Research Report

From Monoculture Farming to Agroforestry Systems: Exploring Transition Barriers and Solutions for Farmers in the Netherlands

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Abstract

Agroforestry farming incorporates trees and shrubs, which offers a wide range of benefits like soil regeneration, carbon capture, and prolonged yields. Current agricultural practices however prioritize monoculture for its efficiency and scale. This comes at an environmental cost, causing biodiversity loss, groundwater acidification, and soil exhaustion. Agroforestry adoption is low, and potential barriers are hindering the transition from monoculture to agroforestry. While monoculture is prevalent in the Netherlands, research on barriers to adopting agroforestry is lacking, and findings from other regions may not directly apply. This study addressed this gap by examining barriers perceived by Dutch farmers and potential solutions. Through 12 semi-structured interviews using qualitative methods, insights were collected from farmers practicing monoculture, transitioning, or engaged in agroforestry. Thematic analysis, as well as applying the Theory of Planned Behavior to social barriers, revealed insights that can guide Dutch farmers toward sustainable profitability and aid the government in developing strategic support for a transition to a sustainable food system.

Contents

Introduction

Background of Research

Monoculture, the cultivation of a single crop or breeding one livestock species, contrasts with agroforestry, which combines trees and shrubs with arable land or with livestock (Smith et al., 2012). The prevalence of monocropping stems from its scalability, simplified management, and harvest convenience, driven partly by global food system trends favoring fewer crop varieties (Wilson & Lovell, 2016). Despite providing most of our food calories, monoculture contributes to soil depletion, heightened disease and pest risks, and increased pesticide use (Balogh, 2021). This practice diminishes plant diversity, impacting animal biodiversity that naturally controls pests and weakens crop resilience to diseases (Newton, 2016). The impact of monoculture farming extends to climate change, raising concerns about land degradation and its consequences on nutrition security, quality of life, and climate resilience (Saqib et al., 2019).

Agroforestry offers a solution by enhancing food system diversity, resilience, and ecological sustainability. Integrating trees into farming provides benefits like soil regeneration, prolonged yields, carbon capture, water retention, storm resilience, fire prevention, and increased biodiversity (Sollen-Norrlin et al., 2020). Additionally, agroforestry has demonstrated social benefits, including poverty reduction (Do et al., 2020). While agroforestry holds immense promise in fostering sustainable food systems and fortifying remote populations against global warming impacts, monoculture dominates current farmland, and possible obstacles might impede the desired transition (Burgess et al., 2022). In the Netherlands, most farmers engage in monoculture farming, with some adopting agroforestry, while the reasons for the non-adoption by others remains unclear.

Problem Statement and Research Objectives

The literature explores barriers to transitioning from monoculture to agroforestry, covering economic, social, political, and technical challenges. Despite global, regional, country, and provincial studies on agroforestry adoption, none specifically address the barriers faced by Dutch farmers. Notably, a knowledge gap exists in the Netherlands, with no identified study exploring adoption

barriers. Results from studies covering a set of other European countries, such as Rois-Díaz et al. (2018), and findings from country-specific studies like Tsonkova et al. (2018) and Sereke et al. (2016) are not directly applicable to the Dutch context. The reasons behind Dutch farmers' reluctance to adopt diverse agroforestry systems remain uncertain due to limited research in the Dutch agricultural context. This prompts the formulation of the following research objectives:

1) Exploring the perceived barriers hindering Dutch farmers' transition from monoculture to agroforestry.
2) Identifying solutions to these barriers as proposed by Dutch farmers.

Significance of the Study

This study supports SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 15 (Life on Land) by enhancing food security, reducing agricultural emissions, and promoting biodiversity. Addressing the need for change in the Dutch agricultural landscape, it aims to empower farmers to adopt agroforestry for long-term profitability and resilience. The findings can guide government strategies for sustainable food production and inform economic policies, including targeted subsidies for agroforestry farmers.

Literature Review

Transitions in Agriculture

To address the needs of a growing population, extensive forested areas underwent global-scale conversion to farmland. For heightened yields per hectare, intensive monoculture farming replaced traditional methods (Burgess et al., 2022), lowering production costs but leading to soil degradation and contamination from synthetic fertilizers and pesticides (Nguyen et al., 2021). In the latter half of the 20th century, European policy interventions drove the transition to industrial agriculture, prompting widespread large-scale monoculture farming that eliminated hedgerows and trees to clear the way for machinery (Sereke et al., 2016). Decades later, environmental impacts emerged, particularly in some European countries like the Netherlands. Despite possessing the EU's

most productive agricultural sector per unit of land, the Netherlands faces environmental challenges, featuring high ammonia emissions, nitrogen and phosphorus surpluses, and elevated pesticide use per hectare, as illustrated in Table 1 (Grinsven et al., 2019).

Table 1

Environmental pressure per hectare of agricultural land between 2010–2015 (Grinsven et al., 2019)

	Emission or use per hectare UAA (PCU for antibiotics): (Index 100 = mean value EU)							
	Pesticides use	**Antibiotics use**	**Ammonia emissions**	**N surplus**	**P surplus**	**GHG emissions**	**Mean score**	**Rank**
Austria	53	48	93	34	63	84	63	8
Belgium	198	140	199	206	109	245	183	24
Bulgaria	14	89	32	25	114	34	52	7
Croatia	61	94				62	72	12
Czech Republic	73	68	76	127	63	76	80	17
Denmark	57	38	110	129	92	128	92	20
Estonia	25	60	46	44	189	44	68	10
Finland	64	19	53	80	86	93	66	9
France	95	86	84	83	11	89	75	13
Germany	111	147	154	143	17	128	117	22
Greece	43	50	42	102	6	51	49	6
Hungary	66	187	57	64	46	38	76	15
Ireland	28	45	99	65	46	135	70	11
Italy	194	291	116	84	80	79	141	23
Latvia	30	33	30	14	11	45	27	1
Lithuania	37	31	45	23	40	50	38	2
Netherlands	236	68	242	286	195	329	226	25
Poland	64	121	75	78	46	68	75	14
Portugal	126	147	50	29	52	58	77	16
Romania	32	91	44	12	57	43	47	5
Slovakia	43	47	62	55	15	50	46	3
Slovenia	89	29	139	91	80	117	91	19
Spain	95	310	55	65	74	36	106	21
Sweden	30	11	64	65	29	75	46	4
United Kingdom	70	52	80	111	97	120	89	18
EU mean	2.48	115	24.3	57.9	4.37	3.06		
Unit	kg/ha	mg/PCU	kg/ha	kg/ha	kg/ha	tCO_2-eq/ha		

N and P surplus were negative in some countries and therefore the absolute value was used for indexing. Values for the small EU members states Cyprus, Luxembourg and Malta were removed from analysis. Use of traffic light colors of green, yellow to red for index values indicates decreasing sustainability.

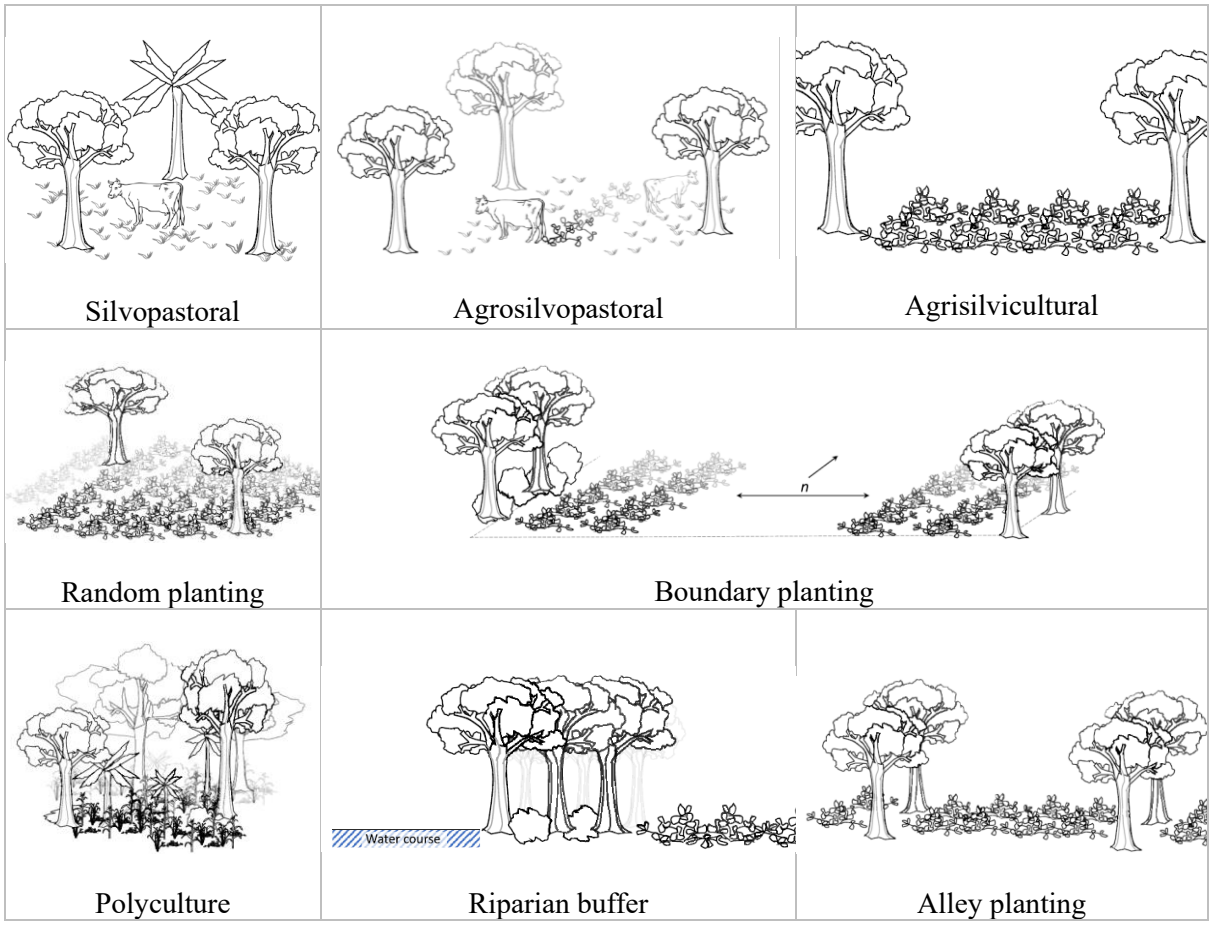
Agroforestry Farming

Before the rise of intensive monocropping, natural farming techniques were used to ensure soil health. An important element of these farming methods includes the use of trees in agriculture, referred to as 'agroforestry'. Agroforestry is an umbrella term that includes the use of woody, perennial species in combination with other crops or livestock. Examples of agroforestry are: *intercropping*, where an annual crop (e.g., maize) is alternated with a tree (e.g., hazelnut); *silvopasture*, where livestock is shaded by trees (e.g., sheep in an apple orchard); and *food forestry*, a

polyculture forest ecosystem of different layers (Burgess et al., 2022). The variations to introduce agroforestry in conventional farming are wide, as shown in Figure 1.

