Master's Thesis Internship – master Sustainable Business and Innovation

FOOD FOREST BUSINESS MODELS IN THE NETHERLANDS: CHALLENGES AND OPPORTUNITIES FOR SCALING

Keywords: Agroforestry, Biodiversity-based agriculture, Business model innovation, Food forest, Grassroot initiative, Scaling, Social enterprise, Socio-technical transitions

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ABSTRACT

The global increase in population and its food demand are threatening ecosystems worldwide. Conventional monoculture practices have maximised production on the short term but have resulted in biodiversity loss, pollution, soil degradation, and desertification. Both researchers and politics stress the need for an agroecological transition. Recently, agroforestry has received renewed interest amongst scholars, this form of biodiversity-based agriculture reintroduces trees in agriculture to increase productivity and resiliency to climate changes. In the Netherlands, the food forest, a specific comprehensive type of agroforestry, is receiving increased attention. Food forests are designed multiple layer ecosystems that mimic the natural functioning of a forest and are based on edible perennial plants. Large societal transitions such as the agroecological transition require system changes and niches are increasingly recognized as important seeds for change. Because food forests are a relatively new phenomenon in the Dutch public and scientific landscape, fourteen food forests have been studied and analysed to gain a deeper understanding of these initiatives. A business model perspective is used to create a knowledge structure around food forests and to explore the possibilities and challenges for scaling. Business models are increasingly considered as a key to business success and for its potential to accelerate transitions through non-technological innovation. Four business model archetypes have been discovered, which significantly differ regarding their value proposition and how these values are created, exchanged and captured. The supporting and regulating ecosystem services form the basis of every food forest business model, while especially the provisioning and cultural ecosystem services are what differentiates them. The Recreational, Communal, Experimental, and Productional food forest each faces archetype specific challenges and opportunities for scaling.

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TABLE OF CONTENTS

1. INTRODUCTION

The global population and its food demand are increasing rapidly and may continue to do so for decades (Tilman, Balzer, Hill, & Befort, 2011). This requires more food to be produced, sustainably, from less land, through more efficient use of natural resources and with minimal impact on the environment (Hobbs, 2007). Concerns about conventional agriculture, which is characterized by deforestation, overgrazing, soil degradation, and biodiversity loss (Steinfeld et al., 2006), stress the need for an agroecological transition (Ferguson, & Lovell, 2014). Currently, the agroecological transition is led by two forms of ecological modernisation (Duru, & Therond, 2015). The first, and most dominant pathway is efficiency-substitution agriculture, which aims to improve the input use efficiency while minimizing environmental impact by technological innovation. The second pathway, which is further explored in this study, is biodiversity-based agriculture. It uses nature as technology and aims to develop ecosystem services and food production by enhancing biological diversity.

There exist several types of biodiversity-based agriculture but especially agroforestry has recently received increased scientific and societal interest (Pumariño et al., 2015; Smith, Pearce, & Wolfe, 2013). Agroforestry is the purposeful integration of woody perennials (trees, shrubs, palms, bamboos) and crops, animals or both, to sustain production for increased environmental, economic, and social benefits for all land users (Rigueiro-Rodríguez, McAdam, & Mosquera-Losada, 2008). Despite its tropical connotation, various agroforestry systems have proven to fare well in temperate zones and after a long period of decline, the amount of initiatives are growing again in Europe (Torralba, Fagerholm, Burgess, Moreno, & Plieninger, 2016). Researchers call for more research on agroforestry practices to build an extensive knowledge structure on existing and new types and forms of agroforestry (Den Herder et al., 2017). This is required to communicate existing knowledge, base future policy on, and to discover its opportunities in contributing to the agroecological transition (Mosquera-Losada et al., 2016; Rigueiro-Rodríguez et al., 2008; Torralba et al., 2016).

There is a lack of literature on agroforestry in the Netherlands (Den Herder et al., 2017), where it has largely disappeared from the landscape during the industrialisation of agriculture (Oosterbaan, & Kuiters, 2009). However, recently a new type of agroforestry is emerging, the food forest. Because of successful experiences in the Netherlands, the Dutch national and local governments, together with NGOs and frontrunner initiatives signed the Green Deal on food forests (GD-219, 2017). In this agreement, the involved actors present their ambition for the scaling of food forest initiatives in the Netherlands. In this Green Deal, food forests are defined as highly diverse, designed ecosystems, inspired by the functioning of a 'natural' forest and aimed to produce a high diversity of food products year-round. To achieve the scaling goal, the Green Deal calls for more research on e.g. the value of food forests, business models, legislative barriers, and other challenges.

Societal transitions such as the agroecological transition require large-scale and long-term system changes. Both policy makers and researchers increasingly recognize the importance of social movements in facilitating such transformations (Gernert, Bilali, & Strassner, 2018). Small scale groups or organizations that are built on sustainable movements are called grassroot initiatives (Seyfang, & Smith, 2007). It is a challenge for these initiatives to achieve such a scale that they can make a significant difference on the global level (Wainstein, & Bumpus, 2016). Besides technological innovation, this requires non-technological innovation (Bidmon, & Knab, 2018). Business model innovation is increasingly considered as a key to business success and for its potential to accelerate transitions through non-technological innovation (Bocken, Short, Rana, & Evans, 2014). Business model innovation may help small organisations achieve scale (Wainstein, & Bumpus, 2016), as business model are able to act as a vehicle for new technologies (Bidmon, & Knab, 2018).

The first aim of this study is contributing to the research gap in food forest and agroforestry literature. A business model perspective is used, which is an often-used tool to help understand, analyse, and compare organizations (Osterwalder, Pigneur, & Tucci, 2005). Because food forest initiatives are not expected to be merely homogeneous commercial organizations, the heterogeneous value logics conceptualization of Laasch (2018) is used. This allows to describe how organizations create, deliver and capture all sorts of value, including social and environmental. The first research question is formulated as follows.

1. What are existing food forest business models in the Netherlands?

The second aim of this study is to contribute to the necessary acceleration of the agroecological transition by exploring the possibilities and importance of scaling of Dutch food forest initiatives. Challenges and opportunities for existing and novel business models to act as vehicles for the food forest technology are explored. This leads to the second research question.

2. What are the challenges and opportunities for the scaling of existing business models?

By answering these research questions this study also contributes to the literature on how and through which ways firms bring successful inventions to the market, which is a relatively underexplored field of sustainable innovation (Boons, & Lüdeke-Freund, 2013). A literature review is performed on agroforestry, grassroot initiatives, sustainable business models, and how it is linked to transition theory. A conceptual model is derived to describe and compare different food forest business models in the Netherlands. Data is gathered through participant observation and semi-structured interviews with food forest experts. Because the food forest is a new phenomenon, a phenomenon-driven abductive research approach is used. This will be further elaborated on in the methodology chapter.

2. LITERATURE REVIEW

2.1 AGROFORESTRY BACKGROUND

The Anthropocene is an epoch of environmental and ecological crisis, caused specifically by human activities. WWF's most recent Living Planet Report estimates that 60 percent of life on Earth has disappeared since 1970 (Barret et al., 2018). This rate of biodiversity loss constitutes the sixth major extinction event in the history of life on Earth and it is the first that is specifically human driven (Chapin et al., 2000). The global loss of biodiversity and the devastating effects on ecosystems can be considered as one of the most important threats for human existence (Rockström et al., 2009). Early civilizations such as Easter Island, the Anasazi, Kahoolawe, and the Fertile Crescent have perished because of ecological degradation (Diamond, 1994).

Agroforestry, the age-old agroecological practice of growing crops and trees in interacting combinations, has long been ignored by modern single-commodity-oriented agriculture and science (Rigueiro-Rodríguez et al., 2008). Since 1970 however, agroforestry has gained increased interest when the international scientific community discovered its potential in the tropics. Also, because by then, realisation emerged about the negative effects of the productivist model of agriculture (Duru, & Therond, 2015). In the most recent statement of the UN Convention on Biological Diversity (UNCBD) is called for the creation of diverse agroforestry systems to cope with changing climatic conditions, desertification, and biodiversity loss (CBD-COP14, 2018).

Unlike conventional agriculture and forestry, agroforestry can enhance biodiversity and ecosystem provision whilst benefiting human well-being and agricultural productivity (Torralba et al., 2016). There are endless variations possible in agroforestry systems and scholars have distinguished several categories (Mosquera-Losada et al., 2016). Silvopastoral systems are Europe's predominant form of agroforestry, this practice allows cattle to graze between perennial plants. Other forms are silvoarable systems (the combination of trees with annual plants), forest farming (ranges from mushroom gathering to complex food forest systems), riparian buffer strips (near water bodies), improved fallow (improve barren fields with organic material) and multipurpose trees (Eichhorn et al., 2006; Rigueiro-Rodríguez et al., 2008). These types have in common that it offers the landowner the opportunity to design an integrated high productive land-use system based on the interactive benefits of combining shrubs and trees with crops and/or livestock (Den Herder et al., 2017)

Traditionally, trees served mainly production purposes in the agrarian economy. They were used to produce fodder, fruits, oils, cork, nuts, and wood. Especially in the last century, when there was a drive for increased yields after World War II, trees were separated from agriculture (Duru, & Therond, 2015). Wooded areas impede mechanised agriculture and therefore those areas were ineligible for subsidy schemes for many years. Also, trees were expected to compete for resources, this deleterious effect of trees is however overly simplistic (Eichhorn et al., 2006). Trees benefit shallow rooted plants by intercepting water through condensation of fog and dew, they lift water and nutrients from deeper soil horizons and prevent soil erosion

and evaporation by acting as windbreakers. Trees enhance favourable microclimates, soil quality, and biodiversity, thereby controlling pests and diseases (Torralba et al., 2016).

Also, in the Netherlands silvopasture has long existed as the predominant agroforestry activity. In the 20th century, high stem fruit trees and husbandry was a popular combination. However, since 1970 most of these trees have been replaced with intensively managed low stem trees. These new cultivars were not livestock proof, which resulted in the end of this large-scale practice (Oosterbaan, & Kuiters, 2009). Since the negative effects of conventional agriculture are known, there have been small scale agroforestry experiments in the Netherlands. Several modern agroforestry systems have proven to be compatible with present day agriculture and are able to have a higher productivity over a longer period (Rigueiro-Rodríguez et al., 2008). However, Dutch food forests and other agroforestry systems still only exists as a niche.

