

When Star and Griesemer introduced the concept of boundary objects, they analyzed how heterogeneity and cooperation co-existed and were managed during the early years of the Berkeley's Museum of Vertebrate Zoology. In this context, they identified material objects like specimen, field notes, museums and maps of particular territories as boundary objects.

Boundary objects used to be physical objects like field notes or maps. When two (or more) different social worlds come together, these boundary objects are recognized in each group but can bear different meanings. Boundary objects can either transgress the boundary and enable communication between different worlds or even help to reconfigure the boundary (Wiles, 2018.)

Meanwhile, the term *boundary object* evolved and is now also used for more abstract concepts like sustainability or resilience. Brand and Jax (2007), for example, analyzed the meaning(s) of resilience. They identified a tension between an original, descriptive notion of resilience and more recent, malleable and vague interpretation. They suggest that *resilience*, similar to *sustainability*, became vague when it turned from a descriptive concept into a boundary object over time. The concept was uncoupled from its origin and transformed into variations that fit special interest groups. Exactly this variety of interpretations and applications makes boundary objects politically successful. Following Eser (2003), the authors argue that boundary objects can enable the discussion between different groups even when they do not agree upon aims or interests. Therefore, boundary objects can, as a communication tool, bridge scientific disciplines as well as the gap between science and policy — at the suspense of being concrete and accountable.

4.4 Classification by Susan Leigh Star and Geoffrey C. Bowker

Ordering, sorting and classifying are not neutral or objective processes. Classifications are not images of reality, rather are they artificial and artistic interpretations, which themselves produce social realities. From this point, Bowker and Star (1999) start their argumentation. In their monograph *Sorting things out: Classification and its consequences*, the authors explore how categories and standards shape the modern world. They investigate a variety of classification systems, including the International Classification of Diseases, the Nursing Interventions Classification, race classification under apartheid in South Africa, and the classification of viruses and of tuberculosis. They show that classification systems can shape both worldviews and social interactions — and rendering things invisible plays an important role thereby.

Categories are often made and kept in obscurity but they do not only sort things out, they also valorize some points of view and silence others. Bowker and Star refer, for example, to the Nursing Interventions Classification. It classifies nursing activities into services like washing, bedding, feeding, etc. for accounting purposes. Humor or encouragement, generally aspects of interaction and emotional work with patients, are not mapped in the system and are thus not recorded. As a consequence, these activities are not billable and thus not

recognized as paid work. Moreover, from the system's point of view, nursing work appears to be a collection of billable functional services such as washing, bedding, feeding, etc., and thus reflects back to the nurses the 'valuable' and 'worthless' parts of their work. In other words, the classification systems influences how nurses perceive their working reality. This political invisibility, however, does not mean that such non-represented activities are actually invisible, but rather, they are made invisible by the classification systems (intentionally or unintentionally) at the level of informational representation. 'Political invisibility' could also be framed as political ignorance (Schubert, 2017).

The concepts of "boundary objects" or "boundary infrastructures" are relevant, too. Boundary objects and infrastructures inform, coordinate and cooperate at the boarder, when different social worlds are in touch and exchange, but do not overlap or merge into each other. They enable the informational border traffic between social worlds without the need that they align themselves with each other to a larger extent. According to Bowker and Star, the problem of most modern information infrastructures, is that they are not good border infrastructures. They disregard the heterogeneity of social worlds (intentionally or unintentionally) which leads, as a consequence, to problematic representations or even the exclusion of certain social worlds and their members. Information infrastructures are not neutral means, but they contribute to social realities. Therefore, they must inevitably be questioned in their moral and political dimensions. Beyond pure criticism, Bowker and Star thus advocate a more far-reaching claim that includes the actual construction of border infrastructures. (Schubert, 2017)

Bowker and Star's concept of classification was applied, for example to disability classification systems (Admon-Rick, 2013). People with disabilities in many countries are eligible for payments from the health sector. Therefore, their impairments get classified, their bodies numbered, and the eligibilities determined. This often happens within a medical committees. Admon-Rick analyzes in her article how the techno-scientific disability classification system, that underlies the work of such medical committees, frame disability as a physiological, bodily manifestation. Secondly, she investigates how the classification system co-produces (a) the people, that meet these classifications, as calculable persons and (b) the government institutions, that set out to encode and treat these persons, as centers of calculation As a test case, she focuses on the emergence of this system and its application for work injuries in Israel during the 1950s.

5 Research questions

As agroforestry is not yet legally defined in Germany yet, practices are not fixed and many different approaches are possible. Agroforestry can include different ways of acting and thinking and this study accounts for the high diversity through interviewing different actors of agroforestry in Germany. This study will trace how the different agroforestry practices in Germany evolved in the last 70 years, including how actors from politics, science and praxis see and justify them. As agroforestry promises to unite economical and ecological benefits, the final question will deal with the relation between ecology and productivity.

This thesis sets out to map the current agroforestry landscape in Germany and asks:

(a) How did agroforestry institutionalize in practice, politics, lobby groups and research after 1945?
(b) Which trajectories do actors in agroforestry experience?
(c) How do actors motivate their engagement in agroforestry?
(d) How do actors themselves define agroforestry in Germany?

6 Methodology: Grounded Theory

The methodological approach depends on the research question. When I ask actors about their trajectories, definition of and motivation for agroforestry, the data should be able to speak. Letting the material speak requires an inductive methodology like Grounded Theory. Grounded Theory is one of the most common methodologies in the social sciences. It was first developed by Glaser and Strauss (1967), modified by e.g. Strauss and Corbin (Strauss and Corbin, 1996) and throughout the years discussed and adapted by other authors: Adele E. Clarke introduced situation analysis a new method for immersing in data and Kathy Charmaz adopted Grounded Theory to a constructivist world view (Charmaz, 2006; Clarke and Keller, 2012). Grounded Theory as developed by Glaser & Strauss abandons theory testing in favor of theory generation/building. This is an inductive (not naive!) way to generate theories which are firmly grounded in real data. Grounded Theory immerses in the data and through coding and categorizing arrives at a core category or theory in the end. Data analysis starts right away during data collection and both are iterative processes. Grounded Theory works with *theoretical sampling*, i. e. taking the most variant cases as samples and adding new samples until no new categories emerge. Then, the core category should be applicable to all the cases sampled and also to new cases (Strauss and Corbin, 1996).

Answering the research questions requires qualitative data, either gained as primary or

secondary data. Primary data could be interviews where the trajectories and worldviews of the participants is of interest. In contrast to that, secondary data could be media articles, scientific papers or posters, expert reports or policy reports where information is disseminated to a broader public. These documents can be analyzed regarding the underlying assumptions or worldview agroforestry holds. This data does not represent a population (e. g. the "population" of people concerned with agroforestry) and therefore does not tell us anything about shares and percentages. Nevertheless, choosing the most distinct positions and views provides us with a comprehensive overview of the different worldviews in agroforestry. The data used are descriptive in nature and help generating concepts of worldviews.

"[...] methods are tools; a researcher's methodology determines the way in which a tool will be utilized" (Hesse-Biber and Johnson, 2015, p. 6). I chose Grounded Theory as my methodology and this defines *how* I use the tools. "Methods *are* merely tools. However, some tools are more useful than others. [...] Let your research problem shape the methods you choose." (Charmaz, 2006, p. 15, emphasis in original). The research questions defines *which* tools I will use.

6.1 Methods of Data Collection

Therefore, the data type is related to the overall methodology. Grounded Theory often analyses interviews (fully structured, semi-structured or unstructured) and documents, whereas documents can both be used as resource and as topic[9] (Prior, 2004). For this research I conduct interviews with actors in agroforestry and use scientific and political documents as a resource. I also account for their origin, but the focus is on the content. Overall, the research question and the methodology condition each other and both define the data types, the methods of data collection and the methods of data analysis.

Grounded Theory works with initial and theoretical sampling. Initial sampling is the point of departure, a preliminary definition of the cases to be studied. In contrast to that, theoretical sampling is the direction where the research is heading (Charmaz, 2006). For initial sampling, I defined four groups in agroforestry that would be of interest:

- Lobby groups
- Politics
- Praxis
- Science

[9] E.g. Caitlin Rosenthal used contemporary plantation records as a topic to study the history of slavery as a history of business practices. She did not use the plantation records as a resource of information but rather analyzed their role and entanglements. She concluded that the plantation records accounted for slaves as inventory and depict routines and hierarchies on plantations (2018).

Table 1: Number of interviewees corresponding to their actor group and code

Actor group	Number of interviewees	Code
Lobby groups	1	I-01
Politics	1	I-07
Praxis	6	I-02, I-04, I-05, I-06, I-08, I-09
Science	3	I-01, I-03, I-10

Interested society and the media landscape would be two more groups. As it is difficult to clearly define and reach the interested society, I excluded this group from the study. Together, the actor groups shape the agroforestry landscape. I assume that it is important to ask these different actors and to keep their background in mind since it might influence their angle to look at agroforestry.

6.1.1 In-depth Interviews

Overall, I interviewed ten actors from the four different areas identified above: One person from a lobby group, one person from politics, six practitioners from different agroforestry systems and two scientists from different institutions. After gaining an overview over the agroforestry landscape in Germany, I tried to find one or two persons from each actor group. Often several actors would have been interesting, but due to time and capacity reasons, I interviewed the persons that were responding first. I wanted to interview more practitioners since the practices can differ widely and persons might thus have gained different experiences. Among the participants were three women and seven men and all were between 30 and 50 years old. All interviews were conducted between March 12th, 2021 and September 14th, 2021, mostly via Zoom (according to pandemic regulations and spatial issues). One interview was conducted in person, one via telephone. The interviews took between 00:31:41 and 01:21:45 hours, with an average of 00:51:45 hours. For more details see table 1 and 2. Table 2 also describes the interviewees' backgrounds, where they come from, what their formation, what are they doing, what is their profession is etc. I recorded all interviews to transcribe, code and analyze them more easily and in order to have a reliable data foundation. I stored the data only on my personal computer and did not share the raw data with other persons.

In line with Rapley, I consider the interview a "joint reproduction" (2004, p. 16). The reality that the interviewee produces, emerges from the interaction between interviewee and interviewer but it relates to the world that exists outside the interview room. Through precise questioning, in-depth interviews can partially uncover the interviewees' worldviews

Table 2: Interview details and interviewee's backgrounds

Code **Actor group** **Location**	**Date** **Duration** **Medium**	**Interviewee's background**
I-01 Lobby / science North	2021-03-12 00:56:05 Zoom	Member of a German lobby group for agroforestry, with a scientific background in forestry and soil sciences and works as a scientist for biomass production and energy wood at a German university. I-01 had the first scientific project on agroforestry (especially on micro climate and water balance) in 2007 and was also involved in the 2014–2019 project AUFWERTEN.
I-02 Praxis South	2021-03-13 01:08:23, 00:47:56 In person	Farmer with 4 ha meadow orchards in Southern Germany. Main source of income: 100 ha arable land, 22 ha grassland and 60 cattle. Organic farming since 1986, demonstration farm for organic farming. Fruits from the meadow orchards (mostly apples) are marketed mostly in the farm shop and are not a substantial source of income. The meadow orchards are subsidized either by a cultural landscape conservation or nature conservation program (KULAP / VNP).
I-03 Science South	2021-03-16 00:40:08 Zoom	Professor at a German University, giving lectures about global agroforestry systems and involved in research. The goal is to understand the interactions between different ecosystem components and to more accurately predict ecosystem dynamics. The interviewee was trained in forest biology and ecology and holds a PhD in forestry.
I-04 Praxis South	2021-08-23 00:46:10 Zoom	Farmer with wood pasture for hogs (Hutewald) in Southern Germany, about 200 pigs in three areas. The wood pasture areas are located on family owned forest plots. Marketing of pork meat and forestry is the main income since 2020. The idea was sparked during a vacation stay. Wood pasture started small as a hobby with six pigs, increased to 17 for an animal welfare research project, and finally was extended to 200 pigs. The interviewee is a DeFAF member.

Continued on next page

I-05 Praxis North	2021-08-23 01:07:09 On telephone	Business person with a consulting company and a tree nursery for fast growing trees, three full-time employees. The company is located in Hamburg. The interviewee studied agriculture, focused on bio-energy and showed in the Master thesis that Germany needs additional sources of wood if the climate protection targets are to be met. After studies, I-05 became CEO of a company that now produces biomass for the energy sector. The core field is to consult farmers and to plan, implement, grow, harvest and market energy wood together with or for land owners. In 2016, the company extended their advisory services to the combination of SRCs and chicken run. The interviewee is a DeFAF member.
I-06 Praxis South	2021-08-25 01:21:45 Zoom	Farmer with 14 ha newly planted nut and fruit trees (pear, service tree, sorb tree, walnut, tree hazel) in Southern Germany, which are ready for harvest in 5–10 years. The interviewee was trained as a design draftsman, took over the grandfather's farm after his death, completed an agricultural formation (necessary in Germany to receive subsidies) and transformed the arable farm (partially) into an agroforestry farm with grassland. Currently 25% (3.25 ha) of the farm are managed as agroforestry. Management of grassland is outsourced to a neighboring farmer. The farm is run as a sideline business, further income is generated by an office job. The interviewee is a DeFAF member.
I-07 Politics North	2021-08-31 00:42:14 Zoom	Research assistant involved in preparing the petition "Increasing productivity, climate resilience and biodiversity — promoting agroforestry" for the German Parliament in January 2021 (BT, 2021a). The interviewee was trained in environmental management and agricultural sciences, came into contact with agroforestry during the Master studies and is now working as a research assistant to a member of the Committee on Food and Agriculture, where the petition was prepared.

Continued on next page

I-08 Praxis South	2021-09-01 00:36:42 Zoom	Farmer, living and working on a community farm in Palatinate since 2020, head of a tree nursery and agroforestry consulting company, trained in forest ecosystem management and gained experience on a farm for agroforestry / syntropic agriculture in Brazil. The farm focuses on regenerative agriculture, including agroforestry, ploughless arable farming, holistic pasture farming etc. 10 ha agroforestry plus 20 ha arable land which will successively be turned into agroforestry, 300 chicken and 300 layer, large animal husbandry will follow in 2022, 6–10 people working and living on the farm incl. children. Community life is organized in a "sociocraty", i.e. with the idea to create both a resilient ecosystem and a diverse democratic society. Area and farm house are rented from a foundation focusing on resilient agriculture. 30.000 trees and hedges (mostly chestnut, walnut, hazelnut, pecan and almond for nut production and as windbreak) were planted on 10 ha in 2020, crowdfunded by the foundation and to be long-term rented by the farming community. The interviewee is a DeFAF member.
I-09 Praxis North	2021-09-02 00:47:54 Zoom	Nut farmer in Brandenburg (4.5 ha, 200 walnut trees, 30 varieties, ready for harvest in 4–6 years), runs a tree nursery, consulting and nut store. The interviewee is self-employed since 2019 with 3–5 part time employees and interns and already sales nuts from neighboring nut farmers. The business grows organically. I-09 is trained in organic farming, agricultural management and marketing and is a DeFAF member.
I-10 Science South	2021-09-14 00:34:41 Zoom	Practical scientist from a governmental research institute for agriculture. The interviewee was trained as a horticultural engineer and environmental planner and supervised a nine year project (2009–2018) that examined the potential of agroforestry for the energy wood production in organic farming in Southern Germany. I-10 wrote the Master thesis in the AUFWERTEN project about area competition in agroforestry systems in part-time with the research job. The interviewee's institute is a member of the DeFAF.

and assumptions – as opposed to ethnography for example. Here it would take a longer time to investigate practices and the reasons why they are pursued stay hidden.

I used a semi-structured interview type. In my case that means that I prepared a sequence of questions that fitted the interviewee (according to personal background, work, area of action ect.), i.e. prepared myself with all the questions I wanted to ask. I informed myself about the interviewees background and prepared pre-formulated questions (see appendix B Interview Guideline). During the interview, I was open to deviate from the question order and exact formulations, especially if there were natural bridges from one question to another. My intention was to allow for a natural flow of the conversation. Often in one question the interviewees touched upon other topics I wanted to ask anyways, then I followed up on this. Only when the topic changed abruptly, I used the pre-formulated questions to gain security. I could allowing this open type since I am not aiming at comparability but on uniqueness. I do not want to directly compare the interviewees' answers but I want to learn about the interviewees' personal ideas and experiences and be open for serendipity. Aiming at uniqueness needs less structure, allows for a more natural flow, freedom, and improvisation but also needs thorough preparation.

All interviews were conducted in German. I went for this option as German is the mother tongue of all participants, including myself. It ensured that the information was transported as accurately as possible between the interviewer and interviewee and no information was lost due to communication difficulties. Afterwards, I transcribed the interviews literally and coded the German texts with English codes. For citing important excerpts in the main text, I adapted the German piece to a flowing language (i.e. removed all *ehm* and half-sentences) and translated these into English staying close to the German style. Unfortunately, nuances of the very figurative German language were lost in this process but when indispensable, I explained the idea behind the German expression. In the interview excerpts, *I* reads *Interviewer* and *I-00* is the interviewee's code (see table 2).

Grounded Theory works with theoretical sampling, i.e. sampling stops when saturation is achieved and new data points don't create any new concepts (Charmaz, 2006; Glaser and Strauss, 1967). All interviewees are individuals who have their own story to tell and who interpret the world in their own way, it would be tremendously interesting to listen to so many more stories. However, this thesis is limited in time and page numbers so that I did not more than ten interviews. This was already enough to analyze the interviewees' trajectories, motivations and definitions of agroforestry in an elaborate manner.

Table 3: Ethnographic data: 8. Forum Agroforstwirtschaft (8th Forum Agroforestry)

Code	Event	Participants/Key players
E-01	8. Forum Agroforstwirtschaft (8th Forum Agroforestry) Date: September 30th, 2021 Venue: Bernburg (Saale) Mode: hybrid (on-site + online)	Bernt Farcke (Ministry for Environment, Agriculture and Energy, Saxony-Anhalt), Dr. Tanja Busse, Prof. Dr. Eicke Lüdeling (University of Bonn), Felix Riecken (rieckens landmilch GmbH), Dr.-Ing. Eicke Zschoche (farmer), Reiner Düpow (farmer), Christian Warnke (Warnke-Agrar-GmbH), Burkhard Kayser (Agroforst Consulting), Prof. Dr. Patrick Worms (European Agroforestry Federation (EURAF)), Prof. Dr. Alexandra-Maria Klein (University of Freiburg)

6.1.2 Ethnographic Data

I witnessed the 8. Forum Agroforstwirtschaft (8th Forum Agroforestry, online) on September 30th, 2021 in Bernburg (Saale, Germany). The forum followed the motto *Thinking agriculture differently* and provided key notes, a panel discussion and several speeches by key players of German agroforestry. The forum was organized by the DeFAF.

I used the forum mainly to double check if my preliminary results can be backed by the key players of agroforestry in Germany. Therefore, I focused mostly on content not on performation, so that the gathered material might be closer to interviews than to ethnographic data. As far as ethics are concerned, I dare to use clear names and positions when I cite the participants since the recordings are publicly available.

6.1.3 Literature

When adequate, the literature I identified for the literature review will appear as material throughout the analysis. It contextualizes the interviewee's statements into the scientific background.