Figure 1

Variety of possibilities when introducing agroforestry (Burgess et al., 2022)



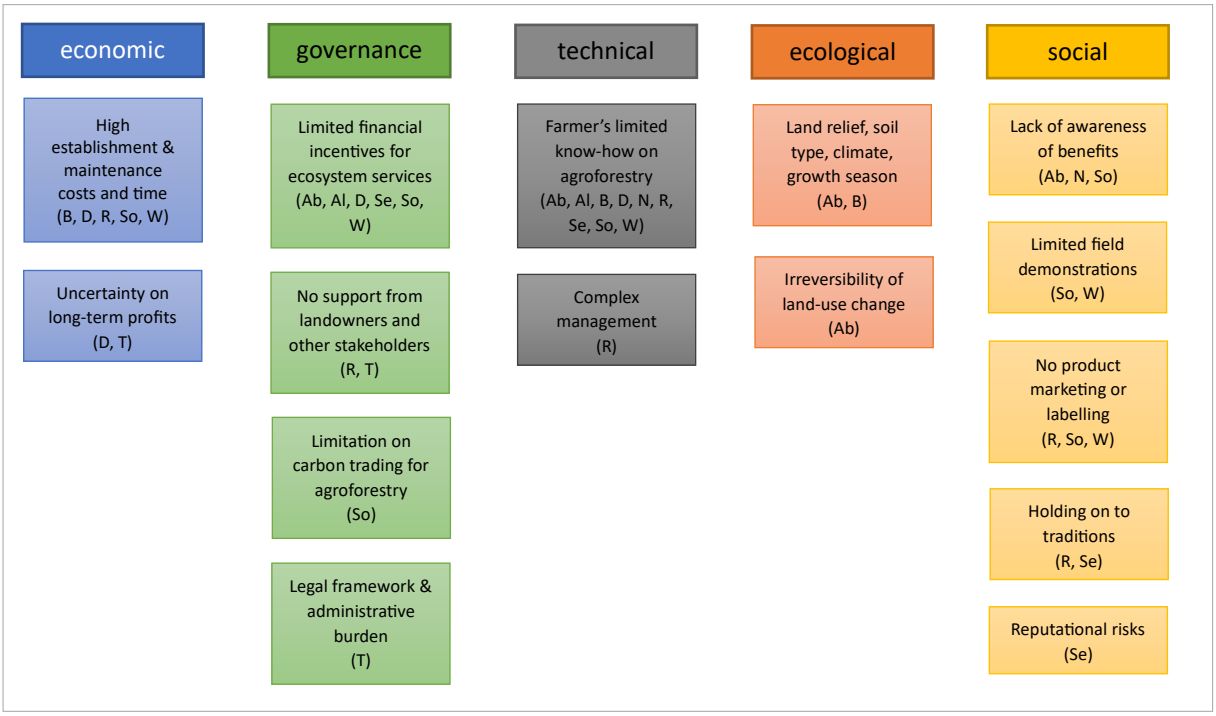
In addition to promoting sustainable food production, agroforestry offers vital environmental services in the face of climate change. Despite its numerous benefits, present farmland is predominantly monocultural. Hence, this literature review aims to explore barriers to transitioning from monoculture to agroforestry systems, aiming for sustainable food production.

Agroforestry Adoption Barriers

Agroforestry adoption barriers were extracted from ten journal articles and categorized into economic, governance, technical, social, and ecological challenges (see Figure 2).

Figure 2

Adoption barriers in agroforestry transition found in ten journals



Abbreviation	Author	Year	Research	Method	Location
Ab	Abdul-Salam et al.	2022	quantitative	model simulation	Scotland, U.K.
Al	Albrecht & Wick	2021	mixed	literature review, interviews, and site visits	Worldwide
B	Burgess et al.	2022	qualitative	literature review	Worldwide
D	Do et al.	2020	mixed	interviews, group discussions, model simulation	Vietnam
N	Nguyen et al.	2021	qualitative	surveys and interviews, theory of planned behavior	Vietnam
R	Rois-Díaz et al.	2018	mixed	interviews, narrative thematic data analysis	Europe
Se	Sereke et al.	2016	mixed	interviews, theory of planned behavior	Switzerland
So	Sollen-Norrlin et al.	2020	qualitative	literature review	Europe and beyond
T	Tsonkova et al.	2018	qualitative	interviews	Germany
W	Wilson & Lovell	2016	qualitative	literature review	Worldwide

Note: *Letters between brackets show the source, indicating whether the findings were individual or shared across literature.*

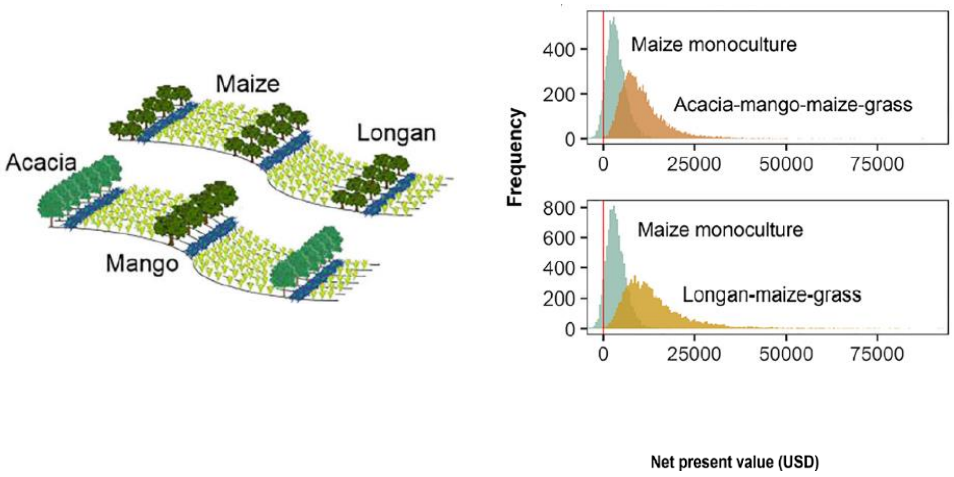
Economic

A prevalent theme in literature revolves around economic barriers. Farmers typically favor short-term profits from annual crops, while agroforestry entails *high initiation* and *maintenance costs* (Sollen-Norrlin et al., 2020; Wilson & Lovell, 2016). Farmers anticipate that initiating agroforestry will be *time-intensive* (Rois-Díaz et al., 2018). Do et al. (2020) conducted a decision analysis, quantifying the net present value (NPV) of long-term agroforestry projects (Figure 3). According to

the model, agroforestry requires at least 2-3 years to become profitable. However, the model's reliability depends on discount rates, yield, and prices, necessitating further investigation to reduce *uncertainties regarding long-term profits*.

Figure 3

Example of NPV analysis for maize-agroforestry. The histograms on the right show a higher NPV for the agroforestry option (Do et al., 2020)



Governance

Upfront financial incentives are crucial to motivate farmers for transitioning, yet they are currently absent (Abdul-Salam et al., 2022; Albrecht & Wick, 2021; Do et al., 2020; Sollen-Norrlin et al., 2020; Wilson & Lovell, 2016). While the EU has initiated policy instruments to promote agroforestry, they fall short in providing adequate financial incentives to compensate for ecosystem services, including ecosystem protection and carbon capture (Sollen-Norrlin et al., 2020). Abdul-Salam et al. (2022) underscored the limitations of using *carbon credits* for additional agroforestry revenue, with insufficient policy mechanisms to incentivize carbon sequestration. Moreover, carbon credits from agroforestry are non-tradeable in the EU trading system (Sollen-Norrlin et al., 2020).

Analyzing over 200 food forests globally, Albrecht and Wick (2021) identified a governance barrier linked to the *absence of collective ownership models* in food forestry. This absence hinders knowledge-sharing, obtaining start-up funds, and accessing larger land parcels. Tsonkova et al. (2018) found that in Germany, the current *legal framework and bureaucracy* impede agroforestry adoption.

Without a land use code for agroforestry, farmers must individually enroll each tree row for subsidies. Additionally, the common practice of leasing agricultural land requires *approval from landowners* for tree planting, making it challenging and time-consuming (Rois-Díaz et al., 2018).

Technical

A common challenge identified across the ten journals is the *skills and knowledge gap* among farmers regarding agroforestry. Insufficient understanding includes lack of expertise on combining trees with existing crops, spatial arrangements, and the timing of harvesting (Burgess et al., 2022; Sollen-Norrlin et al., 2020). Farmers express the *complexity of agroforestry management* compared to monoculture farming, where machinery is more easily utilized (Rois-Díaz et al., 2018).

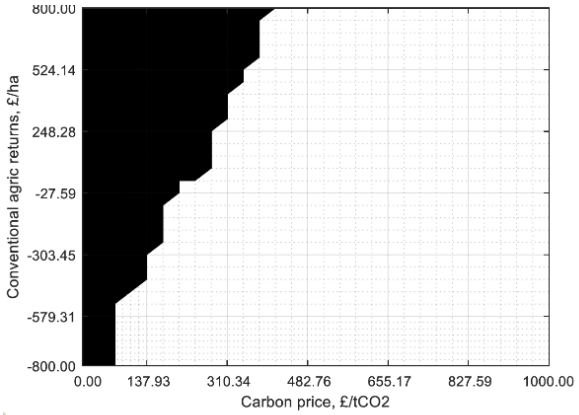
Nguyen et al. (2021) demonstrated that ethnicity plays a role in both the willingness and capacity to adopt agroforestry. Challenges were linked to a *lack of agroforestry knowledge*, insufficient land and labor capacity, financial constraints, and technical management expertise.

Ecological

Abdul-Salam et al. (2022) conducted a study introducing an options analysis to aid farmers in deciding whether to convert conventional agricultural land to agroforestry. The model assesses the *(ir)reversibility of land-use change* and its impact on uncertainty for farmers. Findings indicate that, particularly on hilly land, which has lower carbon capture potential, adoption is less likely. Figure 4 illustrates that, at a carbon price of £138/tCO2, conventional agriculture returns must be below -£300/ha for farmers to consider switching to agroforestry. The decision becomes suboptimal due to uncertainty and irreversibility, except with extremely low agricultural returns or very high carbon prices. Additional *geographical factors*, including soil type, climate, and the growth season, can further limit the transition (Burgess et al., 2022).

Figure 4

Maintaining conventional agriculture vs. adopting agroforestry, when to make the transition based on agricultural returns and carbon prices (Abdul-Salam, 2022)



Black region = maintain conventional agriculture; White region = adopt agroforestry.

Social

Beyond the skills gap, literature consistently highlights a *lack of awareness of benefits*. As traditional agroforestry knowledge declined in 20th-century Europe, farmers lost crucial insights (Sollen-Norrlin et al., 2020; Nguyen et al., 2021). Currently, most farmers are unaware of potential benefits, such as increased and prolonged yield, improved soil health, and water retention, from incorporating trees into agriculture (Abdul-Salam et al., 2022).

Sollen-Norrlin et al. (2020) identified *insufficient product marketing* and *shortage of field demonstrations* as obstacles to farmers' transition. Limited awareness among farmers and consumers about diverse food products results from inadequate marketing. Field demonstrations serve multiple purposes, providing real-world examples, training platforms, financial insights, and environmental impact illustrations. Presently, only a third of farmers seek agroforestry advice, and field demonstrations are scarce (Sollen-Norrlin et al., 2020). The absence of established demonstration plots, like those in Figure 5, hinders farmers from visualizing agroforestry systems (Wilson & Lovell, 2016).

Conducting a literature review, Burgess et al. (2022) identified how intercropping deployment can mitigate climate change. Despite numerous benefits, they recognized *agronomic constraints*,

including consumer preferences for annual crops over perennial produce. *Family or regional traditions* and the *fear of reputational risk* hinder European farmers from adopting agroforestry (Rois-Díaz et al., 2018; Sereke et al., 2016).

Figure 5

Field trials in Northwest Vietnam (Do et al., 2020)

a Coffee-based agroforestry system (Macadamia in coffee-annual crop intercrop)

b Maize-based agroforestry system (Dimocarpus in maize system with grass strips)

c Simple agroforestry system (Shan tea with forage grass)

In summary, the literature review identified numerous adoption barriers, collected mainly through interviews or surveys involving farmers. The knowledge gap in the Netherlands will be studied using a conceptual framework described in the next section.