A food forest shows resemblance with forest farming, which is mentioned by a few scholars (Rigueiro-Rodríguez et al., 2008). However, in contrary to a food forest, forest farming does not necessarily take place in a designed forest. Because there is no exact definition of a food forest yet in literature and the agroforestry definition is too broad, this study uses the Dutch definition of a food forest, as it is defined in the Green Deal. "A food forest is a human design that is inspired by and considers the normal functioning of a forest. It contains a high biodiversity, of which a part can be used as food for humans. The design consists of a high crown layer of mature trees and at least three other layers/niches of lower trees, shrubs and lower vegetation. The soil is of a rich, high quality and the size of the food forest must be robust" (GD-219, 2017, p. 4). As there are several types and definitions of agroforestry systems that are overlapping (Den Herder et al., 2017), more research is required to create for example a clear inventory of new and existing agroforestry practices (Mosquera-Losada et al., 2016).

2.2 NON-TECHNOLOGICAL INNOVATION

In the past decades, the emerging field of technological innovation, has coevolved with a new research field that focuses on how these ideas can be adopted in society, this is called non-technological innovation (Bidmon, & Knab, 2018). For example, innovations are induced by firm characteristics, regulation, and other societal systems that influence the complex journey of new ideas into products or services (Geels, Hekkert, & Jacobsson, 2008). This non-technological perspective on innovation is described systematically by transition and business model theories (Bidmon, & Knab, 2018). Four frameworks have achieved prominence in transition studies (Markard, Raven, & Truffer, 2012). These include strategic niche management (Kemp, Schot, & Hoogma, 1998), transition management (Rotmans, Kemp, & Van Asselt, 2001), the multi-level perspective on socio-technical transitions (Geels, 2002), and technological innovation systems (Hekkert, Suurs, Negro, Kuhlmann, & Smits, 2007; Jacobsson, & Johnson, 2000).

Business model theory has evolved separately from transition studies for a long time (Geels, 2011), but recently attempts have been made to merge these two perspectives into one framework (Boons, & Lüdeke-Freund, 2013; Wainstein, & Bumpus, 2016). So far, the most progress is made on linking the multi-

level perspective (MLP) framework with business model theory (Bidmon, & Knab, 2018). The MLP framework, first introduced by Geels (2002), has proved to be particularly useful to help understanding a concrete system, such as the agri-food or energy system (Wainstein, & Bumpus, 2016). It explains that niches are crucial for transitions because niche actors do not have to adhere to the wider system logics (Geels, 2011). However, when niches are brought to scale, they often face barriers at different levels (Gernert, et al., 2018). The MLP theory distinguishes three levels, which are illustrated in figure 1. The socio-technical landscape represents the macro-level trends that constitute the drivers and barriers for change. One level below is the social-technical regime, which encompasses the existing dynamics between industry, science, culture, policy, user preferences and technology. The metaphor of a lock-in is often used to describe the situation in which actors depend too much on the existing socio-technical regime. The lowest level is the niche level. Niches are influencing and influenced by these higher levels but work on innovations that deviate from the existing regimes, therewith providing the seeds for systemic change (Geels, 2011).

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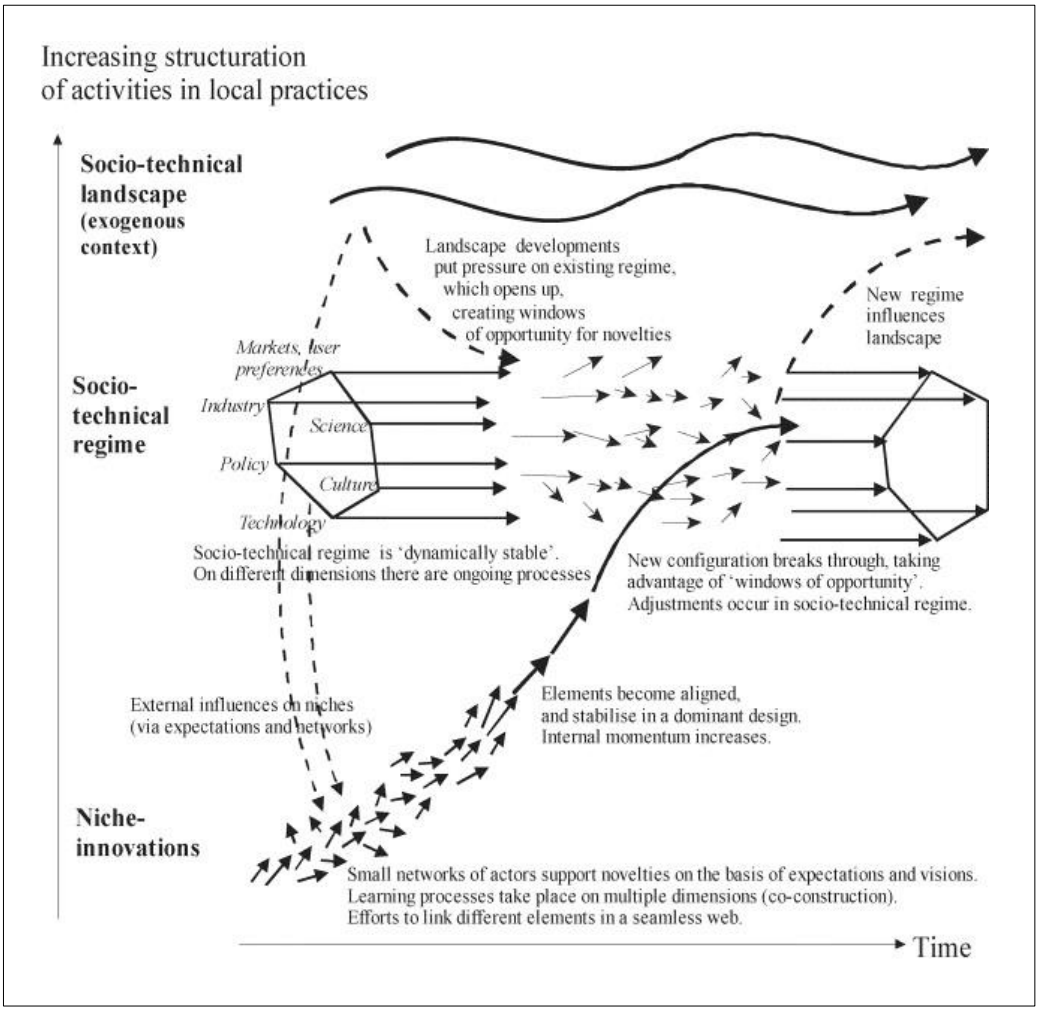

Figure 1. Multi-level perspective on transitions, from Geels and Schot (2007)

2.2.1 The role of business models in societal transitions

Bidmon and Knab (2018) discovered that business models play three roles in societal transitions. Firstly, existing business models hamper transitions because they stabilize the current system. They hold on to an existing technology at the expense of new ones, therewith blocking incoming innovations (Wainstein, & Bumpus, 2016). Secondly, business models also have the potential to drive transitions while intermediating between technological niches and the sociotechnical regime (Bidmon, & Knab, 2018). Business models are highly relevant market devices for new technologies to gain competitive advantage and to facilitate the breakthrough of a technological innovation from niche to regime level (Wainstein, & Bumpus, 2016). Especially this role is of importance for this study and is illustrated in figure 2. The last and third role of business models is less related to a specific technology but to its role in building up a new regime. This non-technological niche innovation can drive transitions without relying on technological innovation (Bidmon, & Knab, 2018).

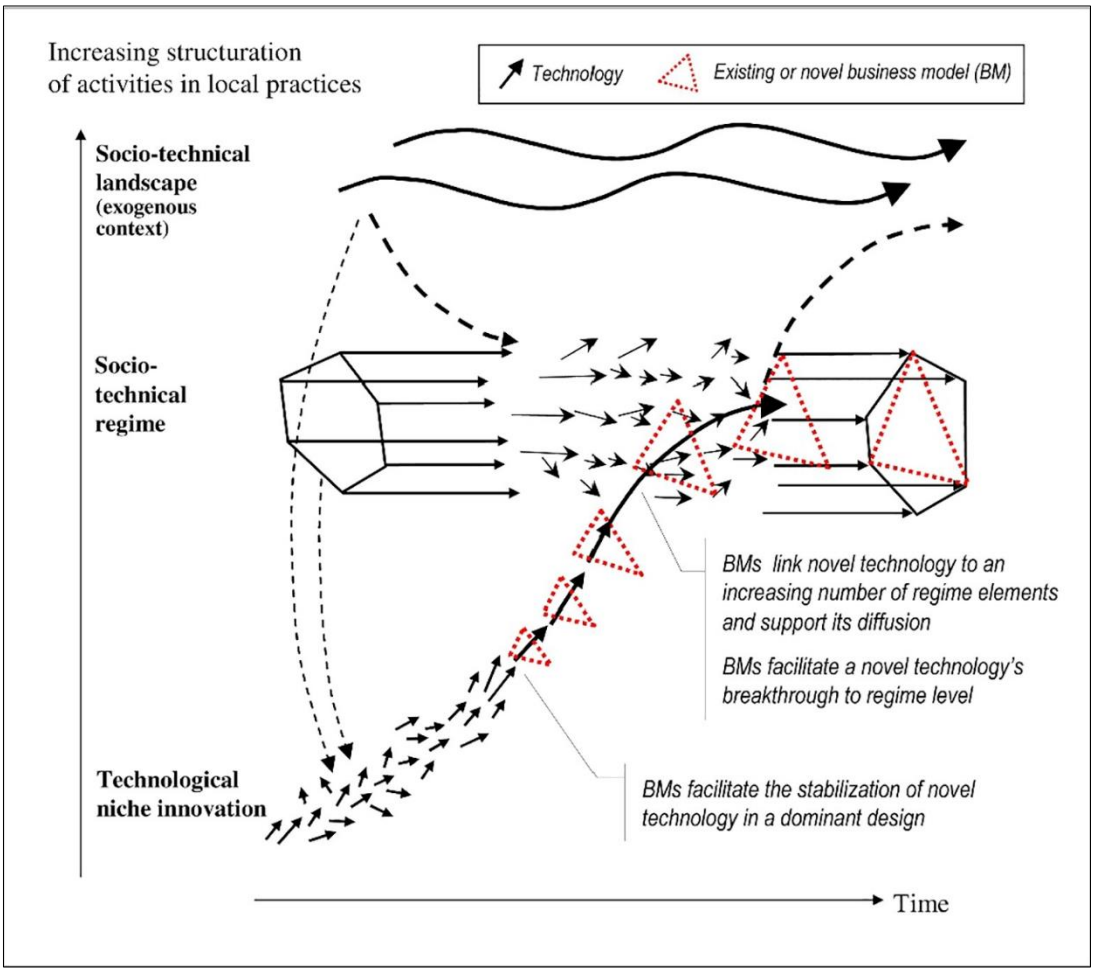

Figure 2. Business models as intermediates between technological niche and socio-technical regime, from Bidmon, and Knab (2018)