6.1.4 Further Material

I gathered the statistical data from the *agroforestry map* (DeFAF, 2021a). Furthermore, I used speeches, policy reports and websites as material. The sources are declared when the material appears in the text.

6.1.5 Reflection

Time, space and a limited amount of interviewees will always set boundaries to scientific research. In this specific case, it was good to speak to practitioners that are not at the forefront of agroforestry lobbyism in Germany. Thereby, it was possible to gain additional insights to what the key players shared on the 8th Forum Agroforestry, for example (E-01). Having had access to both fields increased the diversity and liability of answers. The limiting factor is that most of my interviewees are based in South-Germany and they often raised the issue that landscapes in the north and east of Germany are more monotonous and fields as well as farms are larger than in the south. This means that my interviewees might have had different experiences than practitioners from other parts of Germany. For further studies, it would be interesting to account for that diversity. On the other hand, several other projects (Agroforst Monitoring, 2021; AUFWERTEN, 2017) focused more on the eastern part of Germany, so that my study also brings a different angle into the discourse.

6.2 Methods of Data Analysis

6.2.1 Coding and Memo Writing

When developing Grounded Theory, Glaser & Strauss (1967) analyzed their data in a special way in order to generate a theory; they constantly compared data with data, data with concepts and concepts with concepts throughout the process. With every iteration, they increased the level of abstraction. Importantly, codes and concepts are temporal and can change over time. Right from the beginning, researchers record their thoughts in memos. They help them to reflect about the data, to build a theory and to ensure transparency throughout the analysis.

I transcribed the interviews with the open source software *easytranscript* and coded it with *RQDA*. For rough coding, I went through the transcripts and coded them according to the research questions. Codes like *trajectory, personal background, ecology, economy, motivation, definition* emerged. Afterwards, I went through all the segments of one code to compare data with data, to identify similarities and differences. I noted these insights down in memos that are attached to each code. Finally, I rewrote the memos to present them as my analysis so that the individual stories work together to tell a broader story. Additionally, I used STS concepts to inform my analysis and draw more elaborate conclusions from it.

Data gathering and analysis is not a linear process but rather circular. Therefore, I started with three interviews and pre-analyzed them. These preliminary findings informed my further data collection and analysis.

6.2.2 Layers of Analysis

My material consists of two different layers: Scientific literature and interviews/ethnography. However, both types offer facts and material for analysis. Additionally, I interviewed different actor groups: Scientists and practitioners. These form two groups because the former can be considered *scientific experts* and the latter *practical experts*.

7 The History of Agroforestry in Germany

In this thesis I focus on Central Europe, especially Germany. In the following sections and subsections, we will analyze historic and current practices, see how the term *agroforestry* itself developed, and identify how practices, lobby groups, politics, research and current hurdles are entangled. To situate agroforestry correctly, first a little more historical background is needed.

7.1 Historical Development of Agroforestry Practices

Chalmin and Möndel (2009), Dupraz et al. (2018), Eichhorn et al. (2006), Konold and Reeg (2009), and Nerlich et al. (2013) described the historical development of agroforestry practices thoroughly. The first planned agroforestry systems in Europe have been the dehesa and montados in Spain and Portugal. The earliest evidence dates back to the Copper Age (c. 2500 BC). In Germany, land use is being regulated since the 10th century (pasture in woods, use of common lands etc.). In the Middle Ages, traditional forms of agroforestry with low technological input and high amount of manual labor were common because — when mineral fertilizers had not yet been developed — the interaction of different crops made nutrients available. At that time, trees have been used for production of fruits, fodder, litter, timber or wood for fuel. Additionally, they have been planted on strategic places to combat erosion by wind and water so that they were embedded in diverse systems and utilized to a varying intensity. There have been different local types for different uses: *Schneitelwirtschaft* for food leaves, *Zeidlerei* for wild honey, *Holzwiesen* for hay and leaf hay, *Kopfweiden* for raw material for handicraft, or fruit cultures. In the 16th century, fruit cultivation was increased by law in order to improve people's diet so that meadow orchards became more common.

Meadow orchards (figure 5) can still be found in Germany and are today considered "the holy grail of nature conservation" (I-09, walnut farmer) [10]. Konold and Reeg (2009), who focus on the historical agroforestry systems in Germany, explain this development. They argue that in the time of Enlightenment, orderliness and regularity gained importance so that

[10] Meadow orchards are extensively used; they provide pollen and habitat for insects etc.

fruit meadows were intentionally used as landscape design elements. The idea was to combine the beautiful with the useful and to 'improve' nature by conceptually arranging individual elements. This was also inscribed into law. Over time, other agroforestry systems vanished together with the common lands on which they had been implemented mostly. Hurtig (2020) and Merchant Merchant (1980) agree with Konold and Reeg (2009) about how agroforestry systems have historically been used. Beyond that, they relate their disappearance to a wider transformation of political and societal ideas. In early modern times, wood became sparse due to an increased need for ships and industrial applications, like glass production and iron smelting. This entailed a change in land use management: Common lands were enclosed and privatized, forests had to be cultivated in an economical manner, forest academies were created to pass on the knowledge. The notion sustainability emerged as 'not taking more than what can regrow in the same period' and the land population was deprived of the right to take things for daily use from the forest. Commons were replaced with fruit cultures in order to improve the land as commons were seen as unproductive (see also Reidegeld, 2014). While Konold and Reeg value fruit meadows surpassingly positive, Hurtig and Merchant interpret their symmetrical arrangement, cultivation, and neatness as one of the reasons for the current problems of monoculture. Therefore, they would not classify fruit meadows a throughout positive historic role model for agroforestry. Rather, the narrative is one of domination, human order and improvement; similar to what Blackbourn (2007) described in his book *Conquest of Nature*. On the other hand, if fruit cultures had once been protected by law as a desirable design element (and not as a land management system of the poor), this could be why they survived into the modern era whereas other forms of agroforestry systems did not. How historical political processes still impact today's politics and practices will be uncovered in section 7.5 Politics and the Search for a Legal Definition of Agroforestry.

In the 19th century, the traditional agroforestry systems disappeared gradually due to political, economical and practical reasons. Most of the fruit cultures and other landscape elements (hollow ways, hedges and hedgerows etc.) were lost as a result of mechanization, intensification and the separation of agriculture and silviculture. These systems have often been perceived to hamper modernization and mechanization, so that there was no motivation for farmers to maintain them. On marginal soils, they have been abandoned and on productive soils, they have been replaced by monoculture. Due to inorganic fertilizers, soil fertility did also no longer depend on woods so that agriculture and forestry became two discrete activities. Eichhorn et al. (2006, p. 31) summarize further reasons why silvoarable systems disappeared: Labor-intensive systems became unprofitable due to high labor costs, boundary trees and hedges were removed during land consolidation, and after the Second World War the Common Agricultural Policy (CAP) subsidy regime focused on maximizing

productivity through monocultural systems and made wooded areas ineligible for direct subsidy payments. EU policies promoted the replacement and political strategies on the EU level finally cemented the separation of agriculture and silviculture as two independent and incompatible land use systems (see section 7.5 Politics and the Search for a Legal Definition of Agroforestry). Finally, a stricter quality norm applied to dessert fruit (EEC regulation 1641/71) so that farmers tended to standardize the production in intensively managed orchards.

7.2 Landscape of Current Practices

Today, practitioners try and practice different types of agroforestry — fruit and nut meadows with or without grazing sheep, alley cropping, forest hogs, energy wood and chicken run, forest gardens, etc. — as they generally expect trees, crops and/or livestock to influence each other positively. Many temperate agroforestry systems are adaptations of traditional knowledge, others are new applications (Gordon et al., 2018a; Gordon et al., 2018b). Although the share is still small, it increased in the last years. In the European context, especially France has set the legal terms already in 2015, so that the share of agroforestry increased considerably (CGAAER, 2015; SZ, 2020). Measured by the share of agricultural area, agroforestry systems in Germany represent only a small part of the agricultural practices. In 2016, 50.1% (16.7 m hectares) of the ground area in Germany were used for agricultural practices by 275,000 farms, 30.7% (11.4 m hectares) for forestry and woods (BMEL, 2017). Since agroforestry is not yet officially recognized as a land use system, no statistical data are available about the respective systems. However, the German Association for Agroforestry, (DeFAF) provides an interactive map of agroforestry on their website (DeFAF, 2021a) where practitioners, scientific institutes and educational centers can register their venue [11]. Most of the entries depict farms (102 of 121, see table 4 in the appendix A Tables). Around 70 different farms are registered, cultivating ca. 700 ha (equivalent to 0.04‰ of agricultural area). Of these farms, 59 practice silvopastoral agroforestry (mostly chicken run with poplar for energy wood / material use or fruit / nut trees), 31 practice silvoarable agroforestry (mostly nut / fruit trees for nut / fruit production and / or stem wood in combination with different field crops), and 12 practice agrosilvopastoral agroforestry (mostly poplar with chicken run and different field crops) (table 6 in the appendix A Tables). So, at least by the number of farms, the combination of chicken run and trees is the most prominent in Germany which

[11] The map is neither complete nor entirely representational. Interested persons can register their venue themselves but the entries will not be double-checked. This includes that some farmers registered each of their plots separately and not their farm as a whole. However, the map still gives a good overview over the current practices in Germany.

comes unexpectedly since the interviewees and literature mostly named alley-cropping as the main agroforestry system in the country. x

7.3 Conceptual Development and Lobby Groups

Lobby groups evolved around the globe to promote agroforestry. By finding a tangible definition, they want to have this land-use system legally recognized and financially subsidized. A first step is to find a working definition that the actors can identify with and that helps spreading the idea. In the course of their work, lobby groups can advise governments when they elaborate a legal definition. A legal definition fixes precisely the minimum and/or maximum tree density, licensed tree species, approved combinations etc. and defines access to subsidies. Thus, legal definitions are a final step in closing the topic.

Developing a working definition started in the tropics. As introduced before, agroforestry has a long global history as it has been practiced for more than 6000 years in some parts of the world even though farmers might not call it agroforestry (like maple sirup farmers in Canada or coffee farmers in the tropics etc.). Scientific research started as early as 1982 with the first volume of *Agroforestry Systems*, a journal on agroforestry that is global in scope (Springer Link, 2021). However, finding a comprehensive definition was longsome due to the wide geographical range and accordingly different practices. After ten years of discussion, the first official definition was disseminated for the tropical world — where the contemporary agroforestry movement started — by the World Agroforestry Center (WAC) in Nairobi, Kenya, in the 1970s: Agroforestry is

> a collective name for land use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land management unit as agricultural crops and/or animals, either in some form of spatial arrangement or temporal sequence. In agroforestry systems, there are both ecological and economic interactions between the different components. (cited in Gordon et al., 2018b, p. 2)

This definition is descriptive in nature. It entails the components (woody perennials, agricultural crops and/or animals), their arrangement (spatial or in temporal sequence) and their relation (ecological and economic interactions). Since the time of disseminating this definition, the WAC works as a non-profit organization that tries to advance agroforestry through research and cooperation with farmers in the tropics — with the normative idea "to harnesses the benefits of trees for people and the environment" (ICRAF, 2021). In 1991, the WAC became International Council for Research in Agroforstry (France) (ICRAF), one

of the 15 research centers of the Consultative Group for International Agricultural Research (CGIAR). CGIAR is the world's largest global agricultural innovation network and funded by several governments, foundations and banks (CGIAR, 2021).

The definition for the temperate zone started in the 1980–1990 and struggled likewise. Basically, the definition can be similar to the one for the tropics. Gordon et al. (2018b, p. 1) start their introduction to temperate agroforestry systems with "[a]groforestry is the production of trees, crops and/or livestock on the same piece of land." Nevertheless, there have been different extensions (in the US/Canadian context) like:

> Agroforestry [...] is defined as: intensive land-use management that optimizes the benefits (physical, biological, economic, social) from biophysical interactions created when trees and/or shrubs are deliberately combined with crops and/or livestock. (Gold and Garrett, 2009 in Gordon et al., 2018b, p. 1)

or:

> Agroforestry is a planned and systematic integration of trees (either spatially or temporally) into farming systems in order to derive multiple benefits that include: environmental, ecological, economic and social benefits from a unit land area in a sustainable fashion. These benefits are derived as a result of a series of biophysical interactions that occur at the tree-crop (or tree-animal) interface. (Definition at the University of Guelph, southern Ontario, Canada, in Gordon et al., 2018b, p. 1)

These extensions are not only descriptive but imply a normative stance *why* and with which *quality* these land use systems are implemented (intensive land-use, optimizing the benefits, in a sustainable fashion). If the definitions are interpreted narrowly, they will prefer some systems over others: Meadow orchards would not be managed as intensively as others, some systems would be more sustainable than others or less sustainable than the systems they replace (e.g. heat land/extensive grass land replaced by a SRC combined with a chicken run). As the farmer Felix Riecken argued on the 8th Forum Agroforestry (E-01): Definitions turn complex systems into less complex ones. Therefore, it is critical to be conscious of what definitions can implicate. Especially, legal definitions — which define precisely the tree density, tree species, agroforestry systems that will approved and possibly subsidized — will then determine which agroforestry systems will be implemented and which not. Apparently, today different working definitions can co-exist.

Until 1995 only the tropics were concerned with (modern) agroforestry. When agroforestry reached the temperate zone, a conference in Montpellier in 1997, called *Agroforestry*

for Sustainable Land-Use, was basically the first world congress. The conference was under the auspice of IUFRO (a forest research organization) and organized by two french agricultural research institutions, INRA and CIRAD (namely Daniel Auclair and Christian Dupraz who are to date active in agroforestry research). The first edition of *Temperate Agroforestry Systems* was published in 1997 (Gordon, 1997), research continued and subsequently, the lobby group EURAF was founded in 2011. Since then, the lobby group holds biannual scientific symposia to discuss current developments in European agroforestry (EURAF, 2020). Lobby work intensified Europe-wide and by 2018, EURAF represented over 20 affiliated groups from 15 European countries (see table 5 in the appendix A Tables for a more detailed overview) (Dupraz et al., 2018).

The German lobby group DeFAF — which is also represented in the EURAF — was founded in 2019. The idea developed from a scientific project, AUFWERTEN (2014–2019), that brought together scientists and practitioners (see also section 7.6 Research Projects). Interviewee I-01 explains the founding period as follows:

Interview excerpt 1

> *I-01: I started a project in 2015 called AUFWERTEN: agroforestry environmental services for value creation and energy. It went on for five years and was very application-oriented. Practitioners were also involved and everyone was very motivated. We were able to achieve a lot in this project. We also acted towards politics and practice, and then we debated how to make this initiative permanent. Until then, there were only one or two other actors in Germany who dealt with agroforestry systems, some freelance consultants and the Agroforestry Working Group*[12] *— so there were a few scattered people who dealt with it, but mostly on a scientific level. When we thought about how to institutionalize it, we came up with the idea of founding a professional association. That was the initial idea. Then we received a lot of encouragement from other areas, so that in mid-2019 we made it a reality. Finally, we founded the German Association for Agroforestry*[13] *in Berlin. The topic is very big at the moment, and so I'm very pleased that we're getting a lot of positive feedback and that we've been able to really make a difference so far.* (I-01, lobbyist)

The excerpt mentions that before 2019, the German lobby landscape was organized more loosely. In 2012, the AG Agroforst Deutschland was founded as an association of inter-

[12] AG Agroforst Deutschland of the Socitey for Crop Sciences (Gesellschaft für Pflanzenbauwissenschaften e.V. (GWP))
[13] DeFAF

ested scientists, practitioners and consultants. The focus is on sharing information about how to use trees in the agricultural landscape. The working group is an EURAF member and, since 2013, an official working group of the GWP (AG Agroforst Deutschland, 2020). Since 2009, the symposium *Forum Agroforstsysteme* is taking place on a regular basis (yearly or bi-yearly). The 1st–7th Forum were organized by different (research) groups concerned with agroforestry, e.g. Bayerische Landesanstalt für Landwirtschaft (LfL), Bayerische Landesanstalt für Wald und Forstwirtschaft (LWF), AG Agroforst Deutschland, Zentrum Wald Forst Holz Weihenstephan, Technische Universität München (TUM), Center for Biodiversity and sustainable Land Use (CBL), Georg-August-Universität Göttingen, Brandenburgische Technische Universität (BTU) etc. (DeFAF, 2021d). The 8th Forum Agroforstsysteme in 2021 was the first to be organized by the DeFAF and had the title *Thinking agriculture differently* (Germ. *Landwirtschaft anders denken*) (see section 6.1.2 Ethnographic Data).

The DeFAF maintains a comprehensive website [14] where they inform about their own structure, arguments pro and contra agroforestry, historical and modern systems, the legal and policy framework, agroforestry research, case examples, etc. Most interesting is an interactive map [15] where practitioners, research institutions and education centers can register their venue. Each entry provides information about the type of agroforestry systems, size, year of implementation, motivation etc. (see section 7.2 Landscape of Current Practices).

While closely cooperating with practitioners and doing scientific research, two main goals of the DeFAF are education work and political influence. In January 2021, the German Parliament (Deutscher Bundestag) debated a petition to promote agroforestry and members of the lobby group were invited beforehand to share their ideas with the members of parliament.

7.4 Impediments on agroforestry

Eichhorn et al. evaluates for the 21st century that

> in modern Europe, both agriculture and forestry only exist in their present forms because they are to some extent maintained by subsidies. This has led to the formulation of regulations that separate agricultural and forestry land use into distinct categories. Agroforestry systems, as they fall between the two types of land use, often qualify for neither set of subsidy payments, with the result that their uptake and maintenance is passively discouraged. (Eichhorn et al., 2006, p. 47)

[14] www.agroforst-info.de/, accessed on November 16th, 2021
[15] https://agroforstkarte.agroforst-info.de/, accessed on November 16th, 2021

The lobbyist I-01 also identifies this separation of agriculture and forestry as the main obstacle to agroforestry. S/he argues that it hinders agroforestry in two ways: First, agroforestry does not fit into the current regulation system and second, knowledge about how trees, crops and hedges interfere has been lost in the last century when the regulations formed the practices in such a way that this knowledge was not required any more. In an ideal world, the pig farmer would also love to see the separation of agriculture and forestry being removed as this would allow them (and others) to benefit from agroforestry's ecological advantages.

For practitioners, legislation is very important. Since 2005 agroforestry systems on agricultural lands are eligible for subsidies (VO (EG) Nr. 1698 (2005)) but financial aid by the EU can only be accessed if there is also legal security on the national level, which is not yet the case in Germany. This current legal insecurity is the reason why agroforstry is not attractive for practitioners and not practiced in Germany (Chalmin and Möndel, 2009). Eichhorn et al. (2006) conclude that more legal certainty is needed to benefit from the advantages of mixed agricultural systems in the future.

