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The potentials of agroforestry systems in Denmark and southern Sweden

– A comparative study on farmers' perceptions and agroforestry-related policies

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Skogsjordbrukssystemens potential i Danmark och södra Sverige
- En jämförande studie om jordbrukarnas inställning och skogsjordbruk-relaterade politik

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Abstract

In the face of climate change, the urgent need for sustainable food systems has brought agroforestry under the spotlight in the Global North, for its provision of ecosystem services. Despite being less known in the Danish and Swedish context, the traditional practice of managing livestock in the semi-natural pastures, similar to the cut-and-carry systems in the tropics, is undeniably a form of agroforestry system.

With an agroecological perspective, the study adopted a quantitative statistical analysis, and identified the perceptions of farmers in Denmark and southern Sweden towards temperate agroforestry systems via an online survey. Moreover, the study conducted a qualitative document analysis on grey literatures to review national policies related to agroforestry under the framework of the European Union Common Agricultural Policies (CAP). The connection of motivating and discouraging factors to adopt agroforestry pointed out by the farmers were examined along with the current policies. Farmers' behaviour and attitude were further analyzed by conducting logistic regression modelling to distinguish the tendencies within Danish and Swedish farmers.

The results revealed that 'animal health and welfare', 'landscape aesthetics', 'soil erosion', 'microclimate moderation', 'pollination', and 'carbon fixation' were perceived as positive factors by farmers from both Denmark and southern Sweden; while 'administrative burden' and 'regulation' were regarded as hurdles to include trees and bushes on farmlands. The study further identified the practice of organic operations and high diversity of livestock to be common indicators observed amongst farmers' positive attitude towards agroforestry, regardless of the discrepancy between attitude and behaviour amongst Danish farmers. At the policy level, Denmark offered many agroforestry-related financial support schemes, while the similar schemes in Sweden were generally more restricted in practice and options, except for the diverse and detailed schemes for semi-natural pastures.

It was thus concluded that the silvopastoral systems had a great potential amongst Danish and Swedish farmers if the density restriction was withdrawn. To establish more agroforestry systems, 'pollination' and 'carbon sequestration' could also be further promoted in both regions, while 'soil conservation' and 'microclimate moderation' should be included in the Swedish financial support schemes. Other suggestions followed the two streams to increase landscape heterogeneity and to have more pollinators, fruits and berries. An interdisciplinary collaboration between agriculture and forestry policy makers, and farmers' participation in the policy-making process were further recommended.

Keywords: temperate agroforestry, agriculture, forestry, agroecology, farmers' attitude, Common Agricultural Policy, policy, financial support, Sweden, Denmark

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Looking back on the past eight months, it has been a tough journey from designing the project, collecting responses, analyzing the results, to interpreting the rationales behind them. It would have never been possible without the generous help and kind assistance from many along the way, be it with providing critical feedback on the survey, translating the survey into local languages, snowballing and sharing the survey with Danish and Swedish farmers, and verifying the data analysis results and interpretation.

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Foreword

"Agriculture changes the landscape more than anything else we do.
It alters the composition of species. We don't realize it when we sit down to eat,
but that is our most profound engagement with the rest of nature." – Michael Pollan

My background in forestry and one free-standing course in agronomy back in bachelor's study have transformed me from an idealist and activist in conservation, who used to be against any types of development, into a pragmatist who, after looking into where the collisions occur, is determined to contribute to sustainable food systems in order to take better care of our Mother Earth. The past one and a half year of the studies has manifested itself that the decision of coming to Sweden to pursue a degree in agroecology is so much more than just a romantic aspiration.

Agroecology, a holistic approach that adopts systematic thinking, and addresses comprehensive sustainability by including environmental, social, and economical complexities, has appeared to be the very paradigm shift that the world urgently needs in our current production systems. I was very grateful to be bestowed with this opportunity to join the Agroecology Master's Programme at the Swedish University of Agricultural Sciences on the Alnarp campus to learn about this discipline and the concepts and theories behind it. It was fascinating to learn about the soil components and organisms, the differences between sustainable intensification and extensification, and La Via Campesina, a crucial agroecology grassroots movement initiated by peasants. I was also grateful to be introduced to tools such as the rich pictures, Hawkesbury's Peanut Model, and Sustainability Assessment of Food and Agricultural Systems (SAFA) and further apply them in the analysis of farm units. In addition to the mandatory courses 'Agroecology Basics' and 'Agroecology and Sustainability of Production Systems' that prepared us with holistic approach and systematic thinking, I enhanced my knowledge by taking agricultural and landscape related subjects, such as 'Working with Local Natural Resource Management in Low-Income Countries (online course)', 'Advanced Digital

Landscape Analysis with Geographic Information Systems' and 'Health Promoting Outdoor Environment'.

Yet due to the fact that the courses in the programme were designed in order to accommodate students coming from diverse educational backgrounds, I constantly found myself craving for more in-depth learning and discussions during the first semester when taking obligatory courses. To better equip myself, I decided to take on extracurricular activities, such as joining a development organisation and write agriculture-related articles for their monthly issues. I seized the opportunity to attend the Global Landscape Forum to enhance my knowledge in the role agriculture plays in the landscape, and applied to be a volunteer at the Stockholm EAT Forum organized by EAT Foundation to broaden my horizon in sustainable food systems. The possibility to go on exchange to the University of Copenhagen for a semester also gave me great boost in acquiring skills and knowledge relevant to the thesis project that I intended to conduct.

Despite the ups and downs in the programme, staying positive and open-minded, along with working hard around the field that I am deeply passionate about, are the key spirits that have driven me to date. Agroecologist could be the profession that I dare not to term it myself just yet, I am however very glad that I embarked and already on the journey to becoming one. I hope the skills and knowledge I have gained thanks to the programme can be further found in this thesis project.

1. Introduction

Current food production has sustained the global population of nearly 7.8 billion today, and it will continue to rise to meet the demand of 9.7 billion expected in 2050 (UN 2019). Yet the existing food system is account for nearly one-third of the global greenhouse gas (GHG) emissions, as well as the biodiversity loss in 70% in the terrestrial and 50% in the freshwater ecosystems, according to the Living Planet Report by the World Wildlife Fund (WWF, 2020). With the rising population, critical climate status, and alarming biodiversity loss, a paradigm shift of our current food systems towards sustainable ones is in urgent need in face of these challenges.

While the concept of a 'sustainable food system' often appears to be abstract and unreachable, the concept of 'planetary health diet' supported by many scientific evidences was proposed by the EAT Lancet Report (Willett et al. 2019), building on the 'planetary health' by Rockefeller Foundation-Lancet Commission (Whitmee et al. 2015). Planetary health diet refers to the diets that are healthy for human and sound for the environment on which mankind depends. To realize the planetary health diets, the EAT Lancet Report (Willett et al. 2019) suggested based on the interdisciplinary and holistic studies that improvements in food production is one of the three main pillars, together with dietary change and reduction in food waste. Agroforestry is also clearly indicated as a sustainable practice and contributes to agricultural biodiversity (Willett et al. 2019).

Agroforestry, a term first coined in the 1970s, was sought after as alternative agricultural practices for the Green Revolution. In the spectrum of natural forests and man-made monocultures, agroforestry was considered as a sustainable solution that was more adaptable to local cultures of the Global South (Bene et al. 1977). The study commissioned by the International Development Research Center further led to the establishment of the World Agroforestry Center (International Centre for Research in Agroforestry, ICRAF) in 1988 (ICRAF 2019a).

Despite its long research focus in tropical regions for development reasons, its counterparts in temperate zones received attention in relatively recent years due to their provision of ecosystem services. Starting from the 1980s, interests and momentum for temperate agroforestry has gradually grown in the Global North, such as the United States, Australia and New Zealand, through scientific research,

national initiatives, and governmental supports (FAO 2015a; Mosquera-Losada et al. 2012). Similar trend of development is also found in Europe. Funded research projects like SAFE (Silvoarable Agroforestry for Europe 2000-2005) and AGFORWARD (AGroFORestry that Will Advance Rural Development research projects 2014-2017), and the establishment of European Agroforestry Federation in 2011, which now consists of around twenty national member organisations in Europe (EURAF 2020a), all indicate temperate agroforestry systems has gained an increasing recognition in Europe over the past two decades.

The benefits of ecosystems services offered by agroforestry are now emphasized and promoted at a greater extent for the immediate actions required to reconcile the reoccurring extreme events, especially with heatwaves and heavy precipitation expected to continuously increase in their frequency and intensity in many regions (IPCC 2019). In food production, climate change can be translated into low productivity of crop and livestock related in high confidence to stress induced by higher temperatures and shifts in habitats (Arneth et al. 2019) and reduced nutritional value in crops caused by raising atmospheric CO_2 (IPCC 2019). As food production is crucially dependent on environmentally sound agroecosystems, the deteriorating planetary health due to climate change is thus greatly putting food security at risk (Mbow et al. 2019).

In a time when our Mother Earth is fiercely on fire due to climate change, agroforestry practices and systems that are appropriate in the local agroecosystems can enhance resilience among farmers that are most vulnerable to climate related catastrophes. The high potential in climate mitigation and adaptation of agroforestry, such as higher food productivity, carbon sequestration for both above and below ground, and soil conservation, makes it an effective and sustainable approach in strengthening food security (Feliciano et al. 2018; Mbow et al. 2019).

The following context elaborates on the interactions within the temperate forests, with a highlight on Danish and Swedish cases and supplemented with other examples from Europe. It is then followed by an introduction to the framework of the Common Agricultural Policy under the European Union.

1.1 Temperate agroforestry in Europe

Geographically, temperate agroforestry is practiced in temperate zones which are the bands between 37° N and S and the Arctic and Antarctic circles (66.5° N and S) (Gordon et al. 2018). Agroforestry, termed by World Agroforestry Center as agriculture with trees (ICRAF 2019b), can be defined in the European context as a land management that combines agricultural crops, including pastures, and woody vegetation, such as trees or shrubs, in some spatial arrangement and temporal sequence (FAO 2015a; Mosquera-Losada et al. 2009). Temperate agroforestry in Europe is further categorized into silvoarable, silvopastoral, agrosilvopastoral, and linear systems, depending on the integrated agricultural types and the location of the trees/shrubs (Fig. 2) (Dupraz et al. 2018).

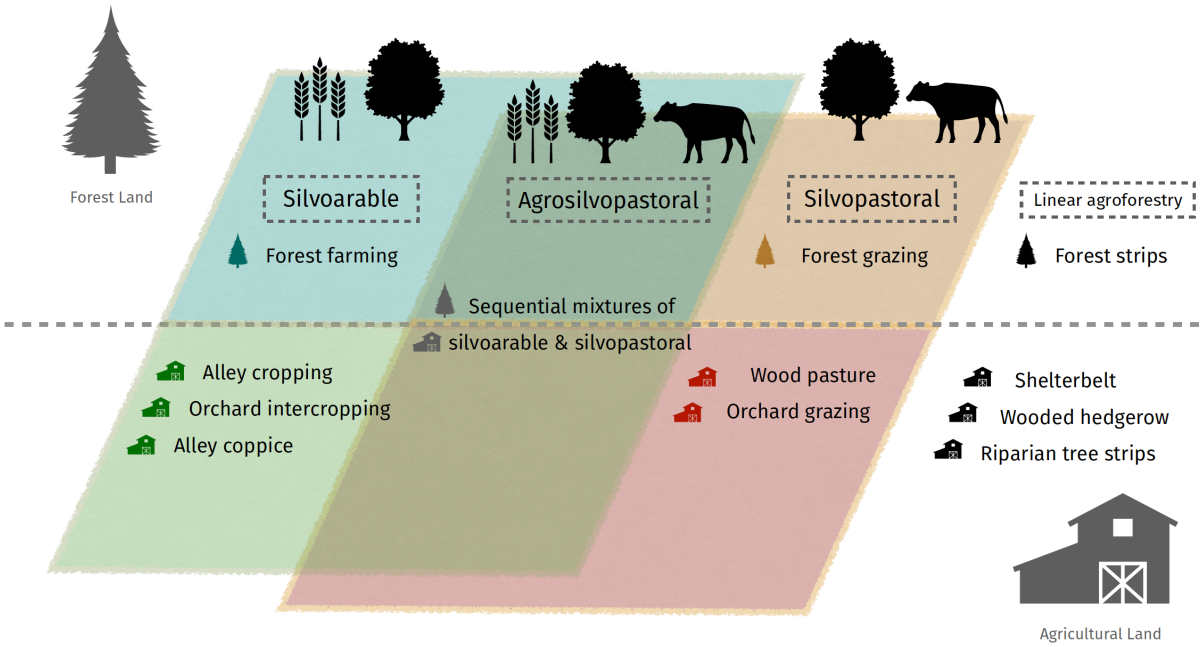


Fig. 2. Illustrated European agroforestry typology, related to agricultural, biodiversity and climate regulations, and national Land Parcel Identification Systems (Dupraz et al. 2018).

1.1.1 System categories

Silvoarable systems

Silvorable systems are the integration of trees and/or shrubs on the crop fields. It can be further subdivided into forest farming and alley cropping.

Defined by Hart (1996), forest farming is a sustainable seven-layered plant-based agroforestry, founded on principles of forest ecosystems. The seven layers are the decomposed elements of natural forests, which consist of fruit and nut trees, shrubs, herbs, perennial vegetables, cover crops and vines (Fig. 3) (Dupraz et al. 2018). Similarly, non-wood forest products (NWFPs), semi-wild non-wood species

and products derived from the forests like mushrooms and berries, have certain linkage with forest farming (Wolfslehner 2019). While 50% of the NWFPs in Europe were only produced exclusively in nature without artificial interference, 40% can be cultivated by human, in addition to being harvested from the wild (Wong & Wiersum 2019).

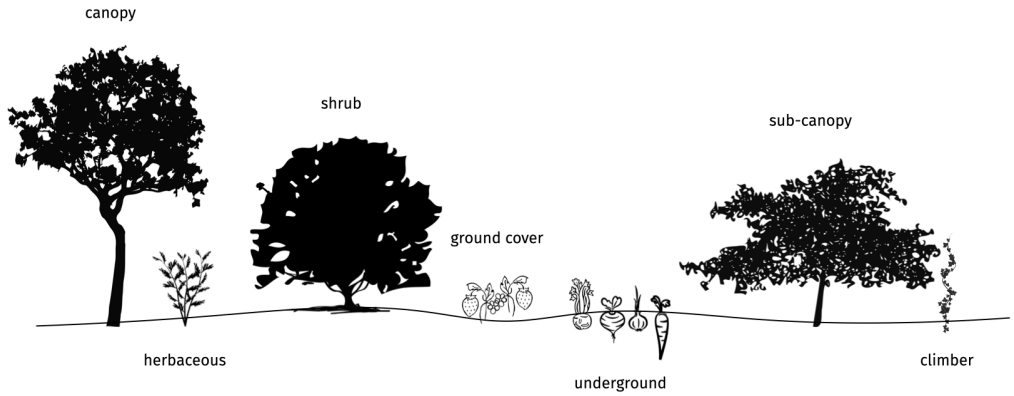


Fig. 3. Seven-layered forest farming defined by Hart (1996).

Alley cropping, according to FAO (2015b), is the cultivation of crops in alleys formed by hedgerows of trees and shrubs, therefore it is also known as hedgerow intercropping. Subcategories of alley cropping include orchard intercropping and alley coppice.

Orchard intercropping is a mix of orchard and crops. An example of this is at Kjærsgård, on Jutland, Denmark, where black currant bushes are planted with a row distance of 9 meters that allows machines to still operate, while grains, clover grass, and legumes are grown in between the bushes on a 9.7-hectare land (Rohde et al. 2018). Researchers in Sweden are also conducting ongoing study consists of 4 rows apple (*Malus spp.*) strips, 3 rows of mixed bushes, with crops like rapeseed (*Brassica napus*), grass/legume ley, beetroots (*Beta vulgaris*) and faba beans (*Vicia faba*) under SAFE (SITES Agroecological Field Experiment), an agroecological umbrella project (Svensson 2017; Sveriges Radio 2017).

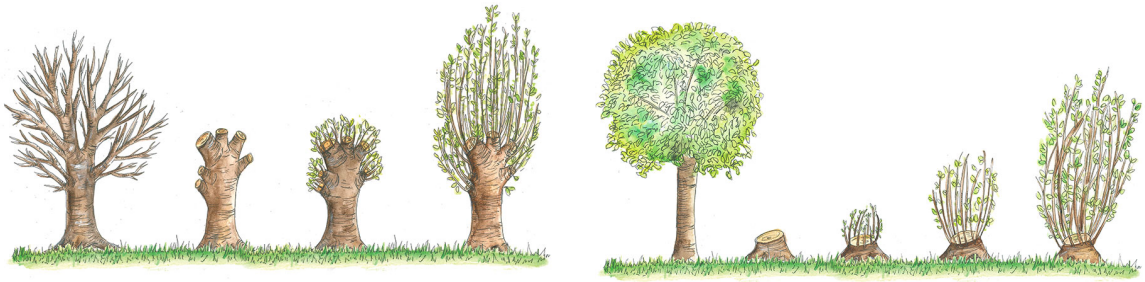
Alley coppice, also termed as trees and inter-trees, refers to coppice grown in between hardwood tree rows (Dupraz et al. 2018). It is an innovative approach to pair short rotation coppice, such as willow (*Salix spp*.) and poplar (*Populus spp*.), with high quality timber like common ash (*Fraxinus excelsior*) (Morhart et al. 2014).

Silvopastoral systems

On the other hand, silvopastoral systems are the combination of ranchland and trees/shrubs. Subsystems under this term are forest grazing, wood pasture, tree fodder, and orchard grazing.

Forest grazing is defined as grazing by farmed animals on forest land entitled officially by regional or national land inventories (Dupraz et al. 2018). An example of such system is pannage, or mast-feeding, which is a traditional practice that domestic swine foraged in oak (*Quercus robur*) or beech (*Fagus sylvatica*) forests (Jakobsen 2018). It was commonly practiced during the 16th and 19th century in Denmark (*oldengæld*), which contributed profoundly to the natural regeneration of these woodlands (Hahn et al. 2007; Jakobsen 2018). In central and northern Sweden, cows, sheep and goats were traditionally migrated to summer pasture in mountainous forests (*fäbodbruk*) (Eriksson 2011), and special high pitch vocal herding calls (*kulning*) were used by shepherdess to call home the livestock despite their distance being miles apart (Jinton 2018; Rosenberg & Ahlbäck 2003).

On the other hand, wood pasture is grazing on woodlands not classified as forest in official documentations (Dupraz et al. 2018). Wooded meadows with many pollarded trees (*hamlingsäng*), with mainly coppiced and few pollarded trees (*stubbskottsäng*), with scattered pollarded and coppiced trees (*löväng*), have their long history in Sweden (Fig. 4) (Brånhult et al. 2013; Dupraz et al. 2018). The meadows were utilized as grazing field in warm seasons, while the deciduous trees and shrubs were pollarded and coppiced for winter fodder (Hultberg 2015). Ash (*F. excelsior*), lime (*Tilia cordata*), hazel (*Corylus avellana*) and oak (*Q. robur*) were common broadleaf species in these Swedish wooded pastures (Naturskyddsföreningen 2008).



A. B.

Fig. 4. Treatment of trees in Swedish wooded pastures: A. pollarded trees, and B. coppiced trees (The Woodland Trust 2018).

Tree fodder refers to the fodder trees planted, scattered or in banks, intentionally in hedgerows or on wood pastures, while orchard grazing is combining grazing animals and orchard system with fruit trees, e.g. cattle grazing on olive (*Olea europaea*) orchard, and sheep grazing on apple (*Malus spp.*) orchard (Dupraz et al. 2018; McAdam 2017). Furthermore, short rotation coppice (SRC), such as willow (*Salix spp.*) and poplar (*Populus spp.*), for bioenergy has started to gain interest for its economic and ecological values in recent decades (Lindegaard et al. 2016).

Agrosilvopastoral systems

As the name suggests, the system consists of both arable and pastoral systems with the addition of trees. One of the living models of this would be the Ydun Have on Samsø, Denmark, a 10-hectare agroforestry system composed of multiple fruit trees and berry bushes, vegetables and hens, which started since 2018 (Rohde et al. 2018). A corresponding soon-established agrosilvopastoral system in Dalsland, Sweden, by 2021, will be a 6-hectare production system of fruit and nut trees in rows, with crops cultivated in the in-rowed alleys crops and white clovers (*T. repens*) under the trees, as well as bees (Sennerdal & Westman 2019).

Linear systems

Unlike the former three systems that are in the agricultural or forest parcels, linear systems are mostly found on the borderlines or on the outer perimeters of the parcels (Dupraz et al. 2018). These linear systems contain wooded hedgerows and riparian tree strips.

Wooded hedgerows could be used as livestock enclosures, boundary of the farmland, or shelterbelt to wind erosion. In Denmark, shelterbelt has its history as a national scheme back in the mid 19 century, as an approach to reduce wind erosion in Mid and Western Jutland, as a result of land conversion from heath to arable land under the pressure of feeding its rising population and losing land to Germany over the 1864 war (EURAF 2020b). Until 1960, the hedgerows were dominantly single row of white spruce (*Picea glauca*) or Sitka spruce (*P. sitchensis*), and often mixed with the Swedish whitebeam (*Sorbus intermedia*) (Busck, Kristensen & Primdah 2007).

Riparian strips, and forest strips situated on classified forest land, are linear systems established in close proximity to streams and rivers (Dupraz et al. 2018). They serve ecological functions that benefit aquatic ecosystems in terms of

intercepting excessive nutrients and contaminants, mitigating runoff and decreasing erosion, providing structurally complex layers as wildlife habitat, and sequestering great amount of carbon (Stutter et al. 2019).

1.1.2 Ecosystem services

Defined by Millennium Ecosystem Assessment (2003), ecosystem services are the benefits people receive from ecosystems, and can be divided in to provisioning, regulating, cultural services and supporting (Table 1). The former three can be further bundled into direct services, while supporting services are indirect services that does not benefit humans directly, yet they are the essential services that support the other three. Direct services include provisioning services, which refer to products from the ecosystems; regulating services, which are derived from the beneficial ecosystem processes; and cultural services, which are the non-material benefits.

Table 1. Ecosystem services adapted from Millennium Ecosystem Assessment (2003) & FAO (2020).

Provisioning	Regulating	Cultural
Food	Microclimate	Mental and physical health
Fresh water	Air quality	Sense of place
Raw materials	Water flow regulation	Aesthetics appreciation
Pharmaceutical resources	Waste water treatment	Inspiration for cultural
	Soil fertility & conservation	art and design
	Pollination	Educational
	Biological control	Recreation and ecotourism
	Carbon sequestration	Spiritual and religious
	Mitigation of extreme events	
Supporting		
	Soil formation	
	Biochemical cycling	
	Habitat for species	
	Maintenance of genetic diversity	

In a meta-analysis, ecosystem services like biodiversity, soil fertility, and erosion control identified in European agroforestry systems, are significantly positive when compared to conventional arable and forestry systems (Torralba et al. 2016). Another study by Ghaley et al. (2015) also suggested that a combined food

and energy (CFE) agroforestry system in Denmark provide a higher overall value of combined ecosystem services than monocultures of wheat (*Triticum aestivum*) field and beech (*F. sylvatica*) forest.

Agroforestry as an agroecosystem is further examined by the lens of ecosystem services. Though cultural services are absent due to the challenges to quantify the aspects (Torralba et al. 2016), provisioning, regulating and supporting services studied in the Danish and Swedish contexts are given below.