2.2.2 Sustainable business models

When two different business models introduce the same innovation to the same customer group, it is possible that one thrives and another withers. This emphasises the relevance of business model research (Wainstein, & Bumpus, 2016). A business model describes how an organization creates and delivers value to its customers, and how it will capture a portion of the value that it delivers (Teece, 2010). It is an often-used conceptual tool to understand, analyse, compare or innovate the business logic of specific firms (Osterwalder et al., 2005). Developed for for-profit organizations, initially business models were used purely commercial. The underlying conceptual structure of organization value logics however, could also be applied to partially commercial or even non-commercial organizations. Therefore Laasch (2018) added institutional logics to the conceptualization of a business model to shape how non-commercial organizations (e.g. religious, governmental, and non-profit) create, propose, exchange, and capture their unique values. Many organizations are not homogeneous in the sense that they are purely commercial. Businesses for sustainability for example, have value logics that are social, environmental and economic (Bocken et al., 2014). Such heterogeneous organizations can be conceptualized through the heterogeneous value logics concept proposed by Laasch (2018).

Proposition (P): What kind of value does the organization offer to whom?

Creation (Cr): How does the organization create value?

Exchange (E): How does the organization exchange value?

Capture (Ca): How is the value created by an organization captured?

2.3 SCALING CHALLENGES AND OPPORTUNITIES

Uncertainty about social gains and market demand, long development times, and the required change at different levels such as infrastructure, organization, technology, and the wider social and institutional context are barriers that every new technology face (Kemp, Schot, & Hoogma, 1998). When niches are brought to scale, they face, besides from these transition barriers, also other scaling challenges such as sector-specific challenges (Bloom, & Chatterji, 2009). This paragraph firstly elaborates on the scaling strategies and challenges for grassroot initiatives. Then, because food forests are understudied, this paragraph provides an overview of the opportunities and challenges found in literature on biodiversity-based agriculture and especially agroforestry. Lastly, opportunities found in literature for novel business models are discussed.

2.3.1 Scaling strategies

André and Pache (2016) mention three strategies for social enterprises to scale their impact. Scaling-up is the process of organizational growth and increasing impact together with revenues. Out-scaling is the process of increasing the organizational impact with the same amount of money. And lastly, scaling-across, focuses on adoption, and diffusion of projects in new settings by other actors (André, & Pache, 2016). This last scaling strategy is of highest potential according to several scholars (Sarkar, & Pansera, 2017). Besides by replication, grassroot initiatives can be scaled across to the next town, region, or country also by translation. Translation is the process of mainstreaming niche ideas by embedding elements into the existing regime (Gernert et al., 2017). The local roots of grassroot initiatives pose a challenge for scaling across (Seyfang, & Smith, 2007). Knowledge is centred around a small group of people and risks not to be shared. It is especially the case if the initiative does not mirror the community's diversity, making it difficult to establish a link with the wider community (Feola, & Nunes, 2014).

Innovations for sustainability often perform poorly compared to mainstream economic activities, which are based in conventional regimes and dominated by market criteria and subsidization. Because grassroot initiatives are less attractive to mainstream investors, innovative strategies are often required. For example, collaborative models such as crowdsourcing, open innovation and peer-to-peer can drive the adoption of business ideas by bringing like-minded investors and firms together (Bocken et al., 2014). Although the failure to replicate social programs is often attributed to management and strategy, it is most of the time a problem of money. Besides financing, the most common obstacles for the scaling of grassroot initiatives are a lack of active members and time (Gernert et al., 2018).

When scaling up, social entrepreneurs must mobilize additional resources that differ from those initially raised to start the venture. Social enterprises must rent new offices, recruit new staff, open new sites, and set up systems to operate from diverse geographical locations (André, & Pache, 2016). In the scaling process, the initiatives risk having to adopt the organizational procedures and forms from which they distanced themselves in the beginning. This requires a robust alternative organizational form. Also, when institutions engage and standardize the upscaling by attracting investments and marketing, they risk decontextualizing them (Gernert et al., 2018).

2.3.2 Biodiversity-based agriculture

Biodiversity-based agriculture introduces a paradigm shift in the objectives and expected performances of agricultural systems and innovations (Caron, Biénabe, & Hainzelin, 2014). It breaks with the productivist agriculture paradigm and re-integrates agriculture in the local social, economic, and ecological rural system (Duru, & Therond, 2015). Although it is a less studied pathway of ecological modernisation than efficiency-substitution based agriculture, some opportunities and challenges can be discovered in literature. The main challenges found on agroforestry are financial and political.

Agriculture and major food companies are slowly becoming more interested in sustainable agriculture (Bishop, Kapila, Hicks, Mitchell, & Vorhies, 2009). However, the high initial costs of agroforestry

projects combined with a lack of predictability of the outcome, still pose a risk for investors. Successful projects are often small and have low revenues, therewith they are not yet convincing enough for the average investor. An exception could be pension funds, for which investing in agroforestry might be attractive, as the physical assets in the form of land and standing timber form a strong backing (Lambooy, & Levashova, 2011).

Ecosystems provide goods and services which are essential for human life, such as clean water and air, food, and medicines. As visualised in figure 3, in the Millennium Ecosystem Assessment (MEA) the ecosystem services are classified into four different categories, the provisioning of goods and products, regulation services, cultural services, and supporting services (Fisher, Turner, & Morling, 2009). The value of this natural capital however, is mostly not incorporated in the economic system. Goods are valued over services, and human made goods and services are valued over the ones provided by nature (Bayon, & Jenkins, 2010). There is a lack of a regulatory framework that rewards positive contributions to ecosystem health (Bishop et al., 2009). To solve these market failures and to effectively incorporate ecosystems' services into corporate decision-making, scholars have discussed and proposed a range of regulatory economic instruments such as taxes, subsidy schemes, tradable permits, and other forms of legislation (Alvarado-Quesada, Hein, & Weikard, 2014; Bayon, & Jenkins, 2010). Thus far however, governments are failing to implement these measures to adequately protect natural areas in its quality and quantity (Guerry et al., 2015).

Besides from a lack of stimulation, the regulatory framework can be obstructing in some cases (Lambooy, & Levashova, 2011). For example, many European national government's prohibited agroforestry systems because their administrative structure only allowed either agriculture or forestry as possible land-use (Rigueiro-Rodríguez et al., 2008). Also, subsidy schemes were and are still being constructed in a way that favours monocultures (Duru, & Therond, 2015). Legislations favouring the incumbent technology is an often-seen barrier in transitions (Jacobsson, & Johnson, 2000). Property rights pose another barrier for conservation practices as they are often not well defined or only for short-term, while agroforestry requires a long-term land use (Bishop et al., 2009; Verweij, & de Man, 2005).

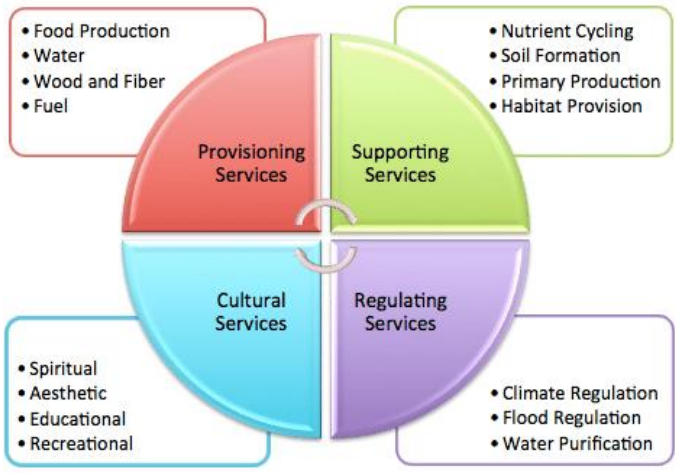

Figure 3. Four ecosystem services with examples, from Millennium Ecosystem Assessment (2005)

2.3.3 Novel business models for biodiversity

There are more and more businesses who do not only support conservation initiatives, but who realize that there are profits to be earned from the restoration of ecosystems (Bishop et al., 2009). Several scholars have studied new business opportunities for biodiversity related business models (Bayon, & Jenkins, 2010) Examples of emerging markets for biodiversity and ecosystem services are ecotourism, sustainable forestry, agroecology, and biodiversity offset credits (Lambooy, & Levashova, 2011; Torralba, et al., 2016). Multinationals for example, are increasingly becoming engaged in sustainability management through these markets (Winn, & Pogutz, 2013).

Market based mechanisms such as certification schemes, eco-labelling, pay-per-ecosystem-service, and biodiversity offsets and credits are intensively studied ways to increase investments in ecosystem management (Bayon, & Jenkins, 2010; Winn, & Pogutz, 2013). Especially this last mechanism has received increased interest from scholars (Alvarado-Quesada et al., 2014; Bishop et al., 2009). A biodiversity credit works almost the same as a carbon credit, it allows companies to outsource nature compensation by buying biodiversity credits or certificates from e.g. private landowners, social enterprises, or biodiversity banks. Generating biodiversity creates biodiversity credits and therewith money for a landowner who for example practices agroforestry. Biodiversity offset markets have a high potential of increasing the market for biodiversity, as it enables any company or individual to compensate for their negative impact by stimulating it elsewhere (Alvarado-Quesada et al., 2014).