Almost all practitioners that I interviewed indeed experienced direct hardships because of the current regulations: The approval of the pig farmer's latest plot took about 3.5 years, his land has no clear status, practitioners receive additional requirements as officials do not want to make mistakes in in the approval procedures, every plot of trees has to be registered separately in the agricultural aid application, subsidies do not only depend on the arrangement but also on the tree species (apple vs. walnut in the meadow orchard). Furthermore, the public administration also lacks experience how to proceed with approvals — current legislation impedes that they deal with agroforestry in an experienced manner so that it prolongs the time for approval. In general, the bureaucratic effort for practitioners is immense:

Interview excerpt 2

I-04: The first plant, that is the first six pigs, were tolerated more or less. I didn't have to go through all the permitting steps. To get from the six pigs to the 17 pigs the following year, I had almost one year of approval. The officials also wanted to see how things were developing, what was going on there? But in order to expand it again and establish it firmly, I had to go through the normal approval process, and that takes time. The difficult part is that we lack role models and each district must work out the legal regulations from scratch. For example, there is no common approval practice in Bavaria, but rather it varies from district to district. Let alone that one would have a common regulation between the federal states, how one should or must deal with forest hogs in

general. (I-04, keeping forest hogs)

Interview excerpt 3

I-05: The chicken forest is for me the only modern agroforestry system, which gets along without subsidies, and yet you are discriminated against and have obstacles put in your way by the agricultural policy and the framework conditions. Nobody wants to harm you, but the framework conditions are simply not made for this and the people at the office always say at first: "No, the ordinance says this and that. I don't oppose trees, but it says that it's —". So we really had situations — "That's no longer a chicken run if there are trees on it, that's a short rotation coppice, double use, that's prohibited, then you have aviaries and no free-range husbandry" (..) This official does not object trees, but the regulation says, that's just the way it is. They just don't want to make any mistakes, sure. (I-05, agroforestry planner and consultant)

Interview excerpt 4

I-08: It is a huge bureaucratic act now to register every single plot, and it would definitively be easier if you could just call the whole system regenerative agroforestry and get a good rate for it. Because we just do a lot of extra work. This is not made any easier by the fact that we have to divide each field individually, and we have to think about the plot sizes and then maybe some extra pieces that are left over, for example, by a key-line system. It in turn means water retention and ultimately protects the valleys from floods, for example. But if you create a key-line system, there are many intermediate pieces that cannot be optimally divided into the parcel size of at least 1000 square meters, and you suddenly have a lot of areas that have a huge additional benefit for nature and for the environment and for the people but for which you suddenly don't get paid anymore, although you actually – and you don't even necessarily get much more yield, but it just makes more sense to divide the landscape up like this or to reshape the landscape that way. Yes. So definitely that would be better. (I-08, community farmer)

Interview excerpt 5

I-09: For me, it's a stupid stupid gray area, because nobody can really classify walnuts, right? For some people it belongs to meadow orchard — a meadow orchard promotion is immense, because that's the holy grail of nature conservation.

In some federal states, even in some counties, this is handled very differently from case to case, because there are simply no statutes where you can look into and say: "Yes, a walnut plantation is worth this, it brings so many eco-points" or whatever and then the official is simply on the safe side. Now it's just a matter of interpretation and I personally experienced that it was interpreted very strictly and I was titled with even more requirements, because the official was just not sure if the grassland will be preserved there. I could prove it by sending them a photo. But it's still different if that's been known for centuries, like with an apple tree, that it's just going to have a certain value at some point. Well. In the end, I had to write an impact compensation plan to prove that my planting does not represent a disadvantage in terms of nature conservation. I have to have ratings done every year, because I can't do that myself, that the grassland composition doesn't deteriorate. (sighs) I have conditions regarding mowing and fertilizing and so on. Yes. I see myself limited, because I actually thought (laughs) or still think that I am doing an ecologically and socially meaningful project. Yes! And for something like that, it would be very helpful if it were a bit more clearly defined, what belongs to it, what is advantageous about it? And then perhaps it could also be promoted. Because the subsidy for meadow orchards would have been helpful at the beginning (laughs), but it just didn't fit. (I-09, walnut farmer)

For other potential practitioners however, the fear is that use will be prohibited once the agroforestry plots show a higher amount of biodiversity. The political actor reports:

Interview excerpt 6

I-07: If, for example, a farmer wants to take these trees away again — he also planted them himself — there should not be any nature conservation reasons afterwards that speak against taking them away again. That is also at least a certain fear of farmers, when they do something for nature conservation that it will be protected afterwards and may no longer be touched. And that is of course very important for farmers, that there are such legal foundations. (I-07, political research assistant)

Next to legal problems there are also other impediments to agroforestry. Newman and Gordon (2018) and Eichhorn et al. (2006) cite the most important of them:

1. practical (methodological) problems: agroforestry is complex in space and time compared to monoculture, trees need to be protected from livestock or wild animals,

pruning is expensive or exceeds farmers' know-how, practitioners might lack skills of harvesting, processing and marketing timber.

2. perceptional problems: "specialization is the order of the day" — implying that farmers lost touch with trees and foresters lost touch with crops and traditional knowledge of agroforestry systems has largely disappeared
3. institutional problems: the focus on single crop within agricultural research institutions and universities reduces the advice and training for af systems available to farmers, ven though research interest rose in recent years, the experimental findings are still preliminary since the lifespan of a cohort of trees in a plot has not been covered yet
4. tenure and policy problems: policies and tenure laws are complex, agroforestry areas lack a clear status, subsidies / tax benefits / grants provide different too little incentive

Impediments are political and practical in nature and condition each other. When the political framework impedes certain practices, they vanish and the knowledge with them. The current agricultural politics developed over the last 70 years.

7.5 Politics and the Search for a Legal Definition of Agroforestry

Since around 70 years, agricultural laws and subsidy schemes in all EU Member States are based on the European CAP. The CAP sets the legal framework for agricultural policy on the EU level and has then to be translated into national law and enforced by the member states. Historically, European nations agreed after the Second World War upon stimulating the agricultural productivity, stabilizing markets and ensuring a fair standard of living for the agricultural community. This agreement was set down in the European Economic Community (EEC) contract (1958) that constituted the beginnings of the European CAP policy and the European Union in a broader sense (BMEL, 2020).

What is more, historical processes (see section 7.1 Historical Development of Agroforestry Practices) still influence contemporary politics. Today, parcels obtain a clear legal status, either are they agricultural land or silvicultural land. Meadow orchards are legally defined, economically feasible and the parcel where fruit trees grow remains agricultural land. Wood pasture on the other hand is an agricultural practice on silvicultural land and thus subject to silvicultural law. This means, forestry authorities can allow it or not but it does not change the main use of the forest parcel; it remains silvicultural land. The situation is different when it comes to planting trees (other than fruit trees) on agricultural lands — the parcel can lose the status of agricultural land and (legally) turn into a forest. For the farmer, use is not ensured and this imposes a great insecurity.

Although the current political regulations impede agroforestry, some political actions tried

to promote this land-use system in the recent past. The term agroforestry was first mentioned by the EU as early as 1986 (Doc A2-116/86) in a resolution on community action for the forest sector. Subsequently, the EU initiated and/or supported different projects (ALWAYS, SAFE, AGROCOP, SUSTAFFOR, AGROFE, AGFORWARD, see table 7 in the appendix A Tables, Dupraz et al., 2018) which exclusively focused on the wood production aspect. This shows that (modern) agroforestry law in Europe is coming from the forestal side [16]. In recent years, EU legislation mentioned agroforestry several times in different contexts (rural development, forest action plan, carbon sequestration, sustainable landscapes, environmental benefits, fire reduction, see table 8 in the appendix A) and by now, agroforestry is legally allowed by the EU. Since 2005, agroforestry systems on agricultural lands are eligible for subsidies (VO (EG) Nr. 1698 (2005)). Since then, different financial incentives have been available (Dupraz et al., 2018).

In 2013, EU law provided a first legal definition of agroforestry system: "Land use systems in which trees are grown in combination with agriculture on the same land. The minimum and maximum number of trees per hectare shall be determined by the Member States taking account of local pedo-climatic and environmental conditions, forestry species and the need to ensure sustainable agricultural use of the land" (EP, 2013, Article 23). Nevertheless, for receiving the funds, EU law needs to be transformed into national law which, by now, happened only in France [17], Spain, Great Britain and Sweden but not in Germany: "The States and the Federal Government have not yet defined which forms of agroforestry systems they would recognize on agricultural land" (own translation, Chalmin and Möndel, 2009, p. 247). As a first step, the petition "Increasing productivity, resilience and biodiversity — promoting agroforestry" (Printed matter 19/24389, BT, 2021a) was debated and accepted in the German Parliament on January 13th, 2021. It demands (among other steps) to reward agroforestry systems by making them eligible for funding even during the current funding period of the EU's CAP (until 2022), to adopt a clear definition of the term agroforestry in order to create legal certainty, to promote agroforestry in vocational and higher education etc. The process was initiated by the Left party in 2019, more precisely by the Left's chairwomen in the Committee on Food and Agriculture (Ausschuss für Ernährung und Landwirtschaft), Dr. Kirsten Tackmann, who convened a non-public expert discussion on agroforestry. Then — due to

[16] Analyzed linguistically, *agroforestry* is a compound word with *forestry* as the primary word and *agro-* determiner. This might classify agroforestry as a forestry practice (rather than an agricultural practice) and determine the focus.

[17] "Since 2001, intercrops are eligible for CAP subsidies (DPEI/SPM/C2001-4008, 8th March 2001), agroforestry plantations receive forestry subsidies (DPEI/SDF/C2001-3010,7th May 2001) and the area planted with trees is eligible for the European PCPR subsidy for lost arable income (DERF/SDF/C2001-3020, 8th August 2001). Agroforestry is therefore currently strongly supported by the regulations within France." (Eichhorn et al., 2006, p. 48)

its importance — the topic was taken up by the two coalition partners, Social Democratic Party (SPD) and Christian Democratic Union / Christian Socialist Union (CDU / CSU) at that time. Their motion was debated in different boards, experts were heard, and it was finally accepted with a great majority [18] on January 13th, 2021.

As this petition was adopted by the German Parliament, further legal steps fall to the German Government, i.e. legal security is not yet established.

7.6 Research Projects

Research agendas are shaped by political ideas. Political bodies on the EU and national level do not only enact laws, they also launch research programs: The Bundesministerium für Bildung und Forschung (BMBF) launched a strategy for sustainability research called Forschung für Nachhaltigkeit (FONA) that funded the AUFWERTEN project, and the EU launched the Horizon 2020 Research and Innovation programme that financed the AGROMIX and MIXED projects. Research teams can apply for funding if their research fits the agenda.

By now, three important long-term agroforestry research projects have been conducted in Germany, agroforst (2005–2008), the LfL project *Development and testing of an agroforestry system for energy wood production in organic agriculture* (*Entwicklung und Erprobung eines Agroforstsystems zur Energieholzerzeugung im ökologischen Landbau*) (2009–2018) and *AUFWERTEN* (2014–2019). The latter sparked the creation of the lobby group DeFAF that is now active in Germany. Let me introduce chronologically where the research projects were situated and how they were initiated and financed. In 2004, the BMBF launched a strategy for sustainability research called FONA. The idea was to initiate and finance different projects concerned with climate protection and sustainability. In the last 16 years, the FONA strategy saw different phases with different amounts of money invested. The current period runs from 2020-2025 and is financed with 4 billion Euro (FONA, 2020, 2021). In the first period (2004–2009 [19]), the German Government launched one special research scope focusing on *Sustainable Forest Management* [20] within which three projects concerning agroforestry were conducted (*agrowood*, *dendroom* and agroforst). The first two focused only on SRCs; the last one was concerned with combining agriculture and the production of high-grade wood. The project agroforst took in fact a multidimensional approach and assessed the effects of value timber production on economy, conservation and scenery

[18] (5 parties in favor (SPD, the Green Party, the Left, Alternative für Deutschland (AfD)), 1 against (Free Democratic Party (FDP)), 0 abstentions) (BT, 2021b)

[19] variable information exists about when the FONA strategy started, see FONA, 2020 and UFZ, 2009. Due to many different but related websites, information was generally difficult to gather.

[20] Project homepage: www.nachhaltige-waldwirtschaft.de, accessed on August 16th, 2021

and was chaired by the Institute for Forest Growth (Institut für Waldwachstum (IWW)) of the University of Freiburg, Germany (IWW, 2008). Reeg et al. (2009) summarized the findings of all three project in their compendium *Anbau und Nutzung von Bäumen auf Landwirtschaftlichen Flächen*. It, too, focuses on the economic side — in the SRC part more than in the agroforestry part — but legal frameworks, practical aspects, nature conservation, history and landscape aesthetics are depicted likewise. Nevertheless, the authors justify research into agroforestry with the increasing need of renewable resources and the strive for reducing CO_2: "The starting point was similar: The increasing demand for renewable raw materials and the need to reduce CO_2 emissions require new ways of land use. Wood production on agricultural land offers interesting options for this" (own translation, Reeg et al., 2009, p. V). According to them, the incentive was not primarily sustainable agriculture but to produce additional wood outside the forests, on agricultural lands. The interviewee I-05, an agroforestry and SRC planner, draws a similar picture. S/he considers the need for additional renewable energies a main driver for current agroforestry. Besides, the project agroforst (and also its successor project Multifunktion Agroforst) was conducted by the IWW which underlines again that the origins of agroforestry research in Germany lie mostly in forestry (DBU, 2010; IWW, 2010).

The second project, *Development and testing of an agroforestry system for energy wood production in organic agriculture* (2009–2018) by the LfL paints a similar picture. The projects ran as a co-operation between LfL and LWF, two institutes for agriculture and forestry, respectively, and both funded by the Bayerisches Staatsministerium für Ernährung, Landwirtschaft und Forsten (StMELF) (LfL, 2018). Here, a farmer initiated the project as s/he wanted to increase the energy autarky of his own organic farm. Therefore, the project focus was also on energy wood and profitability. The project members rated it a success and both institutes applied for a further joint project. The focus has to stay on the same area, however, because the research institutes are limited in their scope.

In the period 2014–2019 the third agroforestry project, called AUFWERTEN, was financed by the FONA strategy, this time under the special research scope *Innovation Groups for Sustainable Land Management*. *AUFWERTEN* is an acronym and reads ***A****groforstliche* ***U****mweltleistungen* ***f****ür* ***Wert****schöpfung und* ***E****nergie* (Engl. Agroforestry Environmental services for value creation and energy) whereas the German verb *aufwerten* literally translates into *to improve*. Whether intentionally or not, *to improve* strongly reminds of the British enclosures in the 15^{th}–18^{th} century, when privateers (gentry) deprived the propertyless population of their commons in order to "improve" the lands by focused monoculture. In this case, *aufwerten* refers to improving post-mining landscapes in Brandenburg. The project

was sustained by several project partners from science, practice and politics [21] and aimed at analyzing prerequisites for practically implementing agroforestry systems and at identifying concrete solutions to existing obstacles and barriers (DeFAF, 2020a). The project focuses on silvoarable agroforestry systems. The introduction to the project report they states why:

> Particularly with regard to the topics of consulting and technology, the explanations in the loose-leaf publications refer primarily to agroforestry systems whose woody plants are managed in short rotation due to a lack of experience and available areas. This sometimes rather one-sided view of agroforestry is in no way to be understood as a restriction of the great variety of possible agroforestry systems, which are increasingly also being implemented, but rather reflects the conditions in the study region of southern Brandenburg at the time of project processing. In the meantime, however, it is becoming apparent that a greater variety of agroforestry systems can be implemented with legal certainty in the future. This is not least also a great success of DeFAF e.V., which is committed to ensuring that agroforestry is significantly advanced in agricultural practice. (DeFAF, 2020b, own translation)

This means that focusing only on silvoarable agroforestry had practical reasons, whereas, on its website, the DeFAF mentions livestock and presents also such pictures (e.g. chicken under trees, DeFAF, 2020c). Despite these limitations, AUFWERTEN proposed a legal definition for agroforestry that also only included crops and trees, i.e. silvoarable systems (AUFWERTEN, 2017).

Currently, there are two more ongoing projects in Germany: Agroforst Monitoring (2021–2022) and SIGNAL (2015–2021). The former is coordinated by the Institute for Landscape Ecology at the Westfälische Wilhelms-Universität (WWU) (University of Münster, Germany) and financed by the Foundation WWU Münster and the Research Group Applied Landscape Ecology and Ecological Planning of WWU Münster whereas the latter is again funded by the BMBF. *Agroforst Monitoring* is a citizen-science project led by students and investigates how agroforestry contributes to climate and soil protection as well as how society perceives the effects of agroforestry. The students developed a catalog of methods with 8 dimensions

[21] Project partners: Brandenburg Technical University (BTU) Cottbus-Senftenberg, University of Bayreuth, University of Applied Sciences Zittau/Görlitz, Technical Unversity of Munich (TUM), Biomasse Schraden e.V. (non-profit association for biomass), NABU e.V. (non-profit association for nature conservation), Landwirtschaftsbetrieb Domin (farmer in South Brandenburg), Municipality Amt Kleine Elster, Leibniz-Institut für Agrartechnik und Bioökonomie Potsdam-Bornim e. V. (ATB, Leibniz Institute for Agricultural Engineering and Bioeconomy), Büro für angewandte Landschaftsökologie und Szenarienanalyse (BALSA, Office for applied landscape ecology and scenario analysis) and VorSicht Atelier for communication) investigating how to implement different forms of agroforestry forms in agricultural practice.

of modern agroforestry: Micro-climate, water and material budgets of soils, companion flora, wild life, crops, livestock, business administration and management, and society. For each dimension, they developed a method how to collect relevant data. The idea is to collect data on existing agroforestry areas with the close participation of practitioners and citizens on a regular basis. According to the origin of the project, the catalog (Version 2021-01) is more elaborated in the fields of micro-climate, water and material budgets of soils, companion flora, wild life and less elaborated in the fields of crops, livestock, business administration and management, and society (WWU, 2021). Although silvopastoral and agrosilvopastoral systems are mentioned, the project partners run mostly alley-cropping systems for energy or high-grade wood (Agroforst Monitoring, 2021). SIGNAL is chaired by the Büsgen-Institute (an institute for forest sciences and forest ecology) of the Georg-August-University Göttingen (Germany). The project is one of 10 interdisciplinary collaborative projects under the umbrella of BonaRes, a funding initiative of the BMBF with the focus on the sustainable use of soils as a limited resource. It acknowledges the importance of fertile soils and emphasizes the need for producing the same or more amount of biomass on these soils in the future. (BonaRes, 2021). The SIGNAL homepage gives an overview over the project goals: "Agroforestry systems are the management of trees and shrubs on cropland or pastureland. [...] SIGNAL aims to investigate new agroforestry cropping systems specifically adapted to the needs of Central European regions, which may be both economically and ecologically superior to conventional systems. The former is a prerequisite for farmers to accept the new cultivation methods, the latter promises added value for environmental quality and biodiversity" (SIGNAL, 2021a) and "SIGNAL will answer the question if and under which conditions the so-called Land Equivalent Ratio (LER), i.e. the yield of intercropping agroforestry applications compared to mono cropping systems, will be significantly and sustainably enhanced" (SIGNAL, 2021b). Case studies are "innovative agroforestry systems, in which crop- or grassland is combined with strips of fast growing tree species" (SIGNAL, 2021b). Therefore, SIGNAL is another project that is led by a forestry institute, researches silvoarable systems and that mentions ecological benefits as the advantages of agroforestry but focuses mostly on the economic benefits in the research. Whereas Agroforst Monitoring is the only project to implement a citizen science approach and to focus (by now) on measuring indicators for water, soil, companion flora and wild live, SIGNAL is focusing on the economic benefits and intensification of agricultural systems. Both projects focus on the combination of wood and crops, i.e. silvoarable systems.