Provisioning Services

Food and raw materials

When zooming into provisioning services, silvoarable systems in Spain, France and the Netherlands, were also observed to produce as much as 40% more than the yields from monocultural arable and woodland systems (Graves et al. 2007). In a 21-year study in Taastrup, Denmark, a CFE system on the experimental farm showed a higher total productivity by 14% to 34%, compared to sole wheat and sole SRC, as well as higher economic returns and resilience against yield fluctuations and discount rates (Xu et al. 2019).

Regulating Services

Microclimate

In the same CFE production system, willow hedgerows of 5 meters in height contributed to a modified microclimate of 4 to 7 times its height (H), stretching to 20 to 35 meters in distance (Foereid 2002). Closer to the leeward side of the windbreak, wind speeds were reduced to more than half of that at 100 meters (20H), air temperatures were higher during daytime and lower at night, soil temperatures were increased, vapor pressures rose, soil moisture was lowered, and 10% less radiation than the field 100 meters from the windbreak (Foereid 2002).

Soil Fertility & Conservation

A study of a silvoarable system, in which wheat (*T. aestivum*) was cultivated alongside poplar (*Populus trichocarpa* × *Populus deltoides*) plantation in Uppsala, observed higher microbiological activity closer to the trees than farther away from them, as well as in the field of the standing trees as opposed to the harvested ones (Browaldh 1997).

Biological control

In a study on predatory anthropods, higher coverage of hedgerow, forest edges, and other woody elements within 20 meters radius from apple (*Malus spp.*)

orchards, contributes to greater abundance of important biocontrol agents like earwig (*Forficula auricularia*) in Skåne (Happe et al. 2019). In a study in Denmark by Langer, naturally occurring parasitoids on cereal aphids, *Praon* sp., were found to be significantly higher in semi-perennial willow (*Salix*. sp.) hedges, compared to annual barley and alfalfa (Langer 2000). The parasitism by *Praon* sp. in the first year, 3.2% closer to the hedge as opposed to 1.4 % farther from the hedges, also indicated SRC hedges could enhance the attacking incidence of parasitoids (Langer 2000).

Carbon sequestration

In terms of mitigating climate change impacts, carbon sequestration potential under regulating services of agroforestry systems was evaluated in one pan-European study. Sonja et al. (2019) found that 8.9% of the total agricultural land in Europe are under multiple environmental pressures, and by adopting different agroforestry systems, these farmlands could potentially store between 1.4% and 43.4% of the total European agricultural GHG emissions.

Pollination

Many studies have put emphasis on adopting landscape approach to practice pollinator conservation. The study by Sjödin et al. (2008) suggests that different insect groups respond to different landscape factors in central Sweden, and proposes that grazing intensity should be diversified for promoting pollinator diversity. In a similar manner, hay-meadows, late extensive grazing, and the herb *Knautia arvensis* are pinpointed to be indicators for rich pollinating insects in semi-natural pastures in Southern Sweden, despite their different preference for farm elements (Franzén & Nilsson 2008). A study by Öckinger and Smith (2008) further reveals surrounding matrix to be more influential than corridors for the dispersal of butterflies in southern Sweden.

Supporting Services

Biodiversity

Studies conducted in Östergötland, southeastern Sweden, have indicated close relationships between maintaining silvopastoral systems and species conservation (Paltto et al. 2011; Ranius & Jansson 2000). Species richness of red-listed epiphytic lichens on old oaks in open oak pastures is 53% higher than that on oaks in secondary woodland developed from oak wood pastures (Paltto et al. 2011). It could be potentially explained that denser woodland holds unsuitable conditions

for the survival of the epiphytic lichens, e.g. less penetrating sunlight, more competition from other lichens and bryophytes, and reduced wind speed for diaspore dispersal (Paltto et al. 2011).

Populations of many red-listed saproxylic beetles, especially *Osmoderma eremita*, *Tenebrio opacus*, *Elater ferrugineus* and *Larca lata*, are significantly negatively affected by the cessation of grazing in prior open oak (*Quercus robur*) pasture, according to Ranius & Jansson (2000) and Ranius (2002). The regeneration of forests from the abandoned pastures causes the premature death of old oaks due to water and nutrient competition, and shading from younger trees, which further results in habitat loss for the beetles (Ranius & Jansson 2000; Ranius et al. 2005).

Biochemical recycling

Nitrous oxide (N_2O) emitted from nitrification of ammonium-H (NH_4–N) and denitrification of nitrate (NO_3^-) of the farmyard manure has been a powerful GHG, having 264 times the global warming potential than that of carbon dioxide (CO_2) (Chadwick 2005; Myhre et al. 2013). Therefore, a reduction of nitrate leaching can be a mitigation approach for climate change, at the same time lessen the impact of eutrophication (Monteny, Bannink, & Chadwick 2006; Smolders et al. 2010). A study in southern Denmark showed that a 20% tree cover of poplar (*P. maximowiczii* × *P. trichocarpa*) on grass–clover (*Lolium perenne–Trifolium repens*) significantly reduced nitrate leaching by 75%, compared to grass–clover with no trees, in outdoor pig production system (Manevski et al. 2019).

The ability to improve nitrogen balance in the agroecosystems can also be contributed by N_2 fixing ability of legumes in symbiosis with root nodule bacteria that has the potential to produce inoculants for nutrient cycling in agriculture. In a study by Ampomah et al. (2012), several indigenous perennial nitrogen-fixing legumes were identified on both farmlands and woodlands throughout the Swedish peninsula, which indicated their promising application in the Swedish agroforestry systems. *Lathyrus pratensis* was found in the edges of arable lands, edges of beech (*F. sylvatica*) forest, and roadsides, while *Trifolium medium* and *Vicia sepium* were identified in meadows and walking paths in forests of Scots pine (*Pinus sylvestris*) and beech (*F. sylvatica*) (Ampomah et al. 2012).

1.2 EU Common Agricultural Policies (CAP)

1.2.1 How CAP has come into shape

The Common Agricultural Policies (CAP), established in 1962, were created to promote mechanisation and intensification with the aim to meet the need for food consumption within the European Union (García-Feced et al. 2014; European Commission 2018). *MacSharry Reform* in 1992 initially diverted the focus of CAP from quantity to quality, under the pressure of unbalanced market price caused by overproduction and the rising awareness of the externalities originated from intensive farming. It lowered support prices at the same time introduced direct payments per hectare or livestock, and granted aids to sustainable agricultural practices in environmental preservation and landscape protection (Blanc 2002; European Commission 2018).

In 1999, the *Agenda 2000 Reform* introduced environmental standards for farmers to comply to, in order to stay eligible of receiving aids, which is known as cross-compliance (European Commission 2018; Massot 2020a). Additionally, social aspects of agriculture were highlighted and enlisted together with environmental considerations under the construction of rural development policy – the second pillar of CAP (Massot 2020a).

Fischler Reform in 2003 took radical approach in decoupling direct payments by introducing Single Farm Payment (SFP), which made subsidies independent from specific crops and their yields, allowing decision making to be flexible and production to reflect the real market (Viaggi et al. 2010). SFPs were available to land managed by following rules related to food safety, animal health and welfare, and environmental protection, covered by the cross-compliance turned mandatory (European Commission 2005a). Cross-compliance comprises Statutory Management Requirements (SMRs) legislated in EU law, and Good Agricultural and Environmental Conditions (GAECs) set by each member state. In 2007, a single common market organisation (CMO) was established after systematizing from 21 separate CMOs, each in charge of different products, to ensure market stability, living standard of farmers and agricultural productivity (Massot 2020b).

Built on the Fischler Reform, CAP had its latest reform in 2013 for the 2014-2020 period. Direct payments were further categorized into compulsory schemes that required adoption by all member states, and voluntary schemes that are

optional to be adopted by member states. The three mandatory schemes are: 1) basic payment 2) greening payment, and 3) young farmer payment (Massot 2020b). Both pillar I and II were consolidated to lead towards more environmentally, socially and economically sustainable agricultural systems (Table 2) (European Commission 2018; Massot 2020a).

Table 2. Common Agricultural Policy of period 2014-2020 adapted from European Commission (2018 & 2020ax).

Pillar I **entirely financed by European Agricultural Guarantee Fund (EAGF)**			**Pillar II** **co-financed by European Agricultural Fund for Rural Development (EAFRD)**
Direct Payments		Market Measures	Rural Development
Compulsory	Voluntary		
Basic payment Green payment Young farmer payment	Areas of natural constraints Voluntary coupled support Redistributive payment Small farmers scheme	Public intervention Storage of products by the private sector Exceptional measures Sector-specific aid schemes	Knowledge transfer and innovation Farm viability and competitiveness Food chain organisation and risk management Restoring, preserving and enhancing ecosystems Resource-efficient, climate-resilient economy Social inclusion and economic development
Cross-compliance			
Statutory Management Requirements (SMRs) at EU level	Good agricultural and environmental conditions (GAECs) at national level		

1.2.2 Current structure of CAP

In the mandatory schemes, *Basic Payment* granted by farm size, and *Green Payment* for climate- and environmentally-friendly agricultural practices, are relevant to the development of agroforestry. These two mandatory direct payments are applicable to active farmers who own eligible area of farmland (Landbrugsstyrelsen 2020a; Jordbruksverket 2020b).

All farmlands of size greater than the minimum size decided by member states and following cross-compliance automatically receive the *Basic Payment*. For farms to be further qualified for the *Green Support*, there are certain requirements need to be met: 1) cultivating several crop categories on the farm which are more than 10 hectares, 2) 5% of ecological focus area (EFA) on arable land more than 15 hectares, and 3) maintenance of permanent grassland for carbon sequestration and biodiversity (European Commission 2020a). Since organic farmers are eligible for the *Green Payment* by nature, these requirements are not applicable to them (European Commission 2020a).

1.2.2 Agroforestry in CAP

Under the framework of CAP, silvoarable system was the first agroforestry system included in aid schemes. It was stated in Article 5 of Regulation 2419/2001 that '*a parcel that both contains trees and is used for crop production shall be considered an agricultural parcel provided that the production envisaged can be carried out in a similar way as on parcels without trees in the same area*' (European Commission 2001). Agroforestry systems were first officially defined as '*land use systems in which trees are grown in combination with agriculture on the same land*' in the European legislation in Article 44 of Regulation (EC) 1698/2005 under Pillar II (European Commission 2005b).

Pillar I: Ecological Focus Area of the Green Payment

The progressive reform in 2013 further acknowledged agroforestry by including it in Pillar I as an ecological focus area (EFA) of the Green Payment, which accounts for 30% of the direct payments (European Commission 2013a & 2018). EFA is one of the three mandatory practices of the Green Payment, along with crop diversification and maintenance of permanent grassland, and it calls for at least 5% on the arable land more than 15 hectares for a greater biodiversity in agroecosystems (European Commission 2018).

Pillar II: Sustainable Use of Forest Land under Rural Development

Along with its first official definition in Regulation (EC) 1698/2005, agroforestry was recognized as a measure for sustainable use of forest land, and encouraged as measure 222 for the first time as a grant in CAP covering up to 80% of the establishment costs (European Commission 2005b). While agroforestry practices only received partial establishment payment in the period of 2007-2013, the Regulation (EU) No 1305/2013 of the 2013 reform made Pillar II attending to both establishment and maintenance of agroforestry systems in the following period (Table 3) (European Commission 2013b).

Connection of agroforestry practices between Pillar I & II

In terms of the eligibility as an arable land under Pillar I, thresholds of tree density have been imposed on agricultural parcels, which has directly affected the payment received by agroforestry practices. It was set as maximum 50 trees/hectare in the period of 2007-2013 (European Commission 2003), and 100 trees/hectare in the current period of 2014-2020 (European Commission 2014). Even though fruit trees are exempted from the limit, the tree density restriction has been translated into a risk to lose Pillar I payment due to agroforestry establishment of Pillar II, and thus has lowered the willingness to adopt agroforestry under the CAP (Santiago-Freijanes et al. 2018).

Table 3. Financial support for agroforestry practices under Common Agricultural Policy adapted from European Commission (2005b, 2013a, 2013b & 2014).

	Pillar I	**Pillar II**
2007-2013		Regulation (EC) No 1698/2005 Article 36 (b) & Article 44, Measure 222 First establishment of agroforestry systems on agricultural land 80% Establishment costs
2014-2020	Regulation (EU) No 1305/2013 Article 46 (e) Ecological Focus Area	Regulation (EU) No 1305/2013 Article 21 (b) & Article 23, Measure 8.2 Establishment, regeneration or renovation of agroforestry systems 80% Establishment costs 100% Maintenance costs for 5 years

1.3 Agroecological perspectives

Agroecology, defined by Gliessman (2018), *is the application of ecological concepts and principles to design and management of sustainable food systems*. Agroecology is the realm of study that looks at not only the production, but also the ecological functions in the natural ecosystem it is based on, as well as the social-economic forces that affect the system (Francis et al. 2003; Gliessman 1995). Agroecological approaches also put farmers under spotlight, emphasizing their roles as producers at the same time knowledge holders and landscape managers should be recognized and supported through participatory research and decision-making (HLPE 2019). Agroforestry as a production system echoes harmoniously with agroecological principles in emphasizing biodiversity, creating synergies for ecosystem services, lowering external resources, and supporting local food provision (FAO 2018).

In the pursuit of sustainable food systems, the evaluation of agroforestry through an agroecological approach, which emphasizes the inclusion of farmers, could provide a more comprehensive understanding of the potential of agroforestry systems. As current scientific studies on the ecosystem services of agroforestry systems in Denmark and Sweden are still very limited, and agroforestry development under CAP also appears to be restricted, learning agroforestry from farmers' perspectives could yield better insights and help identify the opportunities and constraints to increase agroforestry adoption.

2. Aim

The study intends to answer the following two research questions: 1) what are the motivating and constraining factors to adopt agroforestry in farmers' perceptions, and 2) how are these factors reflected by the differences in the recent Danish and Swedish national policies through financial support schemes?

By answering the above questions, the study aims to evaluate the potentials of agroforestry systems in Denmark and southern Sweden from farmers' perceptions and policy aspects.

3. Objectives

In order to achieve this aim, the objectives of the study therefore include:

1) conduct a survey to understand Danish and Swedish farmers' perceptions,

2) map out agroforestry-related national policies in Denmark and Sweden,

3) compare farmers' perceptions and current agroforestry-related policies to identify the gaps, and

4) propose suggestions to increase the potentials for agroforestry adoption.

4. Methods

To meet the objectives, mixed methods were applied to understand farmers' perceptions for agroforestry systems through conducting a statistical analysis through a questionnaire, and to map out national policies relevant to agroforestry development in Denmark and Sweden under the framework of CAP via a qualitative document analysis, with a focus on financial support schemes. To identify the gaps for agroforestry adoption in Denmark and southern Sweden between farmers' perceptions and the ongoing agroforestry-related policies, results of the quantitative study retrieved from bottom-up approach, and qualitative study with top-down perspectives were further synthesized. Based on the gaps identified, suggestions were proposed to further increase agroforestry adoption (Fig. 5).

The reason for choosing a quantitative research was to understand if there are certain tendencies among specific farmer categories, which should be proven via statistical significant differences. On the other hand, the decision for employing document analysis on national policies was made considering the characteristic of the policy documents. Moreover, the rationale behind the mixed methods of

qualitative and quantitative studies was due to their complementary nature in providing validation to strengthen the study result (Wisdom & Creswell 2013). This way, the study could provide a representative and convincing result in order to bring temperate agroforestry forward in northern Europe.

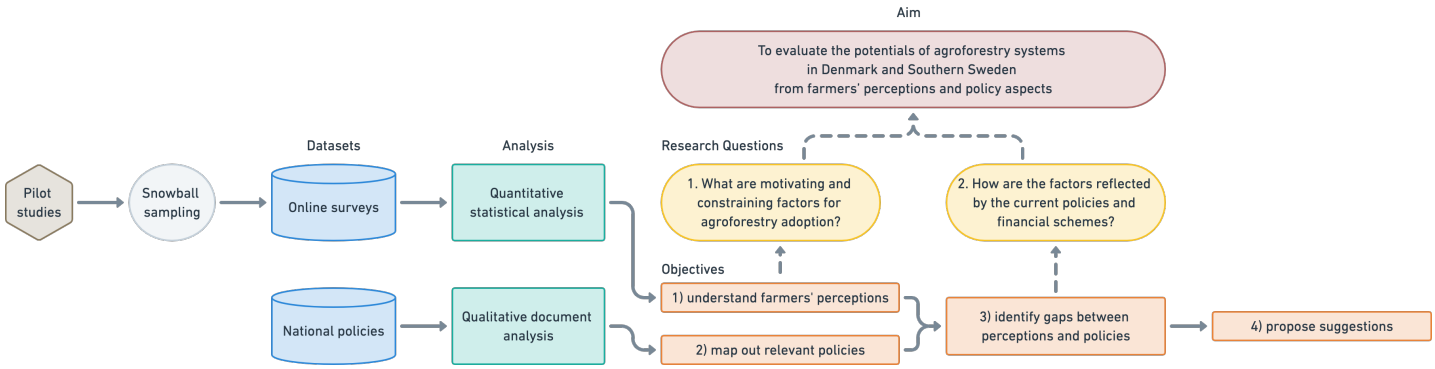


Fig. 5. Simplified flowchart of the mixed methods of quantitative and qualitative approach in meeting corresponding research objectives, research questions and study aim.

4.1 Region selection

The selection of regions between the two countries originated from the initial plan to compare farmers' perceptions in Sjælland and Skåne for their similarities in geographic location and soil compositions. Yet considering the differences in soil types, agroforestry systems in Sjælland and Fyn tend to be agrisilvicultural systems, while silvopasture systems are more dominant in Jutland (DST 2020). The region is therefore further expanded from Sjælland to the whole Denmark in order to include both voices from agrisilvicultural and silvopasture systems.

Along with the expansion of region selection in Denmark, additional eight counties of corresponding latitudes in Sweden were further included in the study in addition to Skåne, which were Östergötland, Jönköping, Kronoberg, Kalmar, Västra Götaland, Blekinge, Gotland, and Halland (Fig. 6). Expanding the region to the whole Swedish peninsula was however not considered due the different agroforestry systems practiced up north where forests dominate and reindeers are herd (García de Jalón et al. 2018).

Fig. 6. Map of the study region in Denmark and southern Sweden for understanding farmers' attitudes towards trees and bushes on farmlands.

4.2 Quantitative research questionnaire

In order to have an overview of farmers' perceptions of agroforestry systems, a quantitative research questionnaire was selected as a research method for statistical analysis. By conducting binary logistic regression modelling on the retrieved responses, the study intends to differentiate certain patterns in perceptions among farmer groups, and identifies the strengths and weaknesses in agroforestry adoption. The knowledge can function as the foundation to further suggest customized assistance and support for respective farmer groups, which can be useful for policy makers in facilitating the shift towards agroforestry systems in Denmark and Sweden.

4.2.1 Design of the questionnaire

Questions

The questionnaire consists of 18 questions, and is divided into two sections, background information and farmers' perceptions. The 14 questions in the first half of the questionnaire, composed of short type-ins, multiple choices and checkboxes, address aspects of socio-demography, farming situation, and farm type. The

remaining 4 matrix questions in the second half are to collect farmers' opinions towards factors affecting their decisions to include trees on their farmlands in production (10 factors), administration (6 factors), environment (9 factors), and socio-economic categories (12 factors).

The level of influence is expressed through self-evaluated 7-level Likert scales when 1 to 7 represent 'very negative', 'moderately negative', 'somehow negative', 'neutral/not relevant', 'somehow positive', 'moderately positive', and 'very positive'. The thorough and comprehensive factors enlisted in the matrix are adapted from an AGFORWARD research on stakeholders' perception of agroforestry in eleven EU countries (García de Jalón et al. 2018).

Respondents

The criteria set for farmers participating in the project are the geographic requirement for the farm in operation to be located in the study regions, and he or she is the main farmer(s) currently managing and operating the farm. The latter avoids repetitive answers from each farm, and reflects a more realistic picture in agroforestry adaptation. The study also seeks to include farmers from both conventional and organic producers, and from different agroecosystems. It is also essential to hear from both non-practitioners and adopters of agroforestry to better identify the gaps for putting the system into practice.

Considerations

The questionnaire was first designed in English by the author, and then translated into Danish and Swedish by local translators with background and knowledge in agroforestry and/or agroecology. The consideration of using local languages attempts to retrieve unbiased responses by being culturally inclusive, at the same time hopefully increase farmers' willingness to fill out the questionnaire. Another concern over higher response rate is to keep the questionnaire at a suitable length, and hence an operation table of the questionnaire was created as a pragmatic tool to screen the necessity of each question by reexamining its purpose and expected result (Appendix I).

It is also important to ensure the questions and answers are simple and straightforward, and do not generate confusion to avoid dropouts. To allow easier understanding and to aid the filling out process, illustrative images of tree planting types and tree locations were created by modifying vector images from Vecteezy,

an open source illustration platform (Appendix II). Furthermore, the order in which the questions are arranged was also often reflected upon, as an organized and logical structure of a questionnaire can also be beneficial in receiving valuable information.

Pilot studies

Prior to distributing the survey to farmers in Denmark and Sweden, small scale pilot studies of convenience sampling were conducted on three farmers connected through personal network respectively in Denmark and Sweden. A pilot study is often carried out to at a small sample size prior to the main study, in order to examine the validity of the research protocols, and minimize the risk of costly mistakes (Crossman 2019; Hassan et al. 2006). These two pilot studies were therefore undertaken to ensure no confusions or difficulties regarding the word of choice, response options, and overall comprehension (van Teijlingen & Hundley 2001). Communications via follow-up calls were made with the farmers after they took the survey, and their feedback and suggestions were considered and adopted for revising the survey before sharing it with larger groups.

4.2.2 Questionnaire distribution channels

Survey platform

The quantitative research questionnaire was created in Danish and Swedish versions on Netigate, an online survey platform. The two versions of the questionnaire formulated in local languages were distributed to respective farmers and conducted online. To be able to perform a meaningful quantitative analysis, it was aimed to receive 150 responses from farmers in both countries respectively.

Snowball sampling

Due to the protected personal information under the General Data Protection Regulation (GDPR), retrieval of farmers' direct contact in the study regions was no longer feasible. In order to receive responses beyond the threshold number from farmers in Denmark and southern Sweden, snowball sampling was thus employed. Snowball sampling is a non-probability sampling method used when the study population holds the characteristic of limited in accessibility and difficult to locate. In such situations, a greater number of study subjects are reached through the network of the initial individuals by adopting snowball sampling (Dimitri et al. 2016).

The Danish respondents were thus reached majorly through virtual newsletters, internal network and Facebook groups, and few physical distribution of printed newsletter of farmers' organisations. The organisations assisted with disseminating the survey comprises of but not limited to the following: Økologisk Landsforening (National Organic Association), Foreningen for Biodynamisk Jordbrug (the Association of Biodynamic Agriculture), Permakultur Danmark (Permaculture Denmark), Friland, Go for Local, Ecolove, Landbrug & Fødevarer (L&F, Agriculture and Food), Plantning & Landskab, as well as farmers' newspapers, LandbrugsAvisen (the Agriculture Newspaper) and Maskinbladet (the Machine Newspaper).

On the other hand, the questionnaire was sent out through newsletters and respective emails to members of relevant organisations in Sweden, e.g. Lantbrukarnas Riksförbund (LRF, Federation of Swedish Farmers), Ekologiska Lantbrukarna (Organic Farmers), SydGrönt, Rekoring, Lund Matvarukooperativ, Bondens Egen Marknad (Farmers' Own Market), Agroforestry Sverige (Agroforestry Sweden), as well as shared in relevant farmers' groups on social media like Facebook, e.g. Nordiskt nätverk för regenerativt lantbruk (Nordic network for regenerative agriculture), Småbrukare och framtidens lantbrukare (Small farmers and the farmers of the future), and Lantbrukaren (the Farmer).