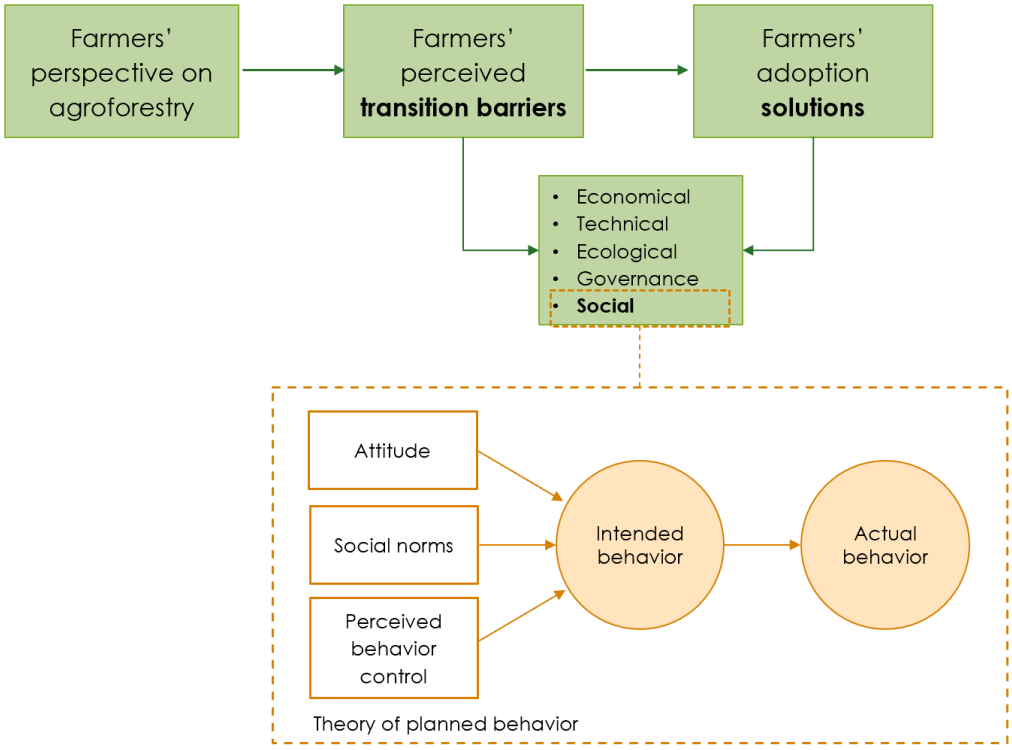
Conceptual Framework

A conceptual framework is used that examines the farmer's perspective on agroforestry, followed by the barriers perceived by farmers, and ends with solutions that can empower farmers to adopt agroforestry (see Figure 6 in green). The perceived barriers and solutions will be explored from different angles, including a comprehensive investigation of the social dimension. The aim of this focus is to capture the root cause why farmers resist transitioning, showcasing particular decision-making and behavior. Therefore, social barriers and solutions will be assessed through the application of the Theory of Planned Behavior (Ajzen, n.d.; Renzi & Klobas, 2008). Frequently utilized in both qualitative and mixed methods research, this theory explores the social aspects of agroforestry

acceptance and adoption, considering social norms, attitudes, and perceived behavior controls (Mcginty et al., 2008; Nguyen et al., 2021; Sereke et al., 2016). Attitude is shaped by farmers' knowledge and the perceived difficulty associated with agroforestry. Social norms encompass environmental expectations influencing farmers' behavior, potentially driven by social pressure or the adoption of neighboring farmers' methods. Perceived behavioral control reflects the individual's sense of influence (Nguyen et al., 2021). The graphical representation of how these elements impact intention and, consequently, farmers' behavior is depicted in Figure 6 in orange.

Figure 6

Conceptual framework



Research Questions

Based on the research gap identified in literature, this study aimed to answer the following research questions:

- **RQ1**: What are farmers' perceived barriers when transitioning from monoculture to agroforestry systems in the Netherlands?
- **RQ2**: What do Dutch farmers need to overcome these barriers to adopt agroforestry?

Methodology

Research Approach and Design

This study adopted a constructivist research philosophy, recognizing that everyone interprets reality through their unique experiences. Considering the subjective meaning farmers attach to monoculture farming and agroforestry, qualitative research was chosen to enable inductive data analysis (Creswell, 2014). Employing face-to-face interviews was considered appropriate to ensure content validity by directly engaging with the population of interest and gaining an in-depth understanding of individual farmers' experiences, behaviors, relationships, and social context within agriculture (Ricci et al., 2019).

Research Scope and Sampling

In qualitative research, sample sizes commonly range from 20 to 30, with 40, 25, and 10 as acceptable alternatives (Mason, 2010). Considering the limited timeframe for data collection and analysis, this study employed a sample size of N=12. To comprehensively grasp barriers at each transition stage, three types of farmers—monoculture, farmers in transition, and agroforestry farmers—were included in the sampling. The study's geographical scope encompassed the Netherlands, with an aim to involve farmers from diverse provinces. Recruitment was done through Dutch farmers' networks like Caring Farmers and Agroforestry Netwerk Nederland, using the following sampling criteria:

Table 2

Sampling criteria

	Inclusion Criteria
1. Monoculture farmers	• Farmer that cultivates 1 or a few annual crops OR farmer that keeps livestock • Number of trees on farm is negligible • May or may not have plans for agroforestry* in the future
2. Farmers in transition	• Original/previous farming method consisted of: o Cultivating 1 or a few annual crops OR keeping livestock • In transition to agroforestry* • Introduction of trees <3 years ago
3. Agroforestry farmers	• Original/previous farming method consisted of: o Cultivating 1 or a few annual crops OR keeping livestock • Current method includes agroforestry* farming • Introduction of trees >3 years ago

**Agroforestry definition based on the Dutch national standard (RVO, 2023), see Appendix.*

Instrument Design

The research instrument is crafted based on the conceptual framework outlined in the literature review chapter. It sequentially explores farmers' perspectives on agroforestry, delves into perceived barriers, and concludes with potential solutions to facilitate agroforestry adoption. Two interview guides —one for monoculture practitioners and another for those transitioning or already practicing agroforestry. Both guides encompass seven main questions, along with optional alternative, guiding, and probing questions for in-depth insights. The Theory of Planned Behavior was used to design questions on attitude, social norms, and perceived behavior control, following the qualitative instrument design of Renzi & Klobas (2008). More details on the research instrument can be found in the Appendix.

Data Collection and Analysis

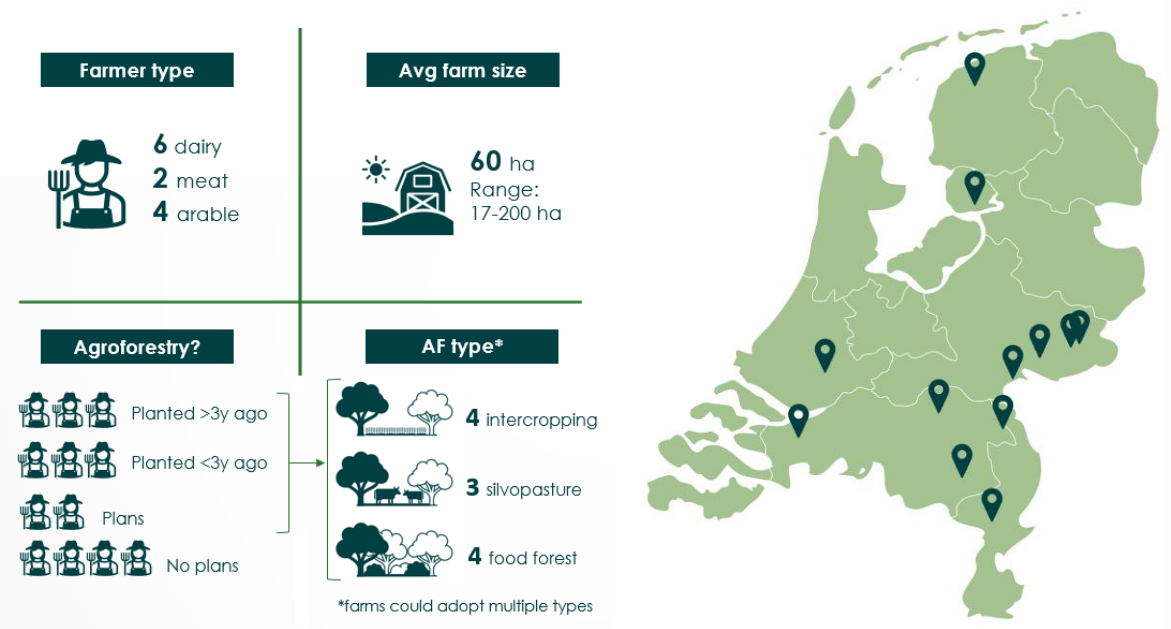
Following the recruitment process, 12 farms that met the inclusion criteria were selected. The participating farmers, depicted in Figure 7, were dispersed across the Netherlands, comprising 6 dairy, 1 beef, and 1 pig farmer, along with 4 arable farmers. The average farm size was 60 hectares, ranging from 17 to 200 hectares. Among these, 6 farmers embraced agroforestry—3 for over 3 years and 3 for less than 3 years. The remaining 6 farmers consisted of 2 with future agroforestry plans and 4 with no intention to adopt.

The agroforestry practitioners, as well as those with plans, implemented various agroforestry types. Of these, 3 farms incorporated both intercropping and a food forest, 3 integrated livestock with trees and shrubs, 1 engaged in intercropping, and 1 established a food forest. Most agroforestry farmers introduced harvestable agroforestry such as fruit and nut trees, while the livestock farmers generally chose fodder hedges.

Among the 12 farms, 7 operated organically, while 5 followed conventional practices. The interviews conducted on these 12 farms involved 14 individuals, including 4 female farmers and 10 male farmers.

Figure 7

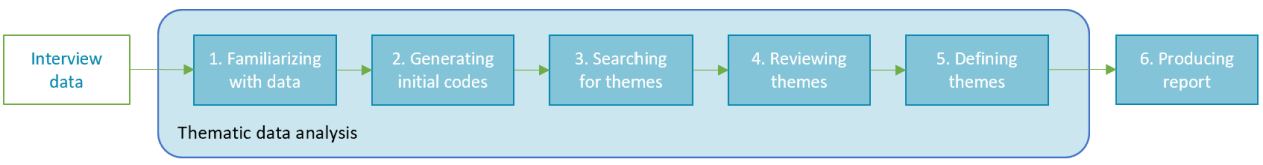
Sampling demographics



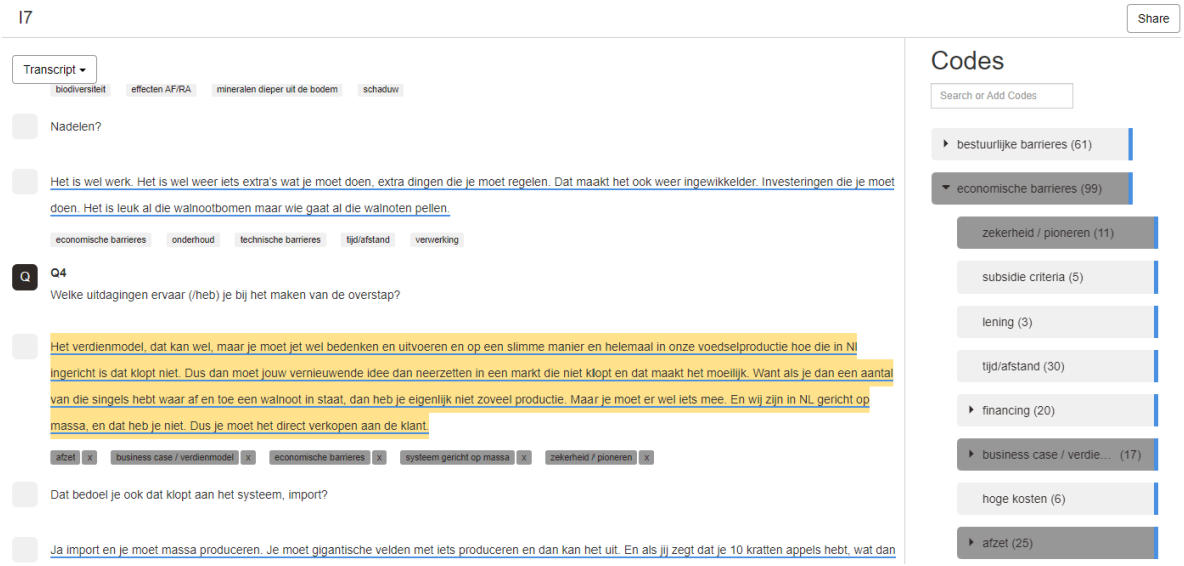
After the interviews took place, the voice recordings were transcribed using manual intelligent transcription. Next, thematic analysis was conducted through a staged approach based on the protocol by Braun & Clarke (2006), as shown in Figure 8a. The thematic data analysis involved familiarizing the data by reading the transcripts, transferring them into Delve, a qualitative data analysis tool, and generating initial codes. The process of coding is shown in Figure 8b. After these first two steps, the analysis continued by searching for themes, reviewing the themes, and drafting a mind map, of which a selection is shown in Figure 8c. Finally, the process included defining the themes, as shown in Table 3, before drafting the write-up of the findings.