As mentioned above, the EU recently funded two new agroforestry projects: AGROMIX (2020–2024) and MIXED. Both projects explore the benefits of mixed farming and agroforestry systems and drive the transition towards resilient farming and efficient land use in Europe (AGROMIX, 2021; MIXED, 2021). Therefore, AGROMIX and MIXED are the first

projects (after AGFORWARD, see below) to focus likewise on all three types of agroforestry systems and on economic, environmental, societal and political questions.

On the European level, two projects stand out: SAFE (2000–2005) and AGFORWARD (2014–2017) (see table 7 in the appendix A Tables). SAFE focuses on silvoarable agroforestry and profitability (Dupraz et al., 2018). "This adoption [in European law] was prepared by a European project dedicated to silvoarable agroforestry (SAFE project, 2000–2005) that produced key elements for silvoarable practices adoption including maps of relevant areas in Europe" (Gordon et al., 2018b, p. 112). AGFORWARD builds on SAFE but has a much wider scope. It includes packages like existing agroforestry systems in Europe, high natural and cultural value agroforestry, agroforestry for high value tree systems, agroforestry for arable farmers, agroforestry for livestock farmers, fiel-and-farm scale evaluation of innovations, landscape-scale evaluation of innovative agroforestry, agroforestry policy development, and dissemination.

Also project logos hint at the projects' content. The logos of agroforst and Agroforst Monitoring depict that the projects mostly researched trees in combination with crop- or woodland (figure 8), whereas the approach to mixed farming is also depicted inthe logos of AGROMIX and MIXED (figure 9). The logos of the lobby groups AG Agroforst Deutschland and DeFAF are interesting. Their logos display a cow in whereas their research focuses mostly on timber production and reciprocal effects between wood/crop/soil (AG Agroforst Deutschland, 2020). (figure 10).

Overall, this means that most of the projects in Germany concerning agroforestry were either conducted in the forestry sector, focused on the production of wood in silvoarable systems or on increasing the profitability of farming systems. Important were quantitative indicators like yield, tree growth, tree density, tree protection, nutrients, water household, fertilization etc. Only in recent years, the project scopes diversified on the European level with projects like AGFORWARD, AGROMIX and MIXED. The German project landscape, in turn, is often either coming from the forestal side or focusing on wood production which might have brought certain path dependencies.

7.7 Analysis: How Agroforestry is Co-Produced

What agroforestry *is* today is co-produced in the realms of practice, lobby groups, politics and research. The co-production concept by Jasanoff (2004a) helps us to see how these different aspects mutually influenced each other.

Most generally, agroforestry can be defined as the combination of trees, crops and / or livestock on the same piece of land. Agroforestry combines agricultural and forestal practices.

Figure 8: The logos of agroforst and Multifunktion Agroforst, depicting trees on crop and grassland (IWW, 2008, 2010)

Figure 9: The logos of MIXED and AGROMIX, depicting trees, fruit trees, crops and animals (AGROMIX, 2021; MIXED, 2021)

Figure 10: The logos of the lobby groups AG Agroforst Deutschland and DeFAF, both depicting trees, crop and arable land, and a cow (AG Agroforst Deutschland, 2020; DeFAF, 2021c)

The political landscape in Germany (and in Europe, too) separated agriculture and forestry as two different entities through the CAP of the last 70 years. Although agroforestry tries to overcome this separation, it is in itself influenced by this very separation, insofar as the lobby groups in Germany focus mostly on agroforestry on agricultural land, i.e. planting trees on agricultural areas. The lobby groups try to shape agricultural politics, to make agroforestry eligible for agricultural subsidies and to convince farmers to practice agroforestry. Bringing agriculture into the forest, e.g. through wood pastures or mushroom farming etc., is not the focus. This means, agroforestry does not only try to shape politics, it is itself shaped by the very political frameworks that already exist — and both get co-produced. Overcoming the divide of agriculture and forestry is (for now) only intended or achievable on agricultural areas. Yet, it is not clear what this will mean for the future. Once agroforestry is defined as "growing trees on agricultural land" it will become even more difficult (or not desirable any more) to extend the practices to the forest itself, e.g. in the form of forest hogs.

Practical knowledge gets co-produced with scientific knowledge and politics. Political funding initiatives shape scientific agendas which in turn influence lobby groups and, through them, politics. Lobby groups are often founded by scientists or based on scientific projects. Scientific projects also draw on practitioners' knowledge, so that practical knowledge is incorporated into scientific findings and therefore, into the orientation of lobby groups. On the other hands, the circulation and dissemination of practical knowledge into the (professional) public depends on how the lobby groups are organized. If they focus on special practices, this will, in turn, also influence the practical knowledge and favor some practices over others. As politics already favored and encouraged trees as biomass production on the agricultural area, funding was offered for corresponding research. As the lobby groups developed from the scientific projects, they also focused on this area in their political work. Therefore, more practical knowledge that focuses on biomass production gets circulated — compared for example to knowledge about forest hogs, fruit or nut production or cultivating multi-functional forest gardens.

7.8 Conclusion: The Lock-In in the Current Political Framework

This is, in a certain way, a lock-in. Practical knowledge would shape politics but the path dependencies of the recent decades inhibit this. Transformations take place on a micro level: Trees can be incorporated into agriculture, but the divide of agriculture and forestry on the meta level cannot be overcome. On the contrary, it can even get reinforced, when agroforestry — the only type of regenerative agriculture that would be a third pillar of land-use — gets squeezed into the current political frame and then looses the momentum to

change the overarching political idea of strictly separated land-use systems.

8 Today's Agroforestry Landscape: A Picture Drawn from Interviews

It requires more effort than analyzing literature to understand current practices and it prompts us to immerse deeper in the interviews and ethnographic material that I gathered (see section 6.1 Methods of Data Collection). I will use literature, interviews and ethnographic data both as a source of facts and as material for interpretation. Taken together, it will paint a sophisticated and heterogeneous picture of the German agroforestry landscape. Notwithstanding that the community is still small, the actors' points of view vary widely. To decode these patterns, I will identify how the actors' biographical trajectories unfolded, what motivates them to (not) practice agroforestry and how they define agroforestry for themselves,

8.1 Trajectories of Practitioners and Experimentation

To better understand *why* people engage in agroforestry, let us now see *who* engages. Tracing the trajectories of both practitioners and scientists reveals that they belong to different scientific traditions. At the early stage of this movement, practitioners display furthermore different characteristics than suggested in literature.

8.1.1 Empirical Material: Where do the Actors Come from?

Table 2 in section 6.1 Methods of Data Collection gives an overview over the interviewees' backgrounds. Practitioners and scientists do not share the same background: practitioners are mostly trained in agricultural sciences whereas the scientists are mostly foresters by training. I-01 studied forestry and turned to soil sciences and agricultural questions after his studies. I-03 studied forestry and forest ecology and turned to questions of use, productivity and environmental values of forest ecosystems. The third scientist I-10 is a horticultural scientist by training, but started the professional life as a project manager for an agroforestry project. All practitioners (I-02, I-04, I-05, I-06 and I-09) and also the political actor (I-07) were trained in agricultural sciences except I-08, who studied international forest ecosystems management. This is an interesting separation: The scientists stem mostly from the forestry area, whereas the practitioners are trained in the field of agriculture. This tendency returns in the sections 7.5 Politics and the Search for a Legal Definition of Agroforestry and 7.6 Research Projects. The areas of politics and research pursue agroforestry to grow wooden products on agricultural lands. Extending wood production is the primary goal. Therefore, forestry

institutes were first engaged in agroforestry research and addressed farmers to practice it. The same sequence is reflected and manifested here: The scientific part falls to forestry, the practical part to agriculture.

The interviewees are concerned about stripped landscapes although they are affected by them to a different degree. They ascribe this development to political decisions. Most interviewees were based in South Germany (practitioners: I-02, I-04, I-06, I-08, scientists: I-03, I-10) and they often argued that "we still got it good in the south but in Brandenburg the farmers really struggle with droughts because the landscapes are so stripped". I reached out to three interviewees in the north-eastern part of Germany (lobbyist: I-01, practitioners: I-05, I-09, politics: I-07) who also mirrored this distinction. They emphasized the boundary between the landscapes in the north and the landscapes in the south in the same way. All interviewees pointed out that the landscapes in the eastern part of Germany are huge and monotonous due to historical developments (mining industries, different developments in land-use systems during the German separation). The uniting factor is that all interviewees refer to the negative consequences of stripped landscapes. They identified these stripped landscapes as the reason for habitat loss, biodiversity loss, biological degradation, instable yields etc. Two interviewees referred to *the land consolidation* (Ger. *Flurbereinigung*) as the intervention that accelerated the stripping of landscape most profoundly. The Land Consolidation Act (Flurbereinigungsgesetz (FlurbG)) was released in the 1970s and rearranges the agricultural land in Germany. Small, scattered parcels are (still) consolidated into bigger ones and border hedges or trees are removed in order to manage the newly formed fields more efficiently. The interviewees report that the process turned in general out well for the farmers but they mention at the same time that the land consolidation decreased biodiversity when environmentally valuable hedges, hedgerows and riparian buffers have been removed. They acknowledge both the betterments for farmers and negative side effects, e.g. land slides during heavy rains that are not hold back by different landscape elements. In German the term has a different connotation then in English. *Bereinigung* means purging or correcting and has a normative stance of cleaning something that has been dirty or disordered. The way the interviewees spoke about this intervention suggests that the rural population considers this as the most important caesura in agricultural politics in the last 100 years. The interviewees are sensitized to how political instruments can reorganize ecosystems and influence the way they live in them on the long term. However, it is not clear if making sense of the world in this way is a precondition for or a result of their own practices.

The practitioners I interviewed started their agroforestry practice right after their professional formation, so I call them *neo-practitioners*. They did not change to agroforestry from another agricultural practice so that their narration does not deal with *change*. Although

their individual stories differ, practitioners display a similar trajectory of how they entered agroforestry practices: (a) they were already sensitized to their later project in some way, (b) they experienced a revelation moment which induced a decision, and (c) they believed that they can achieve their specific goal through an agroforestry practice. They immersed in *real-world experiments* where they constantly produce new knowledge while applying it.

I-04 was sensitized to alternative practices early on. S/he was born into an organic agriculture and forestry family business with arable farming, forestry, fruit trees and beekeeping. S/he studied agriculture and focused on husbandry where s/he was sensitized that animal welfare for pigs needs to be improved:

Interview excerpt 7

> *I-04: I was interested in husbandry and with pigs there was still a lot of need for change. So pigs are one of the animal species that are actually still the furthest behind in animal welfare. Cows already have free-stalls, and chickens have a lot of free-range housing and so on — at least something like that has become established. With pigs, it's all still in its infancy.* (I-04, keeping forest hogs)

During a hiking trip to Corsica, the family witnessed domestic pigs roaming the forests and decided to try this on their own land in Germany. The interest in animal welfare and alternative practices grew over time but a special, personal moment ignited the idea to try pannage in Germany. The interviewee sees pannage as a way to achieve his goal, adequate hog housing. S/he started the trial with six pigs towards the end of his undergraduate studies and continued the project with 17 pigs as a PhD study on animal welfare. Afterwards, s/he transformed the project into a business from which s/he now earns a living (200 pigs). Nevertheless, s/healso needed perseverance; his last request for enlarging the hog farming took 3.5 years for approval. S/he considers his practice a *real-world experiment* that cannot solve the animal welfare issues in hog keeping through replacing other practices entirely but it can at least inform other practices:

Interview excerpt 8

> *I-04: You can certainly keep more pigs in this way but you will not solve the big problem of pig farming. I see it more as food for thought, what can be changed? What things can we learn for pig farming from this relatively natural environment and then make adjustments in the housing. And the second point, I assume that it would be better to specifically create areas on agricultural land that are suitable for pig farming. That you take the whole thing out of the*

forest and then use marginal sites for pig farming, for example. That's where I personally see more potential for scaling it up. (I-04, keeping forest hogs)

Through small-scale on-site experimentation, the interviewee wants to produce new knowledge that can be applied to large-scale implementations. For the scientific realm, these practices could provide valuable insights how attempts to animal welfare work out under real-world conditions.

I-06 was already sensitized to environmental topics when a documentary sparked his interest in agroforestry. On his own fields, s/he experiments with non-native fruit and nut species that might be favored by climate change in the long run. The interviewee was trained as a design draftsman and engineering technician. Although s/he was born into a farm, s/he showed little interest in farming until his grandfather died aged 74 (2014). The property had not been handed over and the interviewee was confronted with inheriting a farm suddenly. This sparked the wish to pursue an agricultural formation although s/he had planned to study mechanical engineering in the first place. Hence, s/he completed an agricultural apprenticeship and s/he started with sheep farming in 2015. The family lands were still leased to other farmers, when an online documentary about agroforestry in France [22] called the interviewee's attention. Thereupon, s/he gathered more online information, contacted experienced agroforestry actors and visited agroforestry farms / test areas in Germany. S/he decided to implement agroforestry systems on own fields and started planning in 2015. S/he planted the first trees, subsidized by cultural land or nature conservation programs (Kulturlandschaftsprogramm (KULAP) / Vertragsnaturschutzprogramm (VNP)), when the leasing contracts expired three years later in 2018. S/he opted for nut and fruit trees on grass land which is now mowed by a neighboring farmer. The interviewee uses parts of the grass for his own ewes, currently 20 in number. In the course of time, the interviewee learned that the farm arrangement does not produce enough income. So, s/he decided to work part time in the first profession and spend the rest for farming. Currently, the investment in the farm is higher than the return but on the long run, the interviewee expects to receive income by selling fruits and nuts as well as wood. When I asked, how a documentation could spark such an interest, s/he reported that s/he was "fascinated to see a harvester moving between trees in France." Additionally to an interest in agricultural machinery, s/he reported that the first year of ewe keeping and forest tending was a revelation moment for environmental hazards and climate change:

Interview excerpt 9

[22] The documentation portrayed the scientific work by Christian Dupraz in southern France (see also 7.6 Research Projects)

I-06: The interest to protect the climate was already there. We noticed that right away, we started with five ewes in 2015 and this was the first dry year. We got the sheep at the end of May, and before that we mowed everything down so that fresh grass would come up. And then it didn't rain all summer! You can imagine how little grass has grown in that year. By this, we noticed already in the first year, really! We can't operate like this in the long run. After that came the forest. Bark beetle every year from April to September. Every week at least once in the forest. Walking through six hectares and looking for bark beetles. That's no fun. If you find something, it's again calling contractors. Cut out trees. And get nothing for it. And then it became more and more evident that we have to do something for nature conservation and climate protection. [...] This system is not stable enough. We artificially nourish our fields with () mineral fertilizer and () then protect it with (.) synthetic pesticides, the soil is somehow kept alive. And then I thought to myself, the system is (.) in the long run (.) not — we can't do that. In 20 years, the soil will be dead. If we only keep it on life support. Yes, and that's why the trees were a cool thing, because you use several stories. It simply creates habitat again, for insects, for birds, other animals. And also sequestrates carbon through wood. (I-06, part-time farmer)

During his professional career, the interviewee never depended upon forestry and agriculture for his livelihood and s/he was already sensitized for environmental topics. For the interviewee, money loss was not decisive but the idea that the system is not stable enough. Next to mitigating climate change and biodiversity loss, agroforestry also improves animal welfare for his own ewes when they enjoy the trees' shadow on hot summer days. Hence, due to his interest in both agriculture and environmental topics, s/he experienced the dry year and bark beetles as negative, traced these occurrences back to climate change and current management methods, and identified agroforestry as a solution.

The trees do not only provide a solution, they offer also a field for experimentation what is possible in times of climate change. I-06 planted "exotic" species like chestnut, pecan, fig, persimmon or American pawpaw because, as s/he framed it, "you can't just always complain, you just have to see what can be done, what are the opportunities?" S/he wants to make the best of climate change and hopes that s/he is successful with experimenting on exotic species. Both I-08 and I-09 also decidedly provide space for experimentation when they test how nut species grow in the light of climate change:

Interview excerpt 10

I-08: Various nuts, chestnuts, walnuts, hazelnuts, heart nuts, pecan nuts, almonds, partially we have exotic things like now almonds, which are not native to Palatinate. There are already some almond trees in the Southern Palatinate that also bear well, so it's also not completely new here (laughs) And yet, of course, it's also a test to see what works here at our location. (I-08, community farmer)

Interview excerpt 11

I-09: We planted four and a half hectares with 200 walnut trees in the north of Berlin, 30 different varieties, which are really meant to be a species test facility. Yes! Just start trying first. The variety descriptions that you get from southern France or from Hungary are nice, yes, they really praise high yields. But (sighs) whether they will also work in Brandenburg, under the prevailing climate change conditions? (sighs) (I-09, walnut farmer)

Indeed, testing and experimentation is an integral part of the practitioners' work. Experimentation is needed because (a) existing knowledge was produced in a different climate zones and (b) climate change renders these experiences insecure. On their own farms, knowledge application and knowledge production intermingles. Outside the laboratory and controlled scientific experiments, the practitioners learn from their own experiences and reincorporate them into their practices. What is more, they can also share their knowledge with other parties.

Apart from experimentation, I-08 and I-09 report similar trajectories of being sensitized, experiencing a revelation moment, and believing that their practice provides a solution. I-08, who now lives on a community farm in Palatinate, used to garden and plant trees with her parents during her childhood days. She gathered several impressions while traveling and during internships on farms, then studied international forest ecosystem management and focused already on agroforestry. She wrote her thesis about forest gardening and then decided to found a farm with her partner. She was inspired by an internship on a syntropic farm in Brazil what made her realize that she wanted to pursue agroforestry as her profession. Now, her vision is to create edible ecosystems and to positively influence the environment. She considers this to be a solution to many problems:

Interview excerpt 12

I-08: If this were practiced worldwide now, we would (a) not have too little food and (b) we would live in an incredible abundance! (laughs) Yes, a lot of problems could be solved by simply applying this globally. (I-08, community farmer)

I-09 was also sensitized to her project, the walnut, early on. She grew up in Berlin and remembers a walnut tree in her parents' garden that yielded plentiful. When she studied organic farming and marketing, she "fancied" the walnut for quite some time. She had the impression that walnut farming is not a topic in Germany and saw that walnuts are mostly imported for selling in supermarkets. With her thesis, she looked into the cultivation potential of walnuts in Germany and concluded that cultivation would be feasible but too little knowledge existed. This experience made her decide to "really try it out and go for it". She looked for land where she then planted 200 walnut trees. She estimates that walnut cultivation can reduce the imports of walnut and also offer a regional substitute for meat products. Since 2019, she is self-employed. Actually, she had planned to cultivate vegetables in the rows between the trees but this was prohibited by law. She is not allowed to plow grass land. Instead, she now re-sells the harvest of neighboring farmers, runs a tree nursery and shares her knowledge about walnut cultivation in Germany. In the beginning, she also applied to funding programs for fruit meadows to have her project subsidized. As there are no role models, uncertainties appeared how the law should be applied and she was excluded from the sponsorship.