4.2.3 Data analysis of questionnaire result

Data cleaning

After receiving all the responses as raw data, data cleaning was performed to ensure the quality of the data and avoid manmade entry errors in the analysis (Dörnyei & Taguch 2009; Rowley 2014). Incomplete responses and responses with fill-out time under 5 minutes were first removed, while contradicting and implausible responses were also taken away when further examining data validation. Contradicting responses refer to those inconsistent answers throughout the survey, e.g. ticking both no livestock yet at the same time selecting certain livestock; and implausible responses were those answering the same level of attitudes towards all the 37 factors.

Data analysis

The analysis of the raw data was performed by using RStudio (Version 1.2.1335, © 2009-2019 RStudio, Inc.). Demographic background of the farmers was examined

by using descriptive statistics, while binary logistic regression modelling was conducted to analyse the tendencies between farmers' attitudes and behaviour.

Logistic regression is a predictive modelling method that uses independent variables to predict the response represented by dependent variables (Hilbe 2009) Binary logistic regression is specifically applied when the predicted response has a binary nature, e.g. yes or no. On the other hand, the independent variables, or predictors, can be continuous or categorical.

The predicted response of logistic regression follows the Bernoulli distribution, a special case of binomial distribution in which a single trial is performed. Bernoulli distribution is shown as the following:

$$0 \leq p \leq 1, \qquad y \in \{0, 1\}, \qquad \begin{cases} p & if\ y = 1 \\ q = 1 - p & if\ y = 0 \end{cases}$$

Where, p denotes probability between 0 and 1, while y belongs to either 0 or 1. The probability of y belonging to 1 is represented by p, and q stands for y belonging to 0.

To calculate the probability of predicted response with independent variables, logit is defined as the natural logarithm of odds, and linked to a linear function of the independent variables. Logistic regression models are therefore constructed on the inverse logit, forming a sigmoid function curve (Fig. 7). The functions are expressed as the following:

$$logit(p_{x_i}) = \ln(odds) = \ln\left(\frac{p_{x_i}}{1 - p_{x_i}}\right) = \beta_0 + \beta_1 x_i$$

$$logit^{-1}(\alpha) = \frac{1}{1 + e^{-\alpha}} = \frac{e^{\alpha}}{1 + e^{\alpha}}$$

Where, subscript i represents the ith independent variable. p_{x_i} stands for the probability of the response for independent variable x_i. α denotes the linear function of the independent variable and its coefficient, $\beta_0 + \beta_1 x_i$. e is the mathematical constant, the Euler number.

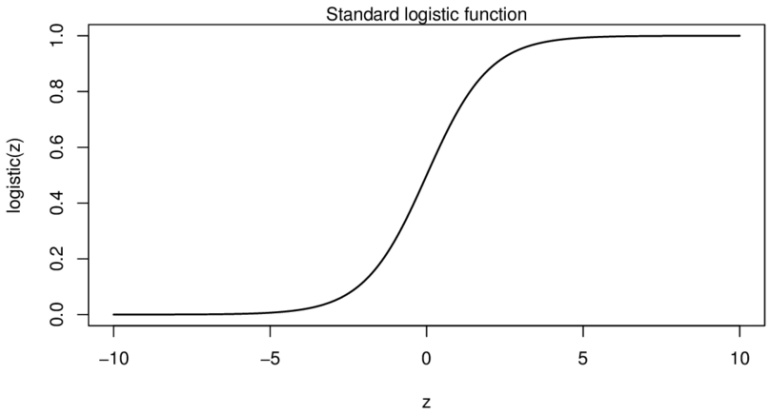


Fig. 7. The standard logistic function (van Elst 2018).

Logistic regression is a powerful tool for a linear relationship between dependent variable and independent variables is not required, nor are the independent variables expected to be normally distributed. Nonetheless, there are some assumptions that the logistic regression is based on. In addition to the binary response expected by binary logistic regression, it assumes a linear relationship between the independent variables and the log of odds (Statistics Solutions 2020; Stoltzfus 2011). Based on the preconditions of Bernoulli distribution, there should be no repeated survey answers and the respondents are independent of each other (Statistics Solutions 2020; Stoltzfus 2011). For a credible prediction, an adequate sample size is essential, and a sample size less than 100 should be avoided (Long & Freese 2001). This requirement was also met by the number of completed surveys from Danish and Swedish farmers. In addition, there are no inter-correlations amongst the independent variables (Statistics Solutions 2020; Stoltzfus 2011), which did not restrict the employment of logistic regression analysis in the study for the independent variables were examined separately.

To identify farmers' tendencies and the factors determining their adoption of agroforestry systems, farmers were first segmented into different levels of tree involvement as the predicted responses. These responses were decided by conducting *k*-means clustering on the count numbers of 'tree formation', 'tree location' and 'tree species' as the three dependent variables. *K*-means algorithm performs iterative calculation to best assign centroids in the predefined cluster number. The number of segments was determined based on the calculations of the total within-cluster sum of squares for different cluster numbers.

Profiling was thus conducted to characterise the clusters by performing binary logistic regression on independent variables, which in the study were the background information of the farm, as well as farmers' attitudes towards different factors. Binary logistic regression is the suitable statistical model for this analysis, as the predicted response for farmers to be in a certain level of tree involvement segment by using an independent variable is also binary, e.g. whether farmers belong to the segment or not.

The likelihood for respondents to belong to a segment based on an independent variable was retrieved from the calculation of the odds ratios and the confidence intervals. Odds ratio represents the change of the odds per one unit increase in the continuous independent variable, or the change of odds for the latter variable component as opposed to the former one in the categorical independent variable. The Wald test was conducted to produce p-values for assessing the significance of the coefficients, and an α-level of 0.05 was used to determine the significance of the results in this study.

4.3 Qualitative document analysis

To review literature of Danish and Swedish agroforestry-related policies, Scopus was chosen as the main database. In view of the goal of this study was to illustrate the potentials of agroforestry development in Danish and Swedish, a scoping review approach which gives room to exploration was chosen over rigid systematic review methods (Karolinska Institutet 2020). Through adopting the methodology of a scoping review, this study intended to identify the core values and key characters of the Danish and Swedish agroforestry systems, and served as a precursor for a systematic review in the Scandinavian context (Munn et al. 2018).

The literature search was conducted with the following search string:

Agroforestry	(TITLE-ABS-KEY (agroforestry) OR (silvoarable) OR (silvopastoral) OR (agrosilvopastoral) OR (farm AND woodland*) OR (forest AND farming*) OR (forest AND grazing) OR (grazed AND forest*) OR (isolated AND trees) OR (scattered AND tree*) OR (tree AND outside AND forest*) OR (farm AND tree*) OR (woodlot*) OR (oak AND tree*) OR (fruit AND tree*) OR (orchard AND intercropping) OR (alley AND cropping) OR (wood* AND pasture*) OR (pollarding) OR (coppic*) OR (fodder AND tree*) OR (pannage) OR (hedgerow) OR (windbreak) OR (riparian AND woodland*) OR (riparian AND buffer AND strip*) OR (buffer AND strip*) OR (riparian AND buffer*) OR (shelter AND belt*) OR (combined AND food AND energy*) OR (integrated AND food AND non-food*) OR (lavskov) OR (skogbete) OR (hamling) OR (stubbskott) OR (löväng) OR (forest AND pasture*)) AND

Country (TITLE-ABS-KEY (Sweden) OR (Denmark)) AND Policy (TITLE-ABS-KEY (policy) OR (common AND agriculture AND policy) OR (forest AND act) OR (subsid*) OR (grant*) OR (support))

Two criteria were applied when filtering the articles: 1) touching upon agroforestry systems and relevant policies, and 2) covering study areas in Denmark and/or Sweden. Titles and abstracts were used as the preliminary assessment, while the contents were further evaluated if in doubt. Nonetheless, the majority of the literature touched upon very different dimensions of agroforestry in Denmark and Sweden, with many only briefly and partially addressing the policies.

Therefore, the scoping review was then pivoted to policy document analysis upon existing governmental policies for a more comprehensive and systematic understanding, and a more meaningful discussion when paired with farmers' perceptions. Document analysis refers to the systematic review and evaluation for extracting the essence and developing an empirical understanding of the data (Bowen 2009). Qualitative document analysis is also a useful tool on policies (Cardno 2018). Policy document analysis was therefore adopted in the study, with the focus of the analysis on policy purpose and practice, to inspect the recent national policies and financial support schemes practiced in Denmark and Sweden under the framework of CAP.

Since agroforestry is currently neither categorized as agriculture nor forestry, the current regulations and financial support schemes relevant to agriculture, forestry and bioenergy were reviewed through the following official websites of organisations in Denmark and Sweden.

Denmark

Danish Agency for Agriculture, Landbrugsstyrelsen (https://lbst.dk/)
Danish Environmental Protection Agency, Miljøstyrelsen (https://mst.dk/)
Danish Nature Agency, Naturstyrelsen (https://naturstyrelsen.dk/)

Sweden

Swedish Board of Agriculture, Jordbruksverket (https://jordbruksverket.se/)
Swedish Forest Agency, Skogsstyrelsen (https://www.skogsstyrelsen.se/)

5. Results

5.1 Farmers Perceptions

5.1.1 Farmers' background

There were in total 137 responses from Danish farmers and 479 from Swedish farmers. After data cleaning, data analysis was conducted on 104 valid responses from Denmark and 369 valid responses from Sweden.

Social demography

From the valid answers, Danish and Swedish farmers surveyed had a similar averaged age of 53, and their averaged years of experience were between 22 and 25, with the major educational background of Danish and Swedish farmers being agricultural training. The majority of Danish farmers participating in the survey were from Jutland, while the Swedish farmers from Skåne and Västra Götaland comprised half of the Swedish respondents (Fig. 8). Swedish farmers participated in the study on average had a greater size of farmland (median = 95.00) than Danish farmers surveyed (median = 35.00). There was also a higher percentage of Danish farmers of study practicing organic agricultural than conventional farmers, while it was the opposite for Swedish farmers surveyed (Fig. 9).

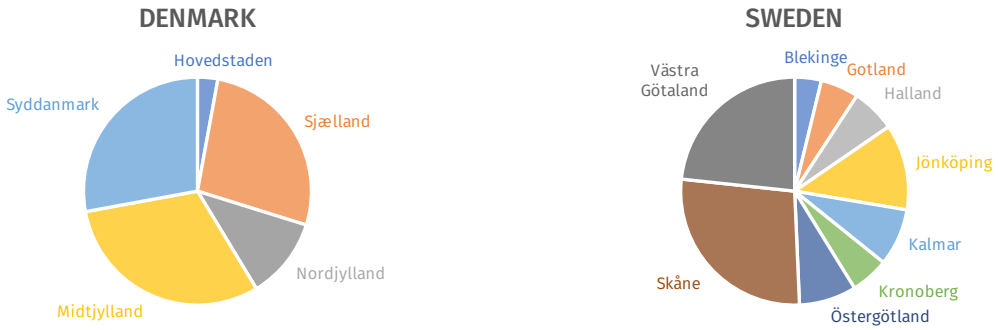


Fig. 8. The Danish regions and Swedish counties of the farmers participating in the study.

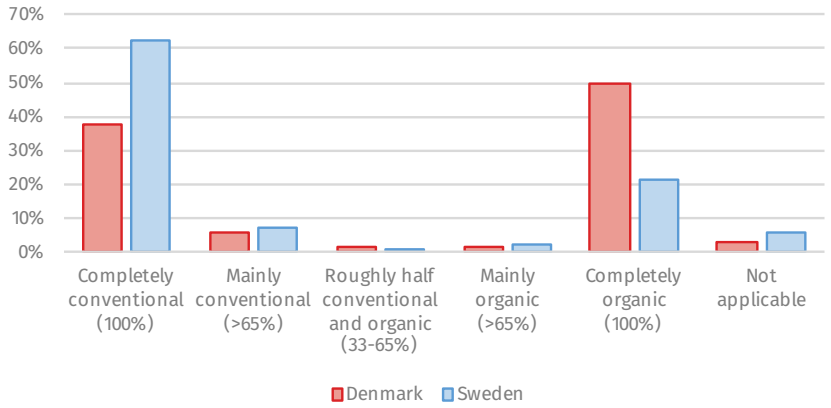


Fig. 9. The percentage of farms in the study managed in the spectrum of conventional and organic practice.

In terms of the number of subsidies, the majorities of Danish and Swedish farmers receive no more than two subsidies for having tree on their farmlands. Yet greater diversity can be observed among Danish farmlands surveyed, as Danish farmers have a greater variety than Swedish farmers in the study in respect of crops, livestock, tree formation, tree location and tree species (Appendix III Table 1).

When looking into respective subsidies for trees on farmlands, 41.35% of Danish farmers do not receive subsidies from having trees, while it is 33.88% for Swedish farmers in the study. Among Danish farmers, '*Shelterbelts and small biotopes*' (29.81%) is the most received subsidy for having trees, followed by '*Basic Payment and Green Support*' (25.96%). The third most received category of financial support is for grassland management, be it 'Environmentally Friendly Agricultural Measures' or '*Care of grass and nature areas*' (20.19%). On the other hand, '*Farm Support and Green Payment*' (54.74%) is the most common subsidy in southern Sweden, while '*Environmental payment for semi-natural pastures and mown meadows and their restoration*' (45.26%) comes in second (Fig. 10).

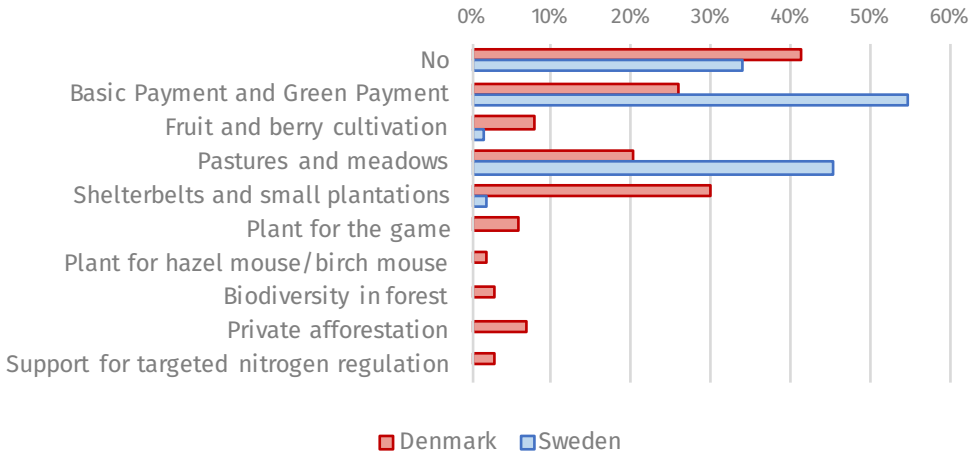


Fig. 10. Bar chart of the percentage of financial supports received by Danish and Swedish farmers surveyed in the study.

Tree formation, location, and species

Regarding tree formation, 'three-rowed hedgerows' are the most common type and appear in 62.50% Danish farmers' farmlands in the study, followed by 'single-rowed hedgerows' (51.92%) and 'solitary trees on farmland' (48.08%); while 'solitary trees on farmland' (67.21%) is the most seen formation on farmlands in southern Sweden, followed by 'in irregular patches' (47.43%), and 'plantation' (37.94%) (Fig. 11).

Of Danish farmers surveyed, the majority of trees could be found 'in the garden' (89.42%), 'in fences to the neighboring yard' (83.65%), 'around the farmstead' (78.85%) and 'shelterbelts' (78.85%); while 'forest' (72.09%), 'on pasture land' (65.85%) and 'in the garden' (64.50%) are where trees are mostly located in Swedish farmlands (Fig. 12).

In connection with species selection, elder (*Sambucus nigra*) is the most identified tree species by 90.38% of the Danish farmers in survey, followed by *Crataegus spp.* (86.54%), and oak (*Quercus spp.*) (85.58%). On southern Swedish farmlands, birch (*Betula spp.*) (92.41%), oak (*Quercus spp.*) (85.64%) and apple (*Malus spp.*) (83.20%) are the most identified tree species (Fig. 13).

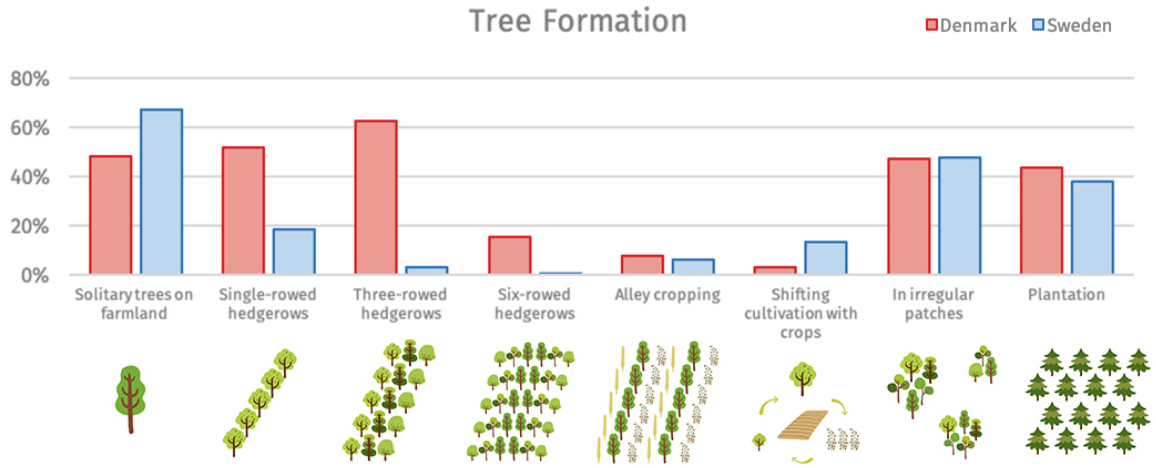


Fig. 11. The percentage of tree formation on the farmlands in Denmark and southern Sweden identified by farmers surveyed in the study.

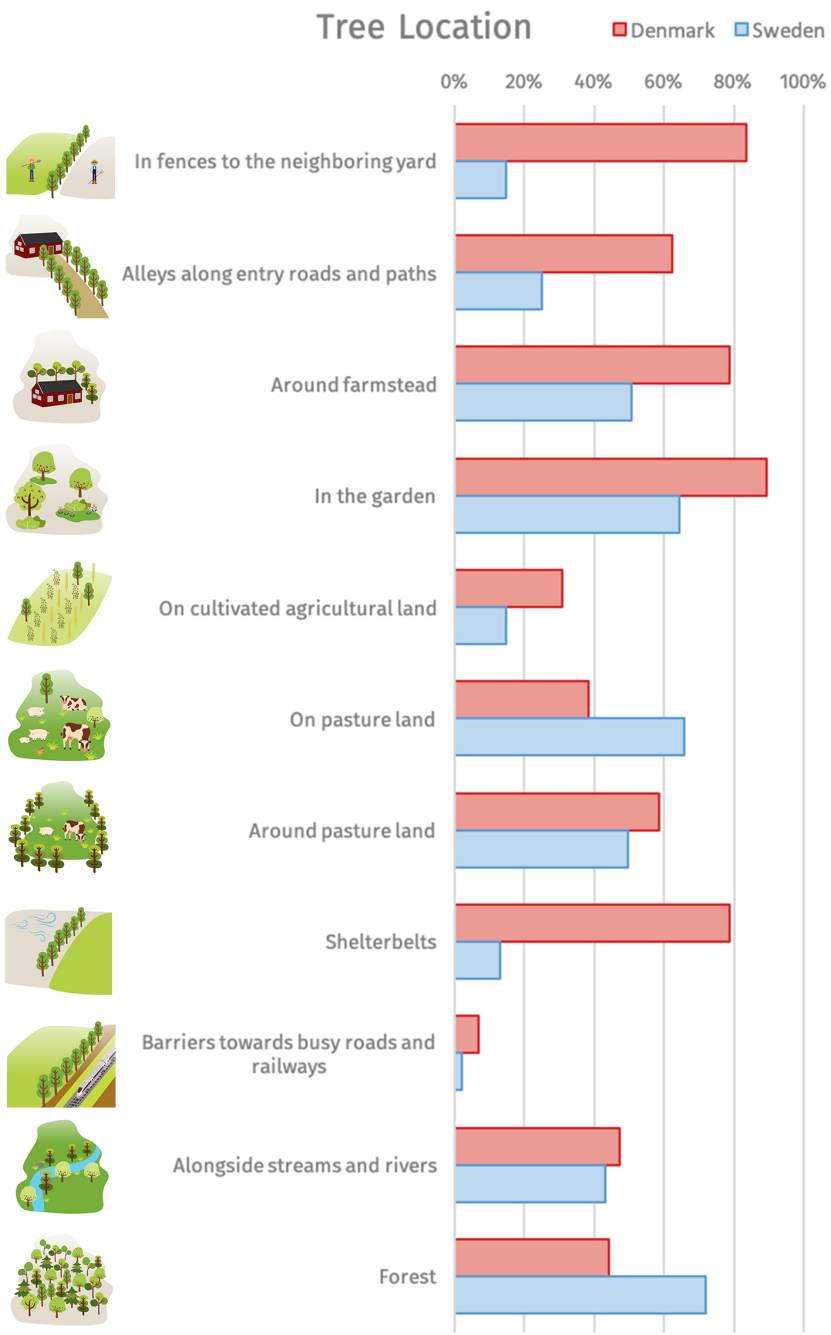


Fig. 12. The percentage of tree location on the farmlands in Denmark and southern Sweden identified by farmers surveyed in the study.

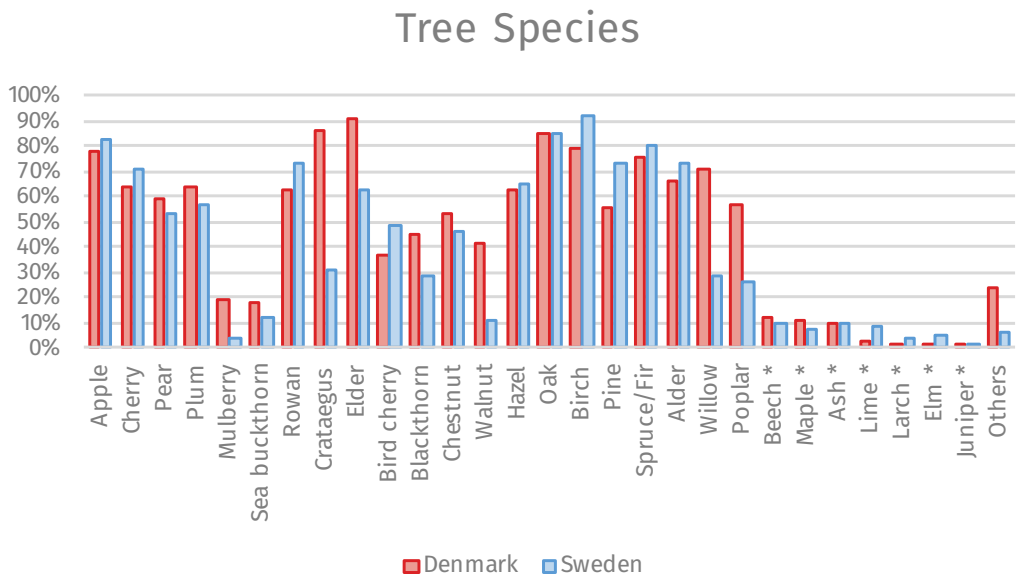


Fig. 13. The percentage of tree species on the farmlands in Denmark and southern Sweden identified by farmers surveyed in the study.