It is often stated that market-based mechanisms will not succeed without governance at international, national, and local levels. However, more and more companies are becoming interested in voluntary biodiversity offsets because of the potential reputational benefits (Bishop et al., 2009). Voluntary initiatives are often small but do exist in for example in the carbon market where it was worth $387 million in 2009 (Bayon, & Jenkins, 2010). In the Netherlands no regulated or voluntary biodiversity offset market exists, but it has proven to be successful in for example Australia and Malaysia (Alvarado-Quesada et al., 2014).

3. METHODOLOGY

3.1 CASE SELECTION & RESEARCH DESIGN

The purpose of this study is threefold. Firstly, it helps building a non-technological knowledge structure on Dutch food forests. Secondly, it explores the challenges and opportunities for the scaling of food forests, to accelerate the agroecological transition. Thirdly, it contributes to the understudied field of how firms bring successful inventions to the market, using a business model perspective. Therewith this study contributes to the main goal of the Green Deal C-219 (GDC-219), which is a cooperation between the Dutch national and local governments, facilitating parties such as 'Stichting Voedselbosbouw Nederland' (Dutch Food Forestry Foundation), NGO's, nature and environmental institutions, research organizations, and front runners. A complete overview of the participants can be found in Appendix A. It is an agreement in which the parties acknowledge the multifunctionality and value of food forests. Because of this value, they share the ambition to expand the acreage of agroforestry in the Netherlands. Therewith, removing the segregation between nature and agriculture from ecological, juridical, and social-economical perspective (GDC-219, 2017).

Food forests are a new phenomenon in the Dutch landscape and in scientific literature. When a topic is addressed of which little or no theory exists, a qualitative approach is often used (Edmondson, & McManus, 2007). Qualitative studies can gain significantly more in-depth and extensive understanding of the studied field, compared to qualitative studies (Rowley, 2012). This study used a qualitative abductive approach. When studying novelties through existing theories, there is a risk of missing important details and nuances (Von Krogh, Rossi-Lamastra, & Haefliger, 2012). Abductive research is particularly suitable for discovering emerging phenomena, as it allows the researcher to continuously go back and forth between the data and the theory. Theoretical frameworks, data collection and analysis are worked on and integrated simultaneously. The former theory is then used as technical literature, mainly to conceptualize the studied phenomenon (Dubois, & Gadde, 2002).

Purposeful sampling is used to find existing food forest initiatives and to get in contact with food forest practitioners and experts. The participants of the Green Deal and especially the four frontrunner food forest initiatives formed the starting point for this study. Additional food forest initiatives were found by link tracing sampling and with the help of sources on the internet such as the website of Stichting Voedselbosbouw Nederland. Following Handcock and Gile (2011), link tracing sampling is a convenient method to discover and get in contact with other actors in the concerned sector making use of existing contacts. In total, fourteen of these food forests have been visited and analysed for this study (Appendix B). The time duration of the study project is the main factor determining this amount. In addition, also the respondent rates, agendas, willingness to cooperate, and the availability of contact details influenced the amount and selection of the studied initiatives.

3.2 CONCEPTUAL FRAMEWORK

The heterogeneous value logic, as conceptualized by Laasch (2018), is used to analyse the business models of the fourteen studied food forests in the Netherlands. From this analysis, four typical business model archetypes have been derived. These business model archetypes form the structure for answering the first research question and for parts of the second research question by describing the archetype-specific challenges and opportunities for scaling. The second research question is answered using an abductive approach. The theoretical framework iteratively developed together with the data gathering and analysis. The MLP framework has proven to be useful for understanding the complexity of transitions and the barriers niches face at different levels when scaling. The integrated MLP framework of Bidmon and Knab (2018) shows the role and importance of business models in transitions, linking both research questions.

3.3 DATA COLLECTION

Literature has been reviewed during the entire thesis project. In the beginning, to gain an understanding of the scientific debate on agroforestry and non-technological innovation. Throughout the fieldwork and writing of this thesis, theory of scaling and grassroot initiatives has been reviewed as part of the abductive research approach. Relevant articles were found with the use of online scientific research platforms Google Scholar and Scopus. Also, government documents and websites of the other participants of the Green Deal have been examined. For writing the research proposal, exploratory conversations have been held with Stichting Voedselbosbouw Nederland and with entrepreneurs from food forests Houtrak and Kreilerwoud for inspiration and to validate the relevance of the research direction and their willingness to cooperate.

In total, fourteen food forests have been visited and analysed for this study. Data was gathered in multiple ways, through qualitative interviews, participant observation, and by visiting presentations and tours. Because of the increased public interest in food forests, certain food forests could only be visited with a guided group tour. Also, twice, an expert requested to attend the presentation prior to an interview. When allowed, data was recorded and transcribed accordingly, an overview can be found in Appendix B.

Qualitative interviews have been held with twelve food forest experts to gain a full understanding of the current business models and the challenges, opportunities, and solutions for scaling. Qualitative interviews help to gain insights into opinions, experiences, processes, attitudes, and predictions (Rowley, 2012). To answer the first research question, a semi-structured interview is used, based on Laasch's (2018) business model conceptualization for heterogeneous organizations. The second research question, about the challenges and opportunities for scaling, required a more open interview structure. Because besides the financial and regulation barriers found in literature, only little is known about the food forest sector.

Adding to the interviews, data is gathered through participant observation. In total, this included nine days of volunteering at various initiatives and attending five three-hour meetings of the student-led administration of food forest Droevendaal. Participant observation allows the researcher to actively participate in commonplace situations, therewith acquiring direct access to both the physical observable environment and the human reality with its activities, feelings, experiences, and thoughts (Jorgensen, 2015).

This form of data is often inaccessible for non-participating observers. These observations contributed to building a useful context, such as understanding the functioning of a food forest, the motives and experiences of the volunteers and the administrative challenges of a food forest.

3.4 DATA ANALYSIS

Semi-structured in-depth interviews constitute the empirical backbone of many qualitative studies in social sciences, an often-used way of analysing this data is by coding (Campbell, Quincy, Osserman, & Pedersen, 2013). Coding allows the researcher to structure and analyze language-based data, such as an interview script, by capturing its essence in a summarizing word or short phrase (Saldaña, 2015). There is no clear guidance in literature for establishing reliable coding of in-depth interviews because different conceptualizations of data require different methodological approaches. For this study, the 1st-order/2nd-order coding conceptualization of Gioia, Corley, and Hamilton (2013) is used. This method is becoming increasingly prevalent for its rigorousness and its transparent visualization of the coding process (Laasch, 2018). Appendix C contains an overview of the coding conceptualisation and Appendix D contains a full overview of the coding scheme.

In the 1st-order analysis, little attempts have been made to distill categories. All terms, describing for example the challenges of a social enterprise, are considered as a category. This could easily lead to 50 to 100 1st-order categories after 10 interviews (Gioia et al., 2013). Then, the research is focused on finding similarities and differences between these concepts to reduce the amount to a more manageable number. If new categories of challenges and opportunities were found, new literature research is conducted and adjusted in the theoretical framework. In the 2nd-order analysis is tried to emerge themes and dimensions from the discovered categories and concepts. This forms the basis to structure the data and enables to make a graphic representation of it. This data structure shows the dynamic interrelationships of the concepts, categories, themes, and dimensions. It does not only present an apparent overview, it is also a key component for demonstrating how the raw data is progressed into terms and themes (Gioia et al., 2013). A reader should be able to look at the grounded model and not only understand the dynamic interrelationships, also the thinking progress of the researcher should become clear. This is an important factor for demonstrating reliability in qualitative research (Saldaña, 2015).

4. FINDINGS

In this chapter the findings are presented to contribute to building a knowledge structure around food forests. From a business model perspective, fourteen food forests have been analysed (Table 1) to gain a deeper understanding of this relatively new phenomenon in the Dutch public and scientific landscape. The value proposition of the studied food forests is similar to that of a well-functioning ecosystem. The supporting and regulating ecosystem services form the basis of any food forest while especially the provisioning and cultural ecosystem services are what differentiates them from each other. The partitioning between cultural and provisioning services determine largely how the broad range of ecosystem values are created, exchanged and captured for the organization behind the food forest and its challenges and opportunities for scaling. Based on this partitioning, four business model archetypes have been distinguished. The process of constructing these archetypes is discussed in the next paragraph. Then, each business model archetype is elaborated on, including its specific scaling perspectives. Lastly, archetype transcending challenges and opportunities for scaling are discussed.

Food Forest:	**Archetype:**	**Size (Hectare):**	**Since:**	**Appendix:**
1.Droevendaal	Communal	1	2018	B1
2. Hoogerheide	Productional	2	2018	B2
3. Kreilerwoud	Experimental	1.3	2015	B3
4. Ecovredegaard	Recreational	1	2016	B4
5. Roggebotstaete	Recreational	1	2016	B5
6. Haarzuilens	Communal	5.5	2015	B6
7. Schijndel	Productional	20.25	2018	B7
8. Houtrak	Recreational	6.6	2017	B3 & B7
9. Santackergaard	Communal	0.8	2017	B8
10. NoordOogst	Communal	0.5	2017	B
11. Ketelbroek	Experimental	2.42	2009	B7
12. Weerwoud	Recreational	4	2016	B9
13. De Groene Oase	Recreational	5	2017	B10
14. Den Food Bosch	Communal	1	2017	B

Table 1. Studied food forest initiatives

4.1 FOUR BUSINESS MODEL ARCHETYPES

Whereas the supporting and regulating ecosystem services are mostly the same for each studied food forest, a wide variation is found regarding cultural and provisioning services. Two eminent binary variables have been discovered that significantly influence the value proposition of the studied food forests. Two binary variables offer four possible scenarios, which form the four food forest business model archetypes. This is illustrated in figure 4, where the two variables are placed respectively on a horizontal and vertical axis. This paragraph explains the choice of the two binary variables before elaborating on the four business model archetypes separately.

The first variable is whether the food forest has a romantic or a rational orientation of the plants. This is the most visible difference between the studied food forests and is determined by the plant lay-out and diversity. "There are only three people that know their way around Ketelbroek because we have over 400 plant species spread around the food forest. Then the question arose, how can we scale and rationalize the production while retaining the ecological conditions of a food forest? This led in our jargon to the distinction between a Romantic food forest, in which there is always something to eat, and the Rational food forest, in which there are clear lanes and for example 16 species per hectare" (Van Eck, Appendix B7). In a Rational food forest, the plants are oriented in clear lanes to reduce complexity and to simplify harvesting. Seven of the studied food forests are largely rational arranged for this purpose and therewith focus extra on the production of goods. The other seven food forests have a more Romantic orientation of the plants, allowing for a higher plant diversity and complexity. These Romantic oriented food forests are eminently suitable for cultural services but are less suitable for scalable production.