Neo-practitioners and practitioners whom I call *transitioners*, i.e. practitioners who change parts of or successively their whole farm into an agroforestry system, display different trajectories. Pannell (1999) suggests a certain process for farmers when adopting a new practice: Being aware of the innovation, conducting a successful smaller trial, perceiving that the innovation is worth trialing on a larger scale, and perceiving that the innovation promotes the farmer's objectives. My sample contained neo-practitioners who display a special trajectory pattern that does not fit Pannell's suggestions. Nevertheless, through other interviewees and the 8th Forum Agroforestry (E-01), other trajectories were glimpsed. The agroforestry consultant (I-05) reports that some clients step by step turned to agroforestry when they experienced that their yields became insecure:

Interview excerpt 13

> *I-05: We've already had two farmers who are really genuine conventional farmers, but who have always been interested in innovative methods with no-till and so on, who have thought further than conventional agriculture, Then they said, no, we can't continue like this. It's all blowing up in our faces here. And that's why I'm just going to start now, yes, they don't say, I'm going to turn my whole farm into an agroforestry system, but I'll just start planting trees on one area and then see, oh, that really works. Great, then next year I'll do the next area.* (I-05, agroforestry consultant and planner)

On the 8th Forum Agroforestry (E-01) three farmers spoke, who own larger farms and who changed from different practices (partially) to agroforestry. In their speeches, they motivated the audience by emphasizing that "something has to happen now. We have to start now to not face a difficult future". When presenting their farm, the farmers also reported that they started with a smaller agroforestry plot, had good experiences and want to increase the plots in the near future. These two impressions, as unexact as they may be, suggest that the transitioners proceed as Pannell (1999) proposed: They were aware of the innovation, they pursued a successful smaller trial of the innovation, they perceive that the innovation is worth trialing on a larger scale, and they perceive that the innovation promotes their own objectives.

When we analyze their practices as a *real-world* experiment, it shows how the practitioners also learn from "surprises" (Gross and Hoffmann-Riem, 2005, p. 276) and re-incorporate them into their daily practices. The forest hog farmer, I-04, had an unforeseen experience concerning ecological benefits and profitability. S/he started with six hogs as a hobby and increased the number of hogs to 200 in the course of time. When forest hogging turned into a business, s/he realized that this additional income and especially the needs of the hogs, reduced the (economic) pressure in foresting:

Interview excerpt 14

I-04: I'm a little bit more relaxed about forestry. If I have an oak tree, for example, with a big branch at two meters, then that trunk has no quality. Normally I would cut it out and only leave an oak that is at least six meters free of knots. To have a nice veneer wood with corresponding potential. Since I now have these pigs underneath, I tell myself, mh, this oak, with the large branches at 2 m height, the trunk will not be worth much, but it may bring large acorns. Accordingly, it suddenly has a different value for me and I leave it standing and don't cut it down. And especially these coarse trees, the ones with the big crowns, are of course a habitat for many animal species, which brings a greater diversity into the forest. So I can be a bit more relaxed myself and leave trees that don't really meet the normal forestry criteria.

I: Mh mh. That means that product diversity brings serenity, because you have two pillars. You do not have to optimize one by all means but the interplay between both (I-04: exactly) gets improved.

I-04: This was also a new observation for myself.

I: Mh. Didn't you expect it that way either?

I-04: No, actually not at first sight. It developed like that. And that's a similar point: In a forest area, my goal is usually to stock it densely, that means to plant all areas, without gaps. It should become a closed forest plot, because the marginal trees become knotty in every gap, and you want to avoid this by all means. And you lose a stand for another beautiful tree. So you plant the gap. At some point, you will have a closed forest area that is completely dense and dark at the bottom. It's like a cornfield, where everything is dark at the bottom. But now my pigs are inside (laughs) and the pigs are happy when they find a sunny place in the middle of the forest (laughs). That means that the pressure to close this gap became less intense for me. I can relax and leave a hole of 10 by 10, 10 by 20 meters without a tree. I know it's good for the pigs, there's a certain structure in the forest and it doesn't bother me now if it stays that way. (I-04, keeping forest hogs)

In the case of forest hogs, the farmer did not only change his practice, but the practice in turn also shaped the farmer. With silvopastoral agroforestry, s/he changed how s/he manages the forest and this simultaneously changed the farmer's perception and values of the forest.

Another interviewee (I-10) explained that she led a research project where scientists from both forestry and agriculture closely cooperated. She observed that during the project, the partners could learn a lot from each other:

Interview excerpt 15

I: How was the cooperation with the foresters? Because, in Bavaria, forestry and agriculture are also rather separated. How did you get along (laughs), so to speak?

I-10: (laughs) Well, I think that was also one of our strengths, that we got a bit closer. We got along very well, we have now also submitted a new project, which has also been approved. So the collaboration was close. And good. And we were able to learn a lot from each other. Yes, of course you have different ideas, like this. I come from a horticultural background and for me it's often — or with lettuce you have a cultivation period of four weeks, the foresters simply think much more long-term. And they are not as precise as we are in the field, because they simply work with larger areas. So we found a lot of differences and learned a lot from each other. And I think the strength was also that a farmer was there at eye level. (I-10, scientist)

The agroforestry project built a bridge between agricultural and silvicultural scientists and allowed both to experiment.

8.1.2 Analysis: Characteristics of *Neo-Practitioners*

However, by daring to experiment, both the neo-practitioners and the transitioners seem to be the contrary of the farmer that Pannell (1999) depicts in his piece. To farmers, he assigns the qualities of skepticism, uncertainty, ignorance, prejudice and preconceptions which means that farmers have to be *convinced* to change their practices. He adds that new systems need to be profitable to be considered worth trialing in the first place. Both the neo-practitioners and the transitioners, however, display other qualities and expectations than Pannell suggests. They reveal qualities like interest, decidedness, stamina, creativity and flexibility. They may have a second source of income or financial securities, but in their practices they do not opt for profitability as top priority. They are open to *real-world experiments* outside the safe and contained space of the laboratory (Gross and Hoffmann-Riem, 2005; Gross et al., 2003; Gross and Krohn, 2005) — that always bears the danger of failing. Interestingly, the neo-practitioners themselves used the same narration of adopters as Pannell (1999). The interviewees emphasized that not everyone can change due to different obstacles, e.g. time, knowledge, interest, etc. They created a boundary between themselves who pursued agroforestry due to a specific interest or for a specific goal and others who might be in the same situation but who cannot afford the same change. They unanimously said that "a normal farmer" needs to earn money with what s/he does, and that farmers are generally no "people of conviction" for environmental beneficial practices because they go through too many financial constraints. Notably, all the pioneers I interviewed display the contrary.

Therefore, the narrative of the "skeptic farmer" has to be redefined or at least refined. Rogers argues in the *Diffusion of Innovation* theory (2003 [1962]) that five categories of adopters exist in the life cycle of an innovation: Innovators, early adopters, early majority, late majority and laggards. Both the neo-practitioners and the transitioners in this sample belong to the first group. They are all pioneers, or *innovators*. Furthermore, Rogers' theory suggests that people who adopt an innovation early in time have in general different characteristics than people who adopt an innovation later in time. In the case of agroforestry in Germany, the *innovators* are interested, determined, creative, flexible and tenacious. This does not mean that agroforestry is for a special kind of people only. I rather argue that the pioneers at this stage all bring a certain pre-acquired interest with them to take this adventure. In the early stage of an innovation, practitioners need to have experienced this special trajectory

pattern to immerse themselves in the practice. At a later stage, different trajectory patterns might come into play.

Borremans et al. (2016) came to a parallel conclusion when they interviewed farmers (adopters and non-adopters) in Flanders about agroforestry. The study's main interest was to investigate why farmers did (not) adopt agroforestry practices. They found out that conventional farmers suspected negative impacts on compatibility and profitability whereas pioneer farmers saw legal issues as the most important drawback. This shows that prospective practitioners and pioneer practitioners can indeed have different requirements for adopting a practice. Although the authors did not explicate on the farmers trajectories, the findings are parallel insofar that motivations and trajectories go hand in hand. If the motivation the farmers need are different, their trajectories probably also are.

8.1.3 Conclusion: Reshaping Agroforestry through Experimentation

The *real-world experiment* concept by Gross, Hoffmann-Riem and Krohn (2005, 2003, 2005) helps us to see something more. Agricultural practices developed over decades and continue to be shaped by politics. Neither practices nor politics change overnight — and more is needed to change practices than scientific experiments in the (open-air) laboratory. Gross, Hoffmann-Riem and Krohn researched mostly large-scale implementations of new technologies or unique projects, like the restoration of the damp peninsula Montrose Point. Although each farm is only a small-scale implementation of agroforestry, taken together, they show the preconditions for and consequences of agroforestry. Practices develop by being practiced, not in the laboratory. As scientific investigation did not produce a ready-made farming system, practitioners themselves introduced a self-experimental community. In turn, on-site practices can be a wonderful resource for researchers who want to advance agroforestry – researching existing examples is resource effective and can disclose what practitioners pursue and are confronted with. Researching the knowledge application can indeed produce new knowledge and feed it back into the loop.

Even though the examples are limited, we can identify a trend in the practitioners' trajectories. The interviewees were often already sensitized when they experienced a certain revealing moment that made them seek agroforestry as a solution. Interestingly, they have all been trained in the agricultural field but started their professional life directly with agroforestry, so I call them neo-practitioners. In general, this group seems to be prevalent among the pioneers of agroforestry. Farmers, who changed from conventional methods to agroforestry during their professional life, were considerably less in numbers. In their narration, they created an atmosphere of *change*. That most of the farmers started out with agro-

forestry right from the beginning does not mean that they themselves did not experience (unexpected) changes. This is what we will focus on next, on how the farmers changed.

8.2 Motivations and the Relation of Ecology and Economy

When we look at scientific literature for the German agroforestry context, it motivates the adoption of agroforestry differently than the scientists and practitioners in the interviews did. In literature, agroforestry is either motivated by market demand or by environmental sustainability. Scientists deem profitability most relevant for practitioners but practitioners themselves report animal welfare or larger ecological benefits as a reason. When we regard agroforestry through the concept of boundary object by Star and Griesemer (1989), it is at the same time wide enough to unite all these different motivations so that the different actors can communicate with each other, but becomes very precise at an individual level.

8.2.1 Empirical Material: Why do Actors Engage in Agroforestry?

Literature explains the interest in agroforestry by ecological reasons and/or by market demand. Therein, Nerlich et al. (2013) advocate the ecological stance. They take up Nair's argumentation (2011, p. 784) that

> it started with the general public's understanding about the environmental consequences of high-input land-use systems such as invasion of exotic species and alterations to nutrient, energy, and water flows leading to soil erosion, water-quality deterioration, and environmental pollution. Agroforestry gradually gained acceptance as an appropriate approach to addressing some of these environmental problems, and agroforestry initiatives started in North America, China, Australia and New Zealand, and southern Europe.

Opposed to this ecological standpoint, others offer a market oriented explanation. Reeg et al. (2009) claim that interest in agroforestry (and especially in energy wood on arable lands) was sparked in Germany when CO_2 emissions had to be reduced and therefore, the demand for renewable resources increased. To meet this demand, (energy) wood production had to be outsourced to agricultural areas as forestry areas did not have additional potential. This market oriented explanation is also shared by one interviewee, an agroforestry planner and consultant:

Interview excerpt 16

I-05: In this context, we have also dealt with the raw material potentials and have come to the conclusion that if the climate protection strategies are implemented

in Europe, then there is actually no more surplus biomass as forest wood or as waste wood. So, the medium and long-term perspective would have been either to import wood or to develop an additional source of wood. That's when short-rotation plantations came into focus, with fast-growing woody plants on arable land. And the arable land itself is, the largest biomass potential that Germany has to offer. By far. Whether it's annual crops or perennial crops, the corresponding raw material potential is quite considerable. (I-05, agroforestry consultant and planner)

The idea is to increase the amount of biomass produced on arable land and to finally substitute fossil fuels:

Interview excerpt 17

I-05: Just by the fact that there is now a CO_2 price — which is perhaps still much too low, but municipal utilities are now thinking about it, because they know that the price is there and it will be rising. It will probably go up even faster than they thought, or than the laws say at the moment — "do we build another new gas boiler now, or what do we use to replace the coal sector that we now have to shut down"? In the east [of Germany], in particular, there are some municipal utilities that still obtain a lot of heat from coal-fired power plants. Then, what should they substitute that with? Of course, they also have wood in mind and know that as soon as they want to obtain that from the forest, they immediately compete with each other or even with themselves, yes. Because this quantity simply doesn't exist. So no matter at what price they buy it, the quantity will actually not increase. Because the trees don't grow any faster as a result. (laughs) And actually it cannot be tapped more. If you look at the professionally managed forest — actually, the entire private forest is not really present at the timber market, so if you leave that out — but the professionally managed forests: There, the wood utilization is actually already as high as the growth. (..) And, so you can perhaps generate a little additional potential, but not on a scale to substitute coal. Or gas or heating oil in the heating sector. In other words, there has to be an additional energy source. (I-05, agroforestry consultant and planner)

Although (re)substituting coal with wood is portrayed as the long-term goal, this does not seem very likely from a historical point of view. Historically, pre-modern societies depended

on wood. The early modern period was even described as *the wooden age* by national economist Werner Sombart because wood was essential for multiple reasons at that time (see Reidegeld, 2014). The forest was one of the most important economic resources of pre-industrial societies and provided fuel for private and commercial combustion processes, as well as building materials for house and ship construction as well as raw and auxiliary materials for many trades. Consequently, the development of business cycles in the pre-industrial era strongly depended on the availability of wood. This was especially true for the boom in silver mining from the end of the 15th century and during the 16th century. Mining itself, but also the general economic boom stimulated by mining, rapidly increased the demand for wood. When the wooden age reached its peak and turning point in the 18th century, publications started to discuss the danger of wood shortage and the need to save wood. The wood-saving fever also stimulated inventions such as wood-saving stoves. Notwithstanding, it was not until wood had been replaced by fossil fuels such as coal and oil and other building materials such as steel and concrete that the pressure on domestic wood resources was reduced. (Reidegeld, 2014) By today, both population and per capita energy consumption increased many times over. Against this historical background, it seems unlikely that the current fossil fuel consumption could entirely be replaced by wood — neither from the forest nor from the field. Of course, market dynamics can still make this feasible at least to a certain degree and, as evidence shows, these ideas are discussed in research projects, literature and private businesses. Gordon et al. (2018b) head in a similar, market-oriented direction for hard-wood. The authors argue:

> Within the European Union, high-quality hard-woods represent a substantial portion of total forest products imports, with tropical woods currently supplying the deficit. However, prospects are gloomy, and it is likely that less and less raw tropical hardwood will be available during the forthcoming decades. Would it be possible to produce, on agricultural lands, a high quality wood resource substitute for imported tropical woods? Preliminary results indicate that high quality hardwoods may be readily adapted to certain agricultural lands. These species are currently uncommon in forests, and would not compete with native forest production. (Gordon et al., 2018b, p. 110)

Elsewhere, Gordon et al. (2018b) combine the ecological and the economic approach in literature, but they rather focus productivity than on market demand. They follow Nair's viewpoint that "agroforestry is synonymous with proposed solutions to climate change at large scales and for the maintenance of soil health at much smaller scales" (2018b, p. 1) but at the same time, they argue that agroforestry was developed in the tropics where

land shortages and population growth demanded a more efficient production system. So far, market demand, sustainability and productivity can be distilled as the three (possible) reasons why agroforestry currently experiences an upswing.

However, the relation between the ecological and the economic stance is not the choice between *either*, *or*, or *the combination of both*. Instead, the relation is rather complex and varies in science and praxis.

For the scientists (I-01, I-03 and I-10), agroforestry can be a bridge between ecology and economy, but they repeatedly emphasize the economic aspect:

Interview excerpt 18

I-01: I myself see it as a bridge between conventional farming and organic farming. But productivity is of course a very important issue. In Germany, we always speak about the environmental impact of a land-use system, because we simply can afford thinking about it. We don't have to worry about food, which is why we can, to put it bluntly, worry about the environmental impact, but — of course, these issues are interrelated, you can't separate them neatly — but actually productivity is the main reason for agroforestry and that's why it's done in South America and Africa in the smallholder farms. They operate agroforestry systems because they have a greater variety of products and because they have a higher productivity per unit area. And we can even prove these higher yields in Germany on many areas. Productivity is actually a very important criterion. We at the lobby group also have the goal to somehow build a bridge, to combine economy and ecology in agroforestry, as well as agriculture and nature conservation: that both can be achieved on one area. That is quite our goal. (I-01 00:33:45–00:35:04)

Interview excerpt 19

I-03: I have to admit that, up to a certain point, I am also of the opinion that ecological issues — with all their significance and with all their importance and relevance, I don't want to deny that at all — but they are often born out of prosperity. And that's why I don't believe that agroforestry should just be sold as the better or more ecological system, so to speak. It has to be profitable and it has to feed the people. That comes first, and if it also produces the other products in the wake, so to speak, and is ecologically valuable, that's great. But if the first is not given, everything else is only interesting until a drawback comes. Then it will be overturned relatively quickly, I think. (I-03, scientist)

In their opinion, productivity ensures that agroforestry is interesting for farmers in the long term and ecological benefits are used by the lobby group to convince politicians and farmers. Section 7.6 Research Projects shows that scientific research and projects also tend to focus on productivity.

The scientists focus strictly on economic issues and trace ecological issues back to the idea of productivity. They acknowledge that farmers seek the solution for pressing challenges like wind and water erosion or droughts in agroforestry, and subsequently boil these ecological issues down to productivity: "Farmers really see that soil is eroded by wind and water — one always says soil erosion, but actually the humus is eroded for the most part in the upper soil layer and — (breathes) that is actually a productivity problem" (I-01 00:40:10). I-10 projects additionally that agroforestry will even make more sense economically when climate change gets worse. Then, ecological advantages make the yields more resilient:

Interview excerpt 20

I-10: But what is playing a role, for example in Franconia: Yields are no longer secure and stable. And here, agroforestry is a good way to protect against wind erosion. I think that perhaps we will see even more positive effects in the future (I: when climate change worsens?). Exactly, then it makes even more sense, economically.

I: Because then you protect yourself from total failures. Is it then a question of having something or nothing at all instead of how to gain 10 percent more?

I-10: Exactly! So stabilizing yields is a big motivation, I think. Also in the future.
(I-10, scientist)

Can ecological benefits be a motivation on themselves or are they always grounded in economic benefits? Eser et al. (2014) call this the "well-known bifurcation of environmental ethics": conservation (in their case) or agroforestry (in this case) can be motivated by the benefits for humanity (usually called *anthropocentrism*) on the one hand or by the benefits for nature itself (*bio-* or *ecocentrism*) on the other hand. According to Eser et al., it is an ongoing task of moral philosophy to seek an appropriate foundation of environmental ethics but, they conclude, "with regard to concrete problems and pragmatic application it is not the only [task] and probably not even the most important one" (Eser et al., 2014, p. 29). For now, we conclude that agroforestry can be motivated by ecological or economic benefits but the latter are evidently emphasized by scientists.