General attitudes towards various factors

The degree of influence by various factors on farmers' decision to include trees was conducted through a self-evaluated Likert scale. Farmers in both Denmark and southern Sweden consider 'animal welfare' as a positive production factor, while 'animal production' and 'diversity of products' are as well seen positive by Danish farmers. Across environmental factors, 'conservation of soil fertility and erosion control', 'carbon fixation', 'microclimate moderation', 'pollination' and 'landscape aesthetics' as regarded motivating. In addition, 'originality and interests' in administrative factors and 'general farmer's image' in social-economic factors are highly ranked. The means of each factor show that 'biodiversity and wildlife habitat' (6.52), 'landscape aesthetics' (6.40), and 'conservation of soil and erosion control' (6.11), are the most positively perceived among Danish farmers; whereas 'landscape aesthetics' (6.10), 'pollination' (5.99), and 'microclimate moderation' (5.78), are the most positively perceived factors amongst Swedish farmers.

Both Swedish and Danish farmers express 'management costs' and 'administrative burden' to be the most deterring factors. The means of each factor further indicate that Danish farmers surveyed view 'administrative burden' (3.99), 'management costs' (4.03), and 'regulation' (4.18) to be adverse, while 'regulation' (3.41), 'loss by predation' (3.71), and 'administrative burden' (3.80) are seen by Swedish farmers. (Fig. 14).

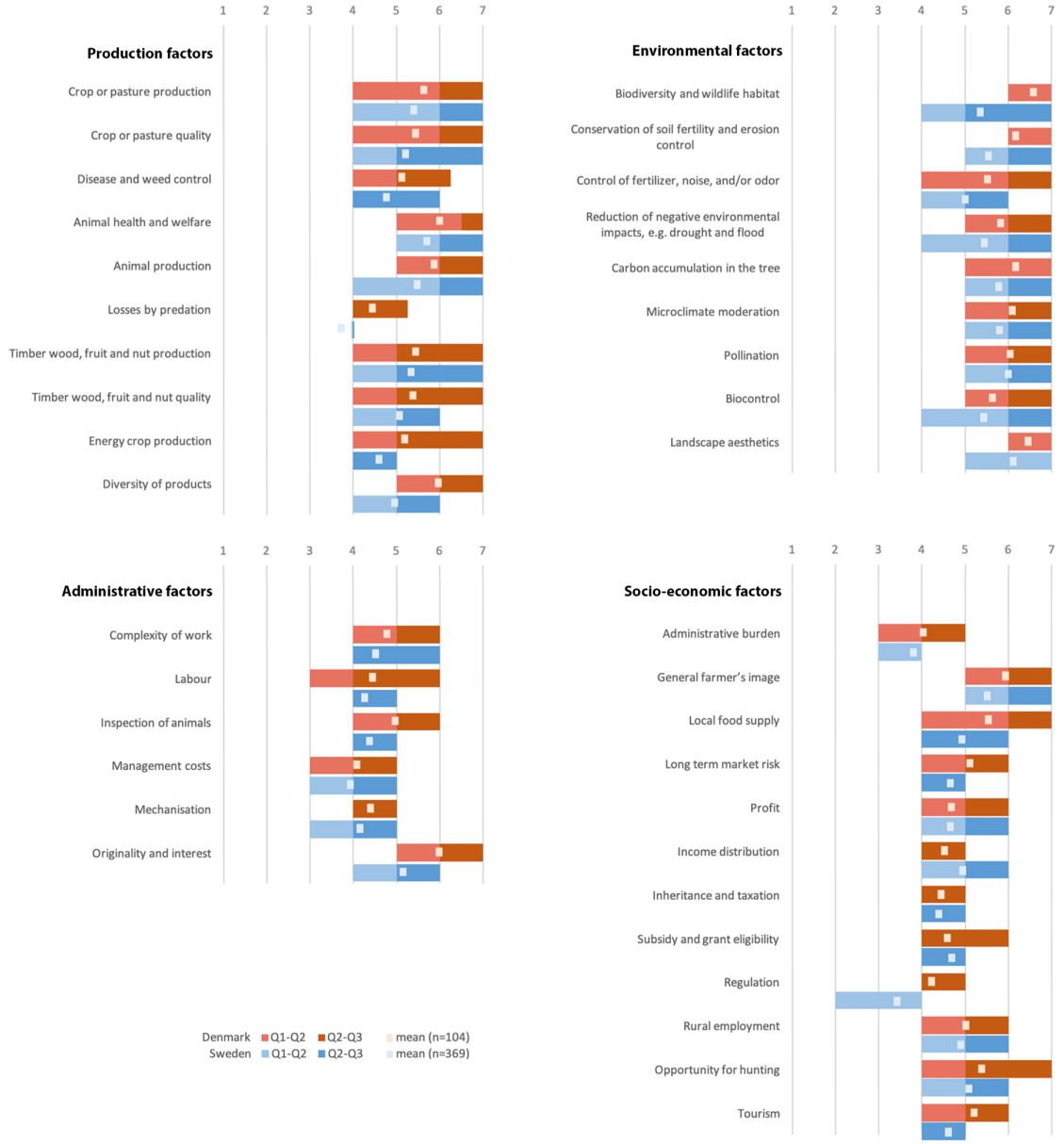


Fig. 14. Respondents' perceptions towards production, administrative, environmental, and socio-economic factors for including trees and bushes on their farmlands (1 = very negative; 7 = very positive).

5.1.2 Attitudes behind different levels of tree involvement

To further understand attitudes behind the behaviour patterns, binary logistic regression modelling was conducted by segmenting the respondents into three clusters based on different levels of tree involvement on farmlands as an indication of farmers' behaviour, which were decided by three dependent variables – tree formations, tree locations, and tree species. The calculations of within-cluster sum of squares supported the division of Danish and Swedish respondents into the following segments: low, medium and high level of tree involvement.

Attitude-behaviour pattern of Danish farmers surveyed

The segment center for the number of tree formation, location, and species for low-level tree involvement is 1.75, 4.29, and 6.00 respectively in Denmark. For medium-level tree involvement segment, the center is 2.98, 6.62, and 13.18 for the number of tree formation, location, and species. As to the segment of high-level tree involvement, the center for the number of tree formation, location, and species is 3.47, 7.00, and 19.77. Among the Danish farmers surveyed, 23.08% of them belongs to 'low level of tree involvement' (n=24), 48.08% are 'medium level of tree involvement' (n=50), and the remaining 28.85% are 'high level of tree involvement' (n=30).

The chances for Danish farmers to be in the low-level tree involvement segment rise per level increase in organic practice (217%), variety of crops (61%) and livestock (76%). On the other hand, Danish farmers are less likely to fall into the high-level tree involvement segment per increase in organic practice (-79%) and variety of livestock (-46%), and the likelihood increases per increase in farm size by hectare (1%). In other words, Danish farmers involving trees at low level have a profile of organic producers who have greater varieties of crops and livestock, and Danish farmers of high-level tree involvement appear more likely to be conventional big farm holder who have less variety of livestock.

There is inconsistency between attitude and behaviour among Danish farmers. Low-level tree involvement Danish farmers perceive 6 factors positively, while 'mechanisation' is deemed negative (Fig. 15). Contrarily, the Danish farmers who involve trees at high level hold negative attitudes towards 16 factors, yet 'opportunity for hunting' is considered positive among high-level tree involvement farmers (Fig. 15; Appendix III Table 5).

The explanation for low-level tree involvement farmers to have a mismatch in their general attitudes towards having trees on their farmlands could be due to the neglected information – leasing period. Despite the positive perceptions of trees and bushes low-level tree involvement farmers hold, the length of the lease period plays a critical role in putting agroforestry in practice.

Attitude-behaviour pattern of Swedish farmers surveyed

For low-level tree involving Swedish farmers, the segment center of the number of tree formation, location, and species is 3.06, 2.68, and 6.24 respectively,

while the center for medium-level tree involvement is 3.42, 3.99, and 11.87. Lastly, the center for high-level tree involvement is 5.77, 6.00, and 16.64 in terms of the number of tree formation, location, and species. Low, medium and high level of tree involvement clusters of Swedish farmers are composed of 27.64% (n=102), 44.72% (n=165) and 27.64% (n=102) of the respondents respectively.

The likelihood of Swedish farmers to be in the segment of low-level tree involvement decrease per increased level towards organic production (-12%), per increased number of total grants received (-26%) and the variety of livestock (-40%). On the opposite side of the spectrum, the chances of Swedish farmers belonging to the segment of high-level tree involvement are higher per increase in the number of received total grants (47%) and livestock variety (38%). These shape the profile of Swedish farmers in the low-level tree involvement segment to be conventional farmers who raise less variety of livestock and have received fewer number of grants, and Swedish farmers who involve trees at high level have characters of raising greater variety of livestock and receiving higher number of grants.

For Swedish farmers, their attitude and behaviour are more coherent. Low-level tree involvement Swedish farmers have negative perceptions towards 20 factors. On the contrary, farmers involving trees at high level have positive view for 10 factors while ‘regulation’ is regarded to be negative for them to include trees and bushes on farmlands (Fig. 15; Appendix III Table 6).

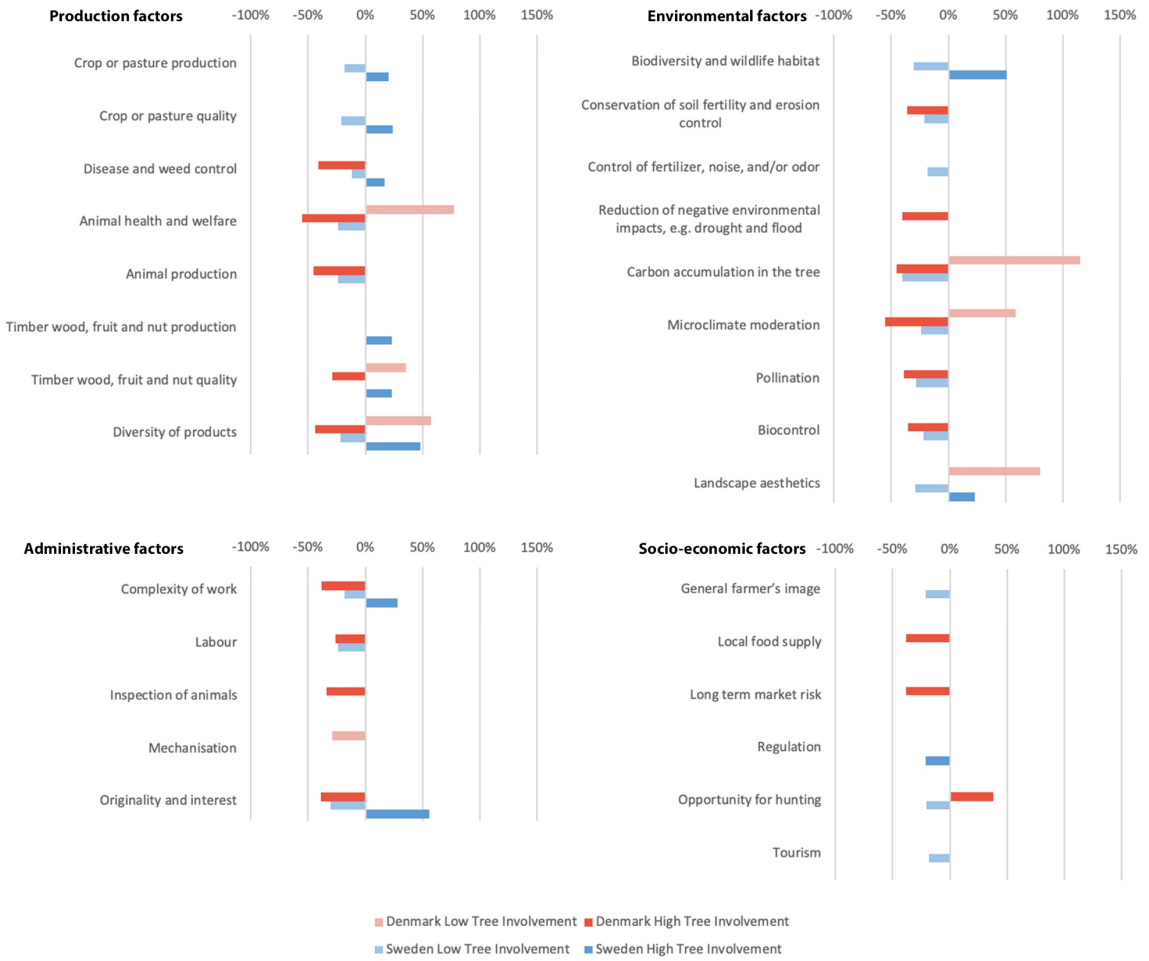


Fig. 15. Likelihood in percentage for Danish and Swedish farmers to be in low-level and high-level tree involvement clusters per increase in Likert scale across various factors which were proven to be statistically significant.

Table 4. Attitudes towards agroforestry systems of farmers in Denmark and southern Sweden.

Denmark		**southern Sweden**	
General Attitude			
Motivating factors	Hindering factors	Motivating factors	Hindering factors
Biodiversity Landscape aesthetics Soil conservation Carbon sequestration Microclimate moderation Pollination Animal health and welfare	Administrative burden Regulations Management costs	Landscape aesthetics Pollination Microclimate moderation Carbon sequestration Animal health and welfare Soil conservation	Regulation Losses by predation Administrative burden
Attitude-behaviour			
Low-level tree involvement	High-level tree involvement	Low-level tree involvement	High-level tree involvement
Generally positive, except for mechanisation	Generally negative, except for opportunity for hunting	Generally negative	Generally positive, except for regulation

5.2 Agroforestry in National Policies

5.2.1 CAP in Denmark and Sweden

Denmark and Sweden became member states of the European Union in 1973 and 1995. Under the umbrella framework of CAP, Denmark and Sweden has adopted the regulations and interpreted the schemes similarly yet with variations (Table 5). For example, in order to receive the *Basic Payment* in Pillar I, the minimum size of holdings is 2 hectares with minimum contiguous 0.3 hectare in Denmark (Landbrugsstyrelsen 2020a), while it is 4 hectares with each parcel no smaller than 0.1 hectare in Sweden (Jordbruksverket 2019a).

Denmark and Sweden have made 105 and 138 regulations respectively for cross-compliance pertaining to: 1) Environment, climate change and good agricultural and environmental condition for soil, 2) Public, animal and plant health, and 3) Animal welfare (Landbrugsstyrelsen 2020b; Jordbruksverket 2019b). In response to GAEC 7 – Landscape, minimum level of maintenance, conditions are made regarding trees on farmland during the breeding season of birds (European Commission 2013c). In Denmark, restrictions of pruning are made on continuous plantings of shrubs and trees longer than 10 meters and solitary trees of crown canopy greater than 4 meters from March 15th to July 31st (Alnor 2019). Whereas in Sweden, pruning of solitary deciduous trees on arable land with crown canopy more than 5 meters is prohibited between April 1st and August 15th, and plowing and tilling are further limited in the 2-meter protection zone around these solitary trees in certain areas (Jordbruksverket 2019b).

As member states has their freedom to tailor its own objectives under Pillar II, Denmark focuses on 1) growth and competitiveness, 2) ecology, 3) nature, environment and climate, and 4) rural development (Landbrugsstyrelsen 2020c). Sweden, on the other hand, works on 1) environment and climate, 2) competitiveness in agriculture, gardening, reindeer husbandry and forestry, and 3) development of new jobs in rural areas (Jordbruksverket 2020a).

Table 5. Grants under Common Agricultural Policy adapted by Denmark and Sweden (Landbrugsstyrelsen 2020a-k; Jordbruksverket 2020a-k)

Denmark	Sweden
The Danish Agency of Agriculture, Ministry of Environment and Food (Landbrugsstyrelsen, Miljø- og Fødevareministeriet)	The Swedish Board of Agriculture (Jordbruksverket)
Pillar I	
- Basic payment scheme (Grundbetalingsordningen) - Green support (Grøn støtte) - Young farmers (Unge landbrugere) - Slaughter prices (Slagtepræmier) - Island support (Ø-støtte)	- Farm support (Gårdstöd) - Green payment (Förgröningsstöd) - Support for young farmers (stöd till unga jordbrukare) - Cattle support (nötkreatursstöd)
Pillar II	
- Organic Area Grant (Økologisk Arealtilskud) - Environmentally Friendly Agricultural Measures (Miljøvenlige Jordbrugsforanstaltninger, MVJ) - Grants for the care of grass and natural areas (Tilskud til pleje af græs og naturarealer) - Maintenance of wetlands, natural water level conditions and lowland areas (Fastholdelse af vådområder, naturlige vandstandsforhold og lavbundsområder) - Maintenance of changed drainage (Opretholdelse af ændret afvanding) - Subsidy for private afforestation (Tilskud til privat skovrejsning) - Grants for sustainable forestry (Tilskud til bæredygtig skovdrift)	- Payment for organic production (Ersättning för ekologisk produktion) - Environmental payment (Miljöersättningar) - Compensation support (Kompensationsstöd) - Animal welfare payment (Djurvälfärdsersättningar) - Environmental investments (Miljöinvesteringar) - Environmental measures in forestry (Miljöåtgärder i skogsbruket) - Competence development and advice (Kompetensutveckling och rådgivning) - Business support (Företagsstöd) - Project support (Projektstöd) - Collaboration project (Samarbetsprojekt) - Innovation project (Innovationsprojekt)

5.2.2 Agroforestry-related financial supports in Denmark and Sweden

The results show that Denmark and Sweden have implemented very similar financial support schemes related to agroforestry with minor differences under the main structures of the CAP.

Pillar I: Direct payments

In Pillar I, agroforestry is not clearly assigned as an EFA measure for the *Green Payment* in either Denmark or Sweden. Direct Payments in both Denmark and Sweden support short rotation coppice for energy production and recognize it as EFA.

Energy production

In Denmark, coppice forest (lavskov) for energy production is considered as a permanent crop for the *Basic Payment* and recognised as one of the EFAs for the *Green Payment* (Table 5) (Landbrugsstyrelsen 2020d). While coppice forest in Denmark is limited to the mixtures or in pure stands of hazel, maple, ash, hornbeam, birch, alder, oak, elm, willow and poplar, energy forest in Sweden for the *Basic Payment* is only restricted to single species of willow, poplar and hybrid aspen (Landbrugsstyrelsen 2020a; Jordbruksverket 2020b). Unlike the mixed coppice forest, and pure alder, willow, poplar stands are considered as the Danish EFA, the EFAs under the Swedish *Green Support* only acknowledge willow (Landbrugsstyrelsen 2020a; Jordbruksverket 2020c). Despite the difference in species, the Danish coppice forest and the Swedish energy forest are both a viable option for EFA at a 0.5 conversion rate (Table 6) (Jordbruksverket 2020c).

To be eligible for the grants, the Danish coppice forest should be managed agriculturally by carrying out coppicing at least once every 10 years, and poplar species at least every 20 years (Landbrugsstyrelsen 2020a). In a similar approach, Swedish energy forest planted on arable land are only eligible for the grants with a harvest period for willow to be within 10 years, and 20 years for poplar and hybrid aspens (Jordbruksverket 2020b).

In terms of tree density, a coppice forest eligible for the direct payments must consist of at least 8,000 approved trees, while a pure poplar stand should have a minimum 1,000 poplars per hectare, reduced from 2,000 trees in 2017 (Landbrugsstyrelsen 2020a). Animals are allowed and farmers can plant up to 100 other scattered trees or shrubs of their choice per hectare in a mixed coppice forest,

and up to 400 in a pure poplar stand (Landbrugsstyrelsen 2020a). Minimum tree density or the inclusion of livestock are nonetheless not specified in the Swedish context. An additional note for a Danish coppice forest to be eligible for direct payments is that windbreaks, game strips and nature should not be the goal of the cultivation of such plantation (Landbrugsstyrelsen 2020a).

Pasture and meadow

With the attempt to keep the landscape open, semi-natural pastures and mown meadows are eligible for the *Basic Payment* in Sweden, whilst forests for timber growth, woodland pasture (skogsbete), limestone pasture (alvarbete), and wetland (våtmarker) are disqualified (Jordbruksverket 2020b). Corresponding restriction for permenant grassland in Denmark is that naturally occurring elements like trees, shrubs and small wetlands should cover no more than 0.05 hectare. (Landbrugsstyrelsen 2020a)

Nitrogen fixation

The EFAs eligible for the Swedish *Green Support* also include nitrogen-fixing crops, yet no trees or bushes are listed (Table 6) (Jordbruksverket 2020c). The other hand, nitrogen fixing crops are ineligible for the Danish EFA.

Table 6. Weighting of different types of ecological focus area for the *Green Payment* adopted by Denmark and Sweden (Landbrugsstyrelsen 2020d; Jordbruksverket 2020c)

Ecological Focus Area	Weighting in Denmark		Weighting in Sweden	
Fallow land			1	
Flower fallow	1	At least 2 different pollen and nectar-producing plants	1.5	Not specified
Pollinator fallow	1.5	At least 3 different pollen and nectar-producing plants, and a minimum of 50% of the total filed area during the growth period	-	
Mowing meadow	1		0.3	
Buffer strips	1.5		-	
Catch crops or green cover	0.3		0.3	
Nitrogen fixing crops	-		1	Limited to herbaceous legumes
Field margins	-		9	
Landscape elements (ancient monuments and lakes)	1		-	
Coppice/energy forest	0.5	Mixed deciduous trees, willow and alder of 8,000 trees/ha and poplar of 1,000 trees/ha	0.5	Limited to willow

Pillar II

Pillar II is corresponded by grants in the Danish Rural Development Program (Det Danske Landdistriktsprogram, LDP) and the Swedish Rural Development Program (Landsbygdsprogrammet).

Support for organic production and conversion to organic production

Both Denmark and Sweden has grants for organic production and conversion to organic production. The Danish *Fruit and Berry Supplement* (Frugt- og bærtillæg) under *Organic Area Grant* (Økologisk Arealtilskud), and the Swedish *Payments for Fruit and Berry Cultivation* (frukt- eller bärodling) under *Payments for Organic Production and Conversion to Organic Production* (Ersättningar för ekologisk produktion och omställning till ekologisk produktion) both support organic production of fruit trees and bushes under a five-year commitment (Landbrugsstyrelsen 2020e; Jordbruksverket 2020d). Only farms with evenly cultivated fruits and berries from the listed 25 and 23 approved types at specific densities in Denmark and Sweden respectively, are eligible for the grant (Table 7) (Landbrugsstyrelsen 2020e; Jordbruksverket 2020d). The fruit and berry agriculture parcel also needs to be contiguous and meet the minimum required size of 0.3 for Denmark and 0.1 for Sweden (Landbrugsstyrelsen 2020e; Jordbruksverket 2020d).

Support for Christmas trees

Before 2013, Danish farmers of Christmas trees and ornamental greenery were able to receive the *Environmental subsidy for Christmas trees and ornamental greenery* (Miljøbetinget tilskud til juletræer og pyntegrønt, MB) for a minimum area of 0.3 hectare at the density of 3,000 trees per hectare, with reduced application of fertilizer and no pesticides (NaturErhvervstyrelsen 2012). Those trees were requested to be harvested no longer than every 10 years (NaturErhvervstyrelsen 2012). Nonetheless, cultivation of Christmas trees and ornamental greenery are now removed from the list of Danish *Basic Payment*, nor is it subsidized by the Swedish version.