The second variable with a significant influence on the value proposition of the studied food forest is whether the food forest initiative is located on public or on private land. This public accessibility largely influences the cultural values and costs structure of the studied food forests. "With food forest Haarzuilens we do things that people like to see in a publicly accessible place, therefore we are eligible for financial support and, we do not have to pay for the land. However, when looking at it from a business perspective, it is not suitable for building up a pension because in 25 years the management contract will end" (Degenaar, Appendix, B6). The value proposition of public accessible food forests is focused more on cultural services compared to private food forests. Four of the studied food forests are located on private lands and are therewith less eligible for subsidies and other funding. Their value proposition is shifted more from cultural services towards provisioning services.

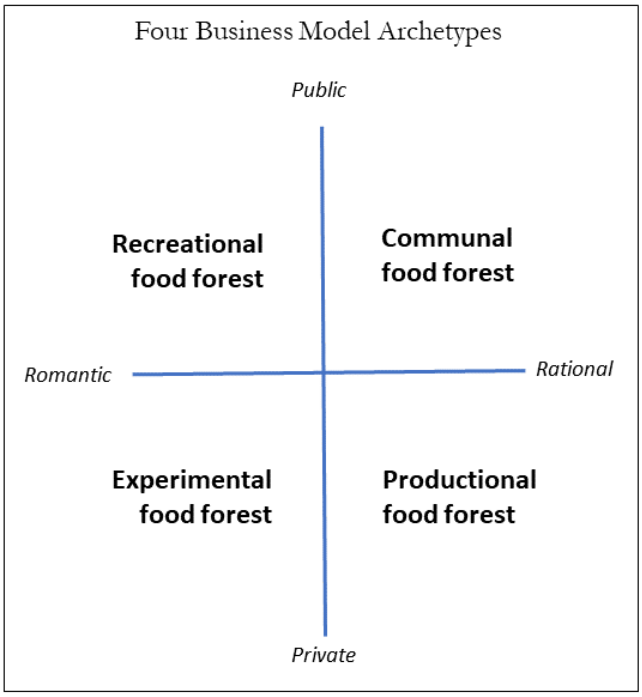

Figure 4. Business model archetypes

4.2 THE RECREATIONAL FOOD FOREST

Five of the studied food forests can be classified as a Recreational food forest (Table 2). Characterised by a high biodiversity and a romantic placement of plants, these food forests are in parks or publicly accessible country estates. Initiators are national food forestry foundations such as Stichting Voedselbosbouw Nederland and Food Forestry Netherlands or locally involved people that created a food forest specific foundation. The value proposition of a Recreational food forest is mainly focused on cultural services, such as recreation, education, local connections, and awareness. The provisioning services are subordinate to the other ecosystem services and are used more as a medium than as a goal. "At the Groene Oase, our main purpose is to create a biodiverse place for people and animals to forage in. We want people to come together, for recreation and education. We are not dependent on food production and are not planning to make any sales" (Den Hartog, Appendix B10). Social values such as awareness creation and the stimulation of the connection between humans, belong to the main values created in a Recreational food forest. "It really pleases me to see how many people hook on to this, all sorts of people join my tours. Left wing and right wing, young and old, it really connects people. Realistically seen is a food forest merely of high cultural value, I do not expect it to become commercially viable" (San Giorgi, Appendix B9).

Costs are kept relatively low for the initiators because the land, and often also the planting material, is provided by the land owner such as local governments or recreational parks. In addition, these initiatives generally receive a management budget. For example, park Lingezegen, in which two of the studied food forests are located, provides 1700 euro per hectare per year for maintenance of e.g. paths and planting material (Van Veluw, Appendix B1). Money is also raised through other subsidies and crowdfunding. "This year we held our third successful crowdfunding, this time to finance the nut trees. Also, I might know someone who wants to dig our pools voluntarily. We are built on local goodwill, otherwise it is financially almost impossible" (Bay, Appendix B10). At food forest De Groene Oase, the volunteers are specialised in raising attention and local involvement before a fundraising. "Before every crowdfunding we do a press release, we make sure we have an article in the local newspaper and we also have been on local television. To get to even more people, we organise information meetings" (Den Hartog, Appendix B10).

The financial dependency on land owners and other sponsors is one of the major challenges of the Recreational food forests. Not only for its existence but also for its functioning. Two initiatives experienced conflicting visions regarding maintenance. "Besides from volunteers, we are mainly dependent on park Lingezegen, as they provide us with the land and planting material. They are checking us regularly, which is why we are removing dead plant material against our will to keep it neat, it would be better to leave it on the ground" (Lenderink, Appendix B4). Whether a food forest should be fully left alone after the planting phase is an ongoing discussion. "We received money for our planting material, under the condition that we leave the forest be. With our current knowledge we would like to interfere to steer and speed up the maturing of the food forest, but we are not allowed to do it" (Stoop, Appendix B5).

The strong reliance on volunteers is an often-mentioned obstacle. "We do not have enough volunteers to help us, and when people come once they leave unfinished projects behind" (Lenderink,

Appendix B4). Not only for current projects but also for future initiatives it could pose a problem according to Kruse. "In cost benefit analysis, it is often taken for granted that volunteers come and plant the forest. In this one-hectare plot there are already more than a thousand hours of work. Imagine the costs if it was not voluntary (Kruse, Appendix B5).

Various opportunities for the scaling of Recreational food forests are proposed. "Every city should have a lead-out area for stressed citizens, like Nijmegen and Arnhem have with park Lingezegen" (Van Veluw, Appendix B1). The studied initiatives show that a dedicated individual or small group can establish a Recreational food forest in a wide variety of places such as parks, living areas, schoolyards, and nature areas. "I think it is a missed opportunity if we do not transform our living space and urban environments to edible ones. For example, small food forests at primary schools have an enormous potential. Such natural areas can be used for physics, chemistry, mathematics, biology, and even cooking lessons" (San Giorgi, Appendix B9).

The Recreational food forest *EcoVredeGaard, Roggebotstaete, Houtrak, Weerwoud, and De Groene oase,*	
Value proposition:	• Prioritizes cultural over provisioning services
Value creation	• Romantic orientation of plants • High biodiversity • Public accessible
Value exchange	• Recreation • Education • Local involvement • Awareness
Value capture	• Free land use • Funding (subsidies, crowdfunding and other sponsoring) • Tours
Scaling challenges	• Dependent on volunteers, willing landowners, subsidies and other forms of local goodwill
Scaling opportunities:	• Suitable for a wide variety of public locations • Easily scalable when there is local goodwill • Low uncertainty

Table 2. Business model of the Recreational food forest and its main challenges and opportunities

4.3 THE COMMUNAL FOOD FOREST

Because of its public accessibility, the Communal food forest shows resemblance with the Recreational food forest. However, the value proposition of the Communal food forest is broader, as it focuses on both cultural and provisioning goals (Table 3). The goals of the Communal food forest are multiple and most evenly grounded in the four ecosystem services. The predominantly clear green lanes could still be considered of high aesthetic value but unveil that the intention of the Communal food forest

is shifted from wild picking to organised picking. Nonetheless, there are often a few spots with a romantic lay-out left in these publicly accessible locations. "The bumps are designed like a park, with over a hundred different species of plants they are enormous hotspots of biodiversity. Ideal to let people taste and experience all possibilities of a food forest but it is less suitable for agriculture. That is why large parts of food forest Haarzuilens are organized rationally. So, we can for example tell unskilled pickers that the second lane hundred meters of berries are ripe for picking. Also, there is a possibility of using machinery in these lanes. This year we started with the first pick-it-yourself subscription for a chef, next year we are planning to start a small-scale pick-it-yourself subscription for the volunteers" (Degenaar, Appendix B6). The more rational and apparent lay-out of the Communal food forest serves the goals better than a purely romantic lay-out. It does not only allow for more scalable and easy picking, it is also more suitable for research. Two of the four Communal food forests are linked to a university. Droevendaal for example, is initiated and managed by WUR (Wageningen University & Research institute) researcher Van Veluw and students. "On land from the WUR, we are building a scientific food forest with the ten-year goal to provide a full diet for ten persons and an annual revenue of 40.000 euros per year on one hectare" (Van Veluw, Appendix B1). The other initiators are similar to the ones found in the Communal food forests and therewith also the inputs such as land and plant material can be acquired similar to the Recreational food forest.

In addition to subsidies and fundraising, Communal food forests can capture value through the sale of products and cultural services. "Besides the sale of food, we are planning to generate revenue for example by offering a school programme. Now we are experimenting with a primary school class that is educated here for 15 days in total. Also, we could provide courses on permaculture, processing of fruit, and pruning. I do not think a full income can be earned from products alone, a substantial part must come from social services" (Van Veluw, Appendix B1). Knowledge can be commercialized through tours, classes and other forms of education. Provisioning services are captured with the sale of raw or processed foods and non-food products such as wood.

The Communal food forest tries to exploit both provisioning and cultural services by community-building. Volunteers, pick-it-yourself subscribers, and entrepreneurs are invited to take part in the development of the food forest. "At Santackergaard, we like to facilitate and involve other people in the project, we have a beekeeper and recently we found someone who wants to cultivate parsnips" (Starink, Appendix B8). The open attitude aimed at stimulation of activity and co-production is a unique characteristic of the Communal food forest. "To reach our goal it is possible that for example ten persons earn 4,000 euros in our food forest. Someone is specialised in giving tours, another grows mushrooms, and another takes care of the chicken tractor. This however raises the question how to evenly share these earnings and who decides what may take place in the food forest" (Van Veluw, Appendix B1).

Especially the initiatives where there are multiple people involved in the design, maintenance and decision making, there are communication and organisational challenges. "The biggest challenge is bringing together all different visions and to prevent that involved people are obstructing each other or doing double work" (Starink, Appendix B8). Not all Communal food forest have difficulties with the organisational

structure and the amount and degree of other people involved differ. Haarzuilens for example, is less complex. "Doing the project with just the two of us saves us quite some problems, as it is easy to make decisions, with multiple persons you may end up in endless meetings and compromises" (Degenaar, Appendix B6).