I-10 summarizes how different the motivations can be for the different actors. Science focuses now on productivity, but was attracted by good market opportunities in the first place

whereas practitioners need other motivations, like animal welfare or long-term investments. In the scientific project she conducted, productivity played the most important role, whereas enhancing biodiversity was only a minor part:

Interview excerpt 21

I-10: Well, productivity played a big role in our project. We wanted to develop an economically feasible system. First of all, we wanted to see how the agricultural crops would yield. [...] Actually, the fear in Bavaria was that it reduces the yield. Then it was rather positive to see that it actually does not have an effect [...] So productivity was in the foreground. But of course the ecological aspect also comes into play. Biodiversity. We were also the first to test native tree species in Germany, simply to spread the risk and also to increase biodiversity. And ultimately, I think it has to be a mixture. So you have to optimize all variables, but it must not be a losing deal for the farmer. Or if it is, then it should be financially compensated. (I-10, scientist)

The reason, why her institute was attracted by agroforestry in the first place, was a promising market for energy wood:

Interview excerpt 22

I-10: It's more these newer systems that the research aims at. Energy wood was the big topic in 2009. Also the Agency for Renewable Resources[23] *totally totally hyped it! That was* the *topic, and the oil price was completely different. So that was really quite promising. That's why we have focused on that.* (I-10, scientist)

Farmers who practice agroforestry already today, still need a further motivation apart from economic benefits — even though they will profit economically even more from agroforestry in the future:

Interview excerpt 23

I: Why would farmers want to do agroforestry? What motivates them?

I-10 : Climate adaptation. Animal Welfare. So with chickens, some are trying this now and feel that it is good. Simply as protection from birds of prey. Many plant high-grade woods simply to have more long term capital gains. For their

[23] Fachagentur für Nachwachsende Rohstoffe

grandchildren because they know that they won't live to see the harvest. Many also, because they know it from the old days and they remember it now, in the sense that this is actually a good thing.

I: That means productivity is a prerequisite but not necessarily a motivation to practice agroforestry? Motivations and prerequisites can differ or coincide?

I-10: Exactly. I think financially it might be easier to just manage the area as it is now. You might neither loose nor gain something with agroforestry. That means you need another motivation. (I-10, scientist)

In the big picture, science, politics and farmers have different — and maybe even contradicting — motivations to practice agroforestry. This passage suggests, that in academia and the lobby group, the values are distributed hierarchically: Productivity is the main goal, whereas ecological benefits are a valuable add-on. The general interest in agroforestry was sparked by a promising market perspective in the last decade. For farmers however, productivity might be indeed a *necessary requirement* of a land-use system, the *concrete or personal motivations* to implement this specific system may yet be manifold.

Practitioners earn money with farming; consequently profitability (at least in the sense of having a return on the invest) is key. Despite this fact, the farmers named mostly greater ecological balance or animal welfare as their drivers on the agroforestry map. Similarly, the practitioners I interviewed never mentioned efficiency as a goal for its own sake but emphasized the ecological effects of agroforestry.

However, different parts of the agroforestry system seem to exist due to different motivations. The DeFAF's *agroforestry map* (DeFAF, 2021a) does not only provide information about the number of agroforestry farmers and the share of agroforestry areas in Germany (section 7.2 Landscape of Current Practices), farmers could also specify their motivations. The entries are accompanied by texts[24] informing us what motivated farmers to establish an agroforestry system. Creating ecological balance was by far the most prevalent motivation. Diversifying the product range, erosion control, improved marketing, contributing to climate protection / climate resilience, improved landscape / aesthetics, and reducing element input into surface waters were indicated similarly often. Increasing productivity and creating research areas seem to be minor motivations. Thus, according to the agroforestry map, the most popular agroforestry types are silvopastoral systems with chicken run and poplar or fruit / nut trees. The most common motivation is protecting livestock and establishing an ecological balance. In chicken runs, poplar trees are often planted to protect the chicken

[24] Unfortunately, they cannot be selected as a filter and thus not counted.

against birds of prey or the sun. Interviewee I-05, a planner and consultant, witnessed that his own clients also strive for animal welfare with this system:

Interview excerpt 24

I-05: These are exactly the actors who say: "I see that my chickens are not doing well, especially in the mobile coops it's too hot in summer. And I also see that chicken are actually a forest birds and not grazers. The livestock would rather scratch under tree and look for any bugs and worms under old leaves than picking grass on the green field. That's not consistent with the chicken." Although we have this image now, a happy chicken sitting in the meadow picking green grass, (laughs) but the reality is, the chicken actually comes from the forest, that's a pre-forest dweller. [...] From the chicken farms, I don't actually have a single client that said: "I'm doing this to use my land more efficiently, to make additional income". That was not with a single one. If anything, that was only a secondary motivation. Rather tending to: "Then I must harvest the trees and that is annoying, how do I do that then?" But maybe that will change if the price of wood increases. (I-05, agroforestry consultant and planner)

In the case of combining poplar and chicken runs, the practitioners motivate their practices with animal welfare, which they ground in an evolutionary argument. They find woody habitats to be a "more natural environment" because they consider chickens to be "originally forest birds". From a sociological point of view, modern chicken breads can also be considered a product of history and human interactions. Apart from that, the main point is that practitioners reason for their practices with animal welfare.

A practitioner who keeps forest hogs reports similar ideas of animal welfare but also clearly points out to the economic part. First, s/he explained that s/he focused on husbandry in his studies and was aware of the (bad) conditions in hog husbandry. S/he started an own trial after s/he had seen hogs roaming the forest on a holiday trip (see also interview excerpt 7). About the relation of economy and ecology, s/he opined:

Interview excerpt 25

I-04: (...) Exactly, the hog farming has developed in such a way. I actually wanted to try it because of the pigs. Yeah, with the six pigs it is clear that one can't earn anything there — it is nothing more than a nice hobby perhaps. But I wanted to develop it for the pigs, then it became a research project, and then of course I saw that it could be developed further, and from there I developed

it in this direction, with marketing and everything I need to earn money with it. (I-04, keeping forest hogs)

For this interviewee, animal welfare has been the main driver and the business eventually becoming profitable, is a positive but undeliberate outcome. I-04 was the only practitioner living on husbandry, but others who keep sheep in their fruit or nut orchards (I-06 and I-09) report likewise that the animals "enjoy" the trees' shade in summer. Since sheep were either a hobby or not their own, they did not focus on the economic part here.

On income generating areas, ecology and economy condition each other. Like the scientists, I-02 traces the ecological benefits back to profitability on the productive areas, but economy and ecology are inseparably linked so that one cannot be pursued without pursuing the other at the same time. S/he emphasizes the importance of a healthy soil. For practical reasons, s/he did not plant trees on the fields but s/he tries to increase the soil health with different methods of regenerative farming (aligned crop rotation, reduced plowing, catch crop, interseeding, etc.) in order to reach basically the same ecological goals like agroforestry (water retention, reducing wind and water erosion, closing nutrition cycles etc.). For the interviewee, on the ecological side, good soil quality is key. On the economic side, long-term profit maximization is key:

Interview excerpt 26

I-02: Regenerative agriculture, it's more sustainable in the sense that you don't aim for the short-term maximum yield, but you aim for soil health and for building soil fertility, and EVENTUALLY (.) — maybe at first you are underperfoming, economically speaking, because it costs money, intercropping, seed, sulfur fertilizer, purple cost money. Or you do a tillage more or buy a special machine, that costs money. But at some point it pays off. At some point the profitability curve goes steeply upwards. Then you can achieve high yields with little effort. Also in our case, at times we have VERY VERY good yields. (I-02, organic farmer)

Although profitability might be the ultimate goal of productive areas, economy and ecology stand on an equal level and condition each other.

The reasons for not pursuing agroforestry on the productive areas are of an economic nature, whereas the agroforestry elements on extensive areas exist for ecological reasons. I-02 does not expect increasing yields through agroforestry, s/he does not opt for a further business pillar, and s/he expects wood to be very cheap in the next years due to a climate-change induced forest decline. Based on these economic arguments, s/he does not practice

agroforestry on the productive fields. Nevertheless, on a former field where soil erosion made arable farming impossible, s/he planted meadow orchards and is maintaining an extensive grass land underneath. Both are intended to increase biodiversity and subsidized by a cultural landscape / nature conservation program (KULAP / VNP). Furthermore, some hedges around the farm should reduce wind erosion, pesticide drift and increase biodiversity. This separation between agroforestry on productive and extensive areas refers to a land sparing approach.

Likewise, the *agroforestry map* (DeFAF, 2021a) offers different motivations for different agroforestry elements: Shrubs are planted mostly for their ecological impact (providing habitat for insects and birds etc.) and not for productivity reasons even though shrub species can bear fruits. In contrast to shrubs, tree species are mostly grown for productive use. The same is also reported by I-04. S/he planted two hedges (200x2 m each) in order to create a wildlife corridor and connect different habitats. For his 30 current and 200 prospective trees, s/he intends a productive use. Once they bear fruits, s/he intends to sell them to the central market or on farmers' markets. Nevertheless, the productive use leaves space for experimentation (see section 8.1 Trajectories of Practitioners and Experimentation). In this land sparing approach, shrubs are rather planted for ecological reasons while trees serve for the productive use.

I-08 offers an additional point of view. While profitability is necessary for her, the ecological benefits weigh (morally) higher. I-08 lives on a community farm in Palatinate and underlined that the community *of course* generates its income through the farming activities and 20–30 persons live on that. For them, economic benefit is necessary but the ecological benefits weigh higher: "Yes, there are definitely different areas in the various zones, which must also be differently productive or differently lucrative. (...) (sighs) and everything as a whole then simply has a much greater benefit than just the economic benefit" (I-08, community farmer). This moral aspiration is also reflected by the community's shared vision:

Interview excerpt 27

> *I-08: (...) So our vision, which also unites all adjacent companies, is just edible ecosystems, edible gardens, edible cities, no? That humans and nature come together and we don't see ourselves as harmful, I'd say, but somehow as beneficial and have a positive influence on our environment again. And create diverse, resilient systems, yes.* (I-08, community farmer)

The farming community in Palatinate and its adjacent companies (consultancies, tree nurseries etc.) are driven by the idea to create edible ecosystems and positive human-nature relationships. The young people in Palatinate convened for practicing community life and

regenerative farming so their trajectories and motivations might differ considerably from other farms. They ground their practices in moral or transcendent motives, so that the ecological benefits weigh higher than the economic benefits.

Dr. Eicke Zschoche, a practitioner whom I would call *transitioner* (see section 8.1 Trajectories of Practitioners and Experimentation), reported no monetary interest when he started with agroforestry. For him, the ecological challenges were so pressing that he had to seek a solution. When he was asked on the 8th Forum Agroforestry (E-01), how he started agroforestry, he answered: "Someone has to start — waiting is wasted time". He informed the audience that he did not have any profit expectation and did not perform any economic calculation when he transformed 10% of his land (5 of 50 ha) into silvoarable agroforestry with energy wood, high-grade wood and nut / fruit trees. When he faced ecological challenges on his farm in Libehna (Anhalt-Bitterfeld district, Saxony-Anhalt), he draw the conclusion to cultivate his land differently. In contrast to the scientists (see interview excerpt 20), he did not boil the ecological issues down to productivity throughout his speech.

Next to economy and ecology, there can also be other motives like regionality or landscape design: I-09 and I-06 would like to engage in regional walnut production and regional fruit juice from meadow orchards respectively. I-06 additionally wants to design the landscape creatively. I-09 started her practice with the idea to produce walnuts in Germany. She saw that they get mainly imported even though they have been growing in this country for many centuries. In her master's thesis, she analyzed the potential of walnut farming in Germany, created a network between farmers and resellers, and finally made it a business in Brandenburg. Therefore, her primary goal was neither to do regenerative farming nor to make money but to grow walnuts regionally — although she of course was confronted with ecologic and economic issues, too. She observes more birds in the trees, that grass grows better around the walnut trees and that she created a good circularity with the sheep that are grazing the walnut orchards. Her dream is to build a regional community of walnut farmers that can share knowledge, networks and also machines. She argued, while reducing competitive thinking, co-operation can also have financial advantages when they distribute risks and costs. This trajectory suggests that I-09 started to produce walnuts regionally and ecological benefits and profitability came as a positive addition. I-06, too, would prefer regional products over imported ones when they are available anyways:

Interview excerpt 28

I-06: My dream is to produce regional fruit juice. We have so many fruit trees in the district. I would love to bundle them and then press juice. It makes no sense for me, to buy fruit concentrate from China, add water here and sell it as

apple spritzer. Here, the apple grow and fall down and rot. Why shouldn't we use our own apples for juice? (I-06, part-time farmer)

Additionally, s/he considers it a responsibility to create a beautiful landscape for fellow beings — and links it to personal interests:

Interview excerpt 29

I-06: I once thought of going in the direction of design or photography professionally and therefore I wanted to be creative in agriculture. That's what I wanted to do, to bring some pleasing elements into the landscape. And to preserve something for the ensuing ages. (I-06, part-time farmer)

Although ecology and economy were important and recurrent topics in the interviews, the interviewees also considered other motivations like regionality or landscape aesthetics in their own practices.

Practitioners mostly reported striving for ecological balance or animal welfare as their motivation. This contradicts Graves et al. (2017), who concluded that farmers need a monetary incentive to change the practices. In all the interviewees' cases, this motivation did not come forward. However, Graves et al. (2017) had interviewed arable farmers, i.e. farmers who did not transitionen to agroforestry (yet), whereas I focused on neo-practitioners. This difference in the sample could possibly explain the difference in motivation. My findings also contradict Rois-Díaz et al. (2017), who proposed that farmers pursue agroforestry due t tradition, diversification of product range and learning from others. However, the authors did not specify the backgrounds of their interview partners so that I can make no attempt to explain the discrepancy in the findings. Furthermore, the sociological studies of agroforestry (Borremans et al., 2016; Graves et al., 2009; Graves et al., 2017; Rois-Díaz et al., 2017) did not trace the special relationships between economy and ecology. They did not specify the motivations and conditions why practitioners immerse in agroforestry.

Some assumptions try to explain the different motivations. Note that there might not be such things like the "true" motivation and the "real" driver as each person will make sense of what they encounter according to what fits their own worldview and needs. However, we could assume that the practitioners have a reliable financial background so that they do not need to focus about productivity. Possibly, they could indeed opt out if they encounter a backlash. Researchers could emphasize productivity because they could just want to make sure that agroforestry is not refused as an "idealistic" practice if one would have to compromise in terms of productivity. It is also imaginable that researchers need to fit into

the current intensification paradigm to be accepted in agricultural research. Starting with ecological balance and animal welfare would maybe cater to a different interest group — or researchers are talking about the *early* and *late majority* in the life cycle of an innovation and not about the few *innovators* that are already part of the movement. Rogers (2003 [1962]) indeed suggested that participant characteristics change during the aging of a movement. Without being able to clarify why motivations differ, we can conclude that they are not mutually exclusive.

8.2.2 Analysis: Agroforestry as a Boundary Concept

As a boundary concept, agroforestry brings together people with different motivations. When a concept can entail different meanings by different actors at the same time, it is called a boundary object (Star and Griesemer, 1989). Regarding the motivations, agroforestry is also a boundary concept. In general, agroforestry can be motivated both by ecology and economy, two reasons that otherwise might even contradict each other. In that sense, agroforestry is roomy enough to unite different motivation as each actor can relate to ecology and economy on an abstract level. One interviewee reported that, on the basis of agroforestry, people can come together who would otherwise have no common ground:

Interview excerpt 30

> *I-01: A typical example is nature conservation and agriculture. Many stakeholders no longer talk to each other because of unresolved conflicts in the past. We, on the contrary, made the wonderful experience that we can bring people together again. For example, we just had a project with the state farmers' association and the state office of NABU*[25]*. It is a nice prospects that we can — even if parties don't always agree one hundred percent, but they work together towards a common goal and they identify overlapping goals. Perhaps they can also find compromises, and that is actually our goal: not to exclude one group of actors, but to try to involve everyone.* (I-01 00:30:45–00:31:31)

On the individuals' level, however, the relation between ecology and economy manifests and becomes very concrete. For the individuals, their specific motivations are strongly structured, individual and concrete. In the joint project, a farmer might want to secure his yields and the nature conservationists might want to increase biodiversity. Together, they can design an agroforestry system with fruit and nut trees. Only as a boundary object, agroforestry can unite different actors and gain momentum.

[25] Naturschutzbund Deutschland e.V. (NABU)

As a boundary object, agroforestry can entail ideas of both: (Sustainable) intensification on the one hand and integrated conservation landscapes focusing on ecological benefits on the other hand. Accordingly, we can also explain how Smith et al. (2012a, 2012b) can argue for reconciling productivity with the protection of the environment as well as define agroforestry as a means for sustainable intensification. What seams mutually exclusive in the first place, becomes harmonized when we regard it as a boundary object.

8.2.3 Conclusion: Different Motivations — Blended in a Boundary Object

Overall, even though the motives to engage in agroforestry are manifold, empirical evidence suggests that the main motivations can be distinguished in either economic or ecological reasons. Economic reasons can be an increased productivity of both the tree and the crop species (mostly in alley-cropping), which was mostly advocated by scientists but not by the practitioners I interviewed. Another monetary incentive can be high market prices for wood, which was advocated in literature and which was also the reason for one scientific project. However, the practitioners also did not name to this as a reason to practice agroforestry. Ecological reasons can also take different nuances. It can refer to climate change and environmental challenges as a whole like mentioned by some articles. Practitioners however see it more as a way to adapt to climate change and as means to reduce the impacts of heavy weather conditions in their nearest surroundings. Another important ecological driver is animal welfare. Farmers improve the benefits for their own animals through agroforestry. The scientists, on the other hand, used to trace the ecological benefits back to economic benefits.

As a boundary object, agroforestry can unite actors with different motivations. Agroforestry is flexible enough to incorporate different motivations. Through that, agroforestry highlights the uniting factors and enables joint projects instead of dispersing project partners due to differing motivations.

8.3 Personal Definitions and the Classification of Agroforestry Systems

No law has finalized yet what agroforestry *is* and *is not* in Germany, but when the actors speak about agroforestry, they implicitly or explicitly define it in their own way. By looking carefully at the interviewees' expressions, we can identify what they consider *to be* and *not to be* agroforestry. I started this analysis by saying that agroforestry systems incorporate trees (mandatory) and crops and / or livestock (selectively). Contrasting to that, the interviewees consider only very specific practices to be agroforestry and the lobby group focuses mostly on silvoarable practices in their work — although they claim to advocate for a very broad (legal)

definition. From the interview excerpts I distill a classification system that is based on the five categories: (1) the *type of practice*, (2) *intentionality*, (3) *complexity*, (4) *intensity*, and (5) the *products* one wants to produce. Compared to a draft for a legal definition, the legal definition might in the future only define very specific systems and such — and subsequently exclude others from funding possibilities. With the classification concept by Bowker and Star (1999), I can show that this classification system will produce a social reality for the practitioners. By gate-keeping the access to subsidies, the legal definition will also influence what practitioners perceive as agroforestry in the future and what not.