Figure 8

a. Thematic data analysis (edited from Braun & Clarke, 2006)



b. Generating codes in data analysis tool Delve



c. Mind map of ecological barriers using Miro (see Appendix for full mind map)

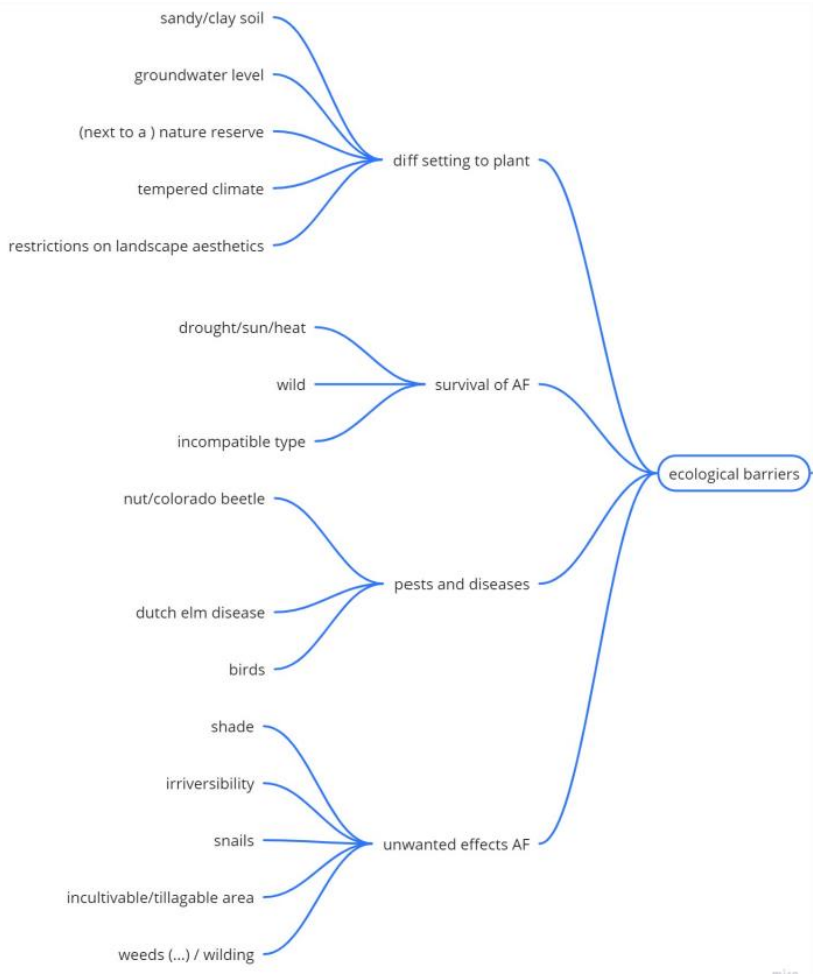


Table 3

Theme definitions

Theme	Definition
Economic barriers	Obstacles related to the financing of agroforestry, the revenue model, the high costs, the time investment, pioneering, and marketing.
Governance barriers	Factors related to governing bodies, such as laws and regulations, permits, landowners and organizations, government, and other parties
Technical barriers	Hurdles that relate to the lack of knowledge and expertise in AF, as well as challenges in planting, maintaining, harvesting, and processing agroforestry (products).
Ecological barriers	Environmental barriers relating to the setting (e.g. soil type, groundwater level, location, climate), the chances of survival of the planting material, diseases and pests, and unintended effects of AF on other crops.
Social barriers	Social norms and opinions of the environment, beliefs, and attitudes of the farmer (based on feelings, experience, or philosophy), and the unawareness and unfamiliarity of the Dutch consumer
Solutions for adoption	Ideas, as well as proven resolutions for adoption barriers, including economic, governance, technical, ecological, and social solutions.

Furthermore, the data was analyzed from a social angle using the Theory of Planned Behavior, emphasizing the answers to Q3-5 (see Appendix). Selective coding was conducted to find attitudes, social norms, and perceived behavior controls. The outcomes of the data analysis are described in the next chapter.

Findings and Discussion

This chapter describes the agroforestry (AF) adoption barriers and solutions by theme, e.g., economic, governance, technical, ecological, and social.

Economic barriers

Agroforestry financing has two sides: startup funding for planting material is usually accessible through subsidies or grants, but **post-planting financing is difficult**. The maintenance, irrigation, and lack of harvest for the initial 5-10 years demand investments mostly from the farmers' capital since banks are generally reluctant to provide loans for agroforestry. Even though lenders advertise

sustainability commitments, farmers have trouble convincing them of agroforestry. Worries expand as farmers and lenders fear agricultural land could be labeled as forest or nature land, leading to substantial depreciation. Self-financing isn't a viable option for many farmers due to thin profit margins in farming. Some find it challenging to contribute even a partial amount, emphasizing the financial strain.

"You have a transition period, that's a big investment without harvest for 5 years" [4]

Furthermore, farmers have significant concerns due to the **absence of a proven business model**. Farmers express concerns about the high costs associated with agroforestry, as the process involves taking a plot out of production, and investments in design, planting, maintenance, irrigation, and harvesting. Additionally, these small- and medium-sized enterprises do not enjoy discounts on energy costs and interest rates that bulk consumers typically benefit from. Apart from costs, some farmers are skeptical about agroforestry's profitability, especially without subsidies. The profitability issue is attributed to the current food system that focuses on mass production. Diversified agroforestry setups clash with the requirement to produce a specific quantity and quality of a single crop, at a certain date. Another example is when seeking SKAL certification, which requires farmers to apply per product, resulting in higher costs for embracing agricultural diversity. This interrelates with the challenges faced in the marketing and sales domain: selling a diverse range of agroforestry products into mass-oriented supply chains proves nearly impossible.

"The concerns are mainly in the area of returns, will we be able to make this profitable, and sales, and that is of course interrelated." [3]

Farmers stress the uniqueness of their farming methods, which include crop failures and the inability to meet large-scale industry demands. These characteristics result in significant challenges in terms of **sales and marketing**. Larger supermarket chains prioritize cost over supporting local farmers, limiting them to short-chain distribution, local stores, or regional sales. This initiates a preference for direct sales to customers, but this path is not without challenges. It includes the absence of local or organic shops in the neighborhood and the difficulty of organizing farm shops on

individual properties. More so, low consumer awareness for agroforestry products (even among those favoring organic choices) contributes to a lack of demand. Some farmers observe a disparity between ‘citizens’ advocating for sustainability and ‘customers’ opting for budget-friendly, flawless-looking products in stores.

> *“If you ask people on the street, do you want food from a food forest? Supporting sustainable local food, yes that's what I want. When you're standing in front of the store shelf, it's often different.” [11]*

Farmers mention that, in addition to the previously stressed financial and sales challenges, engaging in agroforestry demands **considerable time and effort**, posing a burden alongside their regular farming activities. This includes searching for specific trees or shrubs in a food forest, navigating municipal conversations, and applying for land use arrangements. The involvement of volunteers, though helpful, requires organization and additional arrangements. Some farmers see the distance to specific plots as a barrier, leading to labor-intensive efforts and challenges in maintaining plant health. Moreover, time dedicated to public relations (PR) activities, such as managing farm shops, writing newsletters, and social media, further restrict farmers from transitioning to agroforestry.

> *“We can do that, so that's a big advantage, we like to go outside, give workshops, lectures, tours, and that keeps the PR machine running. And then you can continue to exist, but if you just want to milk cows and be on your farm, you can't. That's a bit crazy because it's two jobs that you must be able to do.” [7]*

In essence, farmers perceive the adoption of agroforestry as risky in the absence of crucial elements such as support from lenders, a proven business model, existing sales and marketing strategies, and the necessary time investments.

Governance barriers

The current **legal framework** does not readily facilitate the adoption of agroforestry. Farmers encounter obstacles in acquiring permits for trees, facing municipal opposition due to landscape

concerns. Some opt for planting without permits, introducing uncertainty about future regulatory demands. Despite provincial and municipal support for agroforestry, existing legislation lacks alignment, forcing farmers into risky situations with regulatory uncertainties. Furthermore, Farmers express concerns about evolving legislation, anticipating felling permits and potential burdens like replanting obligations. Uncertainty surrounds maintenance subsidies, with examples of inadequate subsidies causing financial challenges. Changing landscape designation poses a threat to land value, potentially leading to substantial depreciation. Regulatory challenges, such as fodder hedges' exclusion in fertilization space calculations and the need for archaeological research, contribute to the complex regulatory environment.

> *"The municipality thought it was too intense. Very long rows of trees would be planted and that would have too much impact on the landscape." [3]*

Administrative procedures prove lengthy, adding a significant burden as farmers navigate complex and time-consuming interactions with municipal authorities. Some farmers go through years of ongoing conversations without receiving definitive answers. The necessity to secure commitment from the municipality becomes a challenging undertaking, due to sluggishness and indecisiveness in the decision-making process, leading to frustration. Moreover, the involvement of various stakeholders requires continuous efforts to convince, formulate alternative plans, and reapply for permits.

External bodies, like Rijkswaterstaat, the Dutch water management authority, add complexity by imposing planting restrictions in maintenance-sensitive areas like floodplains. Collaborations with entities like meadow bird organizations introduce further challenges due to conflicting preferences.

Last, external **ownership** significantly influences farmers' decisions regarding agroforestry adoption. Several interviewed farmers operate on leased land, where landowners or organizations play a role in on-farm decisions. In some instances, tenants face resistance from landowners who express disinterest in agroforestry practices. The duration of leasing agreements is another pivotal factor impacting the adoption of agroforestry. For instance, farmers with short-term leases, as brief as 1 year, express

uncertainty and an inability to plan due to lease insecurity. Moreover, there is a risk of tenants demanding the restoration of the land to its original state, requiring the removal of trees. The profit-oriented mindset of most tenants further complicates things, as they prioritize maximum returns and are reluctant to the potential devaluation of the land associated with nature-inclusive farming.

> *"I don't have any certainty of leased land next year. I haven't looked more than 1 year ahead for the past 20 years." [11]*

In short, governance-related barriers, encompassing the current legal framework, external dependencies, and ownership dynamics, present considerable challenges to the widespread adoption of agroforestry.

Technical barriers

Farmers often **lack crucial knowledge**, including on design, maintenance, disease management, and the overall business case of agroforestry. The design complexity presents challenges in various aspects, such as species selection, landscape impact, and crop compatibility. Farmers experience it as a tradeoff between diversity and efficiency. Some farmers perceive rows with a single tree species as 'monoculture,' while finding food forests to be intricate and complex. The knowledge gap further extends to pollination requirements, pruning techniques, and irrigation needs. Some farmers feel that this knowledge, for their specific setting, is non-existent or hard to find. Positive effects of agroforestry, such as improved crop yields, water retention, wind reduction, and diet diversification for livestock, are often not well understood or recognized by farmers. The current education system and advisors from companies with vested interests (fertilizer, pesticides, etc.) advocate traditional farming methods, contributing to the lack of awareness of agroforestry benefits. Farmers express the need for concrete evidence through research but face challenges in finding time for involvement. Some prefer personal experience, conducting small-scale pilots before committing to larger agroforestry implementations.

Farmers encounter multifaceted challenges across the different stages of development: **planting, maintenance, harvesting,** and (optionally) **processing**. For starters, the process of planting involves

either manual, which is time-intensive, or machinery planting, potentially causing soil damage. This labor is often overlooked in initial cost calculations.

> *"We rented a crane to plant the largest trees, but we sent them away because the ground was destroyed. You could immediately see that completely compacted puddles remained, while we do this for the soil." [1]*

Second, maintenance issues emerge impacting both the system and other crops. The use of machinery in fields with trees can be problematic, influencing tillage, crop care, and irrigation. Pruning, as well as finding skilled labor for various tasks, isn't easy. Thirdly, diverse agroforestry systems complicate harvesting due to technological limitations, demanding manual picking, and introducing challenges in mechanization adjustments. Machinery is frequently not shareable due to the seasonal nature and limited harvesting timeframe. Last, processing faces hurdles, requiring substantial investments in technology. The dilemma between diversity and efficiency arises, as investing in a processing line for each tree type becomes impractical. Collaborative efforts among farmers could simplify processing and selling, but such collectives are still scarce.

> *"And if there is grain next to it which still needs time to grow, while some of the produce of the trees need to be harvested immediately, which of them is going to win?" [8]*

Overall, the widespread adoption of agroforestry faces substantial technical obstacles, encompassing insufficient knowledge and expertise, along with difficulties in planting, maintenance, harvesting, and processing.

Ecological barriers

Farmers also encounter ecological hurdles in the adoption of agroforestry. For starters, the **ecological context** presents issues, with soil type playing an important role. Sandy soil prevalent in some areas presents challenges related to water retention, elevating the risk of drought. Conversely, clay soil can become muddy after heavy rainfall, raising concerns for cattle farmers regarding livestock clustering under trees and creating mud pools. Certain farmers mention that specific trees

may not align with their ecological environment, suggesting alternative regions within the Netherlands for planting.

After planting, the **survival of the planting** material becomes a concern. Unpredictable climate in the Netherlands, such as sudden prolonged droughts and heat, but also wildlife traits like roe deer contribute to survival chances. While less frequently mentioned, farmers express worries about pests and diseases affecting agroforestry. Concerns range from birds consuming fruit produce to specific challenges like Dutch elm disease or nut beetles affecting hazelnut trees. Farmers must actively manage and monitor potential threats to safeguard their agroforestry systems.