Table 7. Fruit and berry species and their respective density eligible for the *Payment for Organic Production of Fruit and Berry Cultivation* adopted in Denmark and Sweden (Landbrugsstyrelsen 2020e; Jordbruksverket 2020d)

Fruit and berry	Density in Denmark (unit/ha)	Density in Sweden (unit/ha)
Chestnut (Castanea sativa or Castanea crenata)	100 (only grafted plants)	-
Walnut (Juglans regia)	100 (only grafted plants)	-
Sour cherries (Prunus cerasus)	300	300
Apple (Malus domestica)	400	400
Pear (Pyrus communis)	400	400
Plum (Prunus domestica)	400	400
Cherry (Prunus avium)	400	400
Quince (Cydonia oblonga)	400	-
Elder (Sambucus nigra)	600	600
Mulberry (Morus spp)	600	-
Hazel (Corylus maxima)	600	-
Sea buckthorn (Hippophae rhamnoides)	1,200	1,200
Serviceberry berry (Amelanchier laevis or Amelanchier alnifolia)	1,200	1,200
Currant (Ribes nigrum or Ribes rubrum)	1,500	1,500
Gooseberry (Ribes uva-crispa)	1,500	1,500
Blueberry (Vaccinium myrtillus or Vaccinium corymbosum)	1,500	1,500
Rosehips (Rosa rugosa or Rosa canina)	1,500	1,500
Aronia (Aronia melanocarpa)	1,500	1,500
Flower Quince (Chaenomeles speciosa or Chaenomeles speciosa x japonica)	1,500	1,500
Grape (Vitis spp)	1,500	1,500
Raspberry (Rubus idaeus)	2,000	2,000
Blackberry (Rubus plicatus or Rubus fruticosa)	1,200	2,000
Cloudberry (Rubus chamaemorus)	-	3,000
Strawberry (Fragaria x ananassa)	20,000	16,000
Cranberry (Vaccinium macrocarpon)	20,000	16,000
Arctic raspberry (Rubus arcticus)	-	16,000
Wild strawberry (Fragaria vesca)	-	30,000
Lingonberry (Vaccinium vitisidaea)	30,000	30,000

Support for pastures and meadows

Pastures and meadows are financially supported in both countries. For Danish farmlands located in Natura 2000 or with high nature value, *Environmentally Friendly Agricultural Measures* (Miljøvenlige Jordbrugsforanstaltninger, MVJ) provided schemes of four 10-year and seven 20-year commitments throughout 1997 and 2008 to protect these sensitive agriculture areas (Landbrugsstyrelsen 2020f). It includes grassland grazed by horses or ruminants under the grant for *Environmentally friendly operation of grasslands* (Miljøvenlig drift af græsarealer). In addition, removal of arable land (Udtagning af agerjord) and removal of grassland (Udtagning af græs) have encouraged farmers to convert the land into natural biotopes like forests and lakes, yet grazing or mowing is clearly forbidden. Neither

game strips nor agricultural production such as energy forest, ornamental greenery or Christmas trees are allowed (Landbrugsstyrelsen 2020f).

Though MVJ scheme no longer accepts new applications, *Care of grass and nature areas* (Pleje af græs- og naturarealer) is another similar scheme of 5-year commitment in Danmark, targeting Natura 2000 and high nature value lands (Landbrugsstyrelsen 2020g). Meadows and pastures in ecologically sensitive areas continue to be mowed artificially or grazed by horses and ruminants every year to improve the conditions of the biotopes and their biodiversity (Landbrugsstyrelsen 2020g).

In comparison to the Danish schemes for grasslands, Sweden provides overall more diverse and detailed financial support schemes for pastures and meadows. The Swedish grants, *Restoration of Semi-natural Pastures and Mown Meadows* (Restaurering av betesmarker och slåtterängar) and *Semi-natural Pastures and Mown Meadows* (Betesmarker och slåtterängar) under *Environmental Payment* (Miljöersättningar), are provided under a 5-year commitment dedicated to restoring and preserving elements of high natural and cultural-historical values in the agricultural landscape (Jordbruksverket 2020e & 2020f). *Summer cottages* (Fäbodar) under the same scheme is also serving the same purpose, yet mountain pastures (fäbodbete) are distributed in northern Sweden and therefore is not included in the finding of the study (Jordbruksverket 2020g; Adolfsson & Johansson 2018).

Semi-natural pastures and mown meadows and mowing meadow can be further divided into general and particular value (allmänna eller särskilda värden) for general and special care, considering the important plants and animals on the land, or the natural and cultural values (Jordbruksverket 2020e). General care aims at preserving semi-natural wood pasture by retaining single or clustered trees or bushes, preferably older broad-crowned trees and bushes with flowers and berries; and thus, it requests the removal of forestry-like stand, overgrown shrubs, and trees or bushes in ancient and cultural relics (Jordbruksverket 2020e).

More specific additional requirements for particular care are decided by the county administrative board, and therefore the grant for particular care is higher than that of general care (Jordbruksverket 2020e). Other categories only applicable

for special care are *woodland pasture*, *limestone pasture*, *mosaic pasture land* (mosaikbetesmark) and *grass-poor land* (gräsfattiga marker) (Jordbruksverket 2020g). One of the additional requirements for special care is *complement coppice* (komplement lövtäkt), which is a practice of pruning deciduous twigs and branches to be further dried and used as fodder (Jordbruksverket 2020e; Swedish National Heritage Board 2019).

Support for hedgerows and biotopes

Since the launch of the shelterbelt planting scheme in the mid 19th century, hedgerows as shelterbelts have continued to be promoted in Denmark. Nevertheless, the functionality importance of shelterbelts has shifted towards biodiversity enhancement and landscape aesthetics in recent years, as shelterbelts on agricultural lands and natural areas were promoted to be replaced by hedges or small plantings that were beneficial to hazel mice, bees and other pollinating insects (Ministeriet for Fødevarer, Landbrug og Fiskeri 2015).

To meet the objectives, *Landscape and biotope improving plantations* (Landskabs- og biotopforbedrende beplantninger) was designed to promote biodiversity, preserve landscape values, raise recreational values, as well as increase the proportions of connecting lines and small habitats (Landbrugsstyrelsen 2020h). The grant was given to hedges of 1-7 rows and small plantings of less than 0.5 hectares, with the composition being a minimum 75% of deciduous trees and 25% bee-friendly species between 2013 and 2016 (Ministeriet for Fødevarer, Landbrug og Fiskeri 2015).

Its successor, *Shelterbelts and Small biotopes* (Læhegn og småbeplantninger), was part of the Nature package (Naturparkken) under national subsidy from 2017 to 2019, and continued to promote and preserve biodiversity in agricultural and natural areas through dispersal corridors of 3-7 rows, and small plantings of more than 7 rows and maximum 0.5 hectare (Miljøstyrelsen 2019 & 2020). The distribution density of trees and bushes was regulated to be minimum 4,000 trees per hectare, with a maximum 4.5-meter inter-tree distance in small plantings (Miljøstyrelsen 2019). Exceptions for planting trees and bushes not on the code list were allowed considering their biological, historical and cultural contexts (Miljøstyrelsen 2019). Compared to its predecessor, *Landscape and biotope improving plantations*, shrubs

were promoted to account for 75% of the planting and the outermost row should be exclusively shrubs (Miljøstyrelsen 2019). Furthermore, the percentage of species beneficial to pollinators was doubled to minimum 50% in the plantings (Miljøstyrelsen 2019). Nonetheless, grant priories were made according to the applied project size (Miljøstyrelsen 2020).

Under the management of the Danish Nature Agency (Naturstyrelsen), a designated list of tree and bush species are subsidised to be planted on open land to benefit wild animals, such as *Plant for the game* (Plant for vildtet), *Plant for the hazel mouse* (Plant for hasselmusen), and *Plant for the birch mouse* (Plant for birkemusen) (Naturstyrelsen 2020a). Nevertheless, since the habitats of the two mice species are only in certain areas, the supports are provided at small geographical extents compared to other financial supports.

As to Sweden, there are no corresponding schemes to promote hedges as shelterbelts, for stone walls serve similar functions for wind protection (Naturvårdsverket 2014). Yet small habitats are promoted by the financial scheme – *Investment support for the development of natural and cultural environments* (Investeringsstöd för utveckling av natur- och kulturmiljöer). Based on the cultural and environmental importance wood pastures have in Sweden, the scheme incentivizes farmers to help build local attractiveness and achieve national environmental goals pertaining to natural environment conservation and social environment preservation (Jordbruksverket 2020h). In the scheme, farmers can receive the grant by 1) recreating natural and cultural environments like park, garden, avenue, stone wall, and fences; 2) creating small habitats like islet; and 3) restoring buildings of cultural and historical values (Jordbruksverket 2020h).

Support for biodiversity in forest

Silvopastoral systems are especially promoted in Denmark through the financial support *Subsidies for forests for biodiversity purposes* (Skov med biodiversitetsformål). The support is granted to ensure the habitats for endangered species associated with forests, through extensive forestry, forest grazing, old tree conservation, water level restoration, invasive species removal, and protected species promotion (Landbrugsstyrelsen 2020i). Along with the measures, it is clearly stated that livestock like cattle, bison, sheep and horses are allowed for the year-

round grazing, while pigs and goats can be permitted for biodiversity promotion purposes via grazing (Landbrugsstyrelsen 2020i).

Corresponding financial support is also found in Sweden. As one of the *Environmental Investments* (Miljöinvesteringar), Support for environmental measures in the forest (Stöd till miljöåtgärder i skogen) rewards Swedish forest owners for enhancing biodiversity, and increasing cultural and environmental values on forest lands (Jordbruksverket 2020j). In addition to prescribed burn, wetland establishment, monument protection, and niche diversification in the forests, thinning is promoted on different deciduous forest types (ädellövskog and lövrik skog) greater than 0.5 hectare (Jordbruksverket 2020j). The inclusion of livestock is nonetheless not stated.

Support for nitrogen reduction and carbon fixation

To emphasize the environmental services of forests, *Subsidies for private afforestation* (Tilskud til privat skovrejsning) has been granted in Denmark, with the goal to improve aquatic ecosystems by reducing nitrogen leakage from agricultural lands, at the same time contribute to carbon fixation (Landbrugsstyrelsen 2020i). The grants are for farmers who establish forests of a minimum 2.00 hectares on agricultural lands, while higher priority is given to the contribution to nitrogen reduction (Landbrugsstyrelsen 2020i). Both deciduous and coniferous forests are supported under the scheme, yet the amount for subsidies per hectare is double for deciduous forests as opposed to coniferous forests (Landbrugsstyrelsen 2020i). This grant however touches the irreversible conversion from agricultural land to forestry purposes, termed as *fredskov*, regulated by the Forest Act (Skovlovens) (Landbrugsstyrelsen 2020i).

Of similar target to *Subsidies for private afforestation, Subsidies for targeted nitrogen regulation* (Tilskud til målrettet kvælstofregulering) were set to ensure environmental conditions of coastal waters. In addition to the planting of targeted catch crops like cruciferous crops and cereals, energy crops are the alternatives to be cultivated, including ash, alder, hazel, willow, poplar, and elephant grass. The area of energy crops should be a minimum 0.01-hectare contiguous area. Yet if the area is already regarded as ecological focus area, it thus cannot be used to apply for this subsidy as an alternative to catch crops. This grant is also not applicable to

farms authorized as organic production, or have received *MVJ* and *Care of grass and nature areas* (Landbrugsstyrelsen 2020k)

With comparable intention, Sweden also provides a grant under the name of Environmental payment for reduced nitrogen leaching (Miljöersättning för minskat kväveläckage) to reduce nitrogen and phosphorus leaching from arable land and to store carbon in the soil (Jordbruksverket 2020j). Yet woody species were not considered as catch crops or alternatives to grass, legume, mustard, radish and rye (Jordbruksverket 2020j).

Other support in Sweden

To enhance the competitiveness and viability of farms, *Compensation Support* (Kompensationsstöd) is provided to compensate agriculture situated in poor cultivating conditions in Sweden. Farmers receive the amount of grant depending on the area their farmland is in, and the type of agriculture they practice. This financial support scheme provides room for the establishment of silvoarable systems, as fruits and berries, as well as energy forests are regarded as arable crops under agriculture type 4 (Jordbruksverket 2020k). Animals are nonetheless not allowed in such type of agriculture, thus the establishment of a agrosilvopastoral system is not supported by the scheme (Jordbruksverket 2020k).

Table 8. Agroforestry-related financial support schemes available in 2020 in Denmark and Sweden (Landbrugsstyrelsen 2020a-k; Jordbruksverket 2020a-k)

Denmark	Sweden
Pillar I	
Basic Payment Applicable to arable land (including berry and fruit trees, and coppice forest) and grassland.	***Basic Payment*** Applicable to arable land (including berry and fruit trees, and energy forest), pastures and mown meadows. Energy forest is only limited to willow, poplar and hybrid aspen.
Green Payment Coppice forest, including pure stands of willow and alder at 8,000 trees/ha, and pure poplar stands at 1,000 trees/ha, are included as EFA	***Green Payment*** Only willow for energy production is included as EFA. Woody perennials are not listed as nitrogen fixing crops for EFA.
Pillar II	
Fruit and berry supplement Grafted chestnuts and walnuts are enlisted.	***Fruit and berry cultivation*** Chestnuts, walnuts, hazels, and mulberries are not listed.
Care for grass and nature areas	***Semi-natural pastures and mown meadows and restoration*** Financial support scheme is more diverse and detailed.
Shelterbelts and small biotopes Pollinator-friendly species are requested to take up to 50% of the plantings. ***Plant for the game*** ***Plant for the hazel mouse*** ***Plant for the birch mouse***	***Investment support for the development of natural and cultural environments*** E.g. recreating garden, avenue, stone wall, fence, or small habitats like islet.
Subsidies for forests with biodiversity purposes Silvopastoral – cattle, bison, sheep, horses, pigs and goats can be integrated.	***Environmental Investments*** The inclusion of animals is not stated.
Subsidies for private afforestation More subsidies on deciduous than coniferous forests. ***Subsidies for targeted nitrogen regulation*** Ash, alder, hazel, willow, and poplar can be plated as alternatives to catch crops.	***Environmental compensation for reduced nitrogen leaching*** Woody perennials are not listed as catch crops.
	Compensation Support – agriculture situated in poor cultivating conditions Silvoarable – fruits and berries, and energy forests are compensated.

6. Discussion

The discussion of the study first addresses the findings of the three variables determining level of tree involvement on farmlands in Denmark and southern Sweden, as well as their possible causes; then focuses on the comparisons between farmers' attitudes and behaviour, and the possible connections with the policies for such variations in the study region.

6.1 How Policies Have Portrayed Trees and Bushes on Farmland

Trees and bushes are reported on 100% and 99.99% surveyed Danish and Swedish farmlands, while short-term lease contract and greenhouse cultivating setting could be the reasons for zero trees on the farm. The difference in tree formation between Denmark and Sweden could be due to the respective policies, as well as historical and cultural preferences.

6.1.1 Shelterbelt scheme in Denmark

The most reported tree formations 'three-rowed hedges' and 'single-rowed hedges' are very likely to be a result of Danish National Policy on shelterbelt establishment. As previously mentioned, the national movement of shelterbelt planting initiated with the motivation to solve wind erosion. It started from a dissemination of information and plants for windbreak establishment by a non-government organisation, Hedeselskabet (former Danish Heath Society) since the mid 19th century. The long-term engagement was enforced by the planting societies organised by the Hedeselskabet and the subsidy provision by the government (Veihe et al. 2003). The task force of the unemployed, named 'Flying corps', is a manifestation of positive private-public partnership, contributing to hedgerow planting and social cause at the same time (Busck 2003). Within the 25 years between 1938 and 1963, the task force planted 43,350 kilometers of single-rowed hedgerows of white spruce (*P. glauca*) and Sitka spruce (*P. sitchensis*) (Kristensen 2001; Busck 2003; Naturstyrelsen 2020b).

This dedication by the Flying corps boosted the number of single-rowed hedgerows, despite the fact that they were already principally grown as boundaries and timber for private usage prior to 20th century (Busck 2003). Nonetheless, the 50-year lifespan of the single-rowed hedgerows planted by the Flying corps have required progressively replacement since 1970s (Busck 2003). Meanwhile, the

renewed public subsidy scheme from 1975 predominantly subsidized three-rowed hedges, while six-rowed hedges only received its recognition from 1993 (Veihe et al. 2003). These dynamic fluctuations due to the national schemes explain how 'three-rowed hedgerows' are the most common tree formation, followed by 'single-rowed hedgerows'.

The 150-year history of hedgerow cultivation and the policies in Denmark have engaged the farmers to grow hedgerows on their farmlands, and thus it is not surprise to find many trees and bushes are grown against the winds as shelterbelts. According to a leaflet released by Naturstyrelsen (2012), there are 80,000 kilometers of hedges in Denmark, with roughly 300 kilometers of new hedges every year. The grant *Landscape and biotope improving plantations* alone was estimated to have contributed to the establishment of 5,000-hectare small biotopes and approximately 27,000-kilometer windbreaks (Christiansborg 2015), and its decedent *Shelterbelts and small biotopes* was also expected to support 150 hectares of hedges and small biotopes, or 300 kilometers of three-rowed hedges (Miljøstyrelsen 2017).

The findings of the study also show the abundance of elder (*Sambucus nigra*) and *Crataegus monogynya* on Danish farmlands, which corresponds to Agger & Brandts' study (1988), reporting these two types of woody species were the most observed in both linear and patchy biotopes, including hedges.

6.1.2 Semi-natural pastures in Sweden

Trees and bushes planted in irregular patches, as well as their location on pastures, can be jointly interpreted from the long-term agricultural relationship among people, livestock and nature since the Iron Age until the 18th century (Eriksson & Cousins 2014). Pollarded trees and hay from meadows were fed to the livestock as winter fodder, and their manure was further used for increasing crop yields (Eriksson & Cousins 2014; Gerell 2016).

Land reforms in the 19th century led to clearing of forests and draining of lakes and wetlands for food production in the face of growing population, and the industrial revolution resulted in mechanisation and application of artificial fertilizers (Eriksson & Cousins 2014). Mechanisation made small arable fields and pastures scattered in the mosaic landscape less appealing (Kumm & Hessle 2020).

The dependency on livestock manure was also replaced by inorganic fertilizers, allowing crop production to intensify (Eriksson & Cousins 2014; Gerell 2016). The balance of the traditional management between crop cultivation and animal husbandry was therefore disturbed, leaving much of these agricultural lands abandoned due to the perceived low productivity (Eriksson & Cousins 2014).

As a result, the current 461,300 hectares of pastures and meadows are only a small fraction of less than a tenth compared to a century ago, and 76% of them are in southern Sweden (Eriksson & Cousins 2014; Statens Jordbruksverk 2019). Nonetheless, restoration of pastures has been included as one of the targets in national environmental objectives (Swedish Environmental Objectives Council 2008), and the government has also been promoting semi-natural pastures management by providing grants through Rural Development Schemes. Notwithstanding, regional advisors hold different opinions pertaining to the era the culturally significant landscapes are supposed to represent for restoration (Peterson 2005).

Regardless, birch (*Betula spp.*) and oak (*Quercus spp.*) are identified to be the most common species on southern Swedish farmlands, which is also consistent to the facts of farmlands situated in a pasture-dominating landscape in Östergötland In the study by Sandberg & Jakobsson (2018).

6.1.3 Cross-compliance of CAP

Solitary trees are identified to be the most common on Swedish farmlands, as well as the third most common tree formation in Denmark. This could be attributed to the GAEC 7 of Cross-Compliance, in which farmers are requested to retain solitary trees as a landscape feature (Dalgaard et al. 2019; Jordbruksverket 2011). In addition, the result also shows how solitary trees are an important element in agricultural landscape in terms of landscape aesthetics (Hahn 2018; Jordbruksverket 2006). Nevertheless, the result of solitary trees on Swedish farmlands should be handled with care, as the question statement was understood as the trees Swedish farmers planted, which led to nearly 10% of the respondents stating that they do not plant trees on farmlands. Therefore, there could be an overestimation of solitary trees and an underestimation of other tree formations in the Swedish context.

6.1.4 Swedish forests

The result of this study shows forests are reported to be where most trees and bushes are planted by the farmers in southern Sweden, which indicates many farmers are at the same time forest owners. This is supported by the historical role of farmers being the landscape managers, and the traditional practice of forest grazing (Wetterberg 2020). In addition, the finding of this study also points out the third dominant tree formation is plantation, of which 50% are forests. This further suggests a high percentage of farmers practice forestry. Though not all the farmers nowadays own forests like they once did before the 20th century, a great percentage of them are still affiliated with forestry, which is an important industry in southern Sweden (European Commission 2019). There is 48% of the productive forests owned by individual holders, and the number is even more than 60% in most of the counties in southern Sweden (Skogsstyrelsen 2018).

6.1.5 Gardens and boundaries

Gardens are where most trees and bushes are seen on Danish farmlands, as well as the third most observed location in Sweden. It is linked with the fact that farmstead gardens are considered an important element for every cottage in the agricultural landscape in Denmark, which is mentioned by both Primdahl (1999) and Thorpe (1951). It is assumed that gardens play a similar role in Sweden. Flinck (2015) further points out that gardens on Swedish farmlands have changed from majorly vegetables for livelihood and willows for weaving baskets in the 18th century, to more fruit and ornamental trees and bushes in the 19th century.

In Denmark, trees and bushes are also commonly planted as boundaries along the farmland as demarcation of the property. These linear woody components are found across Europe and can be regarded as a historical and cultural character in the agricultural landscape (Müller 2013).

6.2 Gaps for Agroforestry Adoption

The quantitative results of farmers' perceptions in the study suggest that the most positively ranked factors for motivating farmers' inclusion of trees and bushes on their farmlands belong to the environmental category. As many of the agroforestry-related financial support schemes identified in the national policies have strong links to ecosystem services, the following discussion examined the factors and corresponding policies addressing these factors.

6.2.1 Silvopastoral systems in the dichotomy between agriculture and forestry

While farmers' inclusion of trees and bushes is motivated by 'animal health and welfare', which is supported by Basic Payment in Pillar I for pastures and meadows, and Pillar II for its management, the tree density restrictions between 2007-2013 and 2014-2020 hinders the development of agrosilvopastoral systems, confirmed by the study result as 'regulation' is perceived negatively by farmers.

It is a common critique that the dichotomy between agriculture and forestry makes agroforestry adoption difficult, for agriculture is regulated by the CAP while forestry is governed by the national laws (Pasquier 2020; Sandberg & Jakobsson 2018). The inborn conflict of this compartmentalized management also discloses within CAP, where Pillar I represents an agricultural point of view and agroforestry in Pillar II stands from a forestry perspective. Even though both Denmark and Sweden do not adopt agroforestry suggested by CAP to promote forest multi-functionality, the restriction of tree density on agricultural fields for receiving *Basic Payment* has limited the development of agroforestry in both countries (Pasquier 2020; Sandberg & Jakobsson 2018).

The distinct harm is especially seen in Sweden. The launch of maximum tree density on agricultural land in 2007 not only transferred mosaic Swedish landscapes into more homogenous ones by clearing 50% of the hollow trees and 85% of the dead standing trees, but also discouraged the application of financial support for farmland greater than the areas cleared (Jordbruksverket 2010). It is revealed by Sandberg & Jakobsson (2018) that the restriction risks failing confidence among farmers as the policy changes at a fast pace for long-living trees.

Difficulties of agroforest in practice in Denmark is also affirmed by Økologisk Landsforening (2020), farmers lose their *Basic Payment* when they have more than 100 fodder trees per hectare in a silvopastoral system, as the regulation of 8,000

deciduous trees per hectare enlisted as coppice forest in the Danish *Basic Payment* would leave no space for grassland. In comparison, agrisilvicultural systems are easier to develop with fruits and berries in organic practices, as fruit trees are exempted from the 100-tree regulation and higher tree density between 300 to 20,000 trees per hectare is applied to specific fruit trees and berry bushes (Økologisk Landsforening 2020; Rohde et al. 2019).