8.3.1 Empirical Material: What do Actors Consider (not) to be Agroforestry?

Firstly, the interview excerpts showed that agroforestry can be classified according to the *type of practice*, e.g. forest hogs, alley-cropping, meadow orchards etc., which could take place both on agricultural and forestal areas. The lobbyist would like to see the (future) agroforestry definition to be as broad as possible so that it encompasses many different types of agroforestry systems. Thereby, the practitioners themselves would be enabled to choose the systems that fit their ideas best. At the same time, s/he explains why the lobby group focuses primarily on trees on agricultural land:

Interview excerpt 31

I-01: In principle, agroforestry can be a very broad spectrum. Independently of how agricultural funding law will define it, there is also forest farming for example, that is cultivating certain mushroom cultures in forest areas. This is also a type of agroforestry. However, we are actually focusing more on systems based on agriculture. This is due to the fact that land use in Germany and in Europe as a whole is quite strongly separated between forests and agricultural land. This induces so many problems. When trees, that belong to your productive area, are suddenly planted on agricultural land, that really blows up the system. [...] We focus very much on agroforestry that is agricultural in nature, and we assume that these systems always have a higher percentage of arable land. As a rule, the percentage of woody plants is usually no higher than 25 percent. We decided for us, it should be a maximum of 40 percent. The areas would then be loosely but actually completely covered with regards to the stocking degree of the treetops, especially if you consider larger trees. That already produces a forest garden character. If this could be implemented, a very large variety of such systems could be realized. There are the most different backgrounds and there are of course the most different design options. If I consider fruit to be an option, I'll

plant fruit trees; if I want to have more energy wood, I'll probably plant fast-growing groves. There are actually limitless design possibilities and that's where we would like to go: That law makes as few specifications as possible and let the farmers decide what suits their fields and their use concepts best. (I-01 00:16:55–00:20:18)

Although the lobbyist envisions diverse types of practices, the lobby group self reportedly focuses on agroforestry on arable lands, such as alley-cropping or meadow orchards. Regardless this limitation, agroforestry still entails limitless design options for the lobbyist. Although Agroforestry is considered to surpass the very divide of agriculture and forestry (Smith et al., 2012b), the divide itself, seemingly, forced the lobby group to restrict the possibilities and focus on practices on agricultural lands. Then, it would ignore practices like forest hogs or mushroom farming. Historically, the divide between forestry and agriculture was fostered by European politics after the Second World War and separates the two nowadays (still) in both law and practice (see section 7.5 Politics and the Search for a Legal Definition of Agroforestry).

Another interviewee, in contrast, sees agroforestry as a land-use system in its own right, as a third pillar next to agriculture and forestry:

Interview excerpt 32

I-03: We really have to see agroforestry as a further land use system. It's not just a modification but it stands as its own system. It's not forestry, but it's also not classical agriculture. It really is a different system. It also has the goal of producing products — in this case always two at least! Yes. It's a form of land use, it's a form of primary production, but it's just a third pillar. (I-03, scientist)

However, if agroforestry is limited to practices on agricultural land, this contradicts the idea of being a third pillar. I-03 characterizes it as a third pillar because, according to its characteristics, agroforestry is neither forestry nor agriculture. Rather, it incorporates elements of both systems but is distinct from both. If agroforestry would actually be recognized as a third land-use system, laws would need to change accordingly. However, the lobby work and politics focus on agricultural law and subsidies (see section 7.5 Politics and the Search for a Legal Definition of Agroforestry).

The German agroforestry landscape is oriented towards agricultural practices which could entail that forestry based practices may not be considered agroforestry. The interviewee who keeps forest hogs had to *learn* that this practice is also considered agroforestry:

Interview excerpt 33

I: Would you describe forest hogs as agroforestry?

I-04: I sort of learned (laughs) that it IS agroforestry. Originally I didn't think of it as agroforestry. But I was visited by people from the DeFAF. (..) They visited me and then we just talked about it and they said I come under silvopastoral systems. That is, I was considered an agroforestry system, so to speak. For myself, I had not originally classified it as agroforestry. Now that I've looked a little bit more into the whole issue, I can see it, too. (.) Yeah, I mean, I'm kind of doing something agricultural in the forest. I try to push the tree species in the direction I need it for hog farming. Indeed, I see a certain relation to the agroforestry systems. But it is not this agroforestry system that I would have primarily thought of two years ago. I would have thought of short rotation coppices or something like that. (I-04, keeping forest hogs)

In this case, agroforestry indeed first perceived to not include forestal practices; rather the interviewee restricted it to short rotation coppices only. Whereas the lobbyist advocates a broad definition, the practitioners tend to have surprisingly narrow definitions of what agroforestry is. On the other hand, the definitions were also not made by them but they must have perceived them through media, articles, lobby work etc. Hence, their perception reflects mostly a definition that has been created by others. I-04 had first a very narrow definition of agroforestry, i.e. short rotation coppices for energy wood. When the lobby group approached this interviewee, s/he could widen his definition and perceive his own practice also as agroforestry. However, it sounds as if s/he still does not feel at home there. Probably this is linked to what the lobbyist said; that agroforestry *could* be very broad and incorporate practices in the forest, but that the lobby group focuses on practices on arable land. They surely disseminate this very picture to the public and also to farmers so that it eventually does not resonate with their own practices.

Secondly, in another case, agroforestry equals also short rotation coppices or the production of energy wood but the *intention* differentiates it from other fast-growing tree plantations. Next to I-04, also the energy wood consultant, I-05, explicitly defines agroforestry as alley-cropping only:

Interview excerpt 34

I-05: This was our way to the fast-growing tree species. Basically, whether we're supervising fast-growing plantations or agroforestry systems now, those are more or less nuances for us. Because basically agroforestry systems are, as a GENERAL

rule, alley-cropping of woody plants in interaction with annual crops. But as far as our service is concerned or our activity, also the planting material, there is no difference. (I-05, agroforestry consultant and planner)

Here, the definition does not revolve only around the *type of practice*, i.e. fast growing trees on arable land, but also the *intentional interactions* between trees and arable crops are decisive. Energy wood plantations and agroforestry grow the same product, i.e. fast growing trees for energy wood but there is one difference: The former only produce wood, whereas the latter produces wood *and* the trees and crops influence each other (positively). In this case, agroforestry is restricted to the practice of alley-cropping but with the requirement that trees and crops should influence each other.

Thirdly, agroforestry systems can be classified according to their *complexity*. Towards the end of the interview, I-05, who first classified agroforestry as alley-cropping (see interview excerpt 34), recognizes other movements in the agroforestry sector focusing on more diverse systems:

Interview excerpt 35

I-05: Well, we come from the (..) scaling actually, so that we scale down to the agroforestry systems and now agroforestry systems actually have to become more complex and more diverse and smaller and so on. And other consultants, they actually come from an even more complex whole and are now confronted with agriculture, which looks quite one-dimensional and the farmers are really constrained that they can't — even if they wanted to, they couldn't make it so super diverse. But especially if you are from permaculture or from university education and have been taught about these complex ecosystems, when you deal with agroforestry and you are suddenly supposed to only plant a poplar strip — that is close to physical pain for them. (I: Oh.) Because they simply know that it can be done much, much better and much, much more complex. But for the farmer, unfortunately, the poplar strip is already too worn and too freaky, right? That's the dilemma, that there's a lot at odds. (I-05, agroforestry consultant and planner)

Put in other words, agroforestry could also be seen as a gradient between very complex and simpler systems. That means that the third dimension of agroforestry is *complexity*. Additionally, the consultant already suggests that different ideas and capabilities regarding complexity might lead to controversies.

Fourthly, the organic farmer, I-02, implicitly holds a definition depending on *intensity*. S/he cultivates meadow orchards but apparently does not consider them agroforestry. The fruits do not contribute to the farm income, they are often harvested together with volunteers. On the other hand, the farmer argues that both agriculture and agroforestry aim at maximizing biomass production on the field. This implies that — for this farmer — extensively managed meadow orchards are not agroforestry, and agroforestry in turn is intensively managed. I-03, however, witnessed that nature conservationists center on meadow orchards when discussing agroforestry — *because* they are managed extensively.

Fifthly, agroforestry systems can also be classified according to the *products* they produce. I-09, who owns a walnut plantation, only considers wooden products to fit into agroforestry whereas meadow orchards do not. Meadow orchards usually produce fruits but walnuts could be produced in a similar system (trees on grass land). She does not consider her practice to be agroforestry:

Interview excerpt 36

> *I: Would you call walnut cultivation an agroforestry system? Do you use that term?*
>
> *I-09: When I planted this, I didn't know what agroforestry was. I didn't plant that with that ulterior motive. I get that it's basically the same thing, or has similarities (laughs) definitely, but I don't think I would present it that way (breathes), simply because the trees were not planted with the main purpose of value timber. Actually, I also want to use the wood, I also raise the trees so that they grow a high-quality trunk that I can market as value wood afterwards. But valuable wood production on arable land is for me really the basic core of agroforestry. That happens with me, but () secondary. So — yes. Nut production is really in the foreground.* (I-09, walnut farmer)

In her eyes, agroforestry systems focus on the wooden products itself and not on food products. She mentions only valuable wood, but most probably this would also include energy wood and wood for material use but exclude trees for food production — although they all face the same legal constraints. In contrast to that, I-06 and I-08, who both also produce nuts, call their practice agroforestry. They do not limit agroforestry to wood production.

I-08 also differentiates based on products, but for her the decisive factor is whether food is produced or not. She wondered why the (legal) definition should depend on the number of trees and not on the fact that the system produces food:

Interview excerpt 37

> *I-08: One fear that I had at that time, when I read the definition draft for a law (sighs) — I was a bit concerned that it would again only recognize too simple agroforestry systems as such and again only too few numbers of trees, for example. And (breathes) instead of simply saying, quite simply, as soon as food or eatables are produced on the area, it is agriculture — and the food is somehow sold or so, right? (sighs) This would make much more sense than if you limit it to a certain number of trees, right? (sighs)* (I-08, community farmer)

Although both I-08 and I-09 produce walnuts, one would not consider this system agroforestry *because* it produces food whereas the other would consider trees on agricultural land agroforestry *as soon as* they produce food. Yet they share the *product* as the decisive factor and their positions can be considered the two extremes on a gradient.

So far, the interview excerpts made clear that practitioners define agroforestry based on five different categories: the *type of practice*, *intentionality*, *complexity*, *intensity*, and *products*. Each category is a gradient and practices can be more or less complex, more or less intense. Each agroforestry system will therefore be represented by a particular line in the classification system (figure 11). When the definition of agroforestry emanates from the *type of practice*, it can either be very broad and incorporate all agricultural practices in the forest or all forestry practices on agricultural land. Or agroforestry can be defined very narrowly, e.g. incorporate only alley-cropping. Additionally, the question of *intentionality* plays a role, i.e. were the trees and crops planted with the intention to mutually influence each other? Concerning complexity, systems can either include only two components, e.g. poplars and barley, or many different components, e.g. trees, scrubs, bushes, herbs, vegetables etc. in a forest garden. The intensity concerns biomass output. Alley-cropping systems are usually considered to be managed more intensely than meadow orchards or hedges. Finally, the products, one wants to produce, play a role. They can range from energy wood, over high-grade wood and wood for material use to edibles like fruits and nuts or livestock for animal products.

Literature already offers several classification possibilities and organizes agroforestry systems according to their components, spread, management, function or structure in space and time (see section 2 The Case of Agroforestry). This classification scheme applies to agroforestry systems around the world. The new classification system discussed in this section adds five new dimensions which can be considered most important for the German agroforestry landscape as they are derived from the empirical material and grounded in the interviewees' perceptions of agroforestry in Germany.

For I-05, the historical development can explain why so many different ideas waft around

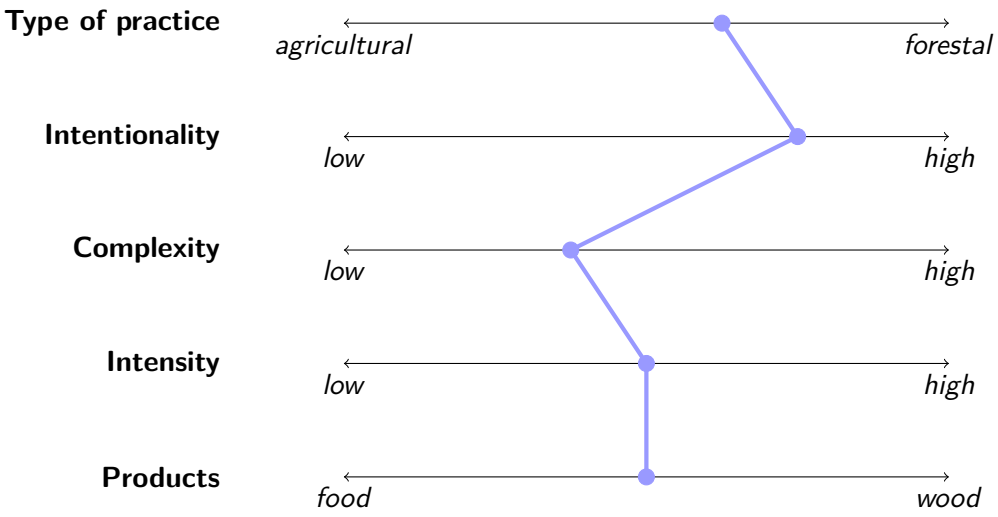

Figure 11: A new classification system for agroforestry in Germany based on the categories of *type of practice*, *intentionality*, *complexity*, *intensity* and *products*. Each agroforestry system would draw a line across the five levels. The blue line could represent the practice of forest hogs, for example.

about what agroforestry actually is. Some years ago, Europeans considered agroforestry to be a tropical practice. When it reached Germany, it was mostly in the form of alley-cropping systems so that practitioners would not relate any other practices to this term. Only recently, the term agroforestry expanded also to different practices like poplars in chicken runs:

Interview excerpt 38

I-05: 10 years ago, when people talked about agroforestry in Germany, they thought mainly of tropical agroforestry systems and (...) maybe meadow orchards. But these modern agroforestry systems, where woody plants are now being cultivated in interaction with annual crops in an alley-cropping system, that's a — I'm not saying that this didn't exist before or that no one had thought about it in any way, but that it has a relevance and is known in agriculture, that's really a process that actually only started maybe four years ago. Also this offer with the chicken forest. We have a small information website, which we did not develop under agroforestry at that time. That would have been only an additional, perhaps also confusing term. It was simply poplars, fast-growing trees on chicken run areas. Now we entitle it differently, as an amazing agroforestry system, but definitely, five years ago the term agroforestry was known to very few farmers. Or at least that they could not imagine that it had anything to do

with their own way of farming. (I-05, agroforestry consultant and planner)

Seemingly, the proliferation of alley-cropping in recent years shifted the focus on this special practice — and ousted other practices. Similar to this report, we also witnessed in the interview excerpts above that practitioners often were either not familiar with the term agroforestry or had mostly alley-cropping systems in mind when they started their practices. This is not by chance. The focus in politics and research in recent years was indeed on silvoarable practices as most of the scientific research projects focused on silvoarable practices and so will the political framework in the near future (7.5 Politics and the Search for a Legal Definition of Agroforestry and 7.6 Research Projects.)

Having said that agroforestry systems in Germany can be classified by five criteria, actors do not necessarily stick to one definition but switch seamlessly between various definitions. A petition on agroforestry was debated in the German parliament on January 13th, 2021 (BT, 2021a). The petition should promote agroforestry as a legal *agricultural* practice that can be subsidized by agricultural funding. To canvass the petition, Isabel Mackensen-Geis delivered a speech where she described what agroforestry is and detailed about a field trip:

> What is agroforestry? A multifunctional land-use system; we have already heard that. You are all familiar with meadow orchards; here, for example, fruit trees and grazing sheep meet. So it's a combination of different land use systems that have already existed [...] for centuries. The task now is to bring this system back to the present time. There are modern agroforestry systems that are primarily production-oriented. The plantation here is not jumbled up like in meadow orchards, but it is laid out in rows so that it can also be cultivated by machines. The advantage here is that the ecological benefits of climate and environmental protection, which have already been described — keywords are "humus formation", "carbon sequestration" and "biodiversity" — are nevertheless maintained. This is a very great system. [...]
>
> Last weekend, I took another look at what the whole thing looks like in practice in Ebertsheim in the Palatinate. [...] There are Hannah and Jessy Loranger, PhD biologists, who started to implement the project of a forest garden in 2018. This was a great opportunity, even though it was winter now; it was a little sad that we couldn't see all the diversity. But it was interesting nevertheless. They specifically chose a meadow orchard that was particularly distressed. The soil was parched, and the trees no longer bore much. With the forest garden they created in 2018, they managed to develop an incredible humus buildup and soil

> looseness, and I was able to see for myself — even in winter — how great these systems are. So I'm very positive that we're doing something right with this motion, going in the right direction. (own translation, BT, 2021b, 25563, A–D)

The speaker seamlessly switches between different definitions of agroforestry sytems. Isabel Mackensen-Geis first refers to the traditional practices and then argues that agroforestry has to be introduced into the 21st century. It has to be managed as a modern land-use system, cultivated with machines and oriented towards productivity. When she speaks about personal impressions, she refers to a visit in a forest garden in Palatinate. This case might only bear few or none of the characteristics of a "modern" agroforestry system (mechanization, productivity, etc.) she described before. Additionally, the practitioners might not benefit from a changing political framework since they are no farmers and do not receive agricultural subsidies.

Indeed, the classification system I proposed offers different dimensions than a possible legal definition. The DeFAF emanated from the AUFWERTEN project in 2019 and tries to shape this process by recommending a legal definition. In *Development of a controllable definition for agroforestry*, project members of the AUFWERTEN project (2014–2019) propose:

> An agroforestry plot is an agricultural parcel (as defined in §4 (1) IACS [26] with reference to §3 (1) No. 2 IACS) on which an agroforestry system is established, whereby the proportion of the woody crop area to the total area of the agricultural parcel may be between 2 and 40% and the distance between two woody crop areas or between the edge of the parcel and the woody crop area closest to it may be a maximum of 100 meters. (AUFWERTEN, 2017, p. 4, own translation)

Contentwise, the proposal regards only trees on arable / grass land as agroforestry and suggests a number of trees, their respective distance as well as the distance towards the parcel border. The proposal might have changed over time. Whereas the practices of some interviewees would be included in this definition, the practices of others would be excluded, e.g. forest hogs.

8.3.2 Analysis: The Consequences of Classification

Some instances show that the different standpoints towards the definition of agroforestry can also create conflicts. At first sight, agroforestry could again be described as a boundary

[26] Integrated Administration and Control System Ordinance

concept (Star and Griesemer, 1989) that encompasses many different definitions and practices at the same time and that allows people to switch seamlessly between different — and distinct — nuances. However, not all practitioners consider their own practices to be included in agroforestry although this would be possible. I-05 also mentioned that "there's a lot at odds" due to the different visions what agroforestry is or ought to be. Interviewee I-08 who runs a highly diverse agroforestry system feared that agroforestry might legally be defined too narrowly when it depends on the number of trees (see interview excerpt 37). Did the boundary object fail?