"The first two years went well, but from what we planted last winter a lot has died last spring in that very dry period. As a result, I am now a bit reluctant to order another batch of trees and start planting again" [3]

Farmers also observe and anticipate **negative effects of agroforestry** on their farms. Issues include wilding, where young shoots grow into unwanted trees, impacting neighboring grassland. Additionally, snails and weeds emerging from forested areas, reduced yields in shady spots, and challenges in tillage due to superficial root development near tree species pose significant concerns. Farmers also express worries about the long-term commitment and irreversibility of agroforestry decisions, complicating land transactions and limiting flexibility.

In summary, ecological barriers encompass soil challenges, survival concerns, pest and disease management, and the unintended ecological consequences of agroforestry.

Social barriers

Next, remarks that involve social barriers are analyzed using the Theory of Planned Behavior, which examines the farmer's attitude towards agroforestry, social norms in society, and perceived behavior controls, e.g., how easy it is for a farmer to display certain behaviors. These three constructs lead to intended behavior, which in turn leads to actual behavior.

For part of the interviewees, their **attitude** towards agroforestry played an important role in the non-adoption. Many farmers have negative beliefs about agroforestry, asserting that trees may not suit the region and could be better placed in other parts of Europe. Some argue that fertile soils should be dedicated to arable farming rather than tree cultivation, considering agroforestry as sacrificing land. Apart from negative beliefs, negative experiences also impact farmer's attitudes. Disappointing outcomes, such as lower yields in tree-surrounded corners of a plot, contribute to a general sense of skepticism. Negative experiences with sustainability projects or trees themselves, including instances where subsidies (for biogas) led to financial ruin, shape a cautious approach. Agroforestry's profitability is a pivotal factor influencing farmers' decisions. Some argue that trees should serve arable farming and be economically viable independently. Decision-making, often driven by profitability, lacks the back-of-the-envelope calculations readily available for traditional farming methods. Farmers fear that adopting agroforestry might reduce their farm's value on paper, opposing idealism against realism in agricultural practices. Lastly, tradition and family heritage strongly influence farmers' reluctance to embrace change in farming techniques. With many farms passed down through generations, endangering this legacy financially is deemed unacceptable. Parents strive to pass on stable farms to their children, who, in turn, are hesitant to deviate from established family traditions. Family tradition becomes a significant barrier, as farmers fear disrupting the successful practices of their forebears.

> *"Our company has a history of more than 100 years. We've taken that a generation further, the next generation must decide for themselves, but for me, it's a piece of family heritage that I want to continue." [12]*

Apart from the farmer's personal attitude, **opinions** from peers, family, and friends, as well as **social norms** in the neighborhood and society, influence adoption. The perspectives of family and friends play an important role, especially for multi-generational farms. Convincing both family members and the wider community about the advantages and feasibility of agroforestry proves to be a significant challenge for farmers. Additionally, status and peer approval contribute to decision-

making, with some farmers preferring to invest in expensive machinery to maintain a certain image. Farmers experience societal pressure to conform to traditional farming practices, creating a reluctance to adopt agroforestry. The desire for a 'neat' farm clashes with the perceived 'messiness' of agroforestry, leading to farmers feeling like outsiders or being labeled as 'messy farmers.' The broader societal view, marked by polarization in discussions around agriculture, influences farmers. Consumers often hold firm opinions on the ideal operation of a farm, yet there exists a gap in their understanding of the complexities involved in production. Taste and price are important, but what's inside a product or where it comes from – consumers don't know. Apart from consumers, a conservative mindset in the farmer's neighborhood, coupled with concerns about judgment, inhibits farmers from deviating from established practices. Farmers may feel belittled or not taken seriously, facing comments that label agroforestry as a mere hobby rather than serious work. The impact on social standing and the opinions of others within the farming community influence farmers' choices.

> *"Often, they have a son or daughter who wants it differently. But in the end, they don't do it because it's shame for the neighborhood, people will talk about you." [9]*

In examining farmers' **perceived capability** to adopt agroforestry, diverse perspectives emerge. Certain traditional farmers express a desire for change but feel compelled to persist in their current practices, as this would be the only way to meet global food demand. Also, the belief is that failure to produce inexpensively locally would result in increased imports. Labor constraints also play a role, with one farmer asserting that they are already operating at maximum labor capacity, making additional changes challenging. Another farmer deems a food forest too labor-intensive to be a feasible option. Furthermore, a segment of farmers question the necessity of adopting agroforestry, stating we should maintain our agricultural origins, which, in their view, does not involve incorporating trees. Some argue that the Netherlands is simply too small for the natural balance sought by agroforestry or broader regenerative farming practices. Additionally, farmers mention that the demanded pace set by the government to transition into more sustainable agricultural practices is unrealistic. The sentiment among some is that change is possible but must occur gradually, given the historical emphasis on increased production at lower costs.

"We have always been able to produce everything because we were going to do more for cheaper. You can't get that to change so quickly; it just takes a while." [5]

In short, a farmer's attitude involves negative beliefs about profitability, tradition, and skepticism, along with societal expectations and concerns about family heritage. Perceived control, influenced by labor constraints and financial challenges, adds complexity. While the social barriers highlighted in this section may seem discouraging, the subsequent section will delve into potential solutions, for social as well as the other barriers, offering a more optimistic perspective.

Solutions to Adopting Agroforestry

This section highlights solutions farmers described to overcome the long list of barriers. Some ideas resolve multiple challenges at a time, but for the sake of readability, those solutions are mentioned under the theme that suits them best: economic, governance, technological, ecological, or social.

In addressing economic challenges, farmers exploring agroforestry in the Netherlands have found practical solutions. Securing funding for planting materials often involves tapping into subsidies or grants from various entities such as the province, municipalities, foundations, companies, and even crowdfunding. While financing other aspects like planning, planting, and maintenance proved more challenging, some farmers successfully navigated these hurdles with support from organizations like RVO, Van Gogh National Park, Brabants Landschap, Staatsbosbeheer, and others. Some even utilized loans, like the IDL Green Fund, with low interest rates. In addition to financial support, farmers see business model innovation as a key solution. Landscape financing, where farmers are incentivized for maintaining land that has both natural and food production value, was mentioned as one approach. They also explored community-based models like Herenboeren, where citizens collectively own a farm and pay the farmer for locally produced crops. Overcoming challenges in the mass-oriented food system, farmers implemented various sales and marketing strategies. These included direct sales through farm shops, participation in local markets, collaborations with high-end restaurants and caterers, and leveraging channels like newsletters and social media. Recognizing the

need for diverse income streams, farmers embraced tourism, set up photo booths, and even considered renting out processing machinery for agroforestry products. Pictures taken on two of the farms showcasing additional income streams are shown in Figure 9. Through a blend of financial resourcefulness, innovative business models, and strategic marketing, these farmers have demonstrated how economic barriers can be navigated.

Figure 9

Income from tourism: Stay in an old cart in a corn field (left) or visit a farm's lunchroom (right).

However, the journey doesn't end there. As farmers step into agroforestry, administrative difficulties appear, requiring governance solutions. Establishing robust stakeholder relationships, particularly with municipal and provincial bodies, proves essential. When formal channels don’t work out, some farmers feel the only route is being pragmatic and keeping a blind eye to certain rules. Awareness within governmental institutions about agroforestry should be improved through proactive engagement. Proposals include sustained incentivization for agroforestry initiatives beyond the initial stage, offering financial security, and committing to long-term policies. Farmers advocate for a coordinating entity, potentially a large nature organization, to guide and support them during the transition to agroforestry.

Apart from solutions for economic and governance barriers, farmers come up with innovative technical solutions. In the area of practical solutions for planting, maintenance, and harvesting

challenges, farmers demonstrate resourcefulness. From manual harvesting methods and recruitment of long-term volunteers to space allocation for machinery, farmers navigate the complexities of agroforestry. Automation has a place in their strategies, by using existing machinery for harvesting and exploring collective purchases with fellow farmers. Innovations like harvest campings, picking days, and the establishment of mini-food forests with customer involvement showcase the adaptability of farmers. Exploring unique solutions, such as leasing out entire food forests, reflects a forward-thinking approach. However, some farmers suspend specific harvesting strategies for future worries, demonstrating a pragmatic outlook. Second, farmers address the knowledge gap in agroforestry through a multifaceted approach. Proactive measures include enrolling in courses, visiting other farms, and participating in community practices, leveraging resources like books, documentaries, and the internet. Another route involves engaging experts from organizations like Stichting Voedselbosbouw, Schevichoven, Agroforestry Network Nederland, and Louis Bolk Institute to design and offer guidance on agroforestry systems. The collaborative spirit extends to both professional and informal networks, where insights from friends, family, acquaintances, and suppliers in the agroforestry domain contribute significantly to farmers' knowledge base.

> *"Next week we will have a group of more than 30 people visiting, from RVO, schools, and the ministry, ultimately to learn. That is the role we have as pioneers." [2]*

This external support that helps farmers in the technical domain also plays a crucial role in overcoming ecological barriers. To address challenges posed by drought, farmers adopt strategies such as installing drip lines and selecting crops known for their resilience against water scarcity. An example of protection against wildlife is shown in Figure 10. Some farmers expect that improving biodiversity could contribute to natural pest and disease management. Ongoing research initiatives, for example one conducted by Wageningen University and Research on strip cultivation and biodiversity, actively involve farmers, fostering collaborative efforts toward ecological sustainability.

Figure 10

Shrub protection against wildlife (black shielding)

Finally, solutions to social challenges are investigated by revisiting farmers' attitudes, social norms, and control beliefs. For starters, farmers not only face negative attitudes but also hold positive perspectives on agroforestry, driven by various benefits. Frequently experienced (or expected) advantages include enhanced food production, income generation, and a notable increase in biodiversity. Farmers also appreciate agroforestry for its role in nitrogen and carbon capture, creating microclimates, and mitigating the impact of extreme weather conditions. A few farmers noted water retention, wind reduction, diet supplementation for livestock, mineral extraction from deep soil, symbiotic relationships with annual crops, and the efficiency of protein production, particularly from nuts. Less mentioned were shortened regeneration periods, reduced pesticide drift, natural fencing, and the social element of attracting tourism and fostering community connections. Beyond these tangible benefits, farmers express diverse personal reasons for adopting agroforestry. Some are driven by concerns about the future and climate change, aiming to create future-proof farming systems.

Others are motivated by a desire to restore the historical landscape of their farms, emphasizing aesthetics, a connection with nature, and the creation of a pleasant work environment. Several farmers find joy and fulfillment on their farms, considering it a place to recharge, eliminating the need for holidays. Pioneering spirit, idealism, a sense of responsibility, altruism, and alignment with personal values also contribute to the decision to embrace agroforestry. Second, positive experiences play a pivotal role in convincing farmers of the sustainability and potential of agroforestry. Overcoming the negative attitudes of peers and challenging social norms, farmers adopt strategies such as role modeling, conducting farm tours, organizing demo days, and educating consumers. Strong visions, emphasizing the creation of a livable world, year-round food production, and high nutritional value, inspire both farmers and the broader community. The power of storytelling is seen as a valuable tool, helping build and retain customer bases, forge relationships with restaurants, and gain support from municipalities and tenants. Having a unique narrative helps in challenging societal norms, and farmers find that establishing a food forest sets them apart. Third, several farmers exhibit optimism regarding their ability to adopt agroforestry. They view it as an opportunity, taking small steps each year and encouraging others to begin the journey. This positive outlook results from the belief that there are enough people capable of engaging in outdoor work, and concerns can be addressed progressively. In essence, overcoming social barriers involves not only showcasing positive examples but also targeting farmers with specific attitudes and a perceived sense of behavioral control.

> *"I see that it gets more and more beautiful over time. That has multiple elements: the visual aspect, but also that you are more in nature, with birds and insect life of all kinds." [6]*

In conclusion, farmers navigating agroforestry have demonstrated innovative solutions to the complex challenges they face. From economic obstacles, where resourcefulness and innovative business models shine, to governance issues, addressed through stakeholder management and strategic relationships. Technical challenges are met with knowledge acquisition and network building, while ecological barriers are solved using external expertise. Lastly, social challenges are tackled through positive attitudes, role modeling, and storytelling.