6.2.2 Transitioned values in the Danish shelterbelts

Wind erosion is believed to be associated with the motivating factors, 'conservation of soil fertility and erosion control' and 'microclimate moderation', identified by the farmers in the study region of Denmark and southern Sweden. In Sweden, the expansion of agricultural land since the 18th century and the removal of windbreak vegetation for merging agricultural parcels have increased the exposure of farmlands to wind erosion (Bärring et al. 2003; Jönsson 1992). Wind erosion on arable land is especially prominent in Skåne, for its intensive agriculture practices on light soil (Bärring et al. 2003). Wind erosion still prevails despite its reduced impact compared to the 1970s and 1980s, for which farmers continue to adopt preventive measures to reduce soil degradation (Bärring et al. 2003; Länsstyrelsen Skåne 2015). These identified factors by Swedish farmers are nonetheless not seen in the existing financial grants in Sweden.

In the Danish context, 'conservation of soil fertility and erosion control' and 'microclimate moderation', along with 'biodiversity and wildlife habitat' and 'landscape aesthetics', are clearly reflected by the transition in the foci of hedgerow establishment. Since the promotion of hedgerow planting in Denmark, the target has shifted from reducing wind erosion and providing shelter effect for agricultural production in the 20th century, to a landscape approach of using hedgerows and biotopes as ecological corridor for biodiversity conservation and landscape aesthetics (Busck 2003; Fritzbøger 2002; Hodge & Reader 2007).

This transition of highlighted functions was also in accordance with how 'biodiversity and wildlife habitat' and 'landscape aesthetics' were deemed more motivating than 'conversion of soil fertility and erosion control' and 'microclimate moderation' by Danish farmers. It was especially associated with the findings of the study that *Shelterbelts and small biotopes* being the most received subsidies, and

‘biodiversity and wildlife habitat’ and ‘landscape aesthetics’ being the most positively perceived factors by the general Danish farmers.

6.2.3 Landscape aesthetics in Denmark and Sweden

In addition to shelterbelts, the most motivating factors, ‘biodiversity and wildlife habitat’ and ‘landscape aesthetics’, regarded by Danish farmers were also identified in other studies. A study by Boon et al. (2004) also showed that private Danish forest owners, who were highly affiliated with agriculture, viewed flora and fauna as the most important objective, followed by landscape aesthetics. The result was also comparable to the study by García de Jalón et al. (2018), which revealed ‘biodiversity and wildlife habitat’ and ‘landscape aesthetics’ were highly valued by the two Danish farms participating in their study.

The highest ranked ‘landscape aesthetics’ by general Swedish farmers corresponds to the finding by Garrido et al. (2017), in which landscape beauty was considered by farmers and landowners in Östergötland as the most important cultural ecosystem service in oak-dominating wood pastures. Landscape aesthetics formed by trees and bushes was therefore most prioritized when it came to pasture management among farmers (Sandberg & Jakobsson 2018). Furthermore, a study by Ostwald et al. (2013) also identified landscape aesthetics as an important factor for farmers in terms of energy crop cultivation. Nevertheless, it is noteworthy that ‘biodiversity and wildlife habitat’ was not regarded as positive among Swedish farmers, which could be associated with the well-aware notion of preventing overgrown of semi-natural pastures to maintain biodiversity (Gustavsson et al. 2007; Paltto et al. 2011).

This valued factor is embedded in the GAEC 7 of the cross-compliance to retain solitary trees as a landscape element, and supported by the Swedish *Semi-natural Pastures and Mown Meadows*, and *Investment Support for the Development of Natural and Cultural Environments*.

6.2.4 Differentiation in energy production

Global consensus on GHG emission reduction could contribute to farmers’ positive perception of trees and bushes with regards to carbon sequestration. The positive attitude towards ‘carbon fixation’ corresponds to the promotion of SRC under the *Basic Payment* and *Green Payment* in Denmark and Sweden. Yet, up to 10 species of deciduous trees can be mixed and are eligible as coppice forest for the

Danish *Basic Payment*, while poplar, willow and hybrid aspen are only subsidized by the Swedish *Basic Payment* individually. In terms of ecological focus area (EFA) under the *Green Payment* in Denmark, lowered density of 1,000 trees per hectare applies only to pure poplar stand, while tree density of 8,000 trees per hectare holds true to mixed coppice forest, as well as pure alder and willow stand in Denmark. On the other hand, only willow plantation is recognized as EFA under the Swedish *Green Payment*. Another support for trees and bushes clearly stating carbon fixation as one of the targets is the Danish *Payment for Private Afforestation*, yet it was insufficiently sought after by farmers according to the study result.

6.2.5 Attention towards pollination

The ascending estimated economic value in pollination service could be accredited for 'pollination' to be seen as a positive factor among farmers. The pollination value of honeybees, especially economically beneficial for apples, strawberries, oilseeds, clovers and faba beans in Sweden, has ascended by 85% over the past decade, reaching 600 million Swedish kroner (Pedersen et al. 2020). The pollination service by bees are also estimated to reach 800 million Danish kroner, particularly important for the yield and quality of oilseed rape, fruits and berries in Denmark (Ahrenfeldt 2015; Axelsen et al. 2011).

The popularity of 'pollination' could be seen in the practice of flower fallow since its introduction as an EFA in Denmark in 2015 and Sweden in 2018 (Landbrugsstyrelsen 2017; Land Lantbruk 2018). Since the launch in 2015, the adoption of flower fallows has been increasing amongst Danish farmers (Landbrugsstyrelsen 2017), it is therefore assumed to also be well-perceived by Swedish farmers, as 'pollination' is the second highest ranked factor among Swedish farmers in the study.

This ecosystem service of trees and bushes to support pollinators is currently promoted in Denmark under the 50% threshold on pollinator-friendly plantings in *Shelterbelts and small biotopes*, but is however not upheld via making nectar-producing woody species eligible as flower fallow under the *Green Payment* in both countries, nor is it highlighted in other financial support schemes in Sweden.

6.3 Key Determinants for Positive Attitudes

With the results of independent variables influencing the level of tree involvement retrieved from binary logistic regression modelling, behaviour tendencies were less motivated by farming practice and attitude factors amongst the Danish farmers; while positive attitudes towards various factors observed in the Swedish farmers did correspond to their behaviour with regards to different levels of tree involvement.

6.3.1 Animal health and Welfare

Despite the different attitude-behaviour tendencies between Danish and Swedish farmers, the diversity of livestock on the farm appears to be the decisive commonality for positive and negative attitudes towards trees and bushes on farmlands amongst all farmers, which could be attributed to the long history of silvopastoral system in the region. While trees and bushes are often comprehended to generate competitions with crops on arable land by farmers in high latitude regions (Dupraz et al. 2018), their existence is undeniably essential to shelter livestock for animal welfare (Sandberg & Jakobsson 2018). This in turn also justifies 'animal health and welfare' was considered one of the motivating factors by both Danish and Swedish farmers in the study, for semi-natural pasture is the second most received grant by 45% of the farmers in southern Sweden, and the third most received one by 20% of the Danish farmers in the study result.

6.3.2 Organic farming practice

Furthermore, the tendency showing organic farmers perceive trees and bushes on farmland more positively than conventional farmers in the result, which is in line with the general impression of organic farmers' higher environmental awareness and less risk-aversive attitude (Läpple 2013; Schoon & Te Grotenhuis 2000; Storstad & Bjørkhaug, 2003). Yet the response from farmers surveyed in the study shows there is an underutilization of *Payment for Fruit and Berry Cultivation* under *Payments for Organic Production*, as they are only used by 15% and 7% of the organic farmers in Denmark and southern Sweden. The higher utilization rate of the grant in Denmark could be the endeavor by Økologisk Landsforening, who has been providing interested farmers with advisory service on agroforestry.

6.3.3 Hunting opportunity for Danish farmers

It is worth noting in the study result that 'opportunity for hunting' stands out to be an incentive for high-level tree involving Danish farmers, who generally perceive trees and bushes on farmland negatively. This result is in line with the Danish study of Gamborg & Jensen (2016), in which conventional farmers are identified to be more utilitarian than organic farmers, seeing wildlife should be used and managed for human benefits. The positive attitude towards 'opportunity for hunting' of high-level tree involving Danish farmers is nonetheless not observed among their negative-attitude holding counterparts in southern Sweden. The explanation for such difference could be due to the contrasting land use composition between Denmark and southern Sweden, where woodlands account for 58% of Swedish land use while they take up only 13% in Denmark (Fig. 16). This assumption is supported by the study of Gamborg et al. (2019), in which they further indicated that Danish farmers considered the establishment of small woodlots most accepted game management practice, and highly acknowledged landscape-oriented approaches in game management.

Currently, the opportunity for hunting is supported by game fence under *Shelterbelts and small biotopes* and *Plant for the game*, while the latter one holds room for greater adoption from the current 6% of the Danish farmers according to the study.

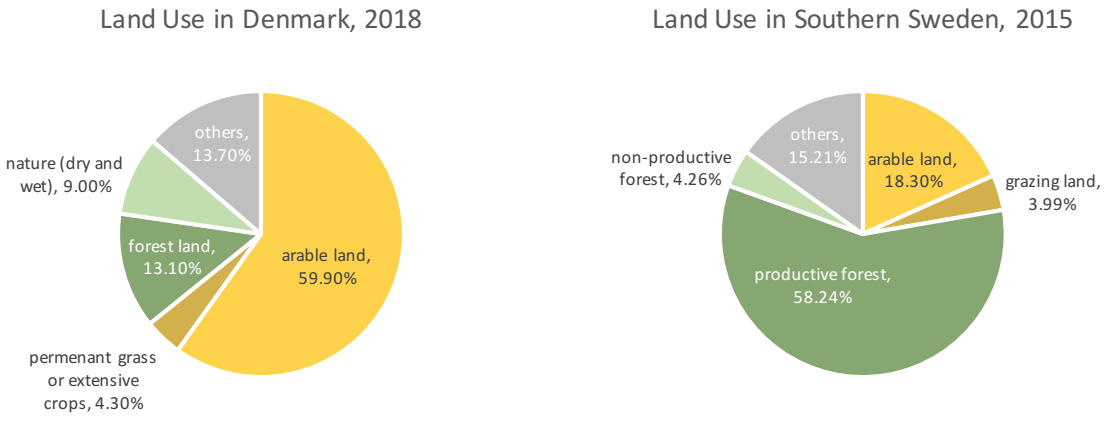


Fig. 16. Percentages of various land use in Denmark and southern Sweden (StatBank Denmark 2020; SCB 2019).

6.3.4 Challenge rooted in mechanisation

Pointed out by positive-attitude holding Danish farmers in the study result, 'mechanisation' perceived to be an inhibiting factor for tree and bushes inclusion

could be due to the higher mechanisation in Denmark. The trend of increase in total area and farm size of farms greater than 50 hectares has been observed in both Denmark and Sweden, which has been supported by the area-based direct payment (Ambros & Granvik 2020; Scown et al. 2020). Agriculture area per holding has thus risen to around 70 hectares per holding in Denmark in 2015, while the number in Sweden in 2016 is around 40 hectares (Danmarks Statistik 2017; Jordbruksverket 2020l).

While averaged agricultural holding can be an indication of mechanisation, small farms in Sweden are gradually increasing, when Danish medium and small farms continue to decrease in percentage and hectares, thanks to the rising interest among consumers regarding local-food consumptions (Ambros & Granvik 2020). In addition, 'mechanisation' was not perceived as impeding by Swedish farmers surveyed, could be a result the slower mechanisation process in more forested regions in Sweden (Kuuse 1974). The difference in mechanisation level between Denmark and Sweden is further supported by the existence of marginal land, which was estimated to cover 10% of the Danish farmland, and up to nearly 20% of the Swedish arable land (Breuning-Madsen et al. 1990; Kumm & Hessle 2020).

This trend in agricultural mechanisation can also be seen in organic production, as only 5.4% of Danish organic farmland falls into the category of small farm less than 20 hectares, while 76.5% of the Danish organic farm is greater than 100 hectares (Landbrugsstyrelsen 2020m). It thereby supported the study result, which suggested organic farmers' general positive attitude towards various factors to include trees and bushes, except for mechanisation.

Despite the fact that 'mechanisation' did play a role in discouraging tree and bush involvement for Danish farmers of positive attitude, the same factor perceived negatively by high-level tree involvement Danish farmers was nonetheless overcome. The reason for this attitude-behaviour mismatch was under the assumption of 'duration of lease' as an unenclosed factor. It therefore requires further identification for the discrepancy between attitude and behaviour for agroforestry in Danish farmers.

6.4 Suggestions for bridging the gaps

Based on the farmers' attitudes and current national policies, the following suggestions are proposed to meet the factors suggested by general farmers' attitudes, as well as the determinants identified by segmented farmers. Main suggestions follow the two streams to increase landscape heterogeneity, and to have more pollinators, fruits and berries.

6.4.1 Increase in landscape heterogeneity

As 'landscape aesthetics' is perceived as a positive factor for including trees and bushes, the farm size based direct payment indirectly supporting the continuous growth of large farms, should be converted into a needs-based support that rewards farmers for adopting diverse land use on farmland, especially for arable lands. Similar to tax brackets, the author argues, arable areas should receive different levels of basic payment based on their diversity level, with homogenous farmlands receiving less and heterogeneous farms being given higher support. The heterogeneity of the farmland could be evaluated in terms of stratification levels and species established on farmland, which could further hamper mechanisation and the development of homogenous agrarian landscape.

To further promote 'animal health and welfare', the tree density limitation on agricultural parcels, which has especially been a well-reported impediment by Swedish farmers (Pasquier 2020; Sandberg & Jakobsson 2018), should be lifted from agricultural parcels to allow silvopastural systems to thrive in both Denmark and southern Sweden. Furthermore, an additional crop code for coppice forest at lower tree density should be provided in Denmark, such as 'lavskov – skovlandbrug', for the inclusion of livestock by allowing farmers to plant grass and fodder trees.

For greater diversity in agricultural landscape, current species eligible for energy forest under *Basic Payment* and EFA under *Green Payment* should also be expanded in the Swedish policy to allow farmers to have more freedom. The promotion for energy forest is in line with the national commitments for Denmark to reduce GHG by 70% by 2030 and land on net zero by 2050 as opposed to the 1990 levels, and the Swedish targets to lower GHG by 63% by 2030 and reach net zero by 2045 (Danish Ministry of Climate, Energy and Utilities 2019; Swedish Environmental Protection Agency 2018).

Despite the cultural and ecological purpose of stone walls to reduce wind erosion on Swedish farmlands, Swedish policy makers could possibly take reference from the Danish *Shelterbelts and biotopes* scheme which is well sought after, and adapt it to the local context to promote bushes. If similar support can be practiced in Sweden, it could also meet many of the positive driving factors, 'soil conservation', 'microclimate moderation', 'landscape aesthetics' and 'pollination', perceived by the farmers in southern Sweden.

6.4.2 More pollinators, fruits and berries

Since 'pollination' is only included in the Danish *Shelterbelts and biotopes* scheme at present, the author therefore suggests the introduction of pollinator-attracting trees in flower fallows to enhance landscape diversity, as well as meeting the farmers' motivations to include trees and bushes for 'pollination' and 'landscape aesthetics' purposes. The foreseen difficulty in relation to mechanisation imposed by these nectar-producing trees and bushes, could be reduced if they are planted in linear formation. This inclusion of trees would specifically benefit the agrarian landscape in southern Sweden, for a disproportion between beekeeping and pollination-required crop cultivation are observed in counties like Skåne, Östergötland and Västra Götaland (Pedersen et al. 2020).

Moreover, the results of this study reveal that there is still room to increase organic farmers' application of the *Payment for Fruit and Berry Cultivation* in both Denmark and Sweden. Further study is required to identify the opportunities to increase the low employment of the scheme. The listed fruit and berry varieties should also be broadened for southern Sweden of similar latitude as Denmark. Therefore, there should be further considerations on the Swedish fruit and berry list to comprise hazel, chestnut and walnut.

The greater options for the *Payment for Fruit and Berry Cultivation* would enable agricultural landscape to further diversify in the trend of increasing organic production in both Denmark and Sweden. With the EU strategy From Farm to Fork in the post-2020 CAP targeting to reach 25% of farmland used for organic production by 2030 (European Commission 2020c), at the same time Denmark aiming to double its current 11% organic fields and Sweden working towards 30% of agricultural land to be organic certified by 2030 (Landbrugsstyrelsen 2020l; Regeringskansliet 2017),

the flexibility in regulation on supported species could enhance the diversity of organic agricultural landscape.

In addition, the cultivation of fruits and berries in agroforestry systems can also contribute to climate mitigation and adaptation by strengthening the local food systems and national food securities. It has been debated that Sweden has dropped the self-sufficiency from 75% to only 50% over the past three decades, being most dependent on imports of vegetable and fruit, followed by meat (LRF 2020). This is also reflected by the negative trade balance regarding the Swedish agricultural goods since 2010, with 'meat and meat products' and 'fruits and vegetables' being the most trade deficit categories between 2014 and 2019 (Jordbruksverket 2020l). In a similar manner, latest analyses in Denmark also reveal the majority of Danish fruit and berry, and vegetable consumptions is imported (Danmarks Statistik 2019 & 2020). Establishing agroforestry systems with fruit and berries in both Denmark and Sweden could raise self-sufficiency, at the same time realise climate action in reducing GHG emission due to the short travel distances of produce in the local food systems.

7. Conclusion

The study concludes that 'animal health and welfare', 'landscape aesthetics', 'soil conservation', 'microclimate moderation', 'pollination', and 'carbon fixation' are considered the motivating factors, while 'administrative burden' and 'regulations' are perceived discouraging by farmers in both Denmark and southern Sweden, despite the differences in geographical conditions, social-economic statuses and national policies. The similar general attitudes illustrated by these farmers are found to lead to contrasting behaviour between Danish and Swedish farmers when they are segmented into smaller groups. In spite of inconsistent attitude and tree-involving behaviour performed by Danish farmers, the adoption of organic practice and the diversity of livestock on the farmlands are the commonalities correlating to positive attitudes amongst Danish and Swedish farmers. It could be due to the higher environmental awareness of organic producers, and the long silvopastoral history and animal welfare for trees and bushes to play such essential roles for livestock.

At the policy level, Denmark offers many financial support schemes that can potentially promote agroforestry in the country, while the financial support schemes are generally more restricted in terms of both practice and options in Sweden, except for the diverse and detailed schemes for semi-natural pastures. When pairing farmers' perceptions with the review of current national policies, study further affirms that silvopastoral systems have a great potential amongst Danish and Swedish farmers, if the density restriction is withdrawn. Pollination and carbon sequestration can also be further promoted in both regions, while soil conservation that is currently not emphasized in the Swedish policies should be included in the Swedish Pillar II. Main suggestions follow the two streams to increase landscape heterogeneity and to have more pollinators, fruits and berries.

Despite the similar general attitudes of farmers and national policies under CAP in Denmark and Sweden, differences are observed when examining farmers' perceptions in smaller segments and reviewing financial schemes in details. These detailed variations could be partly due to the historical policies, and partly a result of current land use composition. Thus, to ensure successful paradigm change, it is crucial for policy makers in agriculture and forestry to collaborate in an interdisciplinary manner to avoid dichotomy. It is also critical to include farmers' groups in the design process of the policies to best understand farmers' specific needs and ensure the practicality of the policy instruments in the fields, in order to encourage agroforestry adoption in both countries.

With the understanding of farmers' general perceptions towards different factors, future studies are encouraged to further investigate the attitudes and behaviour tendencies amongst livestock producers and organic producers for the highest adoption based on their positive interpretation of woody elements on farmlands. It is also essential for future studies to identify the opportunities to increase the application of financial supports, like the Danish *Plant for the game* and *Payment for Fruit and Berry Cultivation* in both Denmark and southern Sweden. To further portray a holistic picture of agroforestry, economic analysis of existing agroforestry production systems, as well as consumers' views and willingness to pay, are also essential aspects to incorporate in the picture for an effective paradigm shift in sustainable food systems.

8. Critical Reflection

It was challenging to work on a comparative study for the thesis project this year, as many plans were disrupted and delayed due to the outbreak of the pandemic. Despite the difficulties, the author tried her best to work around it and refine the content of the study, from which she learned there was never going to be a perfect piece of work. Looking back, there was always room for improvement. The following was thus the space for advancement addressed in self-reflection.

8.1 Data collection

8.1.1 Test sample size

As mentioned in 4.3.1 Design of the questionnaire, the questionnaire was first shared with three farmers in Denmark and Sweden to run a sample test before official survey distribution. The questionnaires in Danish and Swedish were thus revised based on the farmers' feedback. Yet due to the diversity among farmers, there were however still some options in crop and livestock varieties, tree species, and tree locations were not exhaustive. In addition, there were some translated wordings that could have caused misinterpretation. These missed options and misinterpreted statements should thus be analyzed with care as the low percentages of these answers did not necessarily reflect the reality. This also drew an attention to what a sufficient number was for trial tests prior to the dissemination of the survey.

8.1.2 Distribution channels

The distribution channels of the survey in Denmark and Sweden varied slightly due to the restrictions of GDPR, yet overall could be considered corresponding. Danish farmers were reached through many regional branches under L&F and other organisations due to protected personal information, while Swedish farmers were mainly approached individually via contact information from local divisions under LRF, in addition to other organisations. The challenge mainly lied in the translated project description, which misled the farmers to consider the project not relevant to agriculture but forestry at the beginning of the distribution, and could generate bias as only farmers interested in forestry filled out the survey.

8.1.3 Response and completion rates

Despite the lack of number on the total invitees for the survey due to the snowballing of organisations, it was estimated the response rate was between 5-

10%. The overall response rates could have been increased if the data collection period avoided overlapping with the busy seasons like spring and summer for farmers. The response rate of Danish farmers could have also been higher if emails were sent to individual farmers to create a sense of personal touch, instead of through organisations. The higher response rate seen amongst Swedish farmers could be accredited to the personalized survey invites (Heerwegh & Loosveldt 2006).

In addition, the completion rates of the survey by Danish farmers and Swedish farmers were 76% and 77%. The dropout rate of nearly 25% was higher than the individually targeted online surveys of an average 16% (Lozar Manfreda and Vehovar 2002). Despite the fact that the study description provided the estimated time for completion to be 10 to 15 minutes, and further confirmed the time spent with farmers participating in the pilot studies, it could have nonetheless taken up to 15 or 20 minutes, as the survey report showed the median for completion time was about 13 minutes for Danish and Swedish surveys. This variation in expected time spent on the survey could be one reason for the drop-outs.

Furthermore, the formulation of question statements in the second part of the survey, question 15-18, could have been further improved, as it was regarded too complicated and academic, which oftentimes led to confusion and even dropouts from the survey. As the second section was solely composed of matrix questions, which also contributed to higher drop-out rates, and caused fatigue among respondents (Galesic 2006; Knapp and Heidingsfelder 1999).

Moreover, since it was a zero-budget thesis project, the participation of farmers was completely voluntary without survey incentives, which was indicated to motivate the completion rate by up to 27% according to Göritz's study (2006).

8.2 Data analysis

8.2.1 Result interpretation

Due to the nature of anonymous participation in the quantitative study, it was not possible to turn to the participating farmers for in-depth interviews. Therefore, the linkages between farmers' attitudes and policies were inferences drawn with certain supporting evidences, which required further studies to identify the adoption gaps through investigating farmers' perceptions of specific policies in a qualitative approach.