Bowker and Star's concept of classification showed that Classifications are not images of reality, rather are they artificial and artistic interpretations, which themselves produce social realities (Bowker and Star, 1999; Schubert, 2017). Agroforestry in Germany is an emerging topic and yet no final (legal) definition exists. Therefore, actors create their own definitions mediated by the image that the lobby group, media articles, scientific projects, politics etc. (i.e. the German agroforestry landscape in general) creates. Politics is close to set a legal definition that will make several systems eligible to funding — whereas others will come away empty-handed. A legal definition would (at least for a certain amount of time) fix the characteristics and boundaries of agroforestry. I proposed a comprehensive classification system for agroforestry in Germany (see figure 11) but the legal definition will most probably focus on a specific set of systems and not the whole variety. The scientific project AUFWERTEN produced a draft for a controllable definition that focuses on tree densities and distances from the plot border (AUFWERTEN, 2017). If this will be established as the political framework, practices like hog farming, that are not silvoarable in nature, will become excluded from the definition. Therefore, the way agroforestry will be classified (legally) in the future will determine who considers their practices to be agroforestry and who not — even more so than now. Then the classification system rendered practices invisible.

The definition of agroforestry might become a failed boundary object when it is not able to account for the heterogeneous social world of agroforestry in Germany. As a "good" boundary object, the agroforestry definition as a common base should enable the cooperation between different social worlds that get in touch but do not merge, for example lobby groups, practitioners, nature conservationists, politicians etc. However, some voices will be made invisible by the classification system and they will not be represented at the informational level, not in surveys, nor in statistics nor in the media in the long run. This type of political ignorance can indeed create problem situations when a practice could be identified as agroforestry but does not comply with the narrow political definitions. Bowker and Star referred to infrastructures like the Nursing Interventions Classification (see section 4) when they concluded that most modern information infrastructures are not good border

infrastructures since they do not account for the heterogeneity of social worlds. However, both legal definitions and information infrastructures have one thing in common; they act as non-neutral means because they influence social realities — therefore they must constantly be challenged for their moral and political dimensions.

8.3.3 Conclusion: Narrowing Different Ideas Down in one Legal Definition

Based on the interview excerpts, practices in Germany can be classified according to the *type of practice*, their *intentionality, complexity, intensity* and the *products* they produce but the interviewees did not agree on what is agroforestry and what not. Different people consider different things (not) to be agroforestry, also depending on their background and their mission. When agroforestry will be inscribed into a legal definition, this will set the boundaries for the years following. However, this also means that some practices will be included whereas others will be left out. For the practitioners, it might even determine if they can perceive their own practices as agroforestry or not. It will produce a social and also an economic reality insofar as the legal definition decides upon who is eligible for funding and who not.

9 Conclusion: Agroforestry at the Eve of an Official Definition

Historically, agroforestry practices emerged a few thousand years ago and declined when agriculture scaled up. In Germany, meadow orchards survived due to special legal protection as relics of traditional systems. Today, agroforestry is practiced — in traditional, redesigned and new forms — but on a small scale in Central Europe; only in France it received greater attention. According to literature, mainly silvoarable systems will be promising in the (near) future due to sustainability and economic reasons, but looking at the German *agroforestry map* showed that many agroforestry systems are actually maintained for animal welfare and ecological balance. Although literature suggests that modern agroforestry systems in Central Europe are mainly alley-cropping systems, the interviewees understood quite different practices by the term. Their conception led to a new way of classifying agroforestry practices, within the five categories of *type of practice*, *intentionality*, *complexity*, *intensity* and *products*. The *neo-practitioners* haven often already been sensitized when they encountered the idea to practice agroforestry. They share a certain world view that current agricultural or forestal practices entail certain downsides which can be solved with agroforestry practices. Hence, agroforestry is often seen as an alternative practice that can provide a solution to a specific problem — whereas the practices, problems and solutions can indeed vary. On

their trajectory, the actors did not only change their practices, they have also been changed by their practices, e.g. do they perceive ecologic or economic values differently. Essentially, the actors also perceive the meaning and the importance of economy and ecology differently. Whereas to some, economy means increased profitability which is therefore the basis of agroforestry, to others, economy means *living on one's work* and is therefore only one of many pillars in agroforestry. Ecology, on the other hand, can be either a pleasing side product or a reason and goal for practicing agroforestry. Overall, we have to keep in mind that the practitioners right now are all pioneers in their field. Their motivations, trajectories and points of view can change if (or when) agroforestry gains momentum and brings more practitioners aboard.

I started out from a nature conservation point of view. I read Büscher and Fletcher's *The Conservation Revolution: Radical Ideas for Saving Nature Beyond the Anthropocene* (2020) that proposes exactly that: Radical ideas for nature conservation beyond the Anthropocene. A new model of conservation is proposed, *convivial conservation*, i.e. to conserve nature there where humans live, in conviviality. The idea is to leave established conservation models (like protecting "pristine" nature from humans by putting a fence around it and making nature a so called protected area) behind because it did not work — biodiversity is still on decline. The reason is that established nature conservation models ground upon two problematic assumptions: (a) humans are epistemological and ontological different from nature and (b) a capitalist development model that demands continual growth via intensified consumerism. Both are historically intertwined and continue to reinforce each other. The need to enclose spaces *for* nature developed with the enclosures of the English commons in the 16th century, which sparked the capitalist economic system. Henceforth, nature conservation and the capitalist system developed side by side.

For convivial conservation, Büscher and Fletcher reject these two ideas of looking at the world and demand a fundamental transformation. One concrete action would be to promote *integrated conservation landscapes*, that means areas where humans, animals, plants and all other non-humans can live in cohabitation. Can agroforestry be such an integrated conservation landscape, where production and conservation is possible on the same space? At first sight, the answer was clearly: Yes! These are actually quite the arguments that are used to promote agroforestry in Germany. For an STS researcher, this is not enough, of course. So I set out to listen more closely to what the actors have to say about conservation, production, humans, nature and capitalism. I set out to map the agroforestry landscape in Germany.

After the research, the answer changed from: Yes! to: Yes, but... Yes the agroforestry systems in Germany in all their diversity can harbor both production and conservation. But:

The institutionalization does not ground on production and conservation equally. The movement started with foresters who wanted to grow more trees when the price for oil (and thus also for bioenergy) was high. The forests projected that there is not enough space for additional wood in the forests, so they emigrated to the agricultural area. The farmers they brought on board, however, had either different ideas or were to meet obstacles. If one wants to do agroforestry for profitability, the legal hurdles are very high. Agroforestry is still not recognized as a type of land-use so that a lot of bureaucratic work awaits the transitioning farmer. This might be the reason why all the practitioners in my sample reported different ideas. They had the mission to produce walnuts and exotic fruits regionally, to keep up with the times of changing climate, to do something good for their animals or to create retreats for wild animals. However, they mostly had very concrete ideas concerning themselves, their animals or their closer surrounding; concerning things they could *see* like soil that got eroded, droughts that harmed the yield, sheep that suffered from the heat or concerning *imagined* things like closing habitat gaps without referring to concrete wild animal species or even individual animals. This means that the benefits of agroforestry systems will concern themselves, their close surroundings and a more or less unspecific nature. It was not brought up that human-animal conflicts could be resolved through agroforestry. A wolf stays a problematic wolf for sheep, and a beaver stays problematic as well. However, the practitioners did also not jump in on the bandwagon of intensification and productivity. They did not position their practices towards increasing yields, although the scientists and scientific literature projected exactly that. On the other hand, only one interviewee critiqued the capitalist economic system as a whole. Interestingly, all of them referred to the problems it caused, like mono-cropping on huge fields, intensive use of pesticides and fertilizers, that regional structures and hand-work or labor intensive systems are not economically feasible or that hedges had been removed to increase the field size. But no interviewee named the capitalist system as the root cause, except one who envisioned to overcome this system as a whole. Scientist however rather embraced the paradigm of growth and intensification as a means to legitimize agroforestry as a *serious* productive system.

> "The major challenges for mankind in the new millennium are linked to the perfect storm, i.e. the production of more food in the face of climate change, dietary change, population growth and the loss of biodiversity. Agroforestry is a land-use system that has the capacity to provide solutions. However, this will only be achieved if the right species are combined in the right place in the correct spatial and temporal configurations. It is not diversity per se that is important in agricultural sustainability, but diversity with functional integrity. This functional

> integrity, especially in agroforestry systems, can only be understood with further research on mechanisms at many scales." (Newman and Gordon, 2018, p. 295)

As the world today, agroforestry is also a complex topic that needs to be understood on different scales. Some scales like nutrient cycles, yield increase and economic consequences have already been investigated partially. Other scales like effects on biodiversity, rural development or (economic, social and environmental) resilience have been overlooked so far. Although modern agroforestry is imagined to be efficient and to be working with technological equipment, many authors refer to the long history of agroforestry practices and elaborate on the traditional practices — it does not seem to be a contradiction. Rather, modern agroforestry takes up old practical knowledge and advances it with science and technology. The new practices need to form their own niche as the political and legal frame was unfavorable for many decades.

In the process of institutionalization, Germany is close to acknowledge agroforestry as an official land-use system which can be subsidized. What will this mean? Most probably, the definition will depend upon the number of trees growing on agricultural land, which excludes practices in the forest right from the beginning. Additionally, the legal definition will rearrange the agroforestry landscape in Germany. Not everything that counts as agroforestry today will count as agroforestry tomorrow. Hence, classification is also world making. Therefore, it was a precious moment to conduct this research at the eve of *officially defined* agroforestry. If a similar study will be done in several years, when the practice is more established, the findings can paint a completely different picture.

A Tables

Table 4: Share of agroforestry actors in Germany, compiled from the *agroforestry map* (DeFAF, 2021a) (*Status: Sept 27, 2021*)

Actor	**Number**
Agroforestry plot	102
Scientific institution	11
Information or education center	3
Prospective practitioners	5
Total	121

Table 5: Around 20 national agroforestry organizations throughout Europe are represented in the EURAF (adopted and extended from Dupraz et al., 2018).

Country	**Acronym**	**Long form**
Belgium	AWAF	Association pour l'Agroforesterie en Wallonie et à Bruxelles
	WERVEL	Werkgroep voor een Rechtvaardige en Verantwoorde landbouw
Czech Rep	CSPA	Český spolek pro agrolesnictví
Denmark	POL	Plantning og Landskap
France	AFAC AFAF	Association Française Arbres Champêtres et Agroforesteries Association Française d'Agroforesterie
Germany	AG DeFAF	Agroforst Deutschland Deutscher Fachverband für Agroforstwirtschaft
Greece	HAN	Ελληνικό Αγροδασικό Δίκτυο (Hellenic Agroforestry Network)
Hungary	MASZ	Magyar Agroerdészeti Szövetség
Italy	AIAF SISEF	Associazione Italiana Agroforestazione Società Italiana di Selvicoltura ed Ecologia Forestale
Netherlands	AN	Agroforestry Nederland
Poland	OSA	Ogólnopolskie Stowarzyszenie Agroleśnictwa
Portugal	CEF	Centro de Estudos Florestais (ISA, UL)
Spain	AGFE	Asociación Agroforestal Española
Sweden	PS ANNC	Permakultur Sverige Agroforestry Network for Nordic Climates
Switzerland	IG Agroforst	Interessensgemeinschaft Agroforst
UK	FWF	Farm Woodland Forum

Table 6: Share of agroforestry systems, species and usage in Germany, compiled from the *agroforestry map* (DeFAF, 2021a) (*Status: Sept 27, 2021*). One farm can grow several tree/shrub/crop species so that the cumulative number of species outruns the total number of agroforestry systems.

System	Tree species		Tree usage		Shrub species		Shrub usage		Main crops		Farm animals	
Silvoarable: 31	walnut	16	fruits / nuts	18	hazelnut	7	ecol. impact	10	wheat	7		
	apple	12	stem wood	14	elderberry	7	fruits / nuts	8	potatoes	5		
	service tree	12	energy wood	8	rosehip	7	material use	6	rye	4		
	sorb tree	11	ecol. impact	8	sea buckthorn	6	energy wood	3	field grass	3		
	chestnut	10	material use	4	other [27]	12	stem wood	1	vegetables	3		
	cherry	10							corn	1		
	pear	10							other [28]	13		
	plum	9										
	poplar	9										
	other [29]	17										
Silvopastoral: 59	poplar	30	energy wood	30	blackthorn	9	ecol. impact	12			chicken	40
	cherry	18	fruits / nuts	21	elderberry	8	energy wood	6			cattle	6
	apple	17	material use	18	hawthorn	8	fruits / nuts	5			sheep	5
	walnut	15	ecol. impact	6	rosehip	7	material use	5			pigs	1
	plum	12	stem wood	6	blackberry	7	stem wood	0			other [30]	14
	willow	7			hazelnut	7						

Continued on next page

[27] quince, hedge, flowering shrubs, currant, gooseberry, goji berry, loganberry, jostaberry
[28] cereals, grassland, flower seeds, crop rotation
[29] tree hazel, red oak, sessile oak, mulberry, apricot, nectarine, medlar, wild cherry, pine, douglas fir, silver fir, peach, almond, etc.
[30] red deer, geese, horses

System	Tree species		Tree usage		Shrub species		Shrub usage		Main crops		Farm animals	
	other	12			other	12						
Agrosilvopastoral: 12	poplar	7	energy wood	6	cornelian cherry	4	fruits / nuts	5	vegetables	3	chicken	9
	alder	5	fruits / nuts	6	sea buckthorn	3	ecol. impact	2	corn	2	cattle	5
	walnut	5	ecol. impact	6	other	4	material use	1	wheat	2	sheep	2
	willow	4	material use	3			stem wood	1	other	4	pigs	2
	apple	3	trunk wood	2			energy wood	0				
	pear	3										
	other	7										

Table 7: Agroforestry projects between 1995 and 2024, initiated and/or funded by EU and Germany. The focus is mostly on silvoarable systems (adopted and extended from Dupraz et al., 2018).

Acronym	**long form**	**Run time**	**Chairman**	**Website**
ALWAYS	Alternative land-use with agroforestry systems	1995–1998	Daniel Auclair	not available
SAFE	Silvoarable Agroforestry for Europe	2000–2005	Christian Dupraz	www1.montpellier.inra.fr/safe/
–	agroforst	2005–2008	Prof. Dr. Heinrich Spiecker	www.agroforst.uni-freiburg.de/index.php
–	Development and testing of an agroforestry system for energy wood production in organic agriculture	2009–2018	Thomas Huber, Dr. Herbert Borchert (LWF); Dr. Klaus Wiesinger (LfL); Andrea Winterling	www.lfl.bayern.de/schwerpunkte/oekolandbau/080198/index.php
AGROCOP	Combining Agroforestry and Short Rotation Coppice	2012–2015	Michael Nahm	not available
SUSTAFFOR	Bridging effectiveness and sustainability in afforestation	2013–2015	Miriam Piqué	www.sustaffor.eu
AGROFE	Agroforestry Education in Europe (not a research project per se)	2013–2015	Charles Burriel	not available

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Acronym	**long form**	**Run time**	**Chairman**	**Website**
AGFORWARD	AGroFORestry that Will Advance Rural Development	2014–2017	Paul Burgess	www.agforward.eu
AUFWERTEN	**A**groforstliche **U**mweltleistungen **f**ür **Wert**schöpfung und **En**ergie	2014–2019	Dr. Christian Böhm	www.agroforst-info.de/innovationsgruppe-aufwerten/
AGROMIX	stands for mixed farming and agroforestry systems	2020–2024	Dr. Sara Burbi, Centre for Agroecology, Water and Resilience, Coventry University	www.agromixproject.eu
MIXED	stands for mixed farming and agroforestry systems	2020–2024	Tommy Dalgaard and Lise Andreasen, Aarhus University (Denmark)	www.projects.au.dk/mixed/

B Interview Guideline

1. First, please describe your job. What do you do exactly? What is your daily work routine like?
2. How long and how intensively have you been involved in agroforestry? How did you get into it? Why did you choose agroforestry and not another field? What does agroforestry mean to you personally?
3. What opportunities and possibilities do you see in agroforestry in Europe, the Global North and worldwide?
4. How do you think the field AF is divided? Are there different areas?
5. How are you connected within agroforestry? Are you a member of a lobby group?
6. How does the lobby group represent the field? Do you feel represented?
7. How are the Global South and the Global North connected?
8. What is the importance of biodiversity in agroforestry?
9. What is the role of nature conservation in agroforestry?
10. What is the role of productivity in agroforestry?
11. In your opinion, how does AF relate to industrial agriculture?
12. Are you familiar with politics? Can you describe the political system that takes care of regulations for agriculture in general?
13. Are you directly involved with policy instruments?
14. What policy measures or incentive schemes would be needed to establish more agroforestry in your opinion?
15. What is the scientific landscape like in AF?
16. What is the focus of research?
17. What would you like your students to learn in the agroforestry lecture?
18. What is the reception in the general population? Are there any reactions? If so, what are they like?
19. To whom do you sell your products?
20. Do gender roles have any importance in AF? In what way?
21. *In a perfect world...*
    (a) ... what would agroforestry look like?
    (b) ... what would agriculture look like?
    (c) ... what would your work look like? Are you satisfied with your work?
22. Did you lack a question? What did I not cover with my questions?
23. Can you recommend any other contacts for me?
24. May I come back to you again if needed?

Table 8: The term agroforestry appeared in 1986 for the first time in EU legislation. The most important references thereafter are summarized here (adopted and extended from Dupraz et al., 2018).

Year	Resolution	Content
2005	European Agricultural Fund for Rural Development Regulation (1698/2005)	first grant assistance to new areas of agroforestry
2006	EU Forest Action Plan (COM(2006) 302 final)	encourages member states to promote agroforestry systems
2009	Report on EU Agriculture and Climate Change, EU Parliament Committee on Agriculture and Rural Development (2009/2157(INI))	recommends that 'agroforestry, hedges, wooded areas on farmlands and reforestation' are important for carbon sequestration on EU farmland
2012	European Parliament Resolution (20/4/2012) on the 6th Environment Action Programme (2011/2194(INI))	recommends promoting agroforestry as a rural development policy leading to sustainable landscapes
2013	European Agricultural Fund for Rural Development Regulation (1305/2013)	two articles for the creation of new agroforestry areas on agricultural land (Article 23) and forest land (Article 21b). Article 23 of Regulation 1305/2013 provides a legal definition of agroforestry: "Land use systems in which trees are grown in combination with agriculture on the same land. The minimum and maximum number of trees per hectare shall be determined by the Member States taking account of local pedo-climatic and environmental conditions, forestry species and the need to ensure sustainable agricultural use of the land." (EP, 2013)

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Year	Resolution	Content
	CAP direct payments regulation (1307/2013)	includes agroforestry as a type of Ecological Focus Area.
	7^{th} Environment Action Programme to 2020 (Decision 1386/2013/EU)	stresses the environmental benefits of 'sustainable agroforestry'
	Commission's European Forest Strategy (COM(2013) 659 final)	mentions the importance of agroforestry in Rural Development
2014	the European Parliament's Report on the EU Forest Sector (AGRIA8-0126/2015)	emphasizes the importance of agroforestry, especially for carbon sequestration and fire reduction
2017	the European Union's Horizon 2020 research and innovation program — LC-SFS-19-2018-2019: Climate-smart and resilient farming	emphasize and funds environment and climate-smart food production and consumption.

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