Discussion

The findings presented in previous sections accurately answer the formulated research questions. In-depth exploration and thematic analysis of Dutch farmers' perceived adoption barriers yielded interesting insights, with many aligning with global literature. Noteworthy distinctions, specific to the Netherlands, and not previously mentioned in the literature, range from land exchange practices to allow for crop rotation, societal norms emphasizing farm neatness, and undesired ecological effects such as wilding shoots. Reversely, all elements summarized in the literature review, except the one on carbon credit trading, were mentioned by Dutch farmers, showcasing that the data from other regions is useful in determining high-level barriers in the Netherlands. Nuanced details however, such as regulations on fertilization areas, lack of agroforestry in the education system, or high costs for small and medium enterprises are more specific to the Dutch context. It must be noted that the literature review didn't focus on solutions and a direct comparison of Dutch farmers' solutions with those from other regions wasn't feasible.

Moving beyond the comparison with existing literature, the reflexivity of the outcomes will be discussed, recognizing the inherent subjectivity in qualitative research. The researcher's perspective, influenced by a sustainability lens, may have introduced biases. This includes things like probing questions, attitude, and body language, as well as observing patterns and themes that the researcher believes are relevant to answering the research question. Though this subjectivity adds depth and nuance to the findings, it is relevant to discuss how the researcher's subjective point of view may have influenced the outcomes of this research. When searching for interview participants, the text used for recruitment included the word 'monoculture' which was understood as a neutral word for a certain farming method, however, evoked negative farmer sentiments. Though the wording was changed to traditional farming, most of the interviewees were farmers who were not scared away by the initial terminology, potentially biasing the sample. Furthermore, though an inductive data analysis approach was used to explore the transcripts, similar categories as found in the literature (economic, governance, technical, ecological, and social) emerged when doing thematic analysis. This might be a result of priming, where the thinking process of the researcher was influenced by the previously

studied literature. Likewise, although the analysis initially categorized solutions as 'internal' and 'external' based on interview questions, this proved to be less interesting. Consequently, the researcher chose to align the solution themes with the previously identified barriers during the write-up. Furthermore, the researcher's enthusiasm for agroforestry may have influenced the interpretation of statements, potentially skewing positivity. Also, though the data collection and initial analysis were in Dutch, the categorized statements from farmers were translated into English, which may have resulted in nuanced information loss. The key findings, however, are relevant and useful to showcase the barriers and solutions from a farmers' perspective.

The findings carry meaningful implications for policymakers, offering insights to enhance policies, heighten awareness, and provide support for farmers transitioning to more sustainable practices. Using the Theory of Planned Behavior, valuable insights on the social dimension emerged. This can be of help in selecting candidates for transitioning with the right attitude and (perceived) capabilities. Example farmers who showcase competency in adopting agroforestry, can be recruited to help other farmers in transition. Through this role modeling, practiced solutions such as innovative business models, leveraging informal and professional networks, adequate stakeholder management, and storytelling, the attitudes of non-adopters can be positively influenced.

Conclusion

Given the importance of agroforestry in achieving the Sustainable Development Goals, in particular SDG 2, 13, and 15, more research needs to be done in this area. Limitations of previous studies on agroforestry adoption relate to the non-transferability of findings from one region to another. This research aimed to address a critical gap in understanding the adoption of agroforestry among Dutch farmers. Using a qualitative methodology, the study utilized farmer interviews and thematic analysis to comprehensively explore the barriers and potential solutions to agroforestry adoption. Social aspects, such as the farmers' perspectives and perceptions, were explored using the Theory of Planned Behavior. Though many barriers are universal, some newly emerged barriers were

found. This research fills the identified gap in the literature and can be used to support the food system transition.

The sampling used in this study included farmers practicing monoculture, farmers in transition, and agroforestry farmers. It included a broad diversity in farm type, farm size, region, farmer's age, and gender. Other stakeholders involved in the agricultural landscape such as landowners, lenders, policymakers, advisors, retail and nature organizations, and consumers, were not in scope. This limits the all-encompassing nature of this research, especially in the solutions area. Ideas suggested by farmers may not be feasible from a governance or financial perspective and should be further investigated and validated in future studies. Furthermore, some findings might be province-specific, such as the desired landscape view. Future studies could focus on smaller regions to further distillate province-specific barriers and solutions in adopting agroforestry.

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Appendix

Agroforestry Definition

Agroforestry definition based on the Dutch national standard (RVO, 2023):

- **Option A - Trees and crops***: productive or non-productive trees and/or shrubs in combination with arable farming and/or vegetable cultivation. In rows or spread over the plot, consisting of 1 or more production layers. Examples are rows of nut and fruit trees, alternating with rows of grains or vegetables and strip cultivation. A row of trees and shrubs is combined with at least 4 other crops.
- **Option B – Trees and livestock***: examples are planted chicken runs, goats between standard orchards or cattle between fodder trees and shrubs. These may be both productive and non-productive trees and shrubs, and the trees and shrubs are in rows or spread across the plot.
- **Option C – Food forest**: at least 3 vertical vegetation layers, e.g. lower trees, shrubs and underground crops. The vegetation layers may still be developing and provide edible products (fruits, seeds, leaves, or stems) now or in the not-too-distant future. No use of animal manure, artificial fertilizers, or pesticides in the food forest section. Crop code 1940.
  *With a maximum of 100 trees per hectare

Research Instrument

The interview commences with an introduction, including the consent form and participant information sheet verification. The initial questions aim to gather background information on the farmer's methods and attitudes toward agroforestry, serving as a 'warming up' phase. Questions 4 and 5 then scrutinize agroforestry adoption barriers, distinguishing between material and normative aspects, contributing data for block two in the flow diagram.

The flow diagram's first two blocks delve into the farmer's perceptions, guided by the Theory of Planned Behavior (Renzi & Klobas, 2008; Ajzen, n.d.). For instance, Q3 explores behavioral beliefs or attitudes, Q4 delves into control beliefs, and Q5 examines normative beliefs. Finally, questions 6 and 7 collect data for block three, exploring personal and external stakeholder contributions to agroforestry adoption.

Introduction

Welcome. This interview is part of a study about agroforestry. In this study, we will explore the barriers for farmers who currently practice monoculture (e.g., farming a small variety of crops or pasture) and want to transition, or are transitioning to agroforestry (e.g., introducing productive trees on your farm). Agroforestry is still limited in the Netherlands and with this interview, we try to understand why from a farmer’s perspective.

Check the consent form and participant information sheet before starting

Do you have any questions before we start? If not, let's begin.

**Note: Next to the main questions, alternative, guiding, and probing questions are given. The alternative questions can be used when the initial question is unclear to the farmer or when the answer is limited. The guiding questions are designed to dig deeper into certain experiences of the farmer or to guide the farmer into an area of interest. Probing questions are used to provoke further insights.*

Legend

RQ1-2	Research questions (not asked during the interview)
Q1-8	**Standard interview questions**
A	Alternative questions
G	Guiding questions
P	Probing questions

1. Interview Questions for Monoculture Farmers

RQ1: What are farmers' perceived barriers when transitioning from monoculture to agroforestry systems in the Netherlands?

Q1: Can you tell me about your farm? (warming up)

G: Did you change your farming method before?

Q2: What does this method of farming mean to you? (background/behavioral beliefs)

Q3: Can you tell me what you know about agroforestry? (background/attitude)

G: What do you think would be the result of adopting agroforestry at your farm? (behavioral beliefs and outcome)

Would you consider changing your farming method to include agroforestry?

If yes:

Q4a: What factors or circumstances make it difficult or prevent you from making the transition? (control beliefs; capacity to adopt (physical barriers))

A: What is holding you back from making this transition?

A: What is in your way to trial agroforestry at a part of your land?

P: Why do you see this as a challenge?

P: Can you tell me more about your worries?

P: Can you explain that to me?

Q5a: How do people in your environment (family/friends/colleagues) view agroforestry? (normative beliefs (psychological barriers))

P: Would they approve of your decision?

A: Who is practicing agroforestry in your environment?

P: How do you view them?

P: How do you think people in the Netherlands in general view agroforestry?

RQ2: What do Dutch farmers need to overcome these barriers to adopt agroforestry?

Q6a: How could you overcome these obstacles?

A: How would you solve these barriers?

G: Would your opinion change when your neighbor starts practicing agroforestry?

Q7a: What external support would empower you to adopt agroforestry?

G: Are there other ways to get support?

P: How does this help you?

P: Why do you need this?

If no:

Q4b: Why is that?

A: Can you tell me more about your reasons for not considering agroforestry?

G: Where does this idea come from?

P: Can you tell me more about your worries?

P: Why do you see this as a challenge?

Q5b: How do people in your environment (family/friends/colleagues) view agroforestry? (normative beliefs; psychological barriers)

P: How would they respond if you adopted agroforestry?

A: Who is practicing agroforestry in your environment?

P: How do you view them?

P: How do you think people in the Netherlands in general view agroforestry?

RQ2: What do Dutch farmers need to overcome these barriers to adopt agroforestry?

Q6b: What would help you to reconsider this decision?

G: How would your opinion change when your neighbor/friend starts practicing agroforestry?

Q7b: How could support from external stakeholders be of help?

G: How would financial incentives/carbon credits/courses/other guidance change your opinion?

P: Why do you say so?

2. Interview Questions for Farmers in Transition and Farmers who implemented Agroforestry

RQ1: What are farmers' perceived barriers when transitioning from monoculture to agroforestry systems in the Netherlands?

Q1: How come you are farming the way you do today? (background/behavioral beliefs)

G: Did you change your farming method before?

Q2: What does this method of farming mean to you? (warming up)

Q3: Why did you decide to adopt agroforestry?

A: What do you see as the advantages and disadvantages of adopting agroforestry at your farm? (behavioral beliefs)

Q4: Which challenges do (/did) you experience when making the transition?

A: What was in your way to trial agroforestry at a part of your land?

G: What other factors or circumstances made it difficult or prevented you from making the transition? (control beliefs)

A: What are/were your worries?

P: Why did you see this as a challenge?

Q5: What do people in your environment (family/friends/colleagues) think of agroforestry? (normative beliefs)

P: Do they approve of your decision?

A: Who is practicing agroforestry in your environment?

P: How do you think people in the Netherlands in general view agroforestry?

RQ2: What do Dutch farmers need to overcome these barriers to adopt agroforestry?

Q6: How did you overcome the mentioned obstacles (or, if applicable, skepticism)?

A: How did you solve these barriers?

P: What other strategies did you apply to overcome your worries (if applicable)?

Q7: What external support empowered you to adopt agroforestry?

G: Are (/were) there other ways to get support?

P: How does (/did) this help you?

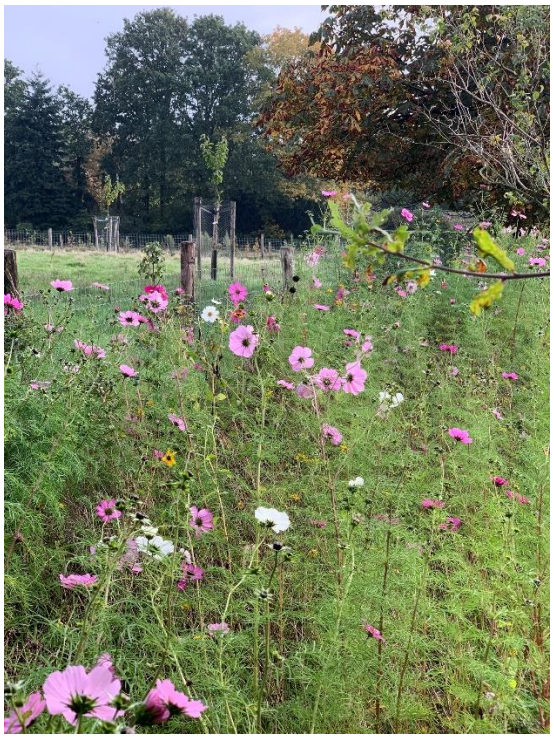
P: Why do you need this?