Similar to the Recreational food forest, the Communal food forest is dependent on volunteers, public land, subsidies, and other funding. However, when a Communal food forest succeeds becoming commercially viable, this dependency will decrease. Especially when food forest entrepreneurs prove to be able to generate a full income out of one or multiple Communal food forests, it will offer high scaling opportunities. So far, however, the food forestry field faces an overall lack of knowledge. "Food forests are hot, everybody screams for data, which is not yet available. Besides financial, also research is required on the other aspects and values that are created in a food forest" (Van Veluw, Appendix B1). Because the studied Communal food forests are economically not dependent on food production, the lack of knowledge can be perceived as a scaling opportunity. Especially for the scientific food forests such as Den Food Bosch and Droevendaal.

The Communal food forest *Droevendaal, Santackergaard, Haarzuilens, Den Food Bosch, and Noordoogst*	
Value proposition:	• Focus on both cultural and provisioning services
Value creation:	• Rational orientation of plants • Sufficient biodiversity • Public accessible
Value exchange:	• Scalable harvesting • (Scientific) Education • Recreation • Local involvement • Awareness
Value capture:	• Sale of o Products (direct, processed, and through pick-it-yourself subscriptions) o Knowledge (Tours, school programmes, and other courses) • Free land use • Funding (subsidies, crowdfunding and other sponsoring)
Scaling challenges:	• Dependent on volunteers, willing landowners, subsidies and other forms of local goodwill • Organisational difficulties
Scaling opportunities:	• Suitable for a wide variety of locations • Easily scalable when there is local goodwill • Could potentially provide a living for food forest entrepreneurs • Demand for more research food forests

Table 3. Business model of the Communal food forest and its main challenges and opportunities

4.4. THE EXPERIMENTAL FOOD FOREST

Experimental food forests are characterized by a romantic design and are located on private agricultural lands and gardens. Started in 2009, Ketelbroek is the oldest studied food forest and probably the first initiative to call itself as such in the Netherlands. Initiator Wouter Van Eck has become a leading expert in the Dutch food forestry field. "From experiences in Kenya I knew that a forest could be made edible. With Ketelbroek we wanted to prove that nature and agriculture are reconcilable. There are mowing grass fields where all birds and insects have disappeared and natural areas where nature is being managed without further thoughts about further social functions such as food production. With Ketelbroek we have shown that a food forest does not need external inputs, no compost, no pesticides, no fertilizers, no water. A forest soil works as a sponge and becomes more fertile every year. The interplay between green energy mining trees and a rich soil life results in a high production. After the planting phase, a food forest is not dependent on human interference, Ketelbroek can easily do without me, but I cannot live without Ketelbroek anymore" (Van Eck, Appendix B7).

Initiators of Experimental food forests are experts or are likely to become experts of their personal food forest. Knowledge is created on new species, varieties, their combinations and interaction with their environment. This knowledge is transferred for example through tours, lectures, courses, and design classes. This offers opportunities to commercially capture this knowledge. "Having my own food forest Kreilerwoud means that I am continuously learning from practical experience and at the same time I have a showcase and location to give my food forest design courses" (Fekkes, Appendix B3). The limited public accessibility restricts cultural services other than education. Recreation, pick-it-yourself, and other community rooted activities do not necessarily take place in the experimental food forest. "If you let unskilled people harvest, you have to be careful with planting a high value lower layer under for example a cherry tree. Also, someone recently told me to keep the species easy and limited to let a pick-it-yourself food forest be successful, this contradicts with what experts say that a successful food forest requires many different species (Fekkes, Appendix B3).

The value proposition of an Experimental food forest is built on both cultural and provisioning services (Table 4). Besides the sharing of knowledge, the production forms an important source of income for the Experimental food forest. "We have an exclusive relationship with a top restaurant, a brewery, and a health food store. Others are jealous because we offer high quality niche products with intense flavours, of which there is high demand. We have organized a fair-trade in a local landscape" (Van Eck, Appendix B7). This is also the case at Kreilerwoud. "I have planted a solid basis of nuts, I believe their yields will provide me a pension in the future" (Fekkes, Appendix B3).

Private lands are less eligible for sponsoring and subsidies, which means high investments are made by the initiators for e.g. planting material and/or land. "I took a significant financial risk by deliberately investing tens of thousands of euros in planting material without being certain of the production. Above that, I planted it on my brother his land, which I can use for 50 percent of the profit. When the production is disappointing or if he wants to step out it will pose an enormous challenge" (Fekkes, Appendix B3).

Besides financial, also time investments are made. "Time is my biggest challenge, planting a food forest is very time consuming" (Fekkes, Appendix B3).

The majority of the fourteen studied food forests have started on formerly degraded land from previous land use. However, especially for the private food forests it is important that all four ecosystem services perform well as soon as possible. Particularly the provisioning services, because Experimental food forests are built on own investments and are more dependent on it than the public food forests. This poses several challenges and uncertainties, especially during the starting phase, when the ecosystems and its services are not yet working optimally. It can take years for a good soil to develop and other supporting services to recover. Young plants are vulnerable for the local microclimate on barren lands, which is characterised by wind, large temperature fluctuations, floods and droughts. The summer of 2018 was one of the warmest and driest in years, this led to starvation of young plants in food forests all over the country. "Especially with these droughts, it is a difficult consideration whether to nurture slow growing trees such as the Chilean pine in my backyard for a few years or to risk planting them in the food forest already to work as quickly as possible to their independence" (Fekkes, Appendix B3).

The initiators of the Experimental food forest are continuously looking for new plant species, varieties, combinations and variations. Often these plants are not native and coming from temperate climate zones from all over the world. Sometimes these plants have been only recently introduced here and therefore do not have a proven record in the Netherlands. The viability, yield, value, and taste of these edible perennial

The Experimental food forest *Ketelbroek and Kreilerwoud*	
Value proposition:	• Focus on both cultural and provisioning services
Value creation:	• Romantic orientation of plants • High biodiversity • Not public accessible
Value exchange:	• Year-round harvesting • Education • Exclusive relationships
Value capture:	• Sale of products and knowledge through e.g. lectures and tours
Scaling challenges:	• Less eligible for subsidies and other forms of funds • High financial and time investments • High uncertainties return on investment • Vulnerable during starting phase
Scaling opportunities:	• Suitable for private landowners • Could provide a living and pension for food forest entrepreneurs • Possibilities for a full diet

Table 4. Business model of the Experimental food forest and its main challenges and opportunities

plants are uncertain and food forest entrepreneurs must rely on information provided by breeders and other sources. "It is unsure how some of the exotic and new species and varieties will do it here. Every location is different because of its soil type, climate, and other local circumstances. I have not been to America to taste them. You have to trust the breeders and other sources such as Plants for a future" (Fekkes, Appendix B2). For these products there are little to no recipes and processing and supply chains are missing.

4.5 THE PRODUCTIONAL FOOD FOREST

A Productional food forest is pre-designed, often with proven plant combinations and focuses purely on large scale production. The initiators are Stichting Voedselbosbouw Nederland and an investor, both convinced of the productional opportunities of a food forest. "I started thinking about a business model when I saw the thesis of Yann Boulestreau, guided by Wouter van Eck he projected that developing nature and long-term profit go hand in hand. However, being convinced is one thing, proving it is the next step. I think Hoogerheide is the first food forest with a business model. The second one is at Schijndel, where a very large food forest will arise" (Van Oorschot, Appendix B2). Schijndel is with 20 hectares ten times the size of Hoogerheide and aims to become the largest food forest of Europe. "We started Schijndel as a pilot to learn from, it is aimed at agricultural production. Ketelbroek is nice, but not suitable for producing volumes. That is why we have clear lanes and 16 to 18 producing species per hectare at Schijndel" (Van Eck, Appendix B7).

A Productional food forests is built on privately owned or leased land. "The largest challenge is land, it is the most expensive factor in these kinds of plans. If farmers want to innovate, they are held back because the first five years there is nothing to be earned. For the long-term however, for a pension fund for example, I believe there is an enormous potential. I try to connect these, by investing my own pension capital in food forest Hoogerheide" (Van Oorschot, Appendix B2). Schijndel is the first food forest on leased land and found a way to bridge the first five years. "We have a 20-year leasing contract, in which the costs of the first five years are spread evenly over the last 15 years. Like other enterprises, first costs are made, then the profits. However, we still have not bargained sufficiently because the chestnut can easily reach the age of 450" (Van Eck, Appendix B7).

The value proposition of a Productional food forest is aimed at provisioning services (Table 5). Hoogerheide and Schijndel both started planting in late 2018 and immediately got in contact with potential customers. "As soon as our plans about 60 different food products in Schijndel had been published, we received a phone call. Vitem, a caterer with 200 locations such as tax offices and hospitals and its headquarters in Schijndel, wanted to take all our future products. I keep saying this, we offer unique products with a unique story, which in our own landscape are simply not being produced enough to meet the demand. An extra benefit of providing through a caterer is that people cannot choose what is on their plate and will be more eager to try new products" (Van Eck, Appendix B7). Also, Hoogerheide has a potential customer

who can introduce new food products to a large variety of people. "I am in contact with a greengrocer who supplies 80 percent of the restaurants in west Noord-Brabant who is very interested. This will grow, as in the beginning we will not be able to supply to everyone" (Van Oorschot, Appendix B2).

The Productional food forests faces several challenges and uncertainties. Firstly, it still depends on volunteers for planting. According to Van Eck however, it can be perceived as a social value and a good opportunity to introduce the concept of a food forest to large groups. "At Schijndel there were days with more than fifty interested volunteers from all over the country, besides from being productive these days were of social value as well" (Van Eck, Appendix B7). The budget of a Productional food forest solely relies on provisioning services and therefore receive the most criticism of the four business model archetypes. Predicting the production is difficult, because of the complexity of food forests there are no trustworthy models for it. "Modelling the production of a food system is like dry swimming. You calculate and make projections in good faith, but a late nightfrost could ruin your apple production and therewith your model. Due to its complexity it is much harder to model a food forest but if you look at walnut production it is slow in the beginning and starts to produce a lot after ten years" (Van Eck, Appendix B7). San Giorgi is not convinced that a full income can be earned from production alone because of three reasons. Natural competition, the required maintenance, and harvesting difficulties threaten the commercial viability.