It should also be kept in mind that Denmark and southern Sweden were seen to be two homogenous areas in the study during the analysis and interpretation of the EU and national policies, in which variations might have existed across counties and regional divisions due to local environmental and socio-economic conditions. Further research in understanding farmers' attitudes and policies at a regional level was essential for promoting heterogenic agroforestry systems in the diverse agrarian landscapes.

8.2.2 Cultural limitation and language barrier

It should be noted that not all relevant studies and policies were reviewed due to language and cultural background, in spite the fact that the author worked as hard as possible to minimize the constraints they might have imposed. Yet it was hoped that the contour of agroforestry created by this study, could provide some insights on farmers' needs and perceptions, as well as facilitate more communications between policy makers and farmers and promote participatory policy-making by including farmers in the process.

8.2.3 Attitude-behaviour gaps behind the suggestions

In the discussion, suggestions were proposed to further increase agroforestry adoption through the motivating factors identified by Danish and Swedish farmers as collective groups. Nonetheless, it needs to be kept in mind that enhancing these factors generally perceived positive by farmers in southern Sweden might be effective, yet this approach alone would not be enough in the Danish context, as there appear to be other factors hindering their adoption of agroforestry systems.

Therefore, the suggestions made according to the generally perceived positive factors should be aware of the attitude-behaviour gaps amongst farmers. The attitude-behaviour gaps, well applied in the field of consumption studies, are defined as the inconsistency between respondents' intentions they express and actions they take (Carrington et al. 2010).

By conducting logistic regression modelling, the results suggested general positive attitude led to higher level of tree involvement amongst Swedish farmers, while it was the opposite for Danish farmers. Further studies are therefore required to identify the disparity of attitude-behaviour amongst Danish farmers in order to assist them in involving trees at higher levels.

Appendix I. Operational Table of the Quantitative Research Questionnaire

Key concept	*Dimension*	*Question formulation*	*Response options*	*Position in the questionnaire*
Socio-demography	Gender	What is your biological sex?	1) Male 2) Female	
	Age	What is your age?	Open response	
	Education	What is your educational background?	1) Primary School Degree 2) Gymnasium Degree 3) Agriculture Degree 4) Bachelor's Degree 5) Master's / PhD Degree 6) Others _____	
Farming	Years of experience	How many years of experience do you have in operating a farm up till March 2020? (number of years)	Open response	
	Location	Which region in Danmark are you operating your farm in?	1) Hovedstaden 2) Sjælland 3) Nordjylland 4) Midtjylland 5) Syddanmark	
		Which region in Sweden are you operating your farm in?	1) Blekinge 2) Gotland 3) Halland 4) Jönköping 5) Kalmar 6) Kronoberg 7) Östergötland 8) Skåne 9) Västra Götaland	
	Size of farm	How many hectares is your farmland (both own and leased land, including grazing land)?	Open response	

Organic certification	Is the farm conventional or organically certified?	1) It is completely conventional (100%). 2) It is mainly conventional (> 65%). 3) It is about half conventional half organically certified (33%-65%). 4) It is mainly organically certified (> 66%). 5) It is completely organically certified (100%). 6) It does not fit into the business (e.g. forestry)
Subsidies	Have you ever received external subsidies for tree-planting activities? (such as shelterbelts, alley cropping, buffer zones, energy crops, wildlife niches or the like) If yes, what are they?	Multiple response options: Grundbetaling og grøn støtte Miljøvenlige Jordbrugsforanstaltninger (MVJ) Pleje af græs- og naturarealer Tilskud til frugt og grønt Landskabs- og biotopforbedrende beplantninger Tilskud til privat skovrejsning Skov med biodiversitetsformål Tilskud til Målrettet kvælstofregulering Plant for vildtet Plant for hasselmusen Plant for birkemusen Others _____
		Multiple response options: Förgröningsstöd Miljö- och klimatvänligt jordbruk (stöd för landsbygdsutvecklingsåtgärder) Ersättning för frukt och bär i ekologisk produktion Skogsbete

			Mosaikbetesmarker Komplement lövtäkt Others _____
Farm type	Crop variety	What crops do you grow for production on the farm?	Multiple response options: grain, fodder grass, grass seed, rapeseed, maize, sugar beet, legume crop, root vegetable, leafy vegetable, herb, berry, mushroom, others _____
	Animal variety	What animals do you raise on the farm as livestock production?	Multiple response options: dairy cow, beef cow, pig, sheep, goat, hen, chicken, duck/goose, bee, others _____, none
	Animal welfare	How are the livestock kept on the farm?	Multiple response options: free roaming in all seasons; free roaming during warm seasons, housed during cold seasons; housed in all seasons; I do not have any animals for livestock production
	Tree planting types	What types of tree plantings do you have on the farm?	Multiple response options: solitary trees on farmland, single-rowed hedgerows, three-rowed hedgerows, six-rowed hedgerows, alley cropping, shifting cultivation with crops, in irregular patches, plantation, others _____, none
	Tree location	Where are the trees found on your farm?	Multiple response options: forest, on the borderlines, along entry road, on pasture land, in the garden, around farmstead, around the grazing areas,

			alongside streams and rivers, against the wind as shelterbelts, others _____, none
	Trees variety	What trees do you grow on the farm?	Multiple response options: apple, cherry, pear, plum, mulberry, sea buckthorn, rowan, crataegus, elder, chestnut, walnut, hazel, oak, birch, pine, spruce & fir, alder, elder, honey locust, willow, poplar, others _____, none
Perception	Production	How the following influences my decision to include trees on the farm: - Crop or pasture production - Crop or pasture quality - Disease and weed control - Animal health and welfare - Animal production - Losses by predation - Timber wood, fruit & nut production - Timber wood, fruit & nut quality - Energy crop production - Diversity of products	7-point scale: very positively moderately positively slightly positively neutral/no opinion slightly negatively moderately negatively very negatively
	Environmental quality	How the following influences my decision to include trees on the farm: - Biodiversity and wildlife habitat - Conservation of soil fertility and erosion control - Control of fertilizer, noise, and/or odor - Reduction of negative environmental impacts, e.g. drought and flood - Carbon accumulation in the tree - Microclimate moderation, e.g. shelter (wind), shade or temperature (frost) - Landscape aesthetics	7-point scale: very positively moderately positively slightly positively neutral/no opinion slightly negatively moderately negatively very negatively
	Management	How the following influences my decision to include trees on the farm:	7-point scale: very positively

	- Complexity of work (knowledge) - Inspection of animals - Labour - Management costs - Mechanisation - Originality and interest - Overall feasibility (social, economic and environmental)	moderately positively slightly positively neutral/no opinion slightly negatively moderately negatively very negatively
Socio-economic	How the following influences my decision to include trees on the farm: - Administrative burden - General farmer's reputation - Local food supply - Long term market risk - Profit - Income distribution - Marketing premium - Inheritance and taxation - Subsidy and grant eligibility - Regulation - Rural employment - Opportunity for hunting - Tourism	7-point scale: very positively moderately positively slightly positively neutral/no opinion slightly negatively moderately negatively very negatively

Appendix II. Agroforestry Perception Questionnaire

Hej! Mitt namn är Carolina Yang och jag läser masterprogrammet i agroekologi på Sveriges Lantbruksuniversitet (SLU). I samband med min masteruppsats kommer jag, genom en kvantitativ studie, att undersöka jordbrukares inställning till agroforestry, även känt som skogsjordbruk. Agroforestry är en odlingsmetod som integrerar träd och/eller buskar med grödor eller boskap.

Tack för att du deltar i denna enkät, den kommer att ta ca 10-20 minuter att genomföra. Enkäten är uppdelad i två delar: 1) bakgrundsinformation, och 2) inställning till agroforestry. Jag hoppas att du tar dig tid att svara på frågorna nedan då ditt deltagande har stor betydelse för studien.

Enkäten är anonym och frivillig, och du kan därmed välja att lämna den när du vill under processen. Den insamlade informationen kommer att hanteras i enighet med Dataskyddsförordningen (GDPR) och endast användas för akademiska syften för att bättre förstå utvecklingen och möjligheterna för skogsjordbruk i Sverige och Danmark.

Har du några frågor när du fyller i enkäten, tveka inte att höra av dig till mig på 073-------. Är du intresserad av att följa upp resultaten från enkäten eller masteruppsatsen är du välkommen att kontakta mig via mejl.

1. Bakgrundsinformation
Frågorna nedan syftar till att förstå och få en överblick av din verksamhet.

1. Vad är ditt biologiska kön?
    - ☐ Man
    - ☐ Kvinna

2. Hur gammal är du?
    _____

3. Vad är din utbildningsbakgrund?
    - ☐ Grundskola
    - ☐ Gymnasium
    - ☐ Lantbruksutbildning
    - ☐ Kandidatexamen
    - ☐ Masterexamen/Doktorsexamen
    - ☐ Annan (t.ex. hantverkarutbildning) _____

4. Hur många år hade du drivit verksamheten i maj 2020? (antal år)
    _____

5. Inom vilket län bedriver du din verksamhet?

- ☐ Blekinge
- ☐ Gotland
- ☐ Halland
- ☐ Jönköping
- ☐ Kalmar
- ☐ Kronoberg
- ☐ Östergötland
- ☐ Skåne
- ☐ Västra Götaland

6. Hur många hektar ingår i din verksamhet, inklusive betesmark? (Både egen och arrenderad mark.)

_____

7. Är verksamheten konventionell eller ekologisk (certifierad eller icke-certifierad)?

- ☐ Den är helt konventionell (100%)
- ☐ Den är huvudsakligen konventionell (>65%)
- ☐ Ungefär hälften är konventionell och hälften ekologisk (certifierad eller icke-certifierad) (35-65%)
- ☐ Den är huvudsakligen ekologisk (certifierad eller icke-certifierad) (>65%)
- ☐ Den är helt ekologisk (certifierad eller icke-certifierad) (100%)
- ☐ Passar inte in i verksamheten (t.ex. pga skogsbruk)

8. Har du någon gång mottagit finansiellt stöd för marker med träd eller trädplantering? (t.ex. vindskydd, alléodling, buffertzoner, energigrödor, djurens livsmiljöer eller liknande) Om ja, vilket/vilka? (Klicka i alla alternativ som stämmer)

- ☐ Nej
- ☐ Gårdsstöd och förgröningsstöd
- ☐ Frukt och bär, Ersättningar för ekologisk produktion och omställning till ekologisk produktion
- ☐ Energiskog som växtodlingsgröda, Kompensationsstöd
- ☐ Allmänna eller särskilda värden, Miljöersättning för betesmarker och slåtterängar
- ☐ Skogsbete, Miljöersättning för betesmarker och slåtterängar
- ☐ Mosaikbetesmarker, Miljöersättning för betesmarker och slåtterängarv
- ☐ Gräsfattiga marker, Miljöersättning för betesmarker och slåtterängar
- ☐ Komplement lövtäkt, Miljöersättning för betesmarker och slåtterängar
- ☐ Annat _____

9. Vilka grödor odlar du på gården i kommersiellt syfte? (Klicka i alla alternativ som stämmer)

- ☐ Spannmål
- ☐ Vall
- ☐ Vallfrö
- ☐ Oljeväxter
- ☐ Majs
- ☐ Baljväxter
- ☐ Rotfrukter
- ☐ Bladgrönsaker
- ☐ Örter
- ☐ Bär
- ☐ Svamp
- ☐ Frukt
- ☐ Nötter
- ☐ Annat _____

10. Vad har du för djurproduktion på gården i kommersiellt syfte? (Klicka i alla alternativ som stämmer)

- ☐ Inga djur
- ☐ Mjölkkor
- ☐ Nötdjur
- ☐ Grisar
- ☐ Får
- ☐ Getter
- ☐ Höns
- ☐ Kycklingar
- ☐ Ankor
- ☐ Gäss
- ☐ Bin
- ☐ Annat _____

11. Hur hålls djuren på gården? (Klicka i alla alternativ som stämmer)

- ☐ Ute året om
- ☐ Ute året om med ligghallar
- ☐ Ute på sommarhalvåret, inne under vinterhalvåret
- ☐ Inne med tillgång till betesområde
- ☐ Inne året om
- ☐ Har inga produktionsdjur

12. Vilken typ av trädplantering har du på gården? (Klicka i alla alternativ som stämmer)

☐ Inga

☐ Enskilda träd på åker eller betesmark

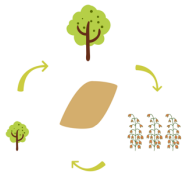
☐ Häckar av enkel rad

☐ Häckar av tre rader

☐ Häckar av sex rader

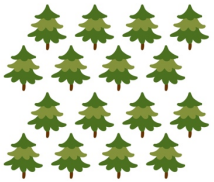
☐ Alléodling

☐ Träda



☐ Träd i olika kluster

☐ Plantage eller växtliknande plantering



☐ Annat _____

13. Var på gården är träden? (Klicka i alla alternativ som stämmer)

☐ Inga

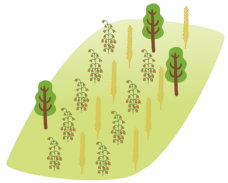
☐ Som staket till granngården

☐ Längs uppfarten till gården

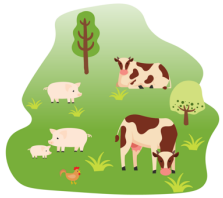
☐ Runt gården

☐ I trädgården

☐ På åkern

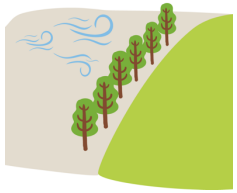


☐ På betesmarken

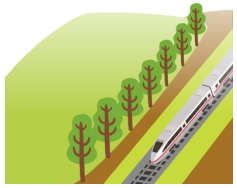


☐ Runt betesmarken

☐ Emot vinden som vindskydd



☐ Ljudbarriärer mot högt trafikerade bil och järnvägar



☐ Längs med bäckar och floder

☐ Skog

☐ Annat _____

14. Vilka typer av träd finns på gården? (Klicka i alla alternativ som stämmer)

- ☐ Inga träd
- ☐ Äpple
- ☐ Körsbär
- ☐ Päron
- ☐ Plommon
- ☐ Mullbär
- ☐ Havtorn
- ☐ Slån
- ☐ Hägg
- ☐ Rönn
- ☐ Hagtornssläktet
- ☐ Fläder
- ☐ Kastanj
- ☐ Valnöt
- ☐ Hassel
- ☐ Ek
- ☐ Björk
- ☐ Tall
- ☐ Gran
- ☐ Al
- ☐ Korstörne
- ☐ Salix
- ☐ Poppel
- ☐ Annat _____

2. Inställning till skogsjordbruk

Denna del syftar till att förstå lantbrukares inställning till skogsjordbrukssystem. Vänligen markera den nivå av inflytande som passar bäst in på dig från 'mycket positiv' till 'mycket negativ'.

15. [Produktion] Aspekten har följande inverkan på mitt val om att plantera eller behålla träd i mitt jordbruksområde.

	Mycket negativ	Måttligt negativ	Något negativ	Neutral / inte relevant	Något positiv	Måttligt positiv	Mycket positiv
Produktion av grödor eller betesmark	☐	☐	☐	☐	☐	☐	☐
Kvalitet på grödor eller betesmark	☐	☐	☐	☐	☐	☐	☐
Sjukdoms- och/eller ogräskontroll	☐	☐	☐	☐	☐	☐	☐
Djurens hälsa och/eller välbefinnande	☐	☐	☐	☐	☐	☐	☐
Djurproduktion	☐	☐	☐	☐	☐	☐	☐
Förluster till följd av rovdjur	☐	☐	☐	☐	☐	☐	☐
Timmer-, frukt- och/eller nötproduktion	☐	☐	☐	☐	☐	☐	☐
Kvalitet hos timmer, frukt och/eller nötter	☐	☐	☐	☐	☐	☐	☐
Produktion av bioenergigrödor	☐	☐	☐	☐	☐	☐	☐
Diversitet av produkter	☐	☐	☐	☐	☐	☐	☐

16. [Hantering] Aspekten har följande inverkan på mitt val om att plantera eller behålla träd i mitt jordbruksområde.

	Mycket negativ	Måttligt negativ	Något negativ	Neutral / inte relevant	Något positiv	Måttligt positiv	Mycket positiv
Arbetets komplexitet	☐	☐	☐	☐	☐	☐	☐
Arbetskraft	☐	☐	☐	☐	☐	☐	☐
Hanteringskostnader	☐	☐	☐	☐	☐	☐	☐
Teknik och maskiner	☐	☐	☐	☐	☐	☐	☐
Originalitet och intresse	☐	☐	☐	☐	☐	☐	☐
Djurinspektion	☐	☐	☐	☐	☐	☐	☐

17. [Miljökvalitet] Aspekten har följande inverkan på mitt val om att plantera eller behålla träd i mitt jordbruksområde.

	Mycket negativ	Måttligt negativ	Något negativ	Neutral / inte relevant	Något positiv	Måttligt positiv	Mycket positiv
Biodiversitet och skapande av habitat	☐	☐	☐	☐	☐	☐	☐
Bevarande av jordens fertilitet och erosionskontroll	☐	☐	☐	☐	☐	☐	☐
Kontroll av gödsel, ljud och/eller lukt	☐	☐	☐	☐	☐	☐	☐
Minska negativ miljöpåverkan t. ex. torka och översvämning	☐	☐	☐	☐	☐	☐	☐
CO2-ansamling i träets massa	☐	☐	☐	☐	☐	☐	☐
Mikroklimateffekter t.ex. skydd (vind), skugga eller temperatur (frost)	☐	☐	☐	☐	☐	☐	☐
Pollinering	☐	☐	☐	☐	☐	☐	☐
Biologisk bekämpning av skadegörare	☐	☐	☐	☐	☐	☐	☐
Landskapsvärden och estetik	☐	☐	☐	☐	☐	☐	☐

18. [Socioekonomiska] Aspekten har följande inverkan på mitt val om att plantera eller behålla träd i mitt jordbruksområde.

	Mycket negativ	Måttligt negativ	Något negativ	Neutral / inte relevant	Något positiv	Måttligt positiv	Mycket positiv
Administrativ börda	☐	☐	☐	☐	☐	☐	☐
Bilden av mig som lantbrukare	☐	☐	☐	☐	☐	☐	☐
Lokalt matutbud	☐	☐	☐	☐	☐	☐	☐
Långsiktiga risker på marknaden	☐	☐	☐	☐	☐	☐	☐
Avkastning	☐	☐	☐	☐	☐	☐	☐

Utökade inkomstkällor	☐	☐	☐	☐	☐	☐	☐
Frågor relaterade till arv och skatt	☐	☐	☐	☐	☐	☐	☐
Möjlighet till ekonomsikt stöd	☐	☐	☐	☐	☐	☐	☐
Regler	☐	☐	☐	☐	☐	☐	☐
Arbetstillfällen på landsbygden	☐	☐	☐	☐	☐	☐	☐
Jaktmöjligheter	☐	☐	☐	☐	☐	☐	☐
Turism	☐	☐	☐	☐	☐	☐	☐

3.
Tack så mycket för att du tagit dig tiden att svara på denna enkät! Om du är intresserad av resultaten in denna enkät eller av uppsatsen är du välkommen att kontakta mig på mejl. Du kan också ange din mejladress nedan.

_____

Tack så mycket för din tid!

Appendix III

Table 1. Social-demographic of the respondents in Denmark and Sweden

		Denmark			Sweden	
		Count	Percentage (n=104)		Count	Percentage (n=369)
Gender	Male	79	75.96		314	85.09
	Female	25	24.04		55	14.91
	Age (mean ± SD)	52.92	± 12.35		53.10	± 12.35
	Years of experience (median, IQR)	22.00	(8.50, 30.00)		25.00	(10.00, 35.00)
Educational Background	Primary School	7	6.73		31	8.40
	High School	4	3.85		65	17.62
	Agriculture Training	38	36.54		172	46.61
	University	13	12.50		45	12.20
	Master/PhD	29	27.88		33	8.94
	Others	13	12.50		23	6.23
Region	Hovedstaden	3	2.88	*Blekinge*	14	3.79
	Sjælland	28	26.92	*Gotland*	20	5.42
	Nordjylland	12	11.54	*Halland*	23	6.23
	Midtjylland	32	30.77	*Jönköping*	45	12.20
	Syddanmark	29	27.88	*Kalmar*	30	8.13
				Kronoberg	20	5.42
				Östergötland	30	8.13
				Skåne	101	27.37
				Västra Götaland	86	23.31
	Hectare (median, IQR)	35.00	(11.00, 109.25)		95.00	(42.00, 185.00)
Conventional-Organic	Completely conventional (100%)	39	37.50		230	62.33
	Mainly conventional (>65%)	6	5.77		26	7.05
	Roughly half conventional and organic (33-65%)	2	1.92		3	0.81
	Mainly organic (>65%)	2	1.92		9	2.44
	Completely organic (100%)	52	50.00		80	21.68
	Not applicable	3	2.88		21	5.69
	Subsidies (median, IQR)	1.00	(0.00, 2.00)		1.00	(0.00, 2.00)
	Crops variety (median, IQR)*	2.00	(2.00, 4.00)		2.00	(2.00, 3.00)
	Livestock variety (median, IQR)*	1.50	(1.00, 2.75)		1.00	(1.00, 2.00)
	Tree formation variety (median, IQR)	3.00	(2.00, 4.00)		2.00	(1.00, 3.00)
	Tree location variety (median, IQR)	7.00	(5.00, 8.00)		4.00	(3.00, 6.00)
	Tree species variety (median, IQR)	13.00	(10.00, 18.00)		12.00	(9.00, 15.00)

*Calculated only in within farmers who cultivate crops or raise livestock by excluding value equals to 0.