Pictures

Monoculture farming: grassland (with clover, top) and corn (bottom)

A conventional farm with a small fruit orchard

A conventional farm with flower strips and trees for own consumption



Hedgerows (in the distance) natural fence the plots in eastern Netherlands

Natural fencing combining agroforestry with livestock

Small food forest in a corner that wasn’t used for cultivation anyway

Wild chestnut planted on the farmer’s property

Intercropping trees with rows of annual crops

Intercropping: a double row of hazelnut trees, combined with grassland

Small islands of food forest in a grassland for cows

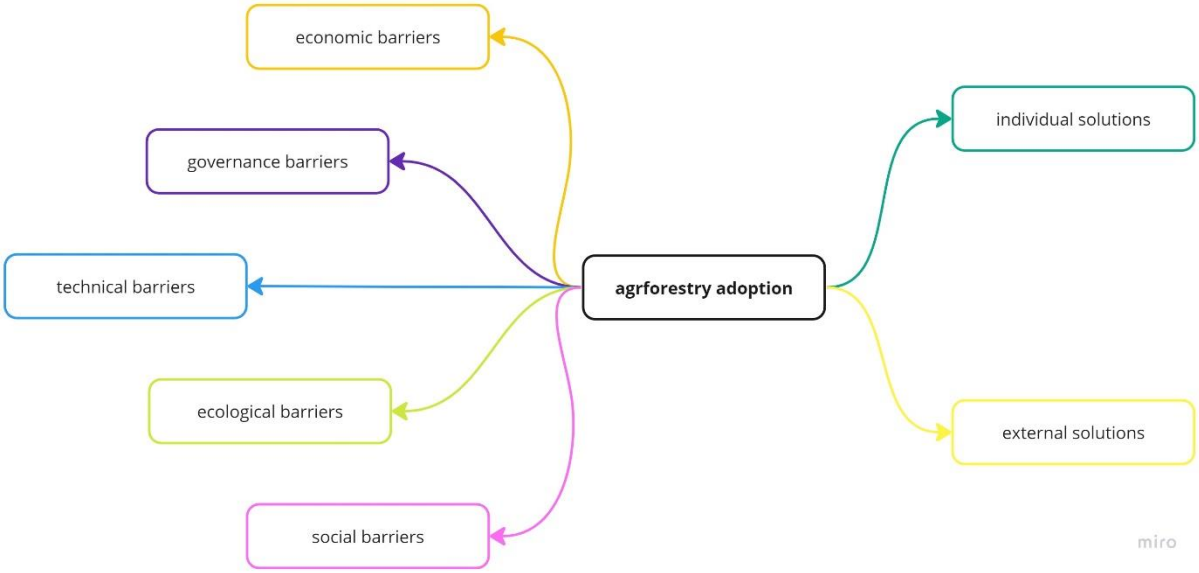
A farmer with agroforestry rows and a food forest

In a 4-year-old food forest

Shop on the farmer's property

Mind map

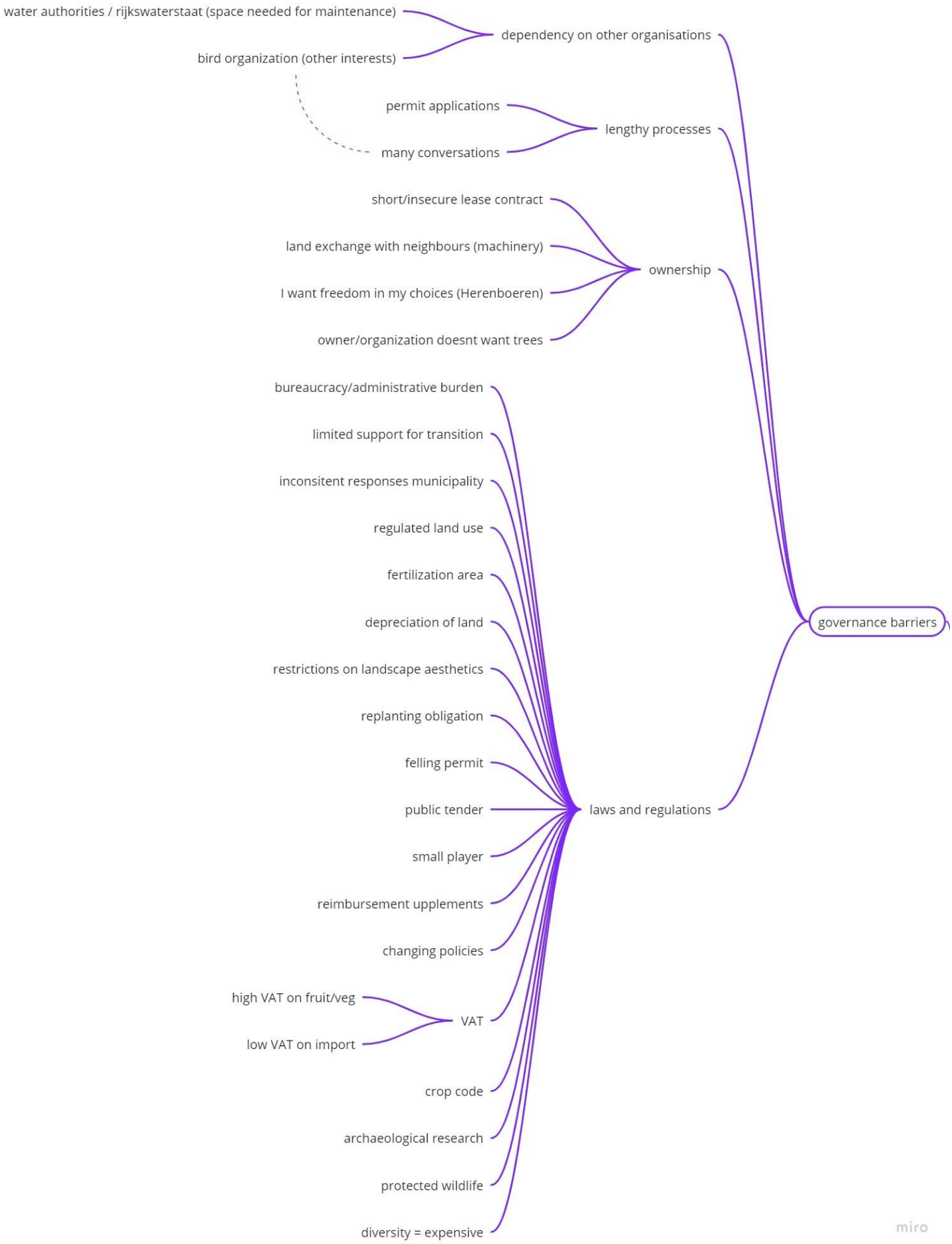
The main levels of the mind map are shown first:



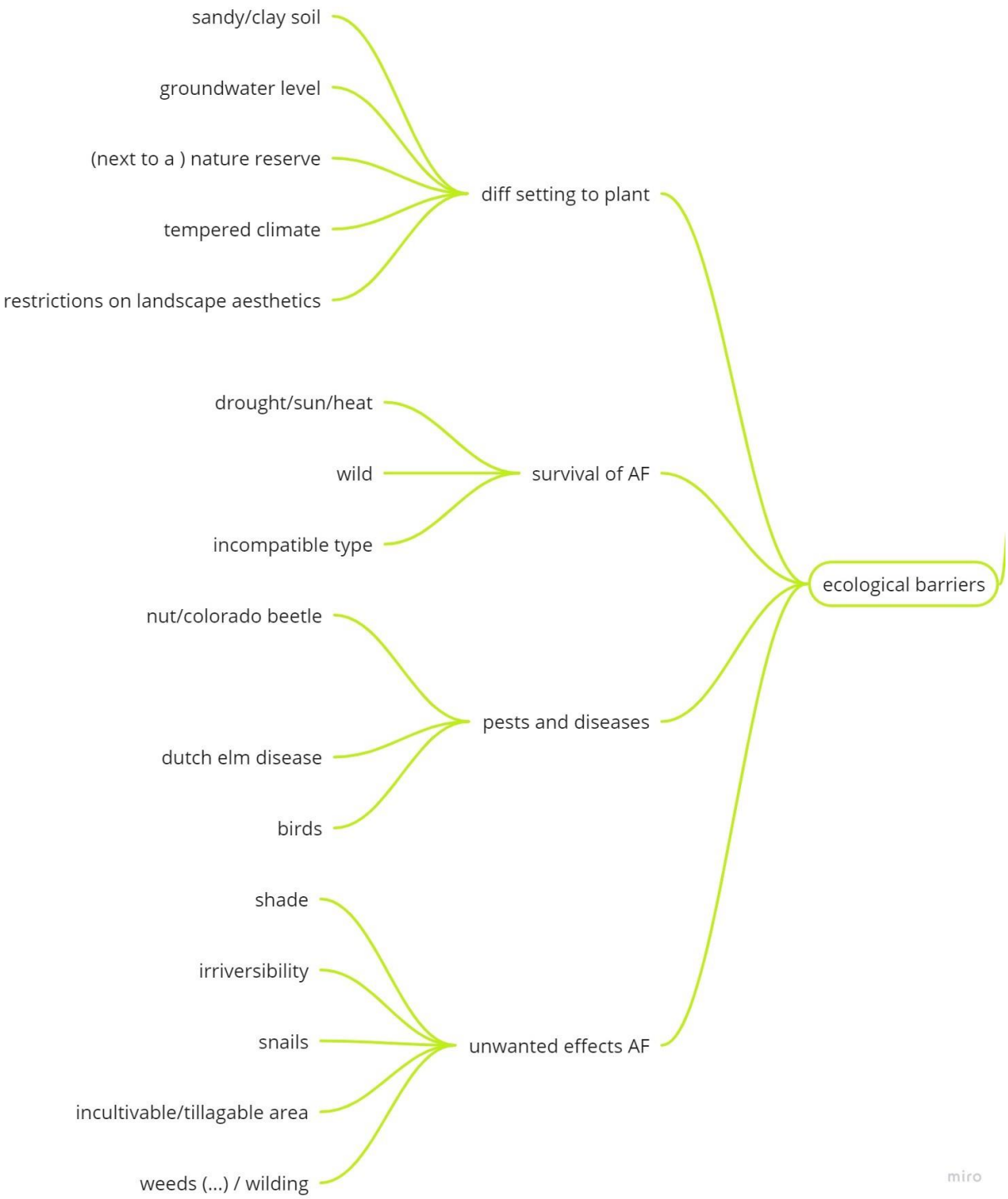
The remaining mind map is shown per theme for readability purposes.


bank doesnt provide loan / says no / cant change bank
(partly) own investment
subsidy criteria dont fit
badly paid / no capital
no shortterm profits
financing
no production initial years
taking plot out of production
energy price high for SME
costly maintenance
high land price
high costs
yields & profits unknown
unproven business case
does it work?
need a lot of guts
uncertainty / pionering
taking a course
GLB application
transport for processing
manual planting
manual harvesting
manual irrigation
manual processing
labour intensive
time intensive
educate volunteers
lands/trees are distant
economic barriers
miro

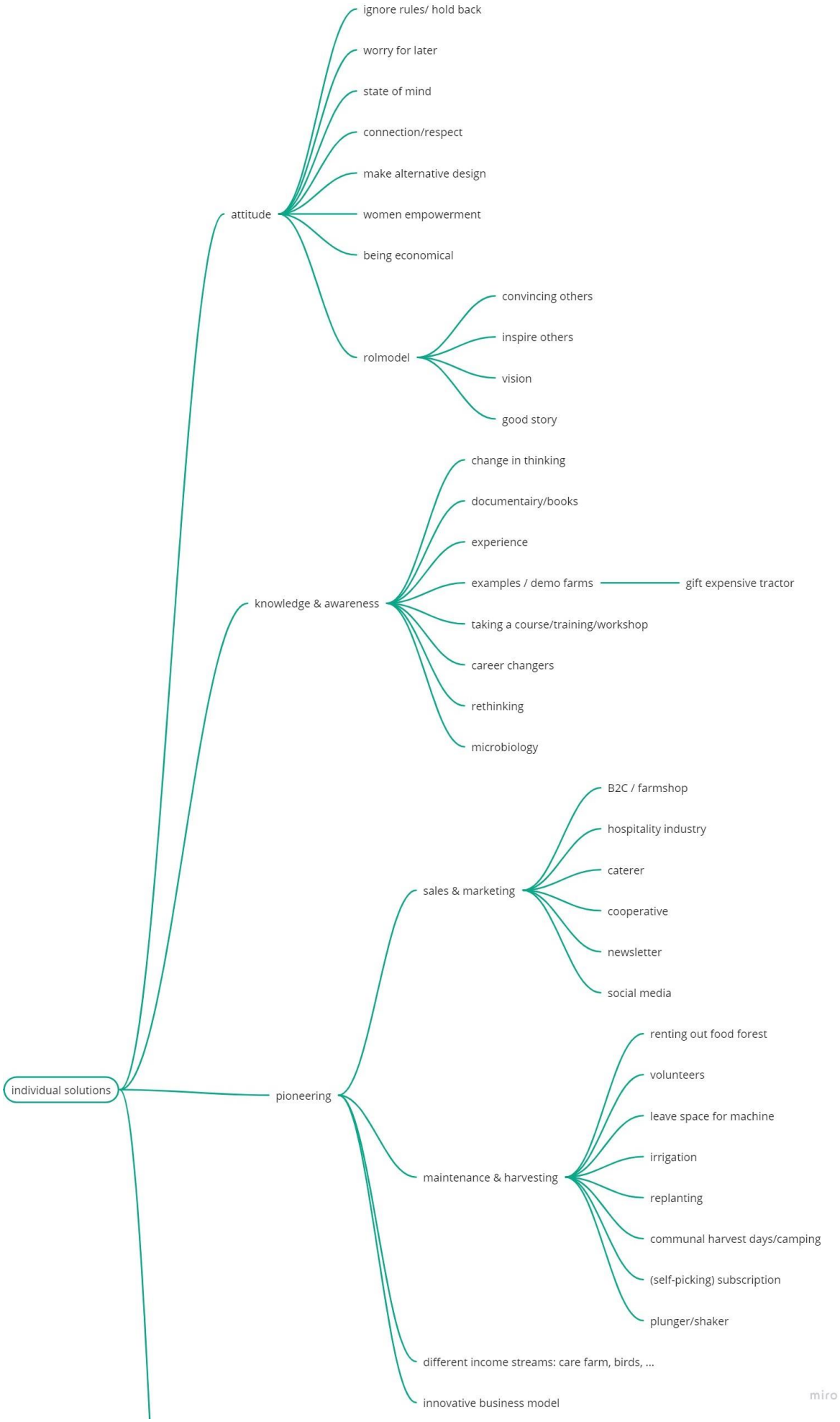

time spend on PR
anonymous organic market
not a salesperson
fewer auctions
no channel
no farming shop
no direct customers
no organic shop closeby
mass-oriented system
sales & marketing
want to sell in neighbourhood/local
strategy supermarkets
consumer awareness is 0
no/unknown demand
low spend on groceries
VOC mentality
cheap import
price buyers
but want quality and taste