Firstly, because of natural competition, food is eaten by other animals than humans. "It is an illusion that we can create a system with a low input and a high output. Food forests are fertile and high producing places in which an animal will often be quicker. A striking example is when I planned to visit a food forest in Romania, just before I arrived they told me that the bear had eaten and molested everything and that there was nothing left" (San Giorgi, Appendix B9). In theory, a well-functioning ecosystem controls plagues and pests. However, it remains unclear whenever something is a plague or belongs to the ecosystem. Unwanted animals and plants are perceived differently by the interviewees and their effect on the production remains uncertain and will differ per location.

Secondly, it is uncertain how much maintenance is required in a Productional food forest. Hoogerheide is going to be intensively managed while Schijndel will be let loose after planting. "In total, I think one person can maintain five hectares. Although it still must be proven, we expect that a modal income can be earned from one hectare. So, from my land, two modal incomes can be earned. One for the owner and one for the food forester" (Van Oorschot, Appendix B2). When pruning is done correctly, it increases the yield of for example fruit trees. Van Eck believes that plants do not require pruning to be productive and questions whether the increased yield surpasses the time and energy input required for pruning. San Giorgi disagrees, "There is a reason why people started pruning and using high density low-stem trees, because it yields more than a few large trees. If at all, someone would achieve commercializing a food forest it would require very intensive management. But from my experiences in the Netherlands and abroad, I expect it not to work. It is top sport; those guys lose weight and gain a lot of muscles because they must work very hard day and night. People tend to forget how hard it is working on the land" (San Giorgi, Appendix B9).

Thirdly, how to commercially harvest is still an unsolved problem. "At the moment it begins to be cost effective to mechanically harvest monoculture nuts on at least 20 hectares of land. Imagine the scale you require to commercially harvest in a food forest, you will not make it with 20 hectares, that is why I do not work with commercial food forests. In the Dutch economy and childlabour free society it is simply not achievable, as it requires too many high-skilled hands" (San Giorgi, Appendix B9). Van Eck also points out that harvesting still poses one of the main challenges of the Productional food forest. "How we are going to harvest, is the most frequently asked question and something we do not have an answer for yet. In our rational set-up, we have for example 200 meters of aronia berries. Boxes and wheelbarrows will ease the harvest in these lanes. However, it is also a task for the Technical Universities to develop robotics to harvest on this scale in the future" (Van Eck, Appendix B7).

The Productional food forest *Hoogerheide and Schijndel*	
Value proposition:	• Prioritizes provisioning services over cultural services
Value creation:	• Rational orientation of plants • Sufficient biodiversity • Not public accessible
Value exchange:	• Scalable harvesting • Education • Exclusive relationships
Value capture:	• Sale of products and knowledge through e.g. lectures and tours
Scaling challenges:	• Dependent on volunteers for planting • Less eligible for subsidies and other forms of funds • High investments • High uncertainties return on investment and commercial viability • Vulnerable during starting phase
Scaling opportunities:	• Allows for unskilled harvesters • Suitable for private landowners • Could provide a living and pension for food forest entrepreneurs • Easily scalable when it proves to be economically viable

Table 5. Business model of the Productional food forest and its main challenges and opportunities

4.6 TRANSCENDING BUSINESS MODELS

In the previous paragraphs, the business models of the studied food forests are compared based on the provisioning and cultural services that make up their value proposition and how these values are captured by the initiatives. However, food forests have a substantial part of their business models in common. The supporting and regulating services are mostly the same for the food forest initiatives, as they automatically develop together with the maturing of the food forest ecosystems. In this way, they are captured indirectly by all food forest initiatives because they are necessary for and stimulate the provisioning and cultural

services. However, regulating and supporting services do not only enhance the food forest ecosystem itself, they extend beyond the boundaries of the food forest initiatives. This offers possibilities to capture these values also directly. Successful examples of capturing values in an additional way are the voluntary carbon market and to a lesser extent, the subsidies and funds for water management and biodiversity creation.

In a food forest, carbon is captured in the form of timber, roots and other sources of organic soil matter such as leaves and twigs (Van Eck, Appendix B7). Besides local soil improvement, the carbon sequestration has a global impact by reducing the carbon in the atmosphere. So far, three food forests have found a way to commercially capture this carbon. The planting material of food forests Houtrak and Droevendaal are sponsored by energy company Greenchoice. "Our plant material is sponsored by Greenchoice. It is an energy company that finances and stimulate projects that support a sustainable lifestyle. We receive a total of €60.000 over four years to invest in 1 hectare" (Van Veluw, Appendix B1). The voluntary carbon market offers an enormous scaling opportunity, "Greenchoice is a very interesting partner, they improve their imago by planting trees to compensate for their grey electricity. That is a win-win situation." (Fekkes, Appendix B3). Also, food forest Haarzuilens' planting material is sponsored for its carbon sequestering capabilities. "Together with the foundation Vriendschapsband Utrecht-Leon we set up a crowdfunding. We presented food forest Haarzuilens as a sister forest of the climate-forest in Nicaragua, which was already financed through that foundation" (Degenaar, Appendix B6). Van Veluw has another idea to make use of a voluntary carbon market at food forest Droevendaal, "The WUR has 6000 employees who are traveling regularly by plane. If they can compensate their flight by buying trees for Droevendaal we will very soon require more than our current hectare. A tree fixes carbon, however you must make sure that the carbon is not released back into the atmosphere. The wood should not be burned but has to remain in the soil or for example used as building material" (Van Veluw, Appendix B1).

It offers both a challenge and an opportunity for food forest initiatives to commercialise also the other regulating and supporting services. "The ecological value for the agricultural fields surrounding us, is often underestimated. Maize is wind pollinated but imagine there were beans cultivated here, our bees would be of inestimable value. It is however difficult to put a price on that" (Starink, Appendix B8). Besides funds and subsidies for water management and biodiversity stimulation, no market exists for these services yet in the Netherlands. For example, the existence of biodiversity banks and credits in other countries is relatively unknown. "The biodiversity credit is a good idea, I did not know of its existence" (Van Veluw, Appendix B1). Van Oorschot adds a critical note, "In general you do not improve the situation with these markets. Polluting actors just buy off a small part of their pollution. I want to get rid of that mechanism. For example, the carbon market sounds nice, but the polluters keep polluting. In the end we need regulations to prevent pollution. The state must invest or force polluting companies to put money into a green investment organization or bank that stimulates biodiversity" (Van Oorschot, Appendix B2). Government facilitated or regulated markets for ecosystem services are an enormous opportunity for the scaling of food forest initiatives. The next paragraph elaborates further on the governmental role.

4.7 POLICY

Governmental logics provide both opportunities and challenges for the scaling of food forests. "Lots is possible when governments are creative and have the courage to start new projects, Brabant is such a progressive province. It has made 400 million euros available to develop 10.000 hectares of new nature" (Van Oorschot, Appendix B2). Especially the public food forests but also the private food forests such as Schijndel depend strongly on the availability of subsidies and public land. Governments therewith play an important role in the scaling of food forests. Besides potentially stimulating, policy is also mentioned by the interviewees as obstructing. Local governments react slow and not proactive (Degenaar, Appendix B6). Destination plans often do not allow building a barn for equipment or require high detailed blueprints. "We were not allowed to build a barn, when we asked for a barn on wheels it got approved" (Lenderink, Appendix B4). Besides obstructing, rules and legislation can be time consuming. "For some species it is difficult to find biological exemplars. Getting exemption for those is a long bureaucratic process" (Van Veluw, Appendix B1).

Since the approval of the GD-219, when food forestry has officially been classified as a type of agriculture, several legislation barriers have been taken away. "Food forestry is nowadays recognized as a form of agriculture; therefore, I am not concerned with rules and legislation regarding destination plans" (Van Oorschot, Appendix B2). However, short term leasing contracts are still the standard and the future destination of the land is often not determined. Threatening the continuity and safety of food forests. "I can plant philosophically my whole land full of trees. If one generation later my son or daughter decides to switch back to agriculture and cultivate potatoes because it earns more, all effort has been for nothing. (Kruse, Appendix B5).

4.8 DESIGN

Most of the food forests are not fully pre-designed and develop together with the growth of the food forest. Allowing for experiments and adjustments. "You start with trees and shrubs, as they start growing we are slowly developing the undergrowth layer" (Degenaar, Appendix B6). Several interviewees mentioned that the design is one of the most challenging aspects of a food forest. With more than 400 edible plants, possibilities for domesticated animals, and non-food products such as wood, there are endless opportunities. Because of this complexity, often the design develops over time. "First, I had the idea to design the whole hectare, make a plan and buy the plants and plant them and finish and let them grow. But it was too difficult, there are so many options to think about. So, we first started with the design method of mister Jake who wrote the book edible food gardens. What is the weakest point of the location and start from there. We observed that those oak trees are stunted, they are 40 years old and I observed that they would have grown more if they did not face limitations. These walnuts here are 20 years old and are also very small, unhappy because of a high-water level during winter" (Van Veluw, Appendix B1). There are aspects that best included directly in the plans, such as the water level. "Choose for a good design, include the most important aspects of a food forest. For example, if you cut down on proper groundwork, you will have to compensate for that

later" (Fekkes, Appendix B3). When there is a high-water level during winter, a large part of the roots of trees such as the walnut die. During summer these shallow rooted plants are sensitive to droughts and are limited in their growth. Therefore, it is important to do measurements and take the water level into account in the design. The water level can be influenced with ditches, pools, and drainage systems. "Digging ditches can lower the water table significantly in winter. At food forest Droevendaal we have proven scientifically that we lowered the water table during winter from 40 cm to 75 cm below surface level. The mole walks that lead into the ditch helped draining the rainwater" (Van Veluw, Appendix B1).

5. DISCUSSION

Food forests form unique and complex systems, which require further research from various other disciplines and perspectives. For this study, the heterogeneous value logic is used as a conceptual framework to help understanding the business models of a wide variety of food forest initiatives. This business model perspective has proven to be useful for analysing a broad range of organisations, ranging from for-profit to non-profit. To be able to compare the fourteen different business models of the studied initiatives, the business model archetypes have been created. It allows for an easier comparison and description because it provides clarity and it improves the communication. However, when compartmentalizing, it is inevitable that the business models are generalized, and details get lost. Nevertheless, four entirely different business models have been found, showing that the same invention can be brought in various ways to the market. Each business model archetype is a vehicle for the food forest technology with its own challenges and opportunities for accelerating the agroecological transition.