Table 2. Subsidies for trees on farmland received by the respondents in Denmark and Sweden

	Denmark			Sweden	
	Count	Percentage (n=104)		Count	Percentage (n=369)
Subsidies (median, IQR)	1.00	(0.00, 2.00)		1.00	(0.00, 2.00)
Grundbetaling og grøn støtte	27	25.96	*Gårdsstöd och förgröningsstöd*	202	54.74
Miljøvenlige Jordbrugsforanstaltninger (MVJ)	12	11.54	*Frukt och bär, Ersättningar för ekologisk produktion och omställning till ekologisk*	6	1.63
Pleje af græs- og naturarealer	18	17.31	*Energiskog som växtodlingsgröda, Kompensationsstöd*	12	3.25
Frugt- og bærtillæg	8	7.69	*Allmänna eller särskilda värden, Miljöersättning för betesmarker och slåtterängar*	160	43.36
Landskabs- og biotopforbedrende beplantninger	5	4.81	*Skogsbete, Miljöersättning för betesmarker och slåtterängar*	30	8.13
Tilskud til privat skovrejsning	7	6.73	*Mosaikbetesmarker, Miljöersättning för betesmarker och slåtterängar*	14	3.79
Skov med biodiversitetsformål	3	2.88	*Gräsfattiga marker*	11	2.98
Tilskud til målrettet kvælstofregulering	3	2.88	*Komplement lövtäkt, Miljöersättning för betesmarker och slåtterängar*	13	3.52
Læhegn og småbeplantninger	31	29.81			
Plant for vildtet	6	5.77			
Plant for hasselmusen	2	1.92			
Plant for birkemusen	1	0.96			
Others	1	0.96		12	3.25
No	43	41.35		125	33.88

Table 3. Tree forms, locations and species on the farms of the respondents in Denmark and Sweden

	Denmark			Sweden	
	Count	Percentage (n=104)		Count	Percentage (n=369)
Tree forms					
Solitary trees on farmland	50	48.08		248	67.21
Single-rowed hedgerows	54	51.92		68	18.43
Three-rowed hedgerows	65	62.50		11	2.98
Six-rowed hedgerows	16	15.38		2	0.54
Alley cropping	8	7.69		23	6.23
Shifting cultivation with crops	3	2.88		48	13.01
In irregular patches	49	47.12		175	47.43
Plantation	45	43.27		140	37.94
Tree locations					
In fences to the neighboring yard	87	83.65		54	14.63
Alleys along entry roads and paths	65	62.50		92	24.93
Around farmstead	82	78.85		187	50.68
In the garden	93	89.42		238	64.50
On cultivated agricultural land	32	30.77		54	14.63
On pasture land	40	38.46		243	65.85
Around pasture land	61	58.65		183	49.59
Shelterbelts	82	78.85		48	13.01
Barriers towards busy roads and railways	7	6.73		8	2.17
Alongside streams and rivers	49	47.12		159	43.09
Forest	46	44.23		266	72.09
			*Around cultivated agricultural land **	3	0.81
			*Between agricultural and pastoral lands **	2	0.54
			Others	11	2.98

Tree species				
Apple (Malus spp.)	81	77.88	307	83.20
Cherry (Prunus avium)	67	64.42	262	71.00
Pear (Pyrus spp.)	61	58.65	196	53.12
Plum (Prunus domestica)	66	63.46	210	56.91
Mulberry (Morus spp.)	20	19.23	15	4.07
Sea buckthorn (Hippophae rhamnoides)	19	18.27	45	12.20
Rowan (Sorbus aucuparia or *Sorbus. intermedia)*	65	62.50	271	73.44
Crataegus spp.	90	86.54	115	31.17
Elder (Sambucus nigra)	94	90.38	231	62.60
Bird cherry (Prunus padus)	39	37.50	179	48.51
Blackthorn (Prunus spinosa)	47	45.19	108	29.27
Chestnut (Castanea sativa or *Castanea crenata)*	55	52.88	171	46.34
Walnut (Juglans regia)	43	41.35	40	10.84
Hazel (Corylus spp.)	65	62.50	239	64.77
Oak (Quercus spp.)	89	85.58	316	85.64
Birch (Betula spp.)	82	78.85	341	92.41
Pine (Pinus sylvestris or *Pinus contorta)*	58	55.77	269	72.90
Spruce/Fir (Picea abies)	79	75.96	295	79.95
Alder (Alnus spp.)	69	66.35	271	73.44
Willow (Salix spp.)	74	71.15	107	29.00
Poplar (Populus spp.)	59	56.73	98	26.56
Beech (Fagus spp.) *	13	12.50	36	9.76
Maple (Acer spp.) *	11	10.58	30	8.13
Ash (Fraxinus spp.) *	10	9.62	37	10.03
Lime (Tilia cordata) *	3	2.88	34	9.21
Larch (Larix decidua) *	2	1.92	15	4.07
Elm (Ulmus spp.) *	2	1.92	21	5.69
Juniper (Juniperus spp.) *	1	0.96	6	1.63
Others	25	24.04	25	6.78

* added categories according to farmers' written replies. Number of count in these categories could be underestimated partly due to the fact that they were not listed in the distributed questionnaire.

Table 4. Attitudes towards different factors of the respondents in Denmark and Sweden

	Denmark			Sweden		
	mean	median	IQR	mean	median	IQR
Production factors						
Crop or pasture production	5.57	6.00	[4.00, 7.00]	5.39	6.00	[4.00, 7.00]
Crop or pasture quality	5.39	6.00	[4.00, 7.00]	5.19	5.00	[4.00, 7.00]
Disease and weed control	5.07	5.00	[4.00, 6.25]	4.75	4.00	[4.00, 6.00]
Animal health and welfare	5.94	6.50	[5.00, 7.00]	5.69	6.00	[5.00, 7.00]
Animal production	5.82	6.00	[5.00, 7.00]	5.47	6.00	[4.00, 7.00]
Losses by predation	4.39	4.00	[4.00, 5.25]	3.71	4.00	[4.00, 4.00]
Timber wood, fruit and nut production	5.39	5.00	[4.00, 7.00]	5.33	5.00	[4.00, 7.00]
Timber wood, fruit and nut quality	5.33	5.00	[4.00, 7.00]	5.05	5.00	[4.00, 6.00]
Energy crop production	5.14	5.00	[4.00, 7.00]	4.59	4.00	[4.00, 5.00]
Diversity of products	5.91	6.00	[5.00, 7.00]	4.94	5.00	[4.00, 6.00]
Administration factors						
Complexity of work	4.72	5.00	[4.00, 6.00]	4.50	4.00	[4.00, 6.00]
Labour	4.39	4.00	[3.00, 6.00]	4.25	4.00	[4.00, 5.00]
Inspection of animals	4.91	5.00	[4.00, 6.00]	4.36	4.00	[4.00, 5.00]
Management costs	4.03	4.00	[3.00, 5.00]	3.92	4.00	[3.00, 5.00]
Mechanisation	4.34	4.00	[4.00, 5.00]	4.14	4.00	[3.00, 5.00]
Originality and interest	5.92	6.00	[5.00, 7.00]	5.14	5.00	[4.00, 6.00]
Environmental factors						
Biodiversity and wildlife habitat	6.52	7.00	[6.00, 7.00]	5.34	5.00	[4.00, 7.00]
Conservation of soil fertility and erosion control	6.11	7.00	[6.00, 7.00]	5.53	6.00	[5.00, 7.00]
Control of fertilizer, noise, and/or odor	5.46	6.00	[4.00, 7.00]	5.00	5.00	[4.00, 6.00]
Reduction of negative environmental impacts, e.g. drought and flood	5.76	6.00	[5.00, 7.00]	5.43	6.00	[4.00, 7.00]

Carbon accumulation in the tree	6.11	7.00	[5.00, 7.00]	5.76	6.00	[5.00, 7.00]
Microclimate moderation	6.03	6.00	[5.00, 7.00]	5.78	6.00	[5.00, 7.00]
Pollination	5.98	6.00	[5.00, 7.00]	5.99	6.00	[5.00, 7.00]
Biocontrol	5.58	6.00	[5.00, 7.00]	5.41	6.00	[4.00, 7.00]
Landscape aesthetics	6.40	7.00	[6.00, 7.00]	6.10	7.00	[5.00, 7.00]
Social-economic factors						
Administrative burden	3.99	4.00	[3.00, 5.00]	3.80	4.00	[3.00, 4.00]
General farmer's image	5.87	6.00	[5.00, 7.00]	5.50	6.00	[5.00, 7.00]
Local food supply	5.49	6.00	[4.00, 7.00]	4.91	4.00	[4.00, 6.00]
Long term market risk	5.06	5.00	[4.00, 6.00]	4.65	4.00	[4.00, 5.00]
Profit	4.63	5.00	[4.00, 6.00]	4.64	5.00	[4.00, 6.00]
Income distribution	4.47	4.00	[4.00, 5.00]	4.93	5.00	[4.00, 6.00]
Inheritance and taxation	4.39	4.00	[4.00, 5.00]	4.37	4.00	[4.00, 5.00]
Subsidy and grant eligibility	4.53	4.00	[4.00, 6.00]	4.67	4.00	[4.00, 5.00]
Regulation	4.18	4.00	[4.00, 5.00]	3.41	4.00	[2.00, 4.00]
Rural employment	4.96	5.00	[4.00, 6.00]	4.88	5.00	[4.00, 6.00]
Opportunity for hunting	5.33	5.00	[4.00, 7.00]	5.07	5.00	[4.00, 6.00]
Tourism	5.15	5.00	[4.00, 6.00]	4.60	4.00	[4.00, 5.00]

Table 5. Demographic background and attitudes of the segmented respondents in Denmark

	Low Level of Tree Involvement [a] n=24 (23.08%)		Medium Level of Tree Involvement [b] n=50 (48.08%)		High Level of Tree Involvement [c] n=30 (28.85%)	
	OR	p-value	OR	p-value	OR	p-value
Gender	2.75	0.031	0.93	0.895	0.33	0.044
	[1.10, 7.04]		[0.30, 2.56]		[0.30, 0.91]	
Age	0.99	0.554	1.04	0.043	0.98	0.213
	[0.96, 1.02]		[1.00, 1.09]		[0.95, 1.01]	
Years of experience	0.98	0.298	1.00	0.880	1.02	0.240
	[0.95, 1.01]		[0.96, 1.03]		[0.99, 1.05]	
Conventional - Organic	3.17	<0.001	1.19	0.143	0.21	<0.001
	[2.17, 6.22]		[0.95, 1.53]		[0.09, 0.35]	
Hectare	1.00	0.106	1.00	0.242	1.01	0.014
	[0.992, 1.00]		[0.992, 1.00]		[1.001, 1.01]	
Total grants	1.09	0.529	0.79	0.215	1.07	0.624
	[0.83, 1.44]		[0.53, 1.11]		[0.81, 1.41]	
Total crops	1.61	0.001	0.68	0.027	0.80	0.088
	[1.25, 2.18]		[0.46, 0.92]		[0.61, 1.02]	
Total livestock	1.76	<0.001	0.91	0.512	0.54	0.002
	[1.31, 2.46]		[0.66, 1.19]		[0.35, 0.76]	
Attitudes						
Production factors						
Crop or pasture production	1.91	0.910	1.31	0.109	0.82	0.121
	[0.79, 1.32]		[0.96, 1.90]		[0.63, 1.05]	
Crop or pasture quality	1.07	0.619	1.18	0.303	0.82	0.159
	[0.82, 1.42]		[0.87, 1.65]		[0.62, 1.08]	
Disease and weed control	1.23	0.130	1.45	0.025	0.59	0.001
	[0.94, 1.64]		[1.06, 2.05]		[0.43, 0.79]	
Animal health and welfare	1.77	0.004	1.46	0.069	0.45	<0.001
	[1.23, 2.67]		[0.997, 2.29]		[0.30, 0.63]	
Animal production	1.51	0.631	1.30	0.176	0.55	0.001
	[1.08, 2.19]		[0.90, 1.94]		[0.39, 0.77]	
Losses by predation	1.14	0.337	1.07	0.644	0.82	0.172
	[0.87, 1.51]		[0.79, 1.46]		[0.62, 1.08]	
Timber wood, fruit and nut production	1.29	0.081	0.92	0.512	0.83	0.193
	[0.97, 1.73]		[0.68, 1.26]		[0.63, 1.10]	
Timber wood, fruit and nut quality	1.35	0.047	1.06	0.716	0.71	0.022
	[1.01, 1.84]		[0.77, 1.47]		[0.52, 0.94]	
Energy crop production	1.25	0.118	1.03	0.822	0.79	0.080
	[0.95, 1.66]		[0.77, 1.40]		[0.59, 1.02]	

Diversity of products	1.57	0.022	1.26	0.255	0.56	0.001
	[1.09, 2.36]		[0.87, 1.94]		[0.38, 0.79]	
Administration factors						
Complexity of work	1.24	0.086	1.39	0.028	0.62	<0.001
	[0.98, 1.59]		[1.05, 1.90]		[0.47, 0.80]	
Labour	1.09	0.479	1.30	0.077	0.74	0.023
	[0.85, 1.41]		[0.98, 1.77]		[0.56, 0.95]	
Inspection of animals	1.28	0.100	1.22	0.239	0.66	0.009
	[0.96, 1.74]		[0.88, 1.71]		[0.47, 0.89]	
Management costs	0.80	0.187	1.60	0.019	0.87	0.403
	[0.57, 1.11]		[1.10, 2.42]		[0.62, 1.20]	
Mechanisation	0.71	0.030	1.72	0.002	0.91	0.545
	[0.51, 0.96]		[1.22, 2.47]		[0.68, 1.22]	
Originality and interest	1.40	0.072	1.26	0.267	0.61	0.007
	[0.99, 2.07]		[0.86, 1.94]		[0.43, 0.86]	
Environmental factors						
Biodiversity and wildlife habitat	1.74	0.065	0.92	0.716	0.71	0.142
	[1.03, 3.37]		[0.59, 1.52]		[0.44, 1.09]	
Conservation of soil fertility and erosion control	1.44	0.069	1.18	0.419	0.64	0.014
	[0.995, 2.19]		[0.81, 1.85]		[0.44, 0.90]	
Control of fertilizer, noise, and/or odor	0.80	0.138	1.88	0.002	0.82	0.181
	[0.59, 1.07]		[1.28, 2.92]		[0.60, 1.10]	
Reduction of negative environmental impacts, e.g. drought and flood	1.11	0.503	1.82	0.008	0.60	0.002
	[0.83, 1.52]		[1.21, 2.94]		[0.43, 0.83]	
Carbon accumulation in the tree	2.15	0.002	1.01	0.963	0.55	0.002
	[1.38, 3.66]		[0.71, 1.50]		[0.37, 0.78]	
Microclimate moderation	1.59	0.024	1.67	0.041	0.45	<0.001
	[1.09, 2.45]		[1.07, 2.90]		[0.29, 0.66]	
Pollination	1.35	0.108	1.35	0.165	0.61	0.006
	[0.95, 1.98]		[0.91, 2.14]		[0.42, 0.85]	
Biocontrol	1.14	0.395	1.50	0.041	0.65	0.009
	[0.84, 1.58]		[1.04, 2.28]		[0.46, 0.89]	
Landscape aesthetics	1.80	0.040	0.77	0.216	0.82	0.332
	[1.09, 3.37]		[0.49, 1.18]		[0.54, 1.23]	
Social-economic factors						
Administrative burden	0.90	0.453	1.55	0.009	0.79	0.096
	[0.69, 1.18]		[1.13, 2.20]		[0.60, 1.04]	
General farmer's image	1.12	0.486	0.86	0.411	1.01	0.967
	[0.81, 1.58]		[0.61, 1.24]		[0.73, 1.40]	
Local food supply	1.32	0.066	1.29	0.138	0.62	0.002

	[0.99, 1.81]		[0.93, 1.84]		[0.45, 0.83]	
Long term market risk	1.04	0.784	1.72	0.005	0.62	0.006
	[0.77, 1.42]		[1.19, 2.56]		[0.43, 0.86]	
Profit	0.84	0.262	1.22	0.251	1.01	0.924
	[0.62, 1.14]		[0.87, 1.75]		[0.75, 1.38]	
Income distribution	0.90	0.559	1.35	0.137	0.88	0.450
	[0.64, 1.27]		[0.92, 2.03]		[0.61, 1.23]	
Inheritance and taxation	0.85	0.353	1.45	0.062	0.87	0.448
	[0.59, 1.19]		[0.99, 2.18]		[0.61, 1.23]	
Subsidy and grant eligibility	0.80	0.085	1.09	0.543	1.17	0.232
	[0.61, 1.03]		[0.82, 1.47]		[0.91, 1.53]	
Regulation	0.86	0.300	1.22	0.239	1.00	0.985
	[0.63, 1.14]		[0.88, 1.73]		[0.75, 1.33]	
Rural employment	1.04	0.808	1.35	0.106	0.75	0.093
	[0.76, 1.43]		[0.94, 1.95]		[0.53, 1.04]	
Opportunity for hunting	0.86	0.280	0.84	0.244	1.38	0.036
	[0.65, 1.13]		[0.61, 1.13]		[1.03, 1.90]	
Tourism	1.30	0.099	1.04	0.865	0.75	0.074
	[0.96, 1.80]		[0.74, 1.45]		[0.55, 1.02]	

[a] center of number of tree formation, tree location, and tree species: 1.75, 4.29, and 6.00
[b] center of number of tree formation, tree location, and tree species: 2.98, 6.62, and 13.18
[c] center of number of tree formation, tree location, and tree species: 3.47, 7.00, and 19.77

Table 6. Demographic background and attitudes of the segmented respondents in southern Sweden

	Low Level of Tree Involvement [a] n=102 (27.64%)		Medium Level of Tree Involvement [b] n=165 (44.72%)		High Level of Tree Involvement [c] n=102 (27.64%)	
	OR	p-value	OR	p-value	OR	p-value
Gender	1.27	0.439	0.68	0.200	1.23	0.515
	[0.68, 2.33]		[0.37, 1.22]		[0.65, 2.27]	
Age	0.99	0.130	1.00	0.824	1.01	0.198
	[0.97, 1.00]		[0.99, 1.01]		[0.99, 1.03]	
Years of experience	0.99	0.314	1.00	0.843	1.01	0.425
	[0.98, 1.01]		[0.99, 1.02]		[0.99, 1.02]	
Conventional - Organic	0.88	0.047	1.04	0.521	1.08	0.193
	[0.77, 0.995]		[0.93, 1.16]		[0.96, 1.22]	
Hectare	1.00	0.427	1.00	0.110	1.002	0.013
	[0.997, 1.00]		[0.997, 1.00]		[1.0005, 1.0037]	
Total grants	0.74	0.004	0.92	0.333	1.47	<0.001
	[0.59, 0.90]		[0.77, 1.09]		[1.21, 1.79]	
Total crops	0.92	0.320	0.96	0.608	1.14	0.116
	[0.77, 1.08]		[0.83, 1.12]		[0.97, 1.34]	
Total livestock	0.60	0.001	1.10	0.416	1.38	0.011
	[0.44, 0.80]		[0.87, 1.38]		[1.08, 1.78]	
Attitudes						
Production factors						
Crop or pasture production	0.82	0.004	1.04	0.578	1.20	0.023
	[0.71, 0.94]		[0.91, 1.18]		[1.03, 1.40]	
Crop or pasture quality	0.79	0.001	1.04	0.577	1.24	0.007
	[0.68, 0.91]		[0.91, 1.18]		[1.07, 1.46]	
Disease and weed control	0.88	0.106	0.98	0.766	1.17	0.049
	[0.76, 1.03]		[0.85, 1.12]		[1.002, 1.38]	
Animal health and welfare	0.76	0.001	1.12	0.151	1.17	0.093
	[0.64, 0.90]		[0.96, 1.31]		[0.98, 1.40]	
Animal production	0.76	0.001	1.13	0.102	1.15	0.104
	[0.64, 0.89]		[0.98, 1.32]		[0.97, 1.37]	
Losses by predation	0.97	0.714	0.95	0.535	1.10	0.289
	[0.82, 1.14]		[0.82, 1.11]		[0.93, 1.30]	
Timber wood, fruit and nut production	0.86	0.063	0.97	0.649	1.23	0.017
	[0.73, 1.01]		[0.83, 1.12]		[1.04, 1.46]	
Timber wood, fruit and nut quality	0.87	0.090	0.95	0.495	1.23	0.014
	[0.73, 1.02]		[0.82, 1.10]		[1.04, 1.46]	
Energy crop production	1.02	0.823	0.98	0.789	1.01	0.943
	[0.85, 1.22]		[0.83, 1.15]		[0.84, 1.21]	

Diversity of products	0.78	0.008	0.89	0.158	1.48	<0.001
	[0.64, 0.93]		[0.76, 1.05]		[1.24, 1.79]	
Administration factors						
Complexity of work	0.82	0.007	0.97	0.695	1.28	0.002
	[0.70, 0.95]		[0.85, 1.11]		[1.10, 1.49]	
Labour	0.76	0.002	1.09	0.270	1.18	0.053
	[0.64, 0.90]		[0.94, 1.26]		[0.999, 1.39]	
Inspection of animals	0.86	0.092	1.07	0.391	1.07	0.452
	[0.73, 1.02]		[0.92, 1.25]		[0.90, 1.27]	
Management costs	0.87	0.088	1.07	0.360	1.06	0.477
	[0.74, 1.02]		[0.93, 1.24]		[0.90, 1.25]	
Mechanisation	0.96	0.572	1.05	0.519	0.99	0.883
	[0.82, 1.11]		[0.91, 1.20]		[0.85, 1.15]	
Originality and interest	0.70	<0.001	0.97	0.673	1.56	<0.001
	[0.59, 0.83]		[0.84, 1.12]		[1.30, 1.88]	
Environmental factors						
Biodiversity and wildlife habitat	0.70	<0.001	1.01	0.934	1.51	<0.001
	[0.59, 0.82]		[0.87, 1.16]		[1.26, 1.82]	
Conservation of soil fertility and erosion control	0.79	0.009	1.07	0.434	1.19	0.073
	[0.66, 0.94]		[0.91, 1.25]		[0.99, 1.44]	
Control of fertilizer, noise, and/or odor	0.82	0.020	1.13	0.117	1.06	0.540
	[0.68, 0.97]		[0.97, 1.33]		[0.89, 1.26]	
Reduction of negative environmental impacts, e.g. drought and flood	0.89	0.139	1.05	0.501	1.07	0.451
	[0.75, 1.04]		[0.91, 1.22]		[0.90, 1.27]	
Carbon accumulation in the tree	0.60	0.002	1.17	0.060	1.11	0.271
	[0.63, 0.90]		[0.995, 1.39]		[0.93, 1.34]	
Microclimate moderation	0.76	0.001	1.17	0.049	1.10	0.280
	[0.65, 0.90]		[1.003, 1.38]		[0.93, 1.33]	
Pollination	0.72	0.002	1.14	0.189	1.21	0.088
	[0.59, 0.89]		[0.94, 1.37]		[0.98, 1.51]	
Biocontrol	0.78	0.002	1.11	0.167	1.15	0.105
	[0.67, 0.91]		[0.96, 1.28]		[0.98, 1.36]	
Landscape aesthetics	0.71	<0.001	1.17	0.089	1.23	0.059
	[0.59, 0.85]		[0.98, 1.40]		[1.00, 1.54]	
Social-economic factors						
Administrative burden	0.99	0.889	1.07	0.330	0.92	0.344
	[0.84, 1.16]		[0.93, 1.24]		[0.79, 1.09]	
General farmer's image	0.79	0.011	1.06	0.469	1.19	0.074
	[0.65, 0.95]		[0.90, 1.26]		[0.99, 1.46]	
Local food supply	0.93	0.359	1.02	0.791	1.05	0.526

	[0.79, 1.09]		[0.88, 1.18]		[0.89, 1.25]	
Long term market risk	0.90	0.229	1.01	0.859	1.10	0.308
	[0.75, 1.07]		[0.86, 1.19]		[0.92, 1.31]	
Profit	0.89	0.106	1.07	0.310	1.04	0.611
	[0.77, 1.03]		[0.94, 1.23]		[0.90, 1.21]	
Income distribution	0.87	0.109	1.00	0.967	1.15	0.114
	[0.73, 1.03]		[0.86, 1.17]		[0.97, 1.37]	
Inheritance and taxation	1.00	0.963	1.13	0.204	0.86	0.171
	[0.81, 1.22]		[0.94, 1.37]		[0.69, 1.06]	
Subsidy and grant eligibility	0.96	0.601	1.16	0.066	0.87	0.127
	[0.80, 1.13]		[0.99, 1.36]		[0.73, 1.04]	
Regulation	1.12	0.138	1.09	0.229	0.79	0.005
	[0.96, 1.31]		[0.95, 1.25]		[0.68, 0.93]	
Rural employment	0.84	0.065	1.01	0.937	1.18	0.075
	[0.70, 1.01]		[0.85, 1.19]		[0.98, 1.42]	
Opportunity for hunting	0.80	0.013	1.11	0.215	1.11	0.249
	[0.67, 0.95]		[0.94, 1.30]		[0.93, 1.33]	
Tourism	0.82	0.030	1.07	0.395	1.12	0.207
	[0.69, 0.98]		[0.91, 1.26]		[0.94, 1.35]	

[a] center of number of tree formation, tree location, and tree species: 3.06, 2.68, and 6.24
[b] center of number of tree formation, tree location, and tree species: 3.42, 3.99, and 11.87
[c] center of number of tree formation, tree location, and tree species: 5.77, 6.00, and 16.64

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