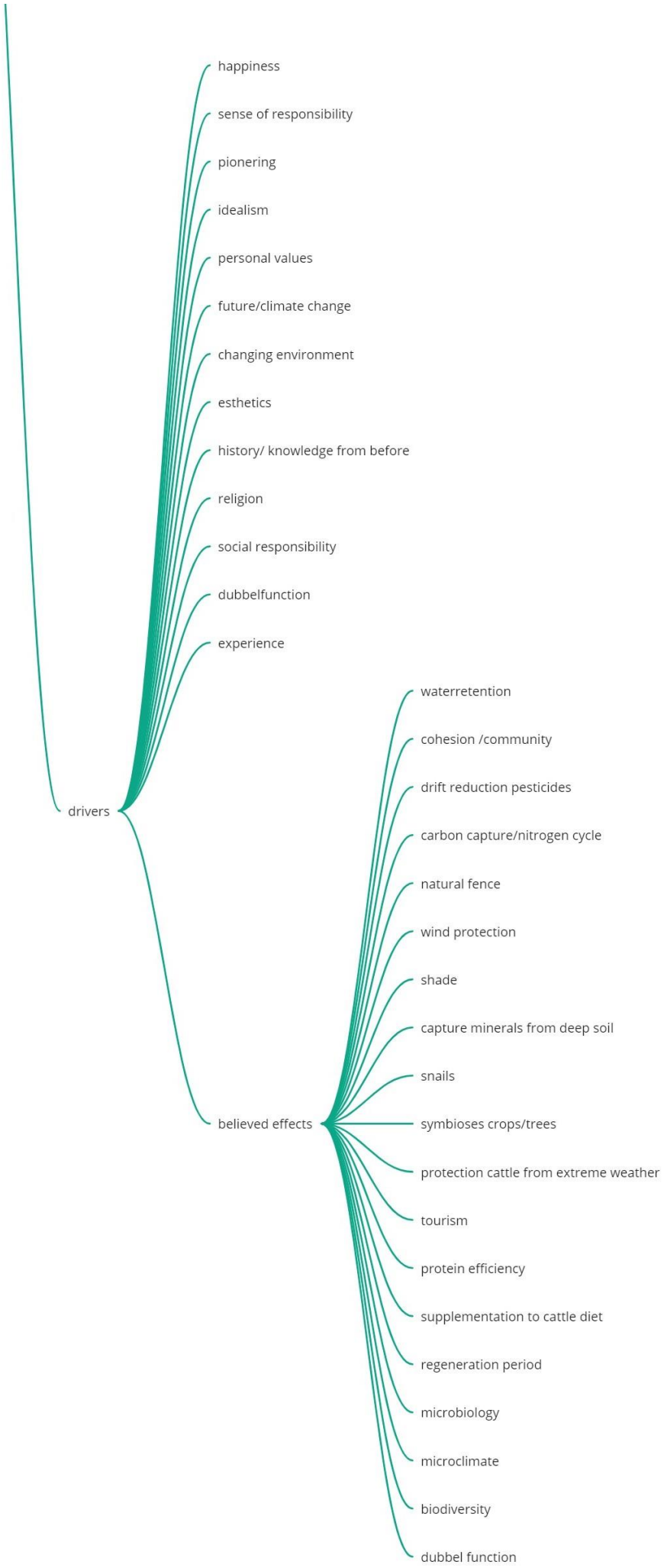

governance barriers
dependency on other organisations
water authorities / rijkswaterstaat (space needed for maintenance)
bird organization (other interests)
lengthy processes
permit applications
many conversations
ownership
short/insecure lease contract
land exchange with neighbours (machinery)
I want freedom in my choices (Herenboeren)
owner/organization doesnt want trees
laws and regulations
bureaucracy/administrative burden
limited support for transition
inconsitent responses municipality
regulated land use
fertilization area
depreciation of land
restrictions on landscape aesthetics
replanting obligation
felling permit
public tender
small player
reimbursement upplements
changing policies
VAT
high VAT on fruit/veg
low VAT on import
crop code
archaeological research
protected wildlife
diversity = expensive

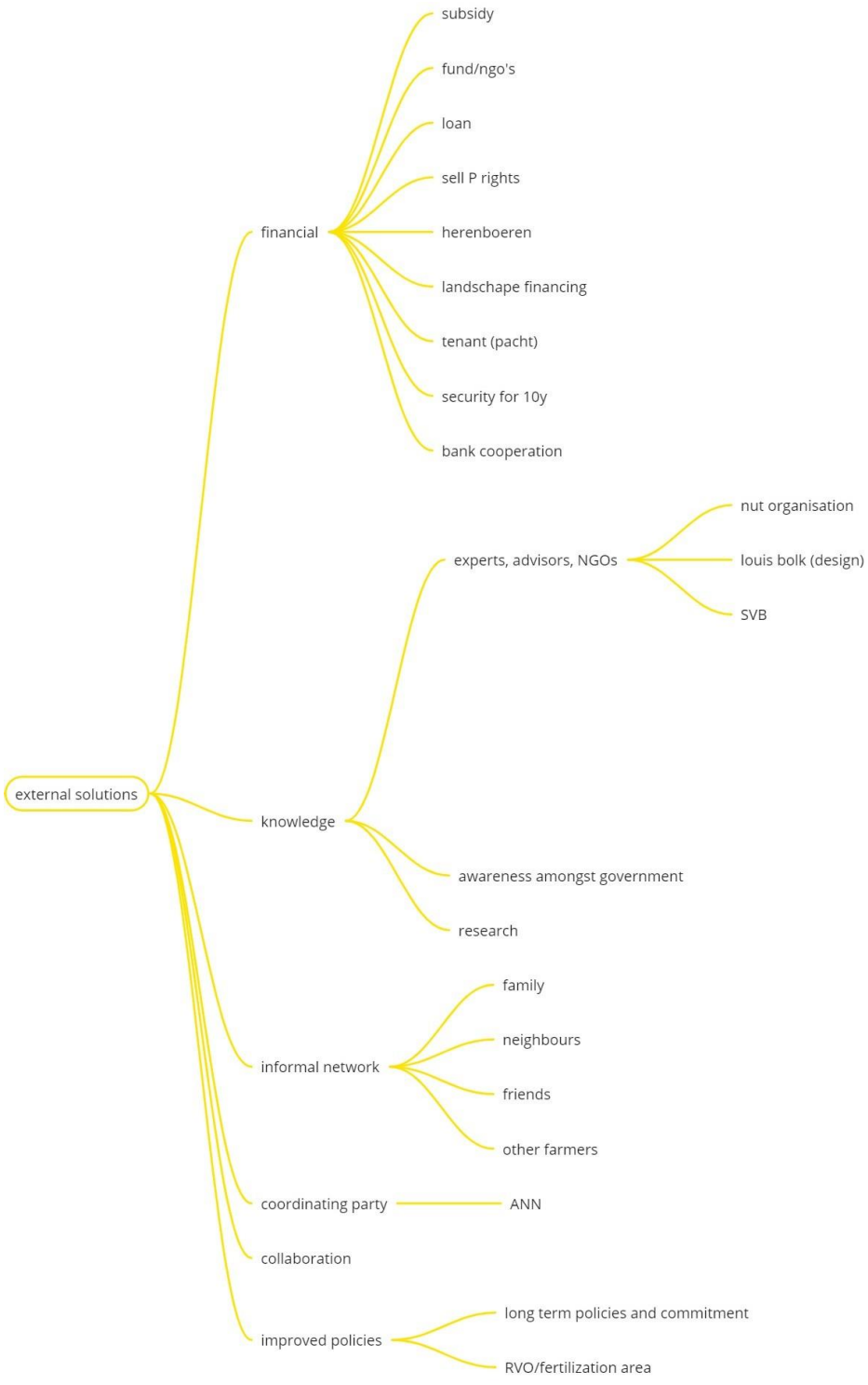

technical barriers
lack of knowledge & expertise
design
knowledge
join research
missing in education system
lobbyists/ 'advisor'
experience
planting
machinery destroys soil
manual time invasive
maintenance
lack of time
lack of skills
lack of equipment
irrigation
no space to use machinery for other crops/cattle
harvesting
manual (lack of time and people)
complexity
seasonability
lack of machinery
machinery expensive and cant share due to seasonality
processing
transport
more work
investment in processing technology
lack of collaboration/cooperation
miro


ecological barriers
diff setting to plant
sandy/clay soil
groundwater level
(next to a) nature reserve
tempered climate
restrictions on landscape aesthetics
survival of AF
drought/sun/heat
wild
incompatible type
pests and diseases
nut/colorado beetle
dutch elm disease
birds
unwanted effects AF
shade
irriversibility
snails
incultivable/tillagable area
weeds (...) / wilding
miro


social barriers
attitude
(negative) experiences
negative beliefs
sacraficing land / fear
driven by profits
tradition and family heritage
social norms & opinions
disadvantages
gloating
status
habit/shame
conservative views
unaware or unknown
gap farm to fork
damage mass production
customer vs. civilian
polarised discussion on agricultural transition
farms should be free of clutter (hygenic)
can't earn a living with AF
being called a hobbyist
odd duck/clutter farmer
neighbours complaining
(control) beliefs
there is no other way
not financially viable
NL to small for ecological balance
responsibility / idealism)
trees dont belong here
family heritage
miro


individual solutions
attitude
ignore rules/ hold back
worry for later
state of mind
connection/respect
make alternative design
women empowerment
being economical
rolmodel
convincing others
inspire others
vision
good story
knowledge & awareness
change in thinking
documentairy/books
experience
examples / demo farms
gift expensive tractor
taking a course/training/workshop
career changers
rethinking
microbiology
pioneering
sales & marketing
B2C / farmshop
hospitality industry
caterer
cooperative
newsletter
social media
maintenance & harvesting
renting out food forest
volunteers
leave space for machine
irrigation
replanting
communal harvest days/camping
(self-picking) subscription
plunger/shaker
different income streams: care farm, birds, ...
innovative business model


drivers
happiness
sense of responsibility
pionering
idealism
personal values
future/climate change
changing environment
esthetics
history/ knowledge from before
religion
social responsibility
dubbelfunction
experience
believed effects
waterretention
cohesion /community
drift reduction pesticides
carbon capture/nitrogen cycle
natural fence
wind protection
shade
capture minerals from deep soil
snails
symbioses crops/trees
protection cattle from extreme weather
tourism
protein efficiency
supplementation to cattle diet
regeneration period
microbiology
microclimate
biodiversity
dubbel function


external solutions
financial
subsidy
fund/ngo's
loan
sell P rights
herenboeren
landschape financing
tenant (pacht)
security for 10y
bank cooperation
knowledge
experts, advisors, NGOs
nut organisation
louis bolk (design)
SVB
awareness amongst government
research
informal network
family
neighbours
friends
other farmers
coordinating party
ANN
collaboration
improved policies
long term policies and commitment
RVO/fertilization area