The studied food forests show that a dedicated individual or small group can establish a food forest. The Recreational food forests can easily be scaled-across through replication. However, because food production is limited, its role in the agroecological transition is mainly translational. It can mainstream food forest niche ideas by introducing it to a broad public. The Communal food forests offers opportunities for both scaling-up and scaling-across. Although it experiences more challenges on the organizational level, it can be scaled across almost similar to the Recreational food forest. In addition, its provisional goals and scalable concept allow for scaling-up, especially when it succeeds producing sufficient quantities it could have a more direct impact on the agroecological transition. Because of high land prices, it is significantly more difficult to scale the Experimental food forest. Also, because the concept requires high skilled initiators and harvesters. However, with the scaling strategy of out-scaling, the initiators can increase their impact by sharing knowledge. Lastly, the Productional food forest is designed for scaling-up and scaling-across. Despite its many challenges and uncertainties, it may have an enormous impact on the agroecological transition if it succeeds in proving its business model.

Food forest initiatives act as local open-laboratories, experimenting with new ways of food production and distribution. Further research is required on the role of food forests in the agroecological transition. For example, for its possibilities for offering a complete and healthy year-round diet. Lots of uncertainties remain on the niche level, for example regarding pests and plagues, designs, harvesting methods, yields, and required maintenance, which are all influencing the economic viability of food forests. The increasing demand for food forests and its products asks for more research on existing and novel business models and on their potential role as intermediates between the food forest niche and the socio-technical regime. New recipes, ways of processing, and supply chains may help to reach consumers and meet user preferences. Also, further research could focus on education programmes that are centred around the food forest. It is suitable for studying several disciplines such as physics, chemistry, biology, mathematics, philosophy, and cooking. Lastly, this study can be repeated using a different sample size. A

smaller scope allows for a more detailed description of the studied food forests and their business models. A larger, potentially international, scale allows for a quantitative analysis and could provide insights into the global agroecological transition.

This study contains several limitations. As described in the beginning of this paragraph, dividing initiatives into a business model archetype deprives their unique characteristics. For the studied food forests, the two variables that make up the archetype framework are largely binary, therewith allowing a clear distinction between the initiatives. However, especially the horizontal variable is not strictly binary. It is for example possible that an initiative exists which is designed half rationally and half romantic. Also, it is imaginable that another, more important, variable is missed or becomes more eminent in the future. It implies that the proposed business model archetypes are not static and should be revised if necessary in future research.

Another limitation is the replicability of this study. No interview has been the same because of the abductive approach and especially because of the largely open character of the interviews. However, the open interview style contributed to collecting a wide range of information from experts with different expertise, increasing the validity of the data. Recording and transcribing the interviews, tours and presentation strengthen the reliability of the research. However, the coding framework is based on interpretation and language and cultural differences pose limitations. The interviews were mostly held in Dutch, but the coding framework and quotes were translated to English, allowing for interpretation and mistakes.

6. CONCLUSION

The agroecological transition is led by two forms of ecological modernisation, of which biodiversity-based agriculture is the less studied pathway. Especially on food forests, which can be considered as the most complex form of agroforestry, a research gap exists. This study contributed to both the research gap and the agroecological transition by creating a non-technological knowledge structure on food forests and by exploring possibilities for non-technological innovation. A business model perspective is used because of two reasons. For its ability to help understand, analyse and compare organizations, and for its proven role in societal transitions. Business models have the potential to act as a vehicle for niche ideas to achieve scale and therewith accelerate transitions.

To answer the first research question, the business models of fourteen food forest have been analysed and compared. The four ecosystem services, as classified by the Millennium Ecosystem Assessment, have proven to be useful for describing the heterogeneous value logics that constitute the business models of the food forest initiatives. Whereas the value proposition regarding supporting and regulating ecosystem services are mostly the same for each studied food forest, a wide variation is found regarding cultural and provisioning services. Two binary variables have been discovered that explain the different value logics of the studied grassroot initiatives. Based on these variables, four business model archetypes have been constructed, each with its own scaling challenges and opportunities.

A Recreational food forest prioritizes cultural services over provisional. Located on public land and financed with public goods, its focus is on recreation, education, and connections between humans and nature. Because there are no uncertainties regarding production, it only requires local and governmental will to scale this business model. The Communal food forest is largely similar to the Recreational food forest, but its focus is on both provisioning and cultural services. The rational lanes allow for pick-it-yourself subscriptions and research on scalable production. The productional goals require a more complex and challenging organisation structure but could potentially offer scaling opportunities if food forest entrepreneurs succeed in creating an income out of these public food forests.

The Experimental food forest is located on private land, resulting in a less diverse cultural value proposition. Besides production, which is seen as a pension investment by the initiators, knowledge is among the main values created in the Experimental food forest. The expert initiators can commercialize their knowledge through e.g. lectures, seminars, tours, and consultancy. High costs for planting material and land and uncertainties regarding the production and viability of food forest belong to the main obstacles for the scaling of Experimental food forests. This is also the case for the Productional food forest, which solely depends on provisional services. Built on trust in certain plant combinations and on the viability of a well-functioning food forest, the Productional food forest is an attempt to find a rational scalable concept that still adheres to the core conditions of a food forest. The uncertainties regarding harvesting, plagues and production, and short-term land leasing contracts pose major obstacles for the Productional food forest.

However, when its business model is proven, it may have an enormous impact on the agroecological transition.

Besides from archetype specific, also archetype transcending challenges and opportunities for scaling have been discovered. At the niche level, each food forest requires a comprehensive design that considers the goals and local circumstances of an initiative. Between the niche and regime level, there are opportunities for novel business models to act as a vehicle for the food forest concept. E.g. related to new school programmes, supply chains, recipes, community-based projects, and the commercializing of regulating and supporting services. The value of carbon sequestration is successfully captured by three food forests through a voluntary carbon market. Also, pollination, biodiversity, and water management are values that potentially could be commercialized because their effects extend beyond the boundaries of a food forest. It is an opportunity for policy to stimulate such markets and to take away the legislative obstacles. Also, by allowing required proceedings, such as groundwork, and exploring long-term land leasing contracts. Most of the studied initiatives exist, because they are supported by local governments with land and/or financial resources. Besides from the government, also universities have proven its ability to act as a catalyst for the food forest niche. By doing research on this complex new phenomenon and by establishing open-source food forest initiatives.

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APPENDIX A. ACTORS INVOLVED IN GREEN DEAL C-219

Dutch Government (Rijksoverheid)

1. De Minister van Economische Zaken en Klimaat, de heer Eric Wiebes, hierna te noemen: EZK;
2. De Staatssecretaris van Infrastructuur en Waterstaat, mevrouw S. van Veldhoven;
3. De Minister van Landbouw, Natuur en Voedselkwaliteit, mevrouw Carola Schouten,

Regional governments (Provincies)

4. Provincie Limburg, te dezen vertegenwoordigd door de heer H.J.H. Mackus;
5. Provincie Flevoland, te dezen vertegenwoordigd door de heer A. Meijer;

Facilitating parties (Faciliterende Partijen)

6. Stichting Voedselbosbouw Nederland, te dezen vertegenwoordigd door de heer F. de Waard;
7. Stichting Voedselbossen Noord Nederland, te dezen vertegenwoordigd door mevrouw A. Limareva;
8. Stichting Both ENDS, te dezen vertegenwoordigd door mevrouw D. Hirsch;
9. Stichting The Tipping Point, te dezen vertegenwoordigd door de heer T. van de Beek
10. Natuur- en Milieu Federaties Nederland, te dezen vertegenwoordigd door mevrouw A. van de Pas;

Research parties (Onderzoekspartijen)

11. Staatsbosbeheer, te dezen vertegenwoordigd door de heer S. Thijsen;
12. Waterschap Limburg, te dezen vertegenwoordigd door de heer P. F.C.W. van der Broeck;
13. Waterschap De Dommel, te dezen vertegenwoordigd door de heer J.L.J. Hendriks;
14. Nederlands Instituut voor Ecologie (NIOO-KNAW), te deze vertegenwoordigd door mevrouw L. E.M. Vet, hierna te noemen: NIOO;
15. Wageningen University, (instituut Environmental Research), te dezen vertegenwoordigd door de heer J.A. de Vos;
16. Stichting Louis Bolk Instituut, te dezen vertegenwoordigd door de heer J.W. Erisman;
17. Stichting Van Hall Larenstein, te dezen vertegenwoordigd door P.C.A. van Dongen;
Partijen 11 tot en met 17 hierna samen te noemen: Onderzoekspartijen.

Frontrunners/ social enterprises (Koplopers)

18. Boerenbedrijf Ketelbroek, te dezen vertegenwoordigd door de heer W. van Eck;
19. Landgoed Welna B.V., te dezen vertegenwoordigd door F. Gorter;
20. Stichting Roggebotstaete Landgoed, te dezen vertegenwoordigd door mevrouw Y. de Rijcke;
21. Landgoed Bleijendijk V.O.F., te dezen vertegenwoordigd door de heer K.J. Kooistra;

Food Forest:	Archetype:	Size (Hectare)	Interviews (persons)	Days of volunteering	Group tours	Appendix:
1.Droevendaal	Communal	1	1	0	1	B1
2. Hoogerheide	Productional	2	1	1	0	B2
3. Kreilerwoud	Experimental	1.3	1	1	0	B3
4. Ecovredegaard	Recreational	1	1	1	0	B4
5. Roggebotstaete	Recreational	1	2	0	1	B5
6. Haarzuilens	Communal	5.5	1	0	0	B6
7. Schijndel	Productional	20.25	1	0	1	B7
8. Houtrak	Recreational	6.6	2	2	0	B3 & B7
9. Santackergaard	Communal	0.8	1	1	0	B8
10. NoordOogst	Experimental	0.5	0	1	0	-
11. Ketelbroek	Experimental	2.42	1	0	1	B7
12. Weerwoud	Recreational	4	1	1	1	B9
13. De Groene Oase	Recreational	5	2	1	0	B10
14. Den Food Bosch	Communal	1	0	0	1	-
Total:		52.4	12 (15-3 double)	9	6	

Table 6. Overview of data collection per